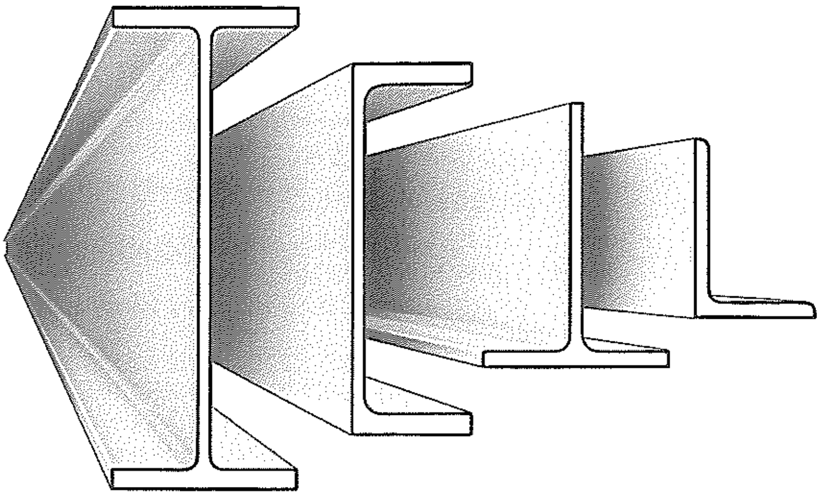
AISC

design capacity tables for structural steel

– second edition –



Volume 1: Open Sections

WB, WC – Grade 300/400

UB, UC, BT, CT, PFC – Grade 300

TFB, TFC – Grade 250

EA#, UA# – Grade 300/250

Grade for angles is dependent on section

AUSTRALIAN INSTITUTE OF STEEL CONSTRUCTION
A.C.N. 000 973 839

LIMIT STATES EDITION TO AS 4100-1990 $S^* \leq \phi R_u$

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DESIGN CAPACITY TABLES FOR STRUCTURAL STEEL

second edition

Volume 1: Open Sections

TABLE OF CONTENTS

Foreword

The Australian Institute of Steel Construction (AISC) was formed in 1962 to serve the interests of all concerned in the design, specification, fabrication, and erection of steel structures.

Today, the AISC is a national body whose purpose is to promote and optimise the use of fabricated structural steel through engineering, research, and the dissemination of knowledge to specifiers, fabricators, suppliers, and students.

Its activities are directed towards fostering the economic and efficient use of steel in buildings, bridges, civil engineering projects, pressure vessels, pipelines, marine and offshore structures, and other fabricated forms.

The Institute is a non-profit organisation which is primarily financed by membership dues.

Engineers, architects and others interested in steel construction are invited to make use of the Institute's services.

Acknowledgments

In the compilation of the *Design Capacity Tables for Structural Steel* - Second Edition, Volume 1, AISC acknowledges with grateful thanks the contribution and assistance of the following organisations and individuals:

- Mr Tim Wilkinson for the preparation of the majority of the tables and text;
- AISC - Technical Services, in particular Mr Arun Syam and Mr Bruce Chapman;
- Palmer Tube Mills (Aust) Pty Ltd, in particular Mr Russell Watkins for the production of the design curves;
- Staff from BHP Research, Melbourne Laboratories, who prepared much of the text and tables in the first edition of this publication, for their advice on this edition;
- Mr Tony Edwards (Redmark Pty Ltd) for the production and artwork in this publication;
- and all those who gave constructive comment and advice on the technical and editorial content of the document.

Preface

The second edition of the *Design Capacity Tables for Structural Steel* (DCT) is a design aid to the limit states Standard *AS 4100-1990: Steel Structures*, published by Standards Australia.

The first edition of the DCT considered standard hot-rolled sections (Grades 250 and 350), welded sections (Grades 300 and 400) and structural steel hollow sections. Due to this large and varying range of sections it was decided to split the future editions of the DCT into volumes. This permits information specific to hot-rolled and welded sections, and hollow sections to be considered separately, without producing a large single publication. In fact, prior to the publication of the second edition of the DCT, the *Design Capacity Tables for Structural Steel Hollow Sections* (DCTHS) was published by AISC. The DCTHS contains information specific to hollow sections in a format similar to the DCT.

The second edition of the DCT is an update of the first edition. At the time of publication, the second edition incorporates the current range of standard hot-rolled and welded structural steel sections. The first volume of the second edition is subtitled *Volume 1: Open Sections* to reflect the section types considered. (The second edition of the DCTHS will be published as *Volume 2: Hollow Sections*).

This volume provides information in a similar format to that contained in the first edition of the DCT with revisions which consider the:

- change of the base steel grade from Grade 250 to Grade 300 for most hot-rolled sections
- introduction of new Universal Beam sections ("Lean Beams")
- deletion of Universal Bearing Piles and the larger Universal Beam and Universal Column sections
- minor dimensional changes to some Universal Beam, Universal Column and Angle sections
- transfer of structural steel hollow sections into a separate volume
- incorporation of Amendments 1 and 2 to AS 4100.

Additionally, comments received from industry have suggested improved methods of listing the information contained in the first edition of the DCT. The suggestions adopted in this edition include:

- renumbering of parts to match, as far as possible, the sections of AS 4100
- restructuring of specific tables (e.g. surface areas, bending) to provide a concise set of information in one table
- section capacities included in member capacity tables
- graphs of members in bending and compression presented in an easier to read format
- a set of tables including all section capacities and capacity information for combined actions.

For information on structural steel hollow sections, and Grade 350 or Grade 250 hot-rolled sections not included in this publication, reference should be made to the DCTHS and the first edition of the DCT respectively.

Arun Syam / Tim Wilkinson
Editors
1994

NOTATION

A_e	effective area of a cross-section
A_c	minor diameter area of a bolt
A_g	gross area of a cross-section
A_n	net area of a cross-section
A_o	plain shank area of a bolt
A_s	tensile stress area of a bolt
b_b, b_{bf}	bearing widths
b_f	width of a flange
b_s	stiff bearing length
b_1 , b_2	greater and lesser leg lengths of an angle section
c_m	factor for unequal moments
d	depth of a section
d_w	depth of web
d_1	clear depth between flanges ignoring fillets or welds
E	Young's modulus of elasticity
e	eccentricity
f_u	tensile strength used in design
f_{uf}	minimum tensile strength of a bolt
f_{up}	tensile strength of a ply
f_y	yield stress used in design
f^*_{va}	average design shear stress in a web
f^*_{vm}	maximum design shear stress in a web
G	shear modulus of elasticity; or nominal dead load
h_s	storey height
I	second moment of area of a cross-section
I_n	I about the (non-principal rectangular) n-axis (for angles)
I_p	I about the (non-principal rectangular) p-axis (for angles)
I_w	warping constant for a cross-section
I_x	I about the cross-sectional major principal x-axis
I_y	I about the cross-sectional minor principal y-axis
J	torsion constant for a cross-section
k_e	member effective length factor
k_f	form factor for members subject to axial compression
k_l	load height effective length factor
k_r	effective length factor for restraint against lateral rotation
k_{sm}	exposed surface area to mass ratio
k_t	correction factor for distribution of forces in a tension member; or twist restraint effective length factor
L	span or member length; or segment or sub-segment length
L_e	effective length of a compression member or laterally unrestrained member
M_b	nominal member moment capacity
M_{bx}	M_b about major principal x-axis
M_{cx}	lesser of M_{ix} and M_{ox}
M_i	nominal in-plane member moment capacity
M_{ix}	M_i about major principal x-axis
M_{iy}	M_i about minor principal y-axis

M_o	reference elastic buckling moment for a member subject to bending: or nominal out-of-plane member moment capacity
M_{oa}	amended elastic buckling moment for a member subject to bending
M_{ox}	M_o about major principal x-axis
M_{rx}	M_s about major principal x-axis reduced by axial force
M_{ry}	M_s about minor principal y-axis reduced by axial force
M_s	nominal section moment capacity
M_{sx}	M_s about major principal x-axis
M'_{sx}	M_s about major principal x-axis with two holes in tension flange
M''_{sx}	M_s about major principal x-axis with four holes in tension flange
M_{sy}	M_s about minor principal y-axis
M^*	design bending moment
M^*_m	maximum calculated design bending moment along the length of a member or segment
M^*_x	design bending moment about major principal x-axis
M^*_y	design bending moment about minor principal y-axis
N_c	nominal member capacity in compression
N_{cx}	N_c for member buckling about major principal x-axis
N_{cy}	N_c for member buckling about minor principal y-axis
N_{om}	elastic flexural buckling load of a member
N_{omb}	N_{om} for a braced member
N_s	nominal section capacity of a concentrically loaded compression member
N_t	nominal section capacity in tension
N_{tf}	nominal tension capacity of a bolt
N_{ti}	minimum bolt tension at installation
N^*	design axial force, tensile or compressive
N^*_{tf}	design tensile force on a bolt
n_{ei}	number of effective interfaces
P	applied concentrated load
Q	nominal live load
R_b	nominal bearing capacity of a web
R_{bb}	nominal bearing buckling capacity
R_{by}	nominal bearing yield capacity
R_u	nominal capacity
r	radius of gyration
r_x	radius of gyration about major principal x-axis
r_y	radius of gyration about minor principal y-axis
r_1	root radius
r_2	toe radius
R^*	design bearing force
S	plastic section modulus
S_x	S about major principal x-axis
S_y	S about minor principal y-axis
S^*	design action effect
s_p	staggered pitch of bolts
t	thickness of a section
t_f	thickness of a flange
t_p	thickness of a ply
t_t	design throat thickness of a weld

t_w	thickness of a web; or size of a fillet weld
V_b	nominal bearing capacity of a ply
V_{fn}	nominal shear capacity of a bolt - strength limit state - shear on threaded area
V_{fx}	nominal shear capacity of a bolt - strength limit state - shear on unthreaded area
V_{sf}	nominal shear capacity of a bolt - serviceability limit state
V_u	nominal shear capacity of a web with a uniform shear stress distribution
V_v	nominal shear capacity of a web
V_{vm}	nominal shear capacity of a web in the presence of bending moment
V^*	design shear force
V_f^*	design shear force on a bolt - strength limit state
V_{sf}^*	design shear force on a bolt - serviceability limit state
v_w	nominal capacity of a fillet weld per unit length
v_w^*	design force per unit length on a fillet weld
v_{wj}	nominal capacity of a welded joint
W	total uniformly distributed applied load
W^*	design action
W_L^*	strength limit state maximum design load
W_S^*	serviceability limit state maximum design load
Z	elastic section modulus
Z_e	effective section modulus
Z_{ex}	Z_e for bending about major principal x-axis
Z_{ey}	Z_e for bending about minor principal y-axis
Z_x	Z for bending about major principal x-axis
Z_y	Z for bending about minor principal y-axis
α_a	compression member factor
α_b	compression member section constant
α_c	compression member slenderness reduction factor
α_m	moment modification factor for bending
α_s	slenderness reduction factor
β_m	ratio of smaller to larger bending moments at the ends of a member
Δ_s	deflection
Δ_b	translational displacement of the top relative to the bottom for a storey height
δ_b	moment amplification factor for a braced member
δ_m	moment amplification factor, taken as the greater of δ_b and δ_s
δ_s	moment amplification factor for a sway member
ξ	compression member factor
η	compression member imperfection factor
π	pi ($\approx$ 3.14159)
λ	slenderness ratio
λ_c	elastic buckling load factor
λ_e	plate element slenderness
λ_{ep}	plate element plasticity slenderness limit
λ_{ey}	plate element yield slenderness limit
λ_n	modified compression member slenderness
ν	Poisson's ratio
ρ	density of a material
ϕ	capacity factor

Note: Additional notation for floor plates is defined in Section 11.8.

PART 1 INTRODUCTION

NOTE

The maximum design loads and design capacities listed in this publication are based on the limit states design method of AS 4100 and the <u>factored</u> limit states design loads and combinations considered within AS 1170. Hence, much of the information contained herein will <u>only</u> be of use to persons familiar with the limit states design method and the use of:

AS 4100: Steel Structures

AS 1170: SAA Loading Code

PART 1 INTRODUCTION

1.1 Steel Structures Standard

The tables in this publication have been calculated in accordance with the Australian Standard *AS 4100-1990: Steel Structures*. As far as possible, the notation and terminology used are the same as those adopted in that Standard. Within this publication:

– "AS 4100" refers to AS 4100-1990: Steel Structures incorporating Amendments 1 and 2;

– "the Tables", "Table" or "Tables" refer to this edition and volume of the *Design Capacity Tables for Structural Steel.*

1.2 Range of Structural Steel Grades and Sections

The Tables contain information on the currently available (at the time of publication) standard open# sections that are within the scope of AS 4100. This includes hot-rolled and welded sections commonly specified in structural engineering. Reference should be made to Section 2 for further details on the structural steel sections considered in the Tables.

Consultation should be made with AISC for current information on structural steel grades and sections that are not contained within this publication.

\# Note: *Sections other than hollow sections are regarded as 'open' sections in the context of this publication.*

1.2.1 Member Sizes Excluded

Sections made from elements less than 3 mm thick are beyond the scope of AS 4100 (Clause 1.1) and are not considered in the Tables.

1.3 Units

The units in the Tables are consistent with those in the SI (metric) system. The base units utilised in the Tables are *newton* (N) for force, *metre* (m) for length, and *kilogram* (kg) for mass.

With some minor exceptions, all values in the Tables are rounded to three (3) significant figures.

1.4 Limit States Design Using these Tables

AS 4100 sets out the minimum requirements for the design, fabrication and erection of steelwork in accordance with the limit states design method. AS 4100 follows a semi-probabilistic limit state basis presented in a deterministic format.

Definition of limit states - When a structure or part of a structure is rendered unfit for use it reaches a 'limit state'. In this state it ceases to perform the functions or to satisfy the conditions for which it was designed. Relevant limit states for structural steel include strength, serviceability, stability, fatigue, brittle fracture, fire, and earthquake. Only two limit states are considered in the Tables - the strength limit state and, where applicable, the serviceability limit state.

Limit states design requires structural members and connections to be proportioned such that the **design action effect** (S^*) resulting from the **design action** (W^*), is less than or equal to the **design capacity** (ϕR_u) i.e.

$$S^* \leq \phi R_u$$

Design action or **design load** (W^*) is the combination of the nominal actions or loads imposed upon the structure (e.g. transverse loads on a beam) multiplied by the appropriate load factors as specified in AS 1170 (SAA Loading Code). These **design actions/loads** are identified by an asterisk (*) after the appropriate action/load (e.g. W^*_L is the maximum design transverse load on a beam).

Design action effects (S^*) are the actions (e.g. design bending moments, shear forces, axial loads) calculated from the **design actions** or **design loads** using an acceptable method of analysis (Section 4 of AS 4100). These effects are identified by an asterisk (*) after the appropriate action effect (e.g. M^* describes the design bending moment).

Design capacity (ϕR_u) is the product of the **nominal capacity** (R_u) and the appropriate value of the capacity factor (ϕ) found in Table 3.4 of AS 4100. R_u is determined from the characteristic values and specified parameters found in Sections 5 to 9 of AS 4100.

For example, consider the strength limit state design of a simply supported beam which has full lateral restraint subject to a total transverse **design load** (W^*) distributed uniformly along the beam.

For flexure, the appropriate **design action effect** (S^*) is the design bending moment (M^*) which is determined by:

$$M^* = \frac{W^* L}{8}$$

where L = span of the beam.

In this case the design capacity (ϕR_u) is equal to the design section moment capacity (ϕM_s), given by:

$$\phi M_s = \phi f_y Z_e$$

where ϕ = the capacity factor
Z_e = effective section modulus
f_y = yield stress used in design

To satisfy the strength limit state, the following relationship (equivalent to $S^* \leq \phi R_u$) is used:

$$M^* \leq \phi M_s$$

The maximum design bending moment (M^*) is therefore equal to the design section moment capacity (ϕM_s), and the **maximum design load** is that design load (W^*) which corresponds to the maximum M^*. (It should be noted that other checks on the beam may be necessary; e.g. shear capacity, bearing capacity).

When considering external loads, in the context of this publication, the **maximum design load** (W^*_L) must be greater than or equal to the imposed **design load** (W^*).

Where applicable, the Tables give values of **design capacity** (ϕR_u) and **maximum design load** (W^*_L) determined in accordance with AS 4100. When using the Tables, the designer must determine the relevant *strength limit state* **design action** (W^*) and/or corresponding **design action effect** (S^*) to ensure that the strength limit state requirements of AS 4100 are satisfied. Where relevant, other limit states (e.g. serviceability, fatigue, etc) must also be considered by the designer. Some information useful for checking the serviceability limit state is included in the Tables.

1.5 Table Contents

For the range of structural steel grades and sections considered, tables are provided for:

(i) **section dimensions and section properties:**

– Dimensions and Properties	(PART 3)
– Properties for Assessing Section Capacity	(PART 3)
– Surface Areas	(PART 3)
– Properties for Fire Design	(PART 3)
– Detailing Parameters	(PART 10)
– Rails, Gantry Girders	(PARTS 12 & 13)

(ii) **design capacity** (ϕR_u) for:

– Members Subject to Bending	(PART 5)
– Members Subject to Axial Compression	(PART 6)
– Members Subject to Axial Tension	(PART 7)
– Members Subject to Combined Actions	(PART 8)
– Connections - Bolts/Welds	(PART 9)

(iii) **elastic flexural buckling load** (N_{om}) (PART 4)

(iv) **maximum design load** (W^*) for:

– Strength Limit State (W^*_L) for Beams	(PART 5)
– Serviceability Limit State (W^*_S) for Beams	(PART 5)
– Strength Limit State (q^*_{st} , P^*_{st}) for Floor Plates	(PART 11)
– Serviceability Limit State for Floor Plates	(PART 11)

Acceptable methods of analysis for determining the **design action effects** are described in Section 4 of AS 4100 and material relevant to some of these methods of analysis is presented briefly in Part 4 of this publication.

PART 2 MATERIALS

PART 2 MATERIALS

2.1 Range of Structural Steel Grades and Sections

Where applicable, these Tables cover the range of structural steel products manufactured in accordance with the general requirements of the following Australian Standards:

AS 3678: Hot-rolled structural steel plates, floorplates and slabs

AS 3679 - Part 1: Hot-rolled structural steel bars and sections

AS 3679 - Part 2: Welded sections

The section sizes and their respective grades listed in the Tables include:

Grade 300 and Grade 400 Welded Beams and Welded Columns to AS 3679.2

Grade 300* Universal Beams, Universal Columns, Parallel Flange Channels and large Angles#

Grade 300* Tees cut from Universal Beams and Tees cut from Universal Columns

Grade 250 Taper Flange Channels, Taper Flange Beams and small Angles# to AS 3679.1

These reflect the *most readily available* selection of steel grades for the above sections. Grade 350 is sometimes available as a higher strength alternative for hot-rolled sections. Grade 300 for welded sections is the standard grade available.

The grade designation (e.g. 300) is based on the nominal yield strength of the steel (in MPa).

Notes: (1) * **All references to Grade 300 steel for hot-rolled sections in this publication refer to the specification of BHP Grade 300PLUS™. At the time of publication, the specification for Grade 300 hot-rolled sections listed in AS 3679.1 varies from that used in these Tables. The difference occurs in the tensile properties required whereas all other requirements are met. It is envisaged that the Australian Standard will be revised to embrace the BHP Grade 300PLUS™ specification. Grade 300PLUS™ replaced Grade 250 as the base steel grade for these sections in October 1994.**

(2) # Large Angles refer to Equal Angles with leg lengths 125 x 125 mm and higher, and Unequal Angles with leg lengths 150 x 90 mm and higher. Small Angles refer to angle sections not included in the above definition for large angles.

(3) The new range of Universal Beams, known as "Lean Beams", introduced in 1994, are included in the Universal Beam listings. These sections are 310UB32.0, 250UB25.7, 200UB22.3, 200UB18.2 and 180UB16.1.

2.2 Yield Stress and Tensile Strength

Table 2.1 lists the minimum yield stresses and tensile strengths for the steel grades covered by this publication and used for calculating the design capacities.

TABLE 2.1: Strengths of Steels

Steel Standard	Form	Steel Grade	Thickness of Material t	Yield Stress f_y	Tensile Strength f_u
			mm	MPa	MPa
AS 3679.2	Plate	400	$t \leq 12$ $12 < t \leq 20$ $20 < t \leq 50$	400 380 360	480
AS 3679.2	Plate	300	$8 < t \leq 12$ $12 < t \leq 20$ $20 < t \leq 150$	310 300 280	430
300PLUS™	Sections	300	$t < 11$ $11 \leq t \leq 17$ $t > 17$	320 300 280	440
AS 3679.1	Sections	250	$t \leq 12$ $12 < t < 40$ $t \geq 40$	260 250 230	410

More details on the strengths of steels can be found in Table 2.1 of AS 4100, the relevant material Standard, or the BHP publication "Hot Rolled and Structural Steel Products - 1994 Edition".

2.3 Properties of Steel

The properties of steel adopted in this publication are shown in Table 2.2.

TABLE 2.2: Properties of Steels

Property	Symbol	Value
Elastic Modulus	E	200×10^3 MPa
Shear Modulus	G	80×10^3 MPa
Density	ρ	7850 kg/m^3
Poisson's Ratio	ν	0.25
Coefficient of Thermal Expansion	α_T	11.7×10^{-6} per °C

Masses

The masses given in these Tables are based on a steel density of 7850 kg/m^3. In practice the tabulated values are affected by rolling tolerances. Masses per metre listed are for the sections only, and do not include any allowances for cleats, end plates, weld metal, etc.

2.4 Availability

2.4.1 Welded Sections

The standard grade for Welded Beams (WB) and Welded Columns (WC) is Grade 300 steel. A higher strength option of Grade 400 is also available.

Lengths of welded sections are available from a minimum of 9 m to a maximum of 30 m. Standard lengths are 12.0, 15.0 and 18.0 metres.

2.4.2 Hot-rolled Sections

The standard base grade for Universal Beams (UB), Universal Columns (UC), Parallel Flange Channels (PFC), large Equal Angles (EA) and large Unequal Angles (UA) is Grade 300 steel (see Section 2.1 above).

The standard base steel grade for Taper Flange Channels (TFC), Taper Flange Beams (TFB), small Equal Angles (EA) and small Unequal Angles (UA) is Grade 250 (see Section 2.1 above).

Higher strength grades, and grades with special impact properties, such as Grade 350L0, are also available as non-standard grades.

Standard lengths for Universal Beams and Universal Columns range from 9 m to 18 m. Standard lengths for Parallel Flange Channels are in the range of 9 m to 16.5 m. Angles are available in lengths from 9 m to 15 m (for the larger sections in Grade 300), and from 7.5 to 12 m (for the smaller angles in Grade 250). Taper Flange Channels and Taper Flange Beams are available in 9 m or 12 m lengths.

Universal Bearing Piles, the 760UB series, the 690UB series, and the some of the 310UC series (198 kg/m and larger) are no longer manufactured.

Further details on length and grade availability can be found in the 1994 edition of the "Hot Rolled and Structural Steel Products" manual produced by BHP or from steel stockists.

Before specifying a section it is wise to check the supply situation if the project requires:

- large tonnages of individual sections,
- larger sizes of welded sections,
- lengths over - 15 m for hot-rolled sections
18 m for welded sections,
- sections with non-standard grades.

PART 3 SECTION PROPERTIES

TABLES

PART 3 SECTION PROPERTIES

3.1 Introduction

The section property tables include all relevant section dimensions and properties necessary for assessing the various limit states of steel structures in accordance with AS 4100. The structural sections included in these tables are:

- Welded Beams
- Welded Columns
- Universal Beams
- Universal Columns
- Structural Tees cut symmetrically from Universal Beams
- Structural Tees cut symmetrically from Universal Columns
- Parallel Flange Channels
- Taper Flange Channels
- Taper Flange Beams
- Equal Angles
- Unequal Angles
- Round and Square Bars
- Square Edge Flat Bars

3.2 Section Property Tables

For each group of sections (except Bars and I- sections with holes) the Tables include:

- Dimensions and Properties (Table type (A)), followed by
- Properties for Assessing Section Capacity to AS 4100 (Table type (B)).

3.2.1 Dimensions and Properties

The Tables give standard dimensions and properties for the structural steel sections listed above. These properties such as area (A_g), second moments of area (I_x , I_y), elastic and plastic section moduli (Z_x , S_x , Z_y , S_y) and torsion and warping constants (J, I_w) are the fundamental geometric properties required by design standards.

3.2.2 Properties for Assessing Section Capacity

These properties are necessary for calculating the section capacities of the structural sections in accordance with AS 4100. The effective section moduli, "compactness" (for I- sections only), and the form factor are tabulated. These values are dependent on the steel grade.

3.2.2.1 Compactness

In Clauses 5.2.3, 5.2.4, and 5.2.5 of AS 4100, sections are described as **compact, non-compact** or **slender** (C, N or S). This categorisation provides a measure of the relative importance of yielding and local buckling of the plate elements in compression caused by bending.

For I- sections, the tables include a column headed "Compactness" where the compactness or otherwise of the sections is indicated for a given axis of bending.

The compactness of an I- section is important when selecting the methods of analysis (elastic or plastic) used to determine the design action effects (Clause 4.5 of AS 4100) or in using the higher tier provisions of Section 8 of AS 4100 for designing members subject to combined actions.

3.2.2.2 Effective Section Modulus

Having evaluated the compactness of a section, the effective section modulus (Z_e) is then calculated. This parameter is based on the section moduli (S, Z) and is used in the determination of the design section moment capacity (ϕM_s). Z_e is calculated using Clauses 5.2.3, 5.2.4 and 5.2.5 of AS 4100. The equations for determining Z_e reflect the proportion of the section that is effective in resisting the compression in the section caused by flexure.

For bending of sections about an asymmetric axis the value of Z_e may depend upon the direction of bending.

Additional notes on the calculation of Z_e are given in Section 3.2.2.3.

3.2.2.3 Form Factor

The form factor (k_f) is defined in Clause 6.2.2 of AS 4100. k_f is used to determine the design section capacity of a concentrically loaded compression member (ϕN_s). The calculation of k_f indicates the degree to which the column section will buckle locally before squashing. k_f represents the proportion of the section that is effective in compression and is based on the effective width of each element in the section (i.e. $k_f = 1.0$ signifies a column section which will yield rather than buckle locally in a short or stub column test). A knowledge of k_f is also important when using the higher tier provisions of Section 8 of AS 4100 for designing members subject to combined actions.

In calculating both Z_e and k_f the following are used:

- for hot rolled sections, the HR (hot-rolled) residual stress classification,
- for welded sections, the HW (heavily welded longitudinally) residual stress classification,
- the values of plate element slenderness depend on the element width and thickness, and the yield stress. For sections where the web and flange yield stresses (f_{yw}, f_{yf}) are different the **lower** of the two is applied to both the web and flange to determine the slenderness of these elements.

Section 3.4 provides an example for calculating Z_{ex} and k_f. More examples can be found in *Worked Examples for Steel Structures*, 2nd Ed., published by AISC.

3.2.3 I- Sections with Holed Flanges

Tables of selected section properties (A_n, Z_x, Z_y, S_x, S_y, Z_{ex} and Z_{ey}) are given for I- sections with holes in the flanges. Standard bolt gauge lengths and number of holes are assumed in these tables. Holes in the tension flange can result in a reduction of the effective section modulus (Clause 5.2.6 of AS 4100).

If the area of the holes in the flange is less than the limit prescribed in Clause 5.2.6 of AS 4100 then the gross section properties may be used. Tables 3.1-15 to 3.1-18 list the net area, and the *gross* section properties (if the area of the holes is less than the limit described above), or the *net* section properties (if the area of the holes exceeds the limit).

3.3 Surface Areas & Properties for Fire Design

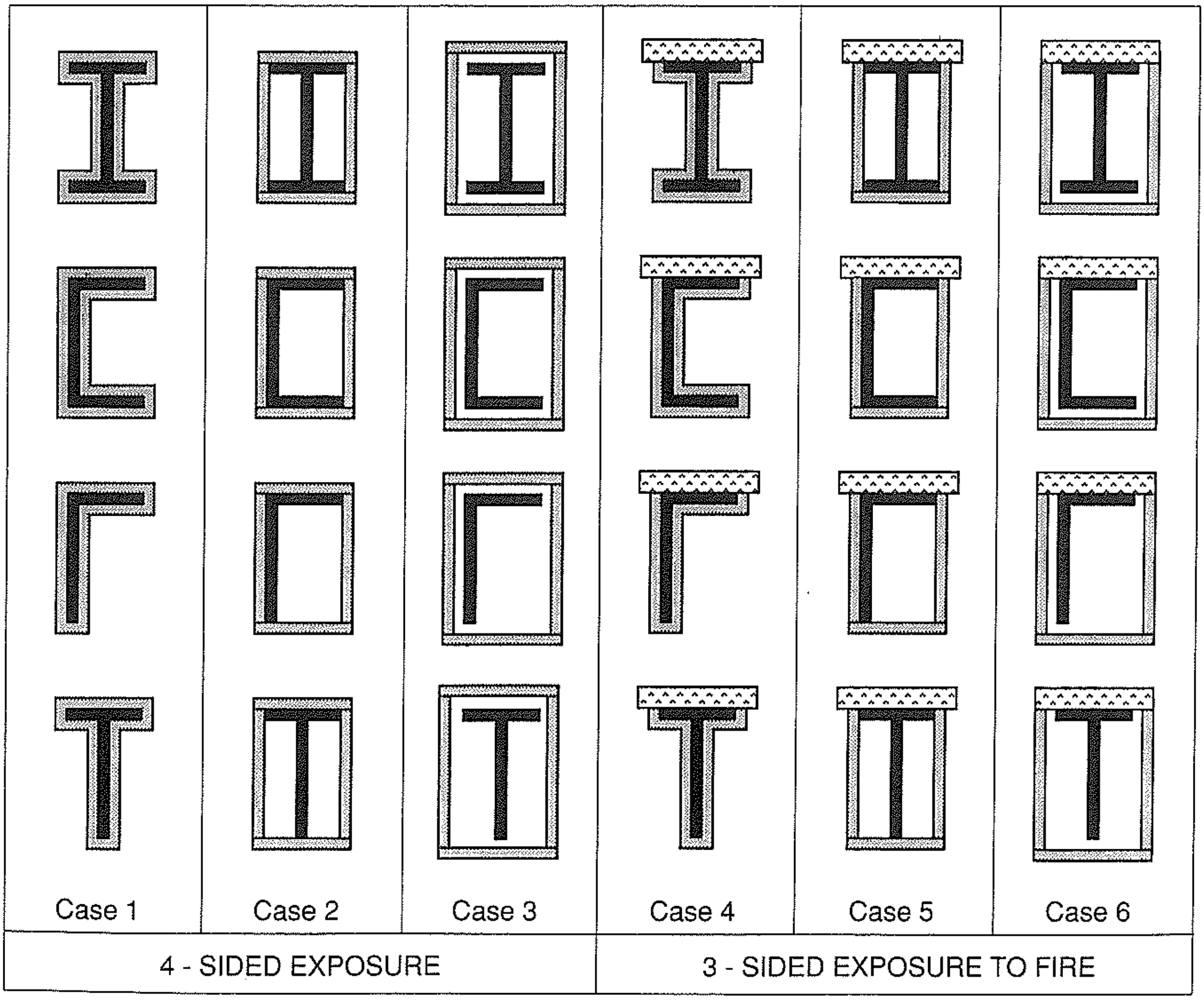
Tables 3.2-1(A) to 3.2-11(A) list surface areas for structural steel sections. In addition, to assist with the design of structural steel sections for fire resistance (Section 12 of AS 4100), values of the exposed surface area to mass ratio (k_{sm}) are tabulated in Tables 3.2-1(B) to 3.2-11(B) for the various cases shown in the figure below. These tables immediately follow each surface area table.

For **unprotected steel sections** the values of k_{sm} corresponding to four- and three- sided exposure should be taken as those corresponding to Cases 1 and 4 respectively.

For members requiring the addition of fire protection materials the reference below may be used to determine the thickness of proprietary materials required for a given value of k_{sm} and Fire-Resistance Level. In the AISC Handbook, the notation *E* is equivalent to k_{sm}.

Suggested reference for Fire Design:

[1] Proe, D.J., Bennetts, I.D., Thomas, I.R., Szeto, W.T., *Handbook of Fire Protection Materials for Structural Steel*, Australian Institute of Steel Construction, 1990.



Cases of fire exposure considered:

1 = Profile-protected
2 = Total Perimeter, Box-protected, No Gap
3 = Total Perimeter, Box-protected, 25 mm Gap
4 = Top Flange Excluded, Profile-protected
5 = Top Flange Excluded, Box-protected, No Gap
6 = Top Flange Excluded, Box-protected, 25 mm Gap

3.4 Example

Determine Z_{ex} and k_f for a 250UB31.4 - Grade 300 steel section.

Solution: (All relevant data are obtained from Tables 3.1-3(A) and 3.1-3(B))

Yield stress, $f_y = 320$ MPa

Flange slenderness $$\lambda_{ef} = \frac{b_f - t_w}{2t_f}\sqrt{\frac{f_y}{250}} = 8.13\sqrt{\frac{320}{250}} = 9.19$$

Web slenderness $$\lambda_{ew} = \frac{d_1}{t_w}\sqrt{\frac{f_y}{250}} = 38.4\sqrt{\frac{320}{250}} = 43.4$$

(a) To calculate Z_{ex} the plate element slenderness values are compared with the plate element slenderness limits in Table 5.2 of AS 4100.

Bending about the x-axis puts the flange in uniform compression. Hence

$\lambda_{ef} = 9.19$ $\lambda_{ep} = 9$ $\lambda_{ey} = 16$ $\lambda_{ef}/\lambda_{ey} = 0.574$ (Table 5.2 of AS 4100)

Bending about the x-axis places one edge of the web in tension and the other in compression. Hence

$\lambda_{ew} = 43.4$ $\lambda_{ep} = 82$ $\lambda_{ey} = 115$ $\lambda_{ew}/\lambda_{ey} = 0.377$ (Table 5.2 of AS 4100)

The flange has the higher value of λ_e/λ_{ey} and hence is the critical element in the section. From Clause 5.2.2 of AS 4100 the section slenderness and slenderness limits are the flange values, i.e.

$\lambda_s = 9.19$ $\lambda_{sp} = 9$ $\lambda_{sy} = 16$

Now $\lambda_{sp} < \lambda_s \le \lambda_{sy}$. $\therefore$ The section is NON-COMPACT.

$Z_x = 354 \times 10^3$ mm^3 $S_x = 397 \times 10^3$ mm^3

$Z_c = \min[S_x, 1.5 Z_x] = \min[397, 1.5 \times 354] \times 10^3 = 397 \times 10^3$ mm^3

$$Z_{ex} = Z + \left[\frac{(\lambda_{sy} - \lambda_s)}{(\lambda_{sy} - \lambda_{sp})}(Z_c - Z)\right] = 354 \times 10^3 + \left[\frac{(16 - 9.19)}{(16 - 9)}(397 - 354)\right] \times 10^3$$
$$= 395 \times 10^3 \text{ mm}^3$$

(b) To determine the form factor (k_f) the plate element slenderness for both the flange and web are compared with the plate element yield slenderness limits (λ_{ey}) in Table 6.2.4 of AS 4100.

Flange $\lambda_{ef} = 9.19$ $\lambda_{ey} = 16$

Web $\lambda_{ew} = 43.4$ $\lambda_{ey} = 45$

For both the web and the flange $\lambda_e < \lambda_{ey}$. Hence both the web and the flange are fully effective and hence the effective area equals the gross area ($A_e = A_g$).

$\therefore k_f = A_e/A_g = 1$

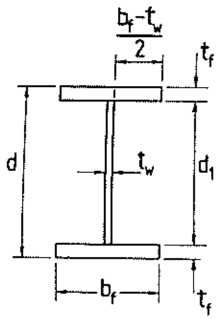
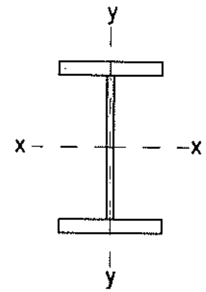


TABLE 3.1-1(A)

WELDED BEAMS
DIMENSIONS AND PROPERTIES



Designation	Depth of Section d	Flange Width b_f	Flange Thickness t_f	Web Thickness t_w	Depth Between Flanges d_1	$\frac{d_1}{t_w}$	$\frac{(b_f-t_w)}{2t_f}$	Gross Section Area A_g	I_x	Z_x	S_x	r_x	I_y	Z_y	S_y	r_y	Torsion Constant J	Warping Constant I_w
	DIMENSIONS					RATIOS		PROPERTIES	About x-axis				About y-axis					
kg/m	mm	mm	mm	mm	mm			mm²	10⁶mm⁴	10³mm³	10³mm³	mm	10⁶mm⁴	10³mm³	10³mm³	mm	10³mm⁴	10⁹mm⁶
1200WB455	1200	500	40.0	16.0	1120	70.0	6.05	57900	15300	25600	28200	515	834	3330	5070	120	22000	280000
423	1192	500	36.0	16.0	1120	70.0	6.72	53900	13900	23300	25800	508	750	3000	4570	118	16500	251000
392	1184	500	32.0	16.0	1120	70.0	7.56	49900	12500	21100	23400	500	667	2670	4070	116	12100	221000
342	1184	400	32.0	16.0	1120	70.0	6.00	43500	10400	17500	19800	488	342	1710	2630	88.6	9960	113000
317	1176	400	28.0	16.0	1120	70.0	6.86	40300	9250	15700	17900	479	299	1500	2310	86.1	7230	98500
278	1170	350	25.0	16.0	1120	70.0	6.68	35400	7610	13000	15000	464	179	1020	1600	71.1	5090	58700
249	1170	275	25.0	16.0	1120	70.0	5.18	31700	6380	10900	12900	449	87.0	633	1020	52.4	4310	28500
1000WB322	1024	400	32.0	16.0	960	60.0	6.00	41000	7480	14600	16400	427	342	1710	2620	91.3	9740	84100
296	1016	400	28.0	16.0	960	60.0	6.86	37800	6650	13100	14800	420	299	1490	2300	89.0	7010	73000
258	1010	350	25.0	16.0	960	60.0	6.68	32900	5430	10700	12300	406	179	1020	1590	73.8	4870	43400
215	1000	300	20.0	16.0	960	60.0	7.10	27400	4060	8120	9570	385	90.3	602	961	57.5	2890	21700
900WB282	924	400	32.0	12.0	860	71.7	6.06	35900	5730	12400	13600	399	341	1710	2590	97.5	8870	67900
257	916	400	28.0	12.0	860	71.7	6.93	32700	5050	11000	12200	393	299	1490	2270	95.6	6150	58900
218	910	350	25.0	12.0	860	71.7	6.76	27800	4060	8930	9960	382	179	1020	1560	80.2	4020	35000
175	900	300	20.0	12.0	860	71.7	7.20	22300	2960	6580	7500	364	90.1	601	931	63.5	2060	17400
800WB192	816	300	28.0	10.0	760	76.0	5.18	24400	2970	7290	8060	349	126	840	1280	71.9	4420	19600
168	810	275	25.0	10.0	760	76.0	5.30	21400	2480	6140	6840	341	86.7	631	964	63.7	2990	13400
146	800	275	20.0	10.0	760	76.0	6.62	18600	2040	5100	5730	331	69.4	505	775	61.1	1670	10600
122	792	250	16.0	10.0	760	76.0	7.50	15600	1570	3970	4550	317	41.7	334	519	51.7	921	6280
700WB173	716	275	28.0	10.0	660	66.0	4.73	22000	2060	5760	6390	306	97.1	706	1080	66.4	4020	11500
150	710	250	25.0	10.0	660	66.0	4.80	19100	1710	4810	5370	299	65.2	521	798	58.4	2690	7640
130	700	250	20.0	10.0	660	66.0	6.00	16600	1400	3990	4490	290	52.1	417	642	56.0	1510	6030
115	692	250	16.0	10.0	660	66.0	7.50	14600	1150	3330	3790	281	41.7	334	517	53.5	888	4770

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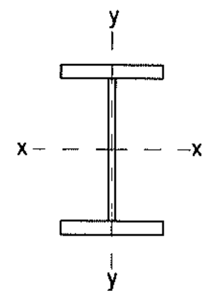


TABLE 3.1-1(B)

WELDED BEAMS
GRADE 300 & 400
PROPERTIES FOR ASSESSING SECTION CAPACITY

Designation	GRADE 300: AS 3679.2							GRADE 400: AS 3679.2						
	Yield Stress		Form Factor	About x-axis		About y-axis		Yield Stress		Form Factor	About x-axis		About y-axis	
	Flange f_{yf}	Web f_{yw}	k_f	Compactness (C, N, S)	Z_{ex}	Compactness (C, N, S)	Z_{ey}	Flange f_{yf}	Web f_{yw}	k_f	Compactness (C, N, S)	Z_{ex}	Compactness (C, N, S)	Z_{ey}
	MPa	MPa			10^3mm^3		10^3mm^3	MPa	MPa			10^3mm^3		10^3mm^3
1200WB455	280	300	0.837	C	28200	C	5000	360	380	0.820	N	28100	C	5000
423	280	300	0.825	C	25800	C	4500	360	380	0.806	N	25700	N	4500
392	280	300	0.811	C	23400	N	4000	360	380	0.791	N	23300	N	3900
342	280	300	0.783	C	19800	C	2560	360	380	0.760	N	19600	C	2560
317	280	300	0.766	C	17900	C	2240	360	380	0.741	N	17700	N	2230
278	280	300	0.733	C	15000	C	1530	360	380	0.705	N	14900	N	1530
249	280	300	0.701	C	12900	C	949	360	380	0.670	N	12800	C	949
1000WB322	280	300	0.832	C	16400	C	2560	360	380	0.807	C	16400	C	2560
296	280	300	0.817	C	14800	C	2240	360	380	0.791	C	14800	N	2230
258	280	300	0.790	C	12300	C	1530	360	380	0.760	C	12300	N	1530
215	300	300	0.738	C	9570	C	903	380	380	0.704	C	9570	N	887
900WB282	280	310	0.845	C	13600	C	2560	360	400	0.830	N	13500	C	2560
257	280	310	0.830	C	12200	C	2240	360	400	0.813	N	12000	N	2220
218	280	310	0.800	C	9960	C	1530	360	400	0.780	N	9480	N	1530
175	300	310	0.744	C	7500	C	901	380	400	0.721	N	7320	N	882
800WB192	280	310	0.824	C	8060	C	1260	360	400	0.808	N	7850	C	1260
168	280	310	0.799	C	6840	C	946	360	400	0.781	N	6640	C	946
146	300	310	0.763	N	5710	C	757	380	400	0.744	N	5510	N	754
122	300	310	0.718	N	4530	N	498	380	400	0.695	N	4340	N	486
700WB173	280	310	0.850	C	6390	C	1060	360	400	0.833	C	6390	C	1060
150	280	310	0.828	C	5370	C	782	360	400	0.807	C	5370	C	782
130	300	310	0.795	C	4490	C	626	380	400	0.773	C	4490	C	626
115	300	310	0.767	C	3790	N	498	380	400	0.742	C	3790	N	486

Notes: (1) For Grade 300 sections the tensile strength (f_u) is 430 MPa.
(2) For Grade 400 sections the tensile strength (f_u) is 480 MPa.
(3) C: Compact Section; N: Non-compact Section; S: Slender Section.

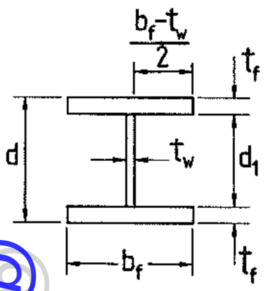
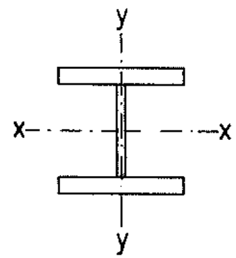


TABLE 3.1-2(A)

WELDED COLUMNS
DIMENSIONS AND PROPERTIES

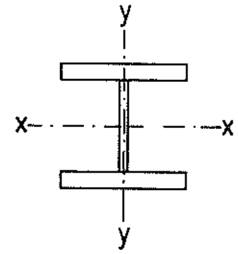


Designation	DIMENSIONS					RATIOS		PROPERTIES											
	Depth of Section d	Flange Width b_f	Flange Thickness t_f	Web Thickness t_w	Depth Between Flanges d_1	$\frac{d_1}{t_w}$	$\frac{(b_f - t_w)}{2t_f}$	Gross Section Area A_g	About x-axis I_x	Z_x	S_x	r_x	About y-axis I_y	Z_y	S_y	r_y	Torsion Constant J	Warping Constant I_w
kg/m	mm	mm	mm	mm	mm			mm²	10⁶mm⁴	10³mm³	10³mm³	mm	10⁶mm⁴	10³mm³	10³mm³	mm	10³mm⁴	10⁹mm⁶
500WC440	480	500	40.0	40.0	400	10.0	5.75	56000	2150	8980	10400	196	835	3340	5160	122	30100	40400
414	480	500	40.0	32.0	400	12.5	5.85	52800	2110	8800	10100	200	834	3340	5100	126	25400	40400
383	472	500	36.0	32.0	400	12.5	6.50	48800	1890	7990	9130	197	751	3000	4600	124	19900	35700
340	514	500	32.0	25.0	450	18.0	7.42	43300	2050	7980	8980	218	667	2670	4070	124	13100	38800
290	506	500	28.0	20.0	450	22.5	8.57	37000	1750	6930	7700	218	584	2330	3550	126	8420	33300
267	500	500	25.0	20.0	450	22.5	9.60	34000	1560	6250	6950	214	521	2080	3170	124	6370	29400
228	490	500	20.0	20.0	450	22.5	12.0	29000	1260	5130	5710	208	417	1670	2550	120	3880	23000
400WC361	430	400	40.0	40.0	350	8.75	4.50	46000	1360	6340	7470	172	429	2140	3340	96.5	24800	16300
328	430	400	40.0	28.0	350	12.5	4.65	41800	1320	6140	7100	178	427	2140	3270	101	19200	16200
303	422	400	36.0	28.0	350	12.5	5.17	38600	1180	5570	6420	175	385	1920	2950	99.8	14800	14300
270	414	400	32.0	25.0	350	14.0	5.86	34400	1030	4950	5660	173	342	1710	2610	99.8	10400	12500
212	400	400	25.0	20.0	350	17.5	7.60	27000	776	3880	4360	169	267	1330	2040	99.4	5060	9380
181	390	400	20.0	20.0	350	17.5	9.50	23000	620	3180	3570	164	214	1070	1640	96.4	3080	7310
144	382	400	16.0	16.0	350	21.9	12.0	18400	486	2550	2830	163	171	854	1300	96.3	1580	5720
350WC280	355	350	40.0	28.0	275	9.82	4.02	35700	747	4210	4940	145	286	1640	2500	89.6	16500	7100
258	347	350	36.0	28.0	275	9.82	4.47	32900	661	3810	4450	142	258	1470	2260	88.5	12700	6230
230	339	350	32.0	25.0	275	11.0	5.08	29300	573	3380	3910	140	229	1310	2000	88.4	8960	5400
197	331	350	28.0	20.0	275	13.8	5.89	25100	486	2940	3350	139	200	1140	1740	89.3	5750	4600

TABLE 3.1-2(B)

WELDED COLUMNS GRADE 300 & 400

PROPERTIES FOR ASSESSING SECTION CAPACITY



Designation	GRADE 300: AS 3679.2							GRADE 400: AS 3679.2						
	Yield Stress		Form Factor	About x-axis		About y-axis		Yield Stress		Form Factor	About x-axis		About y-axis	
	Flange f_{yf}	Web f_{yw}	k_f	Compactness (C, N, S)	Z_{ex}	Compactness (C, N, S)	Z_{ey}	Flange f_{yf}	Web f_{yw}	k_f	Compactness (C, N, S)	Z_{ex}	Compactness (C, N, S)	Z_{ey}
	MPa	MPa			10^3mm^3		10^3mm^3	MPa	MPa			10^3mm^3		10^3mm^3
500WC440	280	280	1.00	C	10400	C	5010	360	360	1.00	C	10400	C	5010
414	280	280	1.00	C	10100	C	5010	360	360	1.00	C	10100	C	5010
383	280	280	1.00	C	9130	C	4510	360	360	1.00	C	9130	C	4510
340	280	280	1.00	C	8980	C	4000	360	360	1.00	N	8830	N	3920
290	280	300	1.00	N	7570	N	3410	360	380	1.00	N	7410	N	3310
267	280	300	1.00	N	6700	N	2970	360	380	1.00	N	6540	N	2860
228	300	300	1.00	N	5210	N	2200	380	380	0.964	S	4860	N	2100
400WC361	280	280	1.00	C	7470	C	3210	360	360	1.00	C	7470	C	3210
328	280	280	1.00	C	7100	C	3200	360	360	1.00	C	7100	C	3200
303	280	280	1.00	C	6420	C	2880	360	360	1.00	C	6420	C	2880
270	280	280	1.00	C	5660	C	2560	360	360	1.00	C	5660	C	2560
212	280	300	1.00	N	4360	N	2000	360	380	1.00	N	4270	N	1950
181	300	300	1.00	N	3410	N	1510	380	380	1.00	N	3330	N	1460
144	300	300	1.00	N	2590	N	1120	380	380	0.964	S	2410	N	1070
350WC280	280	280	1.00	C	4940	C	2450	360	360	1.00	C	4940	C	2450
258	280	280	1.00	C	4450	C	2210	360	360	1.00	C	4450	C	2210
230	280	280	1.00	C	3910	C	1960	360	360	1.00	C	3910	C	1960
197	280	300	1.00	C	3350	C	1720	360	380	1.00	C	3350	C	1720

Notes: (1) For Grade 300 sections the tensile strength (f_u) is 430 MPa.
(2) For Grade 400 sections the tensile strength (f_u) is 480 MPa.
(3) C: Compact Section; N: Non-compact Section; S: Slender Section.

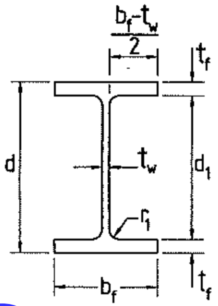
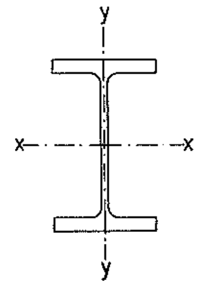


TABLE 3.1-3(A)

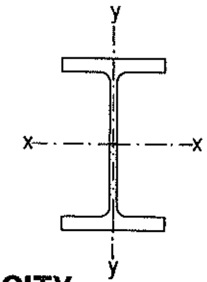
UNIVERSAL BEAMS
DIMENSIONS AND PROPERTIES



Designation	Depth of Section d	Flange Width b_f	Flange Thickness t_f	Web Thickness t_w	Root Radius r_1	Depth Between Flanges d_1	$\frac{d_1}{t_w}$	$\frac{(b_f-t_w)}{2t_f}$	Gross Section Area A_g	About x-axis I_x	About x-axis Z_x	About x-axis S_x	About x-axis r_x	About y-axis I_y	About y-axis Z_y	About y-axis S_y	About y-axis r_y	Torsion Constant J	Warping Constant I_w
kg/m	mm	mm	mm	mm	mm	mm			mm²	10⁶mm⁴	10³mm³	10³mm³	mm	10⁶mm⁴	10³mm³	10³mm³	mm	10³mm⁴	10⁹mm⁶
610UB125	612	229	19.6	11.9	14.0	572	48.1	5.54	16000	986	3230	3680	249	39.3	343	536	49.6	1560	3450
113	607	228	17.3	11.2	14.0	572	51.1	6.27	14500	875	2880	3290	246	34.3	300	469	48.7	1140	2980
101	602	228	14.8	10.6	14.0	572	54.0	7.34	13000	761	2530	2900	242	29.3	257	402	47.5	790	2530
530UB 92.4	533	209	15.6	10.2	14.0	502	49.2	6.37	11800	554	2080	2370	217	23.8	228	355	44.9	775	1590
82.0	528	209	13.2	9.6	14.0	502	52.3	7.55	10500	477	1810	2070	213	20.1	193	301	43.8	526	1330
460UB 82.1	460	191	16.0	9.9	11.4	428	43.3	5.66	10500	372	1610	1840	188	18.6	195	303	42.2	701	919
74.6	457	190	14.5	9.1	11.4	428	47.1	6.24	9520	335	1460	1660	188	16.6	175	271	41.8	530	815
67.1	454	190	12.7	8.5	11.4	428	50.4	7.15	8580	296	1300	1480	186	14.5	153	238	41.2	378	708
410UB 59.7	406	178	12.8	7.8	11.4	381	48.8	6.65	7640	216	1060	1200	168	12.1	135	209	39.7	337	467
53.7	403	178	10.9	7.6	11.4	381	50.1	7.82	6890	188	933	1060	165	10.3	115	179	38.6	234	394
360UB 56.7	359	172	13.0	8.0	11.4	333	41.6	6.31	7240	161	899	1010	149	11.0	128	198	39.0	338	330
50.7	356	171	11.5	7.3	11.4	333	45.6	7.12	6470	142	798	897	148	9.60	112	173	38.5	241	284
44.7	352	171	9.7	6.9	11.4	333	48.2	8.46	5720	121	689	777	146	8.10	94.7	146	37.6	161	237
310UB 46.2	307	166	11.8	6.7	11.4	284	42.3	6.75	5930	100	654	729	130	9.01	109	166	39.0	233	197
40.4	304	165	10.2	6.1	11.4	284	46.5	7.79	5210	86.4	569	633	129	7.65	92.7	142	38.3	157	165
32.0	298	149	8.0	5.5	13.0	282	51.3	8.97	4080	63.2	424	475	124	4.42	59.3	91.8	32.9	86.5	92.9
250UB 37.3	256	146	10.9	6.4	8.9	234	36.6	6.40	4750	55.7	435	486	108	5.66	77.5	119	34.5	158	85.2
31.4	252	146	8.6	6.1	8.9	234	38.4	8.13	4010	44.5	354	397	105	4.47	61.2	94.2	33.4	89.3	65.9
25.7	248	124	8.0	5.0	12.0	232	46.4	7.44	3270	35.4	285	319	104	2.55	41.1	63.6	27.9	67.4	36.7
200UB 29.8	207	134	9.6	6.3	8.9	188	29.8	6.65	3820	29.1	281	316	87.3	3.86	57.5	88.4	31.8	105	37.6
25.4	203	133	7.8	5.8	8.9	188	32.3	8.15	3230	23.6	232	260	85.4	3.06	46.1	70.9	30.8	62.7	29.2
22.3	202	133	7.0	5.0	8.9	188	37.5	9.14	2870	21.0	208	231	85.5	2.75	41.3	63.4	31.0	45.0	26.0
18.2	198	99	7.0	4.5	11.0	184	40.9	6.75	2320	15.8	160	180	82.6	1.14	23.0	35.7	22.1	38.6	10.4
180UB 22.2	179	90	10.0	6.0	8.9	159	26.5	4.20	2820	15.3	171	195	73.6	1.22	27.1	42.3	20.8	81.6	8.71
18.1	175	90	8.0	5.0	8.9	159	31.8	5.31	2300	12.1	139	157	72.6	0.975	21.7	33.7	20.6	44.8	6.80
16.1	173	90	7.0	4.5	8.9	159	35.3	6.11	2040	10.6	123	138	72.0	0.853	19.0	29.4	20.4	31.5	5.88
150UB 18.0	155	75	9.5	6.0	8.0	136	22.7	3.63	2300	9.05	117	135	62.8	0.672	17.9	28.2	17.1	60.5	3.56
14.0	150	75	7.0	5.0	8.0	136	27.2	5.00	1780	6.66	88.8	102	61.1	0.495	13.2	20.8	16.6	28.1	2.53

TABLE 3.1-3(B)

UNIVERSAL BEAMS
GRADE 300
PROPERTIES FOR ASSESSING SECTION CAPACITY



Designation	Yield Stress Flange f_{yf}	Yield Stress Web f_{yw}	Form Factor k_f	About x-axis Compactness (C, N, S)	About x-axis Z_{ex}	About y-axis Compactness (C, N, S)	About y-axis Z_{ey}
	MPa	MPa			10^3mm^3		10^3mm^3
610UB125	280	300	0.950	C	3680	C	515
113	280	300	0.926	C	3290	C	451
101	300	320	0.888	C	2900	C	386
530UB 92.4	300	320	0.928	C	2370	C	342
82.0	300	320	0.902	C	2070	C	289
460UB 82.1	300	320	0.979	C	1840	C	292
74.6	300	320	0.948	C	1660	C	262
67.1	300	320	0.922	C	1480	C	230
410UB 59.7	300	320	0.938	C	1200	C	203
53.7	320	320	0.913	C	1060	C	173
360UB 56.7	300	320	0.996	C	1010	C	193
50.7	300	320	0.963	C	897	C	168
44.7	320	320	0.930	N	770	N	140
310UB 46.2	300	320	0.991	C	729	C	163
40.4	320	320	0.952	C	633	C	139
32.0	320	320	0.915	N	467	N	86.9
250UB 37.3	320	320	1.00	C	486	C	116
31.4	320	320	1.00	N	395	N	91.4
25.7	320	320	0.949	C	319	C	61.7
200UB 29.8	320	320	1.00	C	316	C	86.3
25.4	320	320	1.00	N	259	N	68.8
22.3	320	320	1.00	N	227	N	60.3
18.2	320	320	0.990	C	180	C	34.4
180UB 22.2	320	320	1.00	C	195	C	40.7
18.1	320	320	1.00	C	157	C	32.5
16.1	320	320	1.00	C	138	C	28.4
150UB 18.0	320	320	1.00	C	135	C	26.9
14.0	320	320	1.00	C	102	C	19.8

Notes: (1) For Grade 300 sections the tensile strength (f_u) is 440 MPa.
(2) C: Compact Section; N: Non-compact Section; S: Slender Section.
(3) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

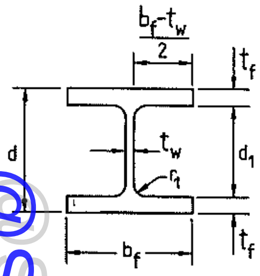
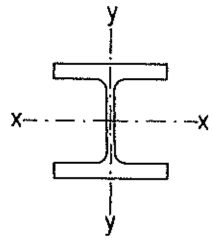


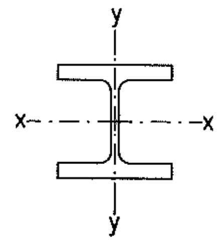
TABLE 3.1-4(A)

UNIVERSAL COLUMNS
DIMENSIONS AND PROPERTIES



Designation	DIMENSIONS						RATIOS		PROPERTIES										
	Depth of Section d	Flange Width b_f	Flange Thickness t_f	Web Thickness t_w	Root Radius r_1	Depth Between Flanges d_1	$\frac{d_1}{t_w}$	$\frac{(b_f - t_w)}{2t_f}$	Gross Section Area A_g	About x-axis I_x	Z_x	S_x	r_x	About y-axis I_y	Z_y	S_y	r_y	Torsion Constant J	Warping Constant I_w
kg/m	mm	mm	mm	mm	mm	mm			mm²	10^6mm⁴	10^3mm³	10^3mm³	mm	10^6mm⁴	10^3mm³	10^3mm³	mm	10^3mm⁴	10^9mm⁶
310UC158	327	311	25.0	15.7	16.5	277	17.7	5.91	20100	388	2370	2680	139	125	807	1230	78.9	3810	2860
137	321	309	21.7	13.8	16.5	277	20.1	6.80	17500	329	2050	2300	137	107	691	1050	78.2	2520	2390
118	315	307	18.7	11.9	16.5	277	23.3	7.89	15000	277	1760	1960	136	90.2	588	893	77.5	1630	1980
96.8	308	305	15.4	9.9	16.5	277	28.0	9.58	12400	223	1450	1600	134	72.9	478	725	76.7	928	1560
250UC 89.5	260	256	17.3	10.5	14.0	225	21.5	7.10	11400	143	1100	1230	112	48.4	378	575	65.2	1040	713
72.9	254	254	14.2	8.6	14.0	225	26.2	8.64	9320	114	897	992	111	38.8	306	463	64.5	586	557
200UC 59.5	210	205	14.2	9.3	11.4	181	19.5	6.89	7620	61.3	584	656	89.7	20.4	199	303	51.7	477	195
52.2	206	204	12.5	8.0	11.4	181	22.7	7.84	6660	52.8	512	570	89.1	17.7	174	264	51.5	325	166
46.2	203	203	11.0	7.3	11.4	181	24.8	8.90	5900	45.9	451	500	88.2	15.3	151	230	51.0	228	142
150UC 37.2	162	154	11.5	8.1	8.9	139	17.1	6.34	4730	22.2	274	310	68.4	7.01	91.0	139	38.5	197	39.6
30.0	158	153	9.4	6.6	8.9	139	21.0	7.79	3860	17.6	223	250	67.5	5.62	73.4	112	38.1	109	30.8
23.4	152	152	6.8	6.1	8.9	139	22.8	10.7	2980	12.6	166	184	65.1	3.98	52.4	80.2	36.6	50.2	21.1
100UC 14.8	97	99	7.0	5.0	10.0	83	16.6	6.71	1890	3.18	65.6	74.4	41.1	1.14	22.9	35.2	24.5	34.9	2.30

TABLE 3.1-4(B)



UNIVERSAL COLUMNS
GRADE 300

PROPERTIES FOR ASSESSING SECTION CAPACITY

Designation	Yield Stress		Form Factor	About x-axis		About y-axis	
	Flange f_{yf}	Web f_{yw}	k_f	Compactness (C, N, S)	Z_{ex}	Compactness (C, N, S)	Z_{ey}
	MPa	MPa			10^3mm^3		10^3mm^3
310UC158	280	300	1.00	C	2680	C	1210
137	280	300	1.00	C	2300	C	1040
118	280	300	1.00	C	1960	C	882
96.8	300	320	1.00	N	1560	N	694
250UC 89.5	280	320	1.00	C	1230	C	567
72.9	300	320	1.00	N	986	N	454
200UC 59.5	300	320	1.00	C	656	C	299
52.2	300	320	1.00	C	570	C	260
46.2	300	320	1.00	N	494	N	223
150UC 37.2	300	320	1.00	C	310	C	137
30.0	320	320	1.00	C	250	C	110
23.4	320	320	1.00	N	176	N	73.5
100UC 14.8	320	320	1.00	C	74.4	C	34.3

Notes: (1) For Grade 300 sections the tensile strength (f_u) is 440 MPa.
(2) C: Compact Section; N: Non-compact Section; S: Slender Section.
(3) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

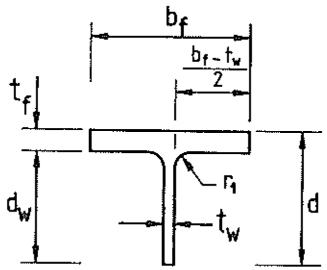
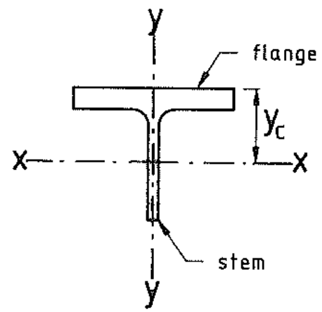


TABLE 3.1-5(A)

TEES CUT FROM UNIVERSAL BEAMS
DIMENSIONS AND PROPERTIES



Designation		From Universal Section	DIMENSIONS: Depth of Section d	Flange Width b_f	Flange Thickness t_f	Web Thickness t_w	Root Radius r_1	Depth to Flange d_w	RATIOS: $\frac{d_w}{t_w}$	$\frac{(b_f - t_w)}{2t_f}$	PROPERTIES: Gross Section Area A_g	Coordinate of Centroid y_c	About x-axis: I_x	Flange Z_x	Stem Z_x	S_x	r_x	About y-axis: I_y	Z_y	S_y	r_y	Torsion Constant J
	kg/m		mm	mm	mm	mm	mm	mm			mm²	mm	10^6mm⁴	10^3mm³	10^3mm³	10^3mm³	mm	10^6mm⁴	10^3mm³	10^3mm³	mm	10^3mm⁴
305BT	62.5	610UB125	305	229	19.6	11.9	14.0	285	24.0	5.54	7970	74.8	68.3	913	297	527	92.6	19.7	172	268	49.7	778
	56.5	113	303	228	17.3	11.2	14.0	285	25.5	6.27	7220	75.6	62.4	825	275	489	92.9	17.1	150	235	48.7	566
	50.5	101	300	228	14.8	10.6	14.0	285	26.9	7.34	6480	77.4	56.7	733	255	456	93.6	14.7	129	201	47.5	393
265BT	46.3	530UB 92.4	266	209	15.6	10.2	14.0	250	24.5	6.37	5890	65.3	38.7	593	193	344	81.1	11.9	114	178	44.9	386
	41.0	82.0	263	209	13.2	9.6	14.0	250	26.0	7.55	5240	66.9	35.0	522	178	318	81.7	10.1	96.3	151	43.8	262
230BT	41.1	460UB 82.1	229	191	16.0	9.9	11.4	213	21.5	5.66	5220	54.4	24.5	451	140	249	68.5	9.31	97.5	152	42.2	349
	37.3	74.6	228	190	14.5	9.1	11.4	213	23.4	6.24	4750	53.8	22.2	413	128	226	68.4	8.30	87.4	136	41.8	264
	33.6	67.1	226	190	12.7	8.5	11.4	213	25.1	7.15	4280	54.2	20.2	372	118	208	68.7	7.27	76.6	119	41.2	188
205BT	29.9	410UB 59.7	202	178	12.8	7.8	11.4	189	24.3	6.65	3810	45.6	13.7	299	87.3	154	59.9	6.03	67.7	105	39.8	168
	26.9	53.7	200	178	10.9	7.6	11.4	189	24.9	7.82	3440	47.5	12.7	267	83.0	147	60.7	5.13	57.7	89.4	38.7	117
180BT	28.4	360UB 56.7	178	172	13.0	8.0	11.4	165	20.7	6.31	3610	39.2	9.68	247	69.6	123	51.7	5.52	64.2	99.2	39.1	168
	25.4	50.7	177	171	11.5	7.3	11.4	165	22.6	7.12	3230	38.9	8.65	223	62.7	110	51.8	4.80	56.1	86.6	38.6	120
	22.4	44.7	175	171	9.7	6.9	11.4	165	24.0	8.46	2860	39.9	7.83	196	57.9	102	52.4	4.05	47.4	73.2	37.7	80.2
155BT	23.1	310UB 46.2	153	166	11.8	6.7	11.4	141	21.0	6.75	2960	30.3	5.30	175	43.4	76.7	42.3	4.50	54.3	83.2	39.0	116
	20.2	40.4	151	165	10.2	6.1	11.4	141	23.1	7.79	2600	30.1	4.69	156	38.8	68.3	42.5	3.82	46.3	71.0	38.4	78.4
	16.0	32.0	148	149	8.0	5.5	13.0	140	25.5	8.97	2030	32.2	3.86	120	33.3	58.7	43.6	2.21	29.7	45.9	33.0	43.1
125BT	18.7	250UB 37.3	127	146	10.9	6.4	8.9	116	18.2	6.40	2370	25.4	2.91	114	28.6	50.8	35.0	2.83	38.8	59.5	34.6	78.7
	15.7	31.4	125	146	8.6	6.1	8.9	116	19.0	8.13	2000	26.5	2.58	97.3	26.2	46.2	35.9	2.23	30.6	47.1	33.4	44.4
	12.9	25.7	123	124	8.0	5.0	12.0	115	23.0	7.44	1630	25.9	2.03	78.6	20.9	36.9	35.3	1.27	20.6	31.8	28.0	33.6
100BT	14.9*	200UB 29.8	103	134	9.6	6.3	8.9	93	14.7	6.65	1910	20.6	1.49	72.3	18.2	32.6	28.0	1.93	28.8	44.2	31.8	52.4
	12.7*	25.4	101	133	7.8	5.8	8.9	93	16.0	8.15	1610	20.8	1.29	62.1	16.2	28.7	28.3	1.53	23.0	35.4	30.8	31.2
	11.2*	22.3	100	133	7.0	5.0	8.9	93	18.6	9.14	1430	19.8	1.11	56.2	13.9	24.5	27.9	1.37	20.7	31.7	31.0	22.4
	9.1	18.2	98	99	7.0	4.5	11.0	91	20.2	6.75	1150	21.0	0.911	43.3	11.8	21.0	28.1	0.568	11.5	17.9	22.2	19.2
90BT	11.1	180UB 22.2	89	90	10.0	6.0	8.9	79	13.1	4.20	1400	19.9	0.857	43.1	12.5	22.6	24.7	0.610	13.6	21.1	20.8	40.6
	9.1	18.1	87	90	8.0	5.0	8.9	79	15.7	5.31	1150	18.9	0.684	36.2	10.1	18.1	24.4	0.488	10.8	16.8	20.6	22.3
	8.1	16.1	86	90	7.0	4.5	8.9	79	17.4	6.11	1020	18.4	0.601	32.6	8.96	16.0	24.3	0.427	9.48	14.7	20.5	15.7
75BT	9.0	150UB 18.0	77	75	9.5	6.0	8.0	67	11.2	3.63	1140	18.3	0.533	29.2	9.16	16.6	21.6	0.336	8.96	14.1	17.2	30.0
	7.0	14.0	74	75	7.0	5.0	8.0	67	13.4	5.00	887	17.6	0.410	23.3	7.26	13.0	21.5	0.247	6.60	10.4	16.7	13.9

Notes: (1) * indicates x- and y-axes are interchanged from that shown on the diagram.
(2) The value of the warping constant, I_w, for Tees is approximately zero.
(3) A 1 mm cutting allowance has been provided off each split tee.

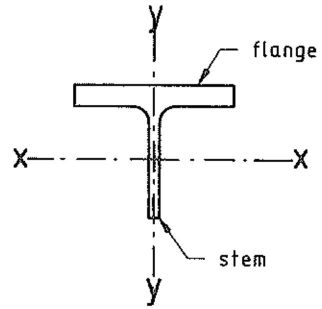


TABLE 3.1-5(B)

TEES CUT FROM UNIVERSAL BEAMS GRADE 300

PROPERTIES FOR ASSESSING SECTION CAPACITY

Designation	Yield Stress Flange f_{yf}	Yield Stress Web f_{yw}	Form Factor k_f	About x-axis Flange Z_{ex}	About x-axis Stem Z_{ex}	About y-axis Z_{ey}
	MPa	MPa		10^3mm^3	10^3mm^3	10^3mm^3
305BT62.5	280	300	0.843	445	288	258
56.5	280	300	0.820	412	237	225
50.5	300	320	0.787	382	183	193
265BT46.3	300	320	0.825	290	168	171
41.0	300	320	0.799	267	137	144
230BT41.1	300	320	0.870	210	146	146
37.3	300	320	0.846	192	121	131
33.6	300	320	0.823	176	97.3	115
205BT29.9	300	320	0.846	131	77.1	102
26.9	320	320	0.819	124	65.2	86.5
180BT28.4	300	320	0.893	104	74.7	96.3
25.4	300	320	0.867	94.0	63.1	84.2
22.4	320	320	0.836	84.6	49.3	70.2
155BT23.1	300	320	0.903	65.0	46.0	81.4
20.2	320	320	0.872	58.2	35.6	69.5
16.0	320	320	0.832	47.3	25.1	43.4
125BT18.7	320	320	0.931	42.9	32.6	58.2
15.7	320	320	0.909	39.0	29.1	45.7
12.9	320	320	0.864	31.4	19.3	30.8
100BT14.9 *	320	320	0.987	27.3	22.9	43.2
12.7 *	320	320	0.961	24.0	19.7	34.4
11.2 *	320	320	0.923	19.5	15.6	30.1
9.1	320	320	0.893	17.8	12.6	17.2
90BT11.1	320	320	1.00	18.7	16.5	20.3
9.1	320	320	0.966	15.2	12.4	16.3
8.1	320	320	0.934	13.4	10.4	14.2
75BT 9.0	320	320	1.00	13.7	12.7	13.4
7.0	320	320	1.00	10.9	9.49	9.89

Notes: (1) * indicates x- and y-axes are interchanged from that shown on the diagam.
(2) For Grade 300 sections the tensile strength (f_u) is 440 MPa.
(3) Z_{ex} Flange — For bending about x-axis which produces compression in the flange.
(4) Z_{ex} Stem — For bending about x-axis which produces compression at the stem.
(5) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

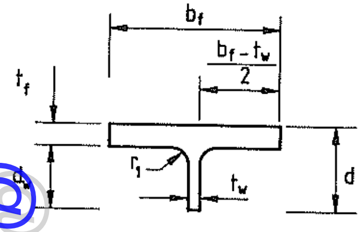
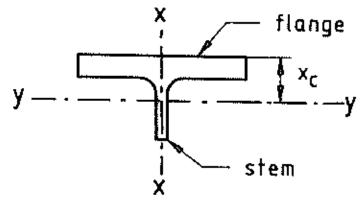


TABLE 3.1-6(A)

TEES CUT FROM UNIVERSAL COLUMNS
DIMENSIONS AND PROPERTIES



Designation	From Universal Section	Depth of Section d	Flange Width b_f	Flange Thickness t_f	Web Thickness t_w	Root Radius r_1	Depth to Flange d_w	$\frac{d_w}{t_w}$	$\frac{(b_f-t_w)}{2t_f}$	Gross Section Area A_g	Coordinate of Centroid x_c	I_y	Flange Z_y	Stem Z_y	S_y	r_y	I_x	Z_x	S_x	r_x	Torsion Constant J
		DIMENSIONS						RATIOS		PROPERTIES		About y-axis					About x-axis				
kg/m		mm	mm	mm	mm	mm	mm			mm^2	mm	10^6mm^4	10^3mm^3	10^3mm^3	10^3mm^3	mm	10^6mm^4	10^3mm^3	10^3mm^3	mm	10^3mm^4
165CT79.0	310UC158	163	311	25.0	15.7	16.5	138	8.76	5.91	10100	30.1	15.0	499	113	222	38.6	62.7	403	614	79.0	1900
68.5	137	159	309	21.7	13.8	16.5	138	10.0	6.80	8720	28.3	12.6	447	96.5	186	38.1	53.4	346	526	78.2	1250
59.0	118	156	307	18.7	11.9	16.5	138	11.6	7.89	7500	26.5	10.5	397	81.2	154	37.5	45.1	294	447	77.6	810
48.4	96.8	153	305	15.4	9.9	16.5	138	13.9	9.58	6180	24.7	8.43	341	65.7	122	36.9	36.4	239	363	76.8	463
125CT44.8	250UC 89.5	129	256	17.3	10.5	14.0	112	10.7	7.10	5690	22.0	5.19	236	48.5	94.3	30.2	24.2	189	287	65.2	521
36.5	72.9	126	254	14.2	8.6	14.0	112	13.0	8.64	4650	20.2	4.07	201	38.5	73.1	29.6	19.4	153	232	64.6	292
100CT29.8	250UC 59.5	104	205	14.2	9.3	11.4	90	9.65	6.89	3800	18.6	2.36	127	27.6	53.2	24.9	10.2	99.5	152	51.8	237
26.1	52.2	102	204	12.5	8.0	11.4	90	11.3	7.84	3320	17.4	1.98	114	23.3	44.4	24.4	8.85	86.8	132	51.6	162
23.1	46.2	101	203	11.0	7.3	11.4	90	12.4	8.90	2940	16.8	1.75	104	20.8	38.9	24.4	7.67	75.6	115	51.1	113
75CT18.6	150UC 37.2	80	154	11.5	8.1	8.9	68	8.44	6.34	2360	15.2	0.909	59.8	14.1	26.9	19.6	3.50	45.5	69.5	38.5	97.9
15.0	30.0	78	153	9.4	6.6	8.9	68	10.4	7.79	1920	13.9	0.707	50.9	11.1	20.8	19.2	2.81	36.7	55.9	38.2	54.3
11.7	23.4	75	152.	6.8	6.1	8.9	68	11.3	10.7	1480	14.1	0.588	41.8	9.62	17.3	19.9	1.99	26.2	40.1	36.6	24.9
50CT 7.4	100UC 14.8	48	99	7.0	5.0	10.0	41	8.10	6.71	938	8.85	0.119	13.5	3.08	6.10	11.3	0.568	11.5	17.6	24.6	17.3

Notes: (1) A 1 mm cutting allowance has been provided off each split tee.
(2) The value of the warping constant, I_w, for Tees is approximately zero.

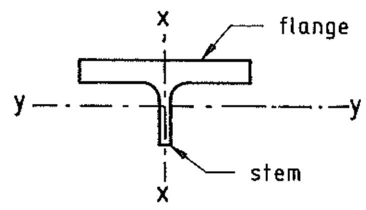


TABLE 3.1-6(B)

TEES CUT FROM UNIVERSAL COLUMNS GRADE 300

PROPERTIES FOR ASSESSING SECTION CAPACITY

Designation	Yield Stress		Form Factor	About y-axis		About x-axis
	Flange f_{yf}	Web f_{yw}	k_f	Flange Z_{ey}	Stem Z_{ey}	Z_{ex}
	MPa	MPa		10^3mm^3	10^3mm^3	10^3mm^3
155CT79.0	280	300	1.00	170	169	605
68.5	280	300	1.00	145	140	518
59.0	280	300	1.00	122	114	441
48.4	300	320	1.00	91.5	85.7	347
125CT44.8	280	320	1.00	72.8	69.3	284
36.5	300	320	1.00	56.4	51.4	227
100CT29.8	300	320	1.00	41.5	40.1	149
26.1	300	320	1.00	35.0	32.6	130
23.1	300	320	1.00	30.1	28.3	112
75CT18.6	300	320	1.00	21.1	21.0	68.3
15.0	320	320	1.00	16.6	15.7	55.1
11.7	320	320	1.00	12.3	13.3	36.8
50CT 7.4	320	320	1.00	4.60	4.60	17.2

Notes: (1) For Grade 300 sections the tensile strength (f_u) is 440 MPa.
(2) Z_{ey} Flange — For bending about y-axis which produces compression in the flange.
(3) Z_{ey} Stem — For bending about y-axis which produces compression at the stem.
(4) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

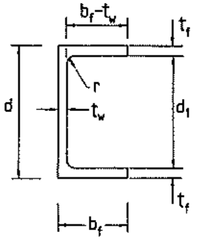
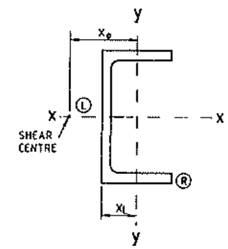


TABLE 3.1-7(A)

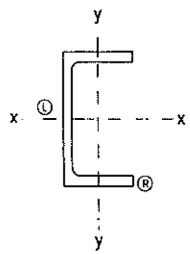
PARALLEL FLANGE CHANNELS
DIMENSIONS AND PROPERTIES



Designation	Mass per m	Depth of Section d	Flange Width b_f	Flange Thickness t_f	Web Thickness t_w	Root Radius r_1	Depth Between Flanges d_1	$\frac{d_1}{t_w}$	$\frac{(b_f-t_w)}{t_f}$	Gross Section Area A_g	Coordinate of Centroid x_L	I_x	Z_x	S_x	r_x	I_y	Z_{yR}	Z_{yL}	S_y	r_y	Torsion Constant J	Warping Constant I_w	Coordinate of Shear Centre x_o
	DIMENSIONS							RATIOS		PROPERTIES		About x-axis				About y-axis							
	kg/m	mm	mm	mm	mm	mm	mm			mm²	mm	10^6mm⁴	10^3mm³	10^3mm³	mm	10^6mm⁴	10^3mm³	10^3mm³	10^3mm³	mm	10^3mm⁴	10^9mm⁶	mm
380 PFC	55.2	380	100	17.5	10.0	14.0	345	34.5	5.14	7030	27.5	152	798	946	147	6.48	89.4	236	161	30.4	472	151	56.7
300 PFC	40.1	300	90	16.0	8.0	14.0	268	33.5	5.12	5110	27.2	72.4	483	564	119	4.04	64.4	149	117	28.1	290	58.2	56.1
250 PFC	35.5	250	90	15.0	8.0	12.0	220	27.5	5.47	4520	28.6	45.1	361	421	99.9	3.64	59.3	128	107	28.4	238	35.8	58.5
230 PFC	25.1	230	75	12.0	6.5	12.0	206	31.7	5.71	3200	22.6	26.8	233	271	91.4	1.76	33.6	77.8	60.9	23.5	108	15.0	46.7
200 PFC	22.9	200	75	12.0	6.0	12.0	176	29.3	5.75	2920	24.4	19.1	191	221	80.9	1.66	32.7	67.8	58.9	23.8	101	10.6	50.1
180 PFC	20.9	180	75	11.0	6.0	12.0	158	26.3	6.27	2660	24.5	14.1	157	182	72.9	1.51	29.9	61.5	53.8	23.8	81.4	7.81	50.3
150 PFC	17.7	150	75	9.5	6.0	10.0	131	21.8	7.26	2250	24.9	8.34	111	129	60.8	1.29	25.7	51.6	46.1	23.9	54.9	4.58	51.0

TABLE 3.1-7(B)

PARALLEL FLANGE CHANNELS
GRADE 300
PROPERTIES FOR ASSESSING SECTION CAPACITY



Designation	mass per metre	Yield Stress Flange f_{yf}	Yield Stress Web f_{yw}	Form Factor k_f	About x-axis Z_{ex}	About y-axis Z_{eyL}	About y-axis Z_{eyR}
	kg/m	MPa	MPa		10^3mm³	10^3mm³	10^3mm³
380 PFC	55.2	280	320	1.00	946	115	134
300 PFC	40.1	300	320	1.00	564	82.3	96.6
250 PFC	35.5	300	320	1.00	421	88.7	89.0
230 PFC	25.1	300	320	1.00	271	45.1	50.4
200 PFC	22.9	300	320	1.00	221	46.7	49.1
180 PFC	20.9	300	320	1.00	182	44.9	44.9
150 PFC	17.7	320	320	1.00	129	38.5	38.5

Notes: (1) For Grade 300 sections the tensile strength (f_u) is 440 MPa.
(2) Z_{eyL} — For bending about the y-axis that causes compression in the web 'L'.
(3) Z_{eyR} — For bending about the y-axis that causes compression in the toe 'R'.
(4) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

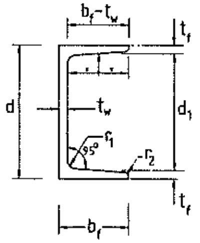
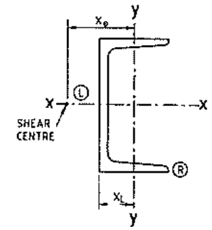


TABLE 3.1-8(A)

TAPER FLANGE CHANNELS

DIMENSIONS AND PROPERTIES



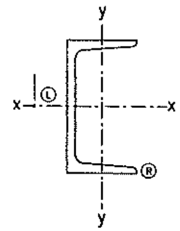
Designation	Mass per metre	Depth of Section d	Flange Width b_f	Flange Thickness t_f	Web Thickness t_w	Radii Root r_1	Radii Toe r_2	Depth Between Flanges d_1	$\frac{d_1}{t_w}$	$\frac{(b_f-t_w)}{t_f}$	Gross Section Area A_g	Coordinate of Centroid x_L	I_x	Z_x	S_x	r_x	I_y	Z_{yR}	Z_{yL}	S_y	r_y	Torsion Constant J	Warping Constant I_w	Coordinate of Shear Centre x_0
		DIMENSIONS							RATIOS		PROPERTIES		About x-axis				About y-axis							
	kg/m	mm	mm	mm	mm	mm	mm	mm			mm²	mm	10^6mm⁴	10^3mm³	10^3mm³	mm	10^6mm⁴	10^3mm³	10^3mm³	10^3mm³	mm	10^3mm⁴	10^9mm⁶	mm
125 TFC	13.4	125	65	8.0	6.0	8.0	4.0	109	18.2	7.37	1710	19.0	4.24	67.8	79.3	49.8	0.618	13.4	32.4	27.4	19.0	35.2	1.74	40.8
100 TFC	9.34	100	50	7.5	5.0	8.0	4.0	85	17.0	6.00	1190	15.4	1.88	37.6	44.3	39.7	0.260	7.52	16.9	15.1	14.8	20.2	0.450	32.1
75 TFC	6.65	75	40	6.5	5.0	8.0	4.0	62	12.4	5.38	847	12.4	0.721	19.2	23.0	29.2	0.115	4.15	9.25	8.52	11.6	12.0	0.109	24.8

PFC

TABLE 3.1-8(B)

TAPER FLANGE CHANNELS
GRADE 250

PROPERTIES FOR ASSESSING SECTION CAPACITY



Designation	Mass per metre	Yield Stress Flange f_{yf}	Yield Stress Web f_{yw}	Form Factor k_f	About x-axis Z_{ex}	About y-axis Z_{eyL}	About y-axis Z_{eyR}
	kg/m	MPa	MPa		10^3mm³	10^3mm³	10^3mm³
125 TFC	13.4	260	260	1.00	79.3	20.2	20.2
100 TFC	9.34	260	260	1.00	44.3	11.3	11.3
75 TFC	6.65	260	260	1.00	23.0	6.22	6.22

Notes: (1) For Grade 250 sections the tensile strength (f_u) is 410 MPa.
(2) Z_{eyL} — For bending about y-axis that causes compression in the web marked 'L'.
(3) Z_{eyR} — For bending about y-axis that causes compression at the toe marked 'R'.

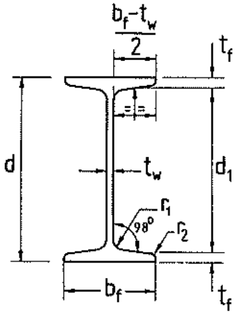
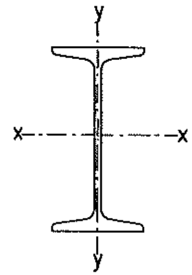


TABLE 3.1-9(A)

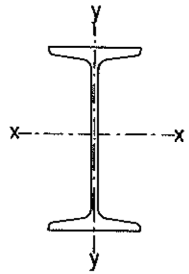
TAPER FLANGE BEAMS
DIMENSIONS AND PROPERTIES



Designation	Mass per metre	Depth of Section d	Flange Width b_f	Flange Thickness t_f	Web Thickness t_w	Radii Root r_1	Radii Toe r_2	Depth Between Flanges d_1	$\frac{d_1}{t_w}$	$\frac{(b_f - t_w)}{2t_f}$	Gross Section Area A_g	I_x	Z_x	S_x	r_x	I_y	Z_y	S_y	r_y	Torsion Constant J	Warping Constant I_w
	DIMENSIONS								RATIOS		PROPERTIES	About x-axis				About y-axis					
	kg/m	mm	mm	mm	mm	mm	mm	mm			mm^2	10^6mm^4	10^3mm^3	10^3mm^3	mm	10^6mm^4	10^3mm^3	10^3mm^3	mm	10^3mm^4	10^9mm^6
125 TFB	13.1	125	65	8.5	5.0	8.0	4.0	108	21.6	3.53	1670	4.34	69.4	80.3	50.9	0.337	10.4	17.2	14.2	40.2	1.14
100 TFB	7.20	100	45	6.0	4.0	7.0	3.0	88	22.0	3.42	917	1.46	29.2	34.1	39.9	0.0795	3.53	6.00	9.31	11.6	0.176

TABLE 3.1-9(B)

TAPER FLANGE BEAMS
GRADE 250
PROPERTIES FOR ASSESSING SECTION CAPACITY



Designation	Mass per metre	Yield Stress Flange f_{yf}	Yield Stress Web f_{yw}	Form Factor k_f	About x-axis Compactness (C, N, S)	About x-axis Z_{ex}	About y-axis Compactness (C, N, S)	About y-axis Z_{ey}
	kg/m	MPa	MPa			10^3mm^3		10^3mm^3
125 TFB	13.1	260	260	1.00	C	80.3	C	15.6
100 TFB	7.20	260	260	1.00	C	34.1	C	5.30

Notes: (1) For Grade 250 sections the tensile strength (f_u) is 410 MPa.
(2) C: Compact Section; N: Non-compact Section; S: Slender Section.

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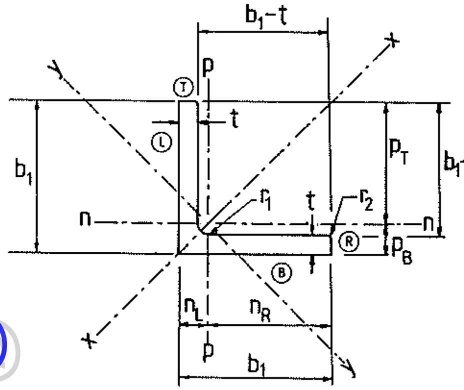
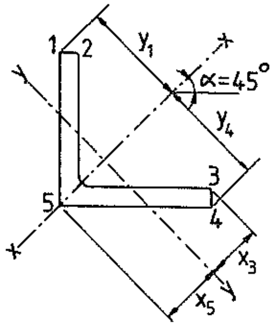


TABLE 3.1-10(A)-1

EQUAL ANGLES
DIMENSIONS AND PROPERTIES
principal x- and y-axes



DIMENSIONS AND RATIOS							PROPERTIES															
Designation: Leg Size $b_1 \times b_1$	Designation: Nominal Thickness	Mass per metre	Actual Thickness t	Root Radius r_1	Toe Radius r_2	$\frac{(b_1-t)}{t}$	Gross Section Area A_g	Coordinate of Centroid $n_L = p_B$	Coordinate of Centroid $n_R = p_T$	About x-axis I_x	About x-axis $y_1 = y_4$	About x-axis $Z_{x1} = Z_{x4}$	About x-axis S_x	About x-axis r_x	About y-axis I_y	About y-axis x_3	About y-axis Z_{y3}	About y-axis x_5	About y-axis Z_{y5}	About y-axis S_y	About y-axis r_y	Torsion constant J
mm mm	mm	kg/m	mm	mm	mm		mm²	mm	mm	10^6mm⁴	mm	10^3mm³	10^3mm³	mm	10^6mm⁴	mm	10^3mm³	mm	10^3mm³	10^3mm³	mm	10^3mm⁴
200 x 200 x	26EA	76.8	26.0	18.0	5.0	6.69	9780	59.3	141	56.8	141	402	643	76.2	14.9	73.9	202	83.8	178	329	39.1	2250
	20EA	60.1	20.0	18.0	5.0	9.00	7660	57.0	143	45.7	141	323	511	77.2	11.8	72.9	163	80.6	147	260	39.3	1060
	18EA	54.4	18.0	18.0	5.0	10.1	6930	56.2	144	41.7	141	295	464	77.6	10.8	72.6	149	79.5	136	236	39.5	778
	16EA	48.7	16.0	18.0	5.0	11.5	6200	55.4	145	37.6	141	266	417	77.9	9.73	72.3	135	78.4	124	212	39.6	554
	13EA	40.0	13.0	18.0	5.0	14.4	5090	54.2	146	31.2	141	221	344	78.3	8.08	71.9	112	76.6	105	176	39.9	304
150 x 150 x	19EA	42.1	19.0	13.0	5.0	6.89	5360	44.2	106	17.6	106	166	265	57.2	4.60	54.9	83.8	62.6	73.5	135	29.3	657
	16EA	35.4	15.8	13.0	5.0	8.49	4520	43.0	107	15.1	106	142	225	57.8	3.91	54.3	71.9	60.8	64.2	115	29.4	386
	12EA	27.3	12.0	13.0	5.0	11.5	3480	41.5	108	11.9	106	112	175	58.4	3.06	53.7	57.0	58.7	52.1	89.3	29.6	174
	10EA	21.9	9.5	13.0	5.0	14.8	2790	40.5	109	9.61	106	90.6	141	58.7	2.48	53.4	46.4	57.3	43.3	72.0	29.8	88.9
125 x 125 x	16EA	29.1	15.8	10.0	5.0	6.91	3710	36.8	88.2	8.43	88.4	95.4	153	47.7	2.20	45.4	48.5	52.1	42.3	77.8	24.4	313
	12EA	22.5	12.0	10.0	5.0	9.42	2870	35.4	89.6	6.69	88.4	75.7	120	48.3	1.73	44.7	38.6	50.1	34.5	60.8	24.5	141
	10EA	18.0	9.5	10.0	5.0	12.2	2300	34.4	90.6	5.44	88.4	61.6	96.5	48.7	1.40	44.4	31.5	48.7	28.8	49.0	24.7	71.9
	8EA	14.9	7.8	10.0	5.0	15.0	1900	33.7	91.3	4.55	88.4	51.5	80.2	48.9	1.17	44.2	26.5	47.7	24.6	40.8	24.8	40.6

Note: The value of the warping constant, I_w, for angles is approximately zero.

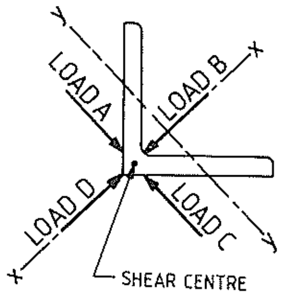


TABLE 3.1-10(B)-1

EQUAL ANGLES
GRADE 300

PROPERTIES FOR ASSESSING SECTION CAPACITY

Designation	Yield Stress f_y	Form Factor k_f	About x-axis: Load A or C Z_{ex}	About y-axis: Load B Z_{ey}	About y-axis: Load D Z_{ey}
	MPa	10^3 mm³	10^3 mm³	10^3 mm³	10^3mm³
200 x 200 x 26EA	280	1.00	602	267	267
20EA	280	1.00	479	218	221
18EA	280	1.00	427	197	204
16EA	280	1.00	369	172	186
13EA	280	1.00	285	136	158
150 x 150 x 19EA	280	1.00	248	110	110
16EA	300	1.00	212	95.7	96.3
12EA	300	1.00	155	72.3	78.1
10EA	320	0.958	114	54.5	65.0
125 x 125 x 16EA	300	1.00	143	63.4	63.4
12EA	300	1.00	110	50.3	51.7
10EA	320	1.00	83.2	38.9	43.1
8EA	320	0.943	64.3	30.7	36.8

Notes: (1) For Grade 300 sections the tensile strength(f_u) is 440 MPa.
(2) The values of Z_{ex} & Z_{ey} depend on the direction of the bending moment. The appropriate value depends on the direction of the load (A, B, C or D) as shown in the diagram.
(3) Grade 300 refers to BHP Grade 300PLUS™. See note (1) on page 2-2.

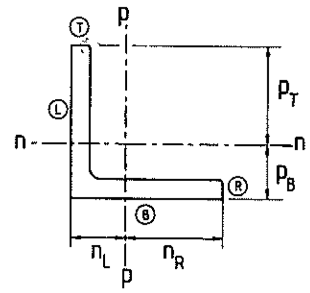


TABLE 3.1-10(C)-1

EQUAL ANGLES
DIMENSIONS AND PROPERTIES
non-principal n- and p-axes

Designation	$I_n=I_p$	$n_L=p_B$	$Z_{nB}=Z_{pL}$	$n_R=p_T$	$Z_{nT}=Z_{pR}$	$S_n=S_p$	$r_n=r_p$	Product 2nd Moment of Area I_{np}
	10^6mm⁴	mm	10^3mm³	mm	10^3mm³	10^3mm³	mm	10^6mm⁴
200 x 200 x 26EA	35.8	59.3	605	141	255	460	60.5	-20.9
20EA	28.8	57.0	505	143	201	363	61.3	-16.9
18EA	26.3	56.2	467	144	183	330	61.5	-15.5
16EA	23.7	55.4	427	145	164	296	61.8	-14.0
13EA	19.7	54.2	363	146	135	243	62.2	-11.6
150 x 150 x 19EA	11.1	44.2	250	106	105	189	45.4	-6.48
16EA	9.48	43.0	220	107	88.7	160	45.8	-5.58
12EA	7.46	41.5	180	108	68.8	124	46.3	-4.40
10EA	6.04	40.5	149	109	55.2	99.9	46.6	-3.56
125 x 125 x 16EA	5.32	36.8	144	88.2	60.3	109	37.9	-3.11
12EA	4.21	35.4	119	89.6	47.0	85.0	38.3	-2.48
10EA	3.42	34.4	99.4	90.6	37.8	68.4	38.6	-2.02
8EA	2.86	33.7	84.9	91.3	31.3	56.8	38.8	-1.69

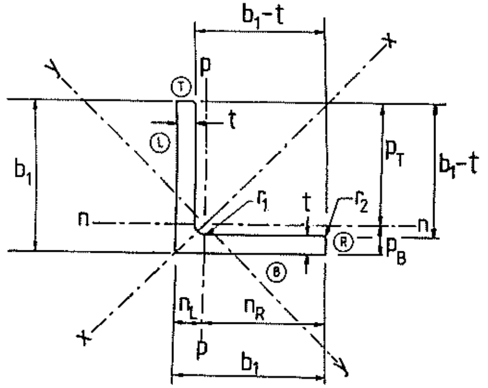
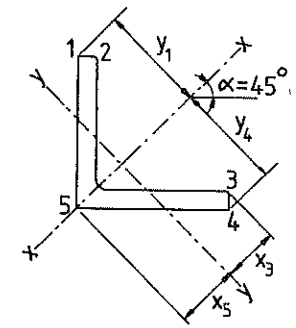


TABLE 3.1-10(A)-2

EQUAL ANGLES
DIMENSIONS AND PROPERTIES
principal x- and y- axes



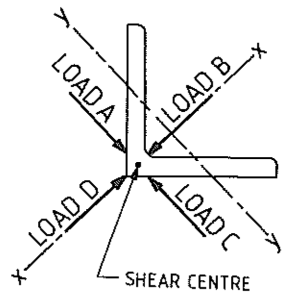
Designation Leg Size $b_1 \times b_1$ Nominal Thickness	Mass per metre	Actual Thickness t	Root Radius r_1	Toe Radius r_2	$\frac{(b_1-t)}{t}$	Gross Section Area A_g	$n_L = p_B$	$n_R = p_T$	I_x	$y_1 = y_4$	$Z_{x1} = Z_{x4}$	S_x	r_x	I_y	x_3	Z_{y3}	x_5	Z_{y5}	S_y	r_y	Torsion constant J
mm mm mm	kg/m	mm	mm	mm		mm²	mm	mm	10⁶mm⁴	mm	10³mm³	10³mm³	mm	10⁶mm⁴	mm	10³mm³	mm	10³mm³	10³mm³	mm	10³mm³
100 x 100 x 12EA	17.7	12.0	8.0	5.0	7.33	2260	29.2	70.8	3.29	70.7	46.6	74.5	38.2	0.857	35.8	23.9	41.3	20.8	37.9	19.5	110
10EA	14.2	9.5	8.0	5.0	9.53	1810	28.2	71.8	2.70	70.7	38.2	60.4	38.6	0.696	35.4	19.6	39.9	17.4	30.7	19.6	56.2
8EA	11.8	7.8	8.0	5.0	11.8	1500	27.5	72.5	2.27	70.7	32.0	50.3	38.8	0.582	35.2	16.5	38.9	14.9	25.6	19.7	31.7
6EA	9.16	6.0	8.0	5.0	15.7	1170	26.8	73.2	1.78	70.7	25.2	39.3	39.1	0.458	35.0	13.1	37.9	12.1	20.0	19.8	14.8
90 x 90 x 10EA	12.7	9.5	8.0	5.0	8.47	1620	25.7	64.3	1.93	63.6	30.4	48.3	34.5	0.501	31.9	15.7	36.4	13.8	24.6	17.6	50.5
8EA	10.6	7.8	8.0	5.0	10.5	1350	25.0	65.0	1.63	63.6	25.6	40.4	34.8	0.419	31.7	13.2	35.4	11.8	20.5	17.6	28.6
6EA	8.22	6.0	8.0	5.0	14.0	1050	24.3	65.7	1.28	63.6	20.1	31.6	35.0	0.330	31.5	10.5	34.3	9.62	16.1	17.8	13.4
75 x 75 x 10EA	10.5	9.5	8.0	5.0	6.89	1340	22.0	53.0	1.08	53.0	20.4	32.8	28.4	0.283	26.6	10.6	31.1	9.09	16.8	14.5	41.9
8EA	8.73	7.8	8.0	5.0	8.62	1110	21.3	53.7	0.913	53.0	17.2	27.5	28.7	0.237	26.4	8.99	30.1	7.87	14.0	14.6	23.8
6EA	6.81	6.0	8.0	5.0	11.5	867	20.5	54.5	0.722	53.0	13.6	21.6	28.9	0.187	26.2	7.15	29.0	6.44	11.0	14.7	11.2
5EA	5.27	4.6	8.0	5.0	15.3	672	19.9	55.1	0.563	53.0	10.6	16.7	29.0	0.147	26.1	5.62	28.1	5.22	8.61	14.8	5.28
65 x 65 x 10EA	9.02	9.5	6.0	3.0	5.84	1150	19.6	45.4	0.691	46.0	15.0	24.3	24.5	0.183	23.7	7.71	27.7	6.60	12.5	12.6	35.1
8EA	7.51	7.8	6.0	3.0	7.33	957	19.0	46.0	0.589	46.0	12.8	20.5	24.8	0.154	23.4	6.56	26.8	5.73	10.5	12.7	20.0
6EA	5.87	6.0	6.0	3.0	9.83	748	18.3	46.7	0.471	46.0	10.2	16.2	25.1	0.122	23.1	5.26	25.8	4.71	8.25	12.8	9.37
5EA	4.56	4.6	6.0	3.0	13.1	581	17.7	47.3	0.371	46.0	8.08	12.7	25.3	0.0959	23.0	4.18	25.0	3.84	6.46	12.9	4.36
55 x 55 x 6EA	4.93	6.0	6.0	3.0	8.17	628	15.8	39.2	0.277	38.9	7.14	11.4	21.0	0.0723	19.6	3.69	22.3	3.24	5.82	10.7	7.93
5EA	3.84	4.6	6.0	3.0	11.0	489	15.2	39.8	0.220	38.9	5.65	8.93	21.2	0.0571	19.4	2.94	21.5	2.66	4.57	10.8	3.71
50 x 50 x 8EA	5.68	7.8	6.0	3.0	5.41	723	15.2	34.8	0.253	35.4	7.16	11.7	18.7	0.0675	18.1	3.73	21.5	3.14	6.00	9.66	15.2
6EA	4.46	6.0	6.0	3.0	7.33	568	14.5	35.5	0.205	35.4	5.79	9.30	19.0	0.0536	17.8	3.01	20.5	2.61	4.76	9.72	7.21
5EA	3.48	4.6	6.0	3.0	9.87	443	13.9	36.1	0.163	35.4	4.60	7.32	19.2	0.0424	17.6	2.40	19.7	2.15	3.75	9.79	3.38
3EA	2.31	3.0	6.0	3.0	15.7	295	13.2	36.8	0.110	35.4	3.11	4.90	19.3	0.0289	17.6	1.65	18.7	1.55	2.53	9.90	1.10
45 x 45 x 6EA	3.97	6.0	5.0	3.0	6.50	506	13.3	31.7	0.146	31.8	4.59	7.41	17.0	0.0383	16.0	2.39	18.8	2.04	3.79	8.71	6.32
5EA	3.10	4.6	5.0	3.0	8.78	394	12.7	32.3	0.117	31.8	3.66	5.84	17.2	0.0303	15.8	1.91	18.0	1.68	2.99	8.76	2.96
3EA	2.06	3.0	5.0	3.0	14.0	263	12.0	33.0	0.0790	31.8	2.48	3.92	17.3	0.0206	15.7	1.31	17.0	1.21	2.02	8.85	0.875
40 x 40 x 6EA	3.50	6.0	5.0	3.0	5.67	446	12.0	28.0	0.0997	28.3	3.53	5.75	15.0	0.0265	14.3	1.86	17.0	1.55	2.95	7.71	5.60
5EA	2.73	4.6	5.0	3.0	7.70	348	11.5	28.5	0.0800	28.3	2.83	4.55	15.2	0.0209	14.0	1.49	16.2	1.29	2.33	7.75	2.63
3EA	1.83	3.0	5.0	3.0	12.3	233	10.8	29.2	0.0545	28.3	1.93	3.06	15.3	0.0142	13.9	1.02	15.3	0.934	1.58	7.83	0.785
30 x 30 x 6EA	2.56	6.0	5.0	3.0	4.00	326	9.53	20.5	0.0387	21.2	1.83	3.06	10.9	0.0107	10.7	0.993	13.5	0.791	1.59	5.72	4.16
5EA	2.01	4.6	5.0	3.0	5.52	256	8.99	21.0	0.0316	21.2	1.49	2.45	11.1	0.00839	10.5	0.799	12.7	0.660	1.26	5.72	1.98
3EA	1.35	3.0	5.0	3.0	9.00	173	8.30	21.7	0.0218	21.2	1.03	1.67	11.2	0.00574	10.3	0.554	11.7	0.488	0.862	5.77	0.605
25 x 25 x 6EA	2.08	6.0	5.0	3.0	3.17	266	8.28	16.7	0.0210	17.7	1.19	2.03	8.89	0.00600	8.97	0.669	11.7	0.512	1.07	4.75	3.44
5EA	1.65	4.6	5.0	3.0	4.43	210	7.75	17.3	0.0173	17.7	0.980	1.65	9.07	0.00469	8.73	0.537	11.0	0.428	0.849	4.72	1.66
3EA	1.12	3.0	5.0	3.0	7.33	143	7.07	17.9	0.0121	17.7	0.684	1.13	9.21	0.00319	8.56	0.373	9.99	0.319	0.583	4.73	0.515

Note: The value of the warping constant, I_w, for angles is approximately zero.

TABLE 3.1-10(B)-2

EQUAL ANGLES
GRADE 250

PROPERTIES FOR ASSESSING SECTION CAPACITY



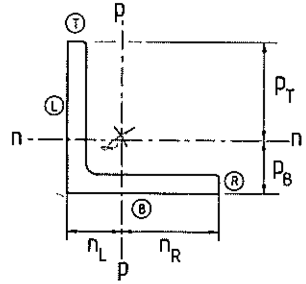
Designation	Yield Stress f_y	Form Factor k_f	About x-axis: Load A or C Z_{ex}	About y-axis: Load B Z_{ey}	About y-axis: Load D Z_{ey}
	MPa		10^3mm³	10^3mm³	10^3mm³
100 x 100 x 12EA	260	1.00	69.9	31.1	31.1
10EA	260	1.00	56.4	25.8	26.1
8EA	260	1.00	45.0	21.0	22.4
6EA	260	1.00	32.3	15.5	18.1
90 x 90 x 10EA	260	1.00	45.6	20.6	20.6
8EA	260	1.00	36.9	17.1	17.8
6EA	260	1.00	26.9	12.8	14.4
75 x 75 x 10EA	260	1.00	30.5	13.6	13.6
8EA	260	1.00	25.8	11.8	11.8
6EA	260	1.00	19.3	9.12	9.67
5EA	260	1.00	13.7	6.75	7.83
65 x 65 x 10EA	260	1.00	22.5	9.90	9.90
8EA	260	1.00	19.2	8.60	8.60
6EA	260	1.00	15.0	6.92	7.07
5EA	260	1.00	11.0	5.23	5.75
55 x 55 x 6EA	260	1.00	10.7	4.86	4.86
5EA	260	1.00	8.10	3.81	3.99
50 x 50 x 8EA	260	1.00	10.7	4.71	4.71
6EA	260	1.00	8.69	3.92	3.92
5EA	260	1.00	6.76	3.15	3.23
3EA	260	1.00	3.99	1.98	2.32
45 x 45 x 6EA	260	1.00	6.88	3.06	3.06
5EA	260	1.00	5.49	2.52	2.52
3EA	260	1.00	3.31	1.61	1.81
40 x 40 x 6EA	260	1.00	5.29	2.33	2.33
5EA	260	1.00	4.24	1.93	1.93
3EA	260	1.00	2.68	1.30	1.40
30 x 30 x 6EA	260	1.00	2.74	1.19	1.19
5EA	260	1.00	2.23	0.990	0.990
3EA	260	1.00	1.54	0.730	0.733
25 x 25 x 6EA	260	1.00	1.78	0.769	0.769
5EA	260	1.00	1.47	0.642	0.642
3EA	260	1.00	1.03	0.479	0.479

Notes: (1) For Grade 250 sections the tensile strength (f_u) is 410 MPa.
(2) The values of Z_{ex} and Z_{ey} depend on the direction of the bending moment. The appropriate value depends on the direction of the load (A, B, C or D) as shown in the diagram.

TABLE 3.1-10(C)-2

EQUAL ANGLES

DIMENSIONS AND PROPERTIES
non-principal n- and p-axes



Designation	About n- and p-axes: $I_n=I_p$	$n_L=p_B$	$Z_{nB}=Z_{pL}$	$n_R=p_T$	$Z_{nT}=Z_{pR}$	$S_n=S_p$	$r_n=r_p$	Product 2nd Moment of Area I_{np}
	10^6mm⁴	mm	10^3mm³	mm	10^3mm³	10^3mm³	mm	10^6mm⁴
100 x 100 x 12EA	2.08	29.2	71.1	70.8	29.3	53.2	30.3	-1.22
10EA	1.70	28.2	60.1	71.8	23.6	42.9	30.6	-1.00
8EA	1.42	27.5	51.7	72.5	19.6	35.7	30.8	-0.842
6EA	1.12	26.8	41.8	73.2	15.3	27.8	31.0	-0.661
90 x 90 x 10EA	1.22	25.7	47.3	64.3	18.9	34.4	27.4	-0.716
8EA	1.02	25.0	40.9	65.0	15.7	28.7	27.6	-0.604
6EA	0.805	24.3	33.2	65.7	12.3	22.4	27.7	-0.475
75 x 75 x 10EA	0.681	22.0	31.0	53.0	12.8	23.4	22.6	-0.399
8EA	0.575	21.3	27.0	53.7	10.7	19.5	22.7	-0.338
6EA	0.455	20.5	22.1	54.5	8.35	15.3	22.9	-0.268
5EA	0.355	19.9	17.9	55.1	6.44	11.8	23.0	-0.208
65 x 65 x 10EA	0.437	19.6	22.3	45.4	9.62	17.4	19.5	-0.254
8EA	0.371	19.0	19.6	46.0	8.07	14.6	19.7	-0.218
6EA	0.296	18.3	16.2	46.7	6.34	11.5	19.9	-0.175
5EA	0.234	17.7	13.2	47.3	4.94	8.97	20.1	-0.138
55 x 55 x 6EA	0.175	15.8	11.1	39.2	4.46	8.11	16.7	-0.103
5EA	0.139	15.2	9.12	39.8	3.48	6.34	16.8	-0.0814
50 x 50 x 8EA	0.160	15.2	10.5	34.8	4.61	8.38	14.9	-0.0928
6EA	0.129	14.5	8.90	35.5	3.64	6.63	15.1	-0.0756
5EA	0.103	13.9	7.36	36.1	2.85	5.19	15.2	-0.0602
3EA	0.0694	13.2	5.25	36.8	1.89	3.46	15.3	-0.0405
45 x 45 x 6EA	0.0922	13.3	6.93	31.7	2.91	5.30	13.5	-0.0538
5EA	0.0734	12.7	5.76	32.3	2.28	4.16	13.6	-0.0431
3EA	0.0498	12.0	4.14	33.0	1.51	2.77	13.8	-0.0292
40 x 40 x 6EA	0.0631	12.0	5.24	28.0	2.26	4.12	11.9	-0.0366
5EA	0.0505	11.5	4.39	28.5	1.77	3.24	12.0	-0.0296
3EA	0.0344	10.8	3.19	29.2	1.18	2.17	12.2	-0.0201
30 x 30 x 6EA	0.0247	9.53	2.59	20.5	1.21	2.22	8.71	-0.0140
5EA	0.0200	8.99	2.22	21.0	0.951	1.76	8.83	-0.0116
3EA	0.0138	8.30	1.66	21.7	0.635	1.18	8.93	-0.00804
25 x 25 x 6EA	0.0135	8.28	1.63	16.7	0.807	1.49	7.13	-0.00750
5EA	0.0110	7.75	1.42	17.3	0.638	1.19	7.23	-0.00632
3EA	0.00765	7.07	1.08	17.9	0.426	0.802	7.33	-0.00445

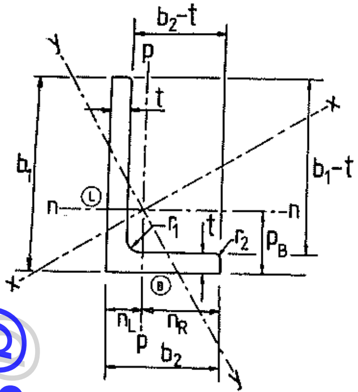
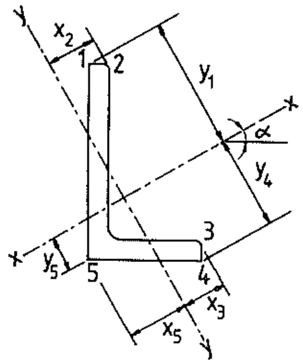


TABLE 3.1-11(A)

UNEQUAL ANGLES
DIMENSIONS AND PROPERTIES
principal x- and y-axes

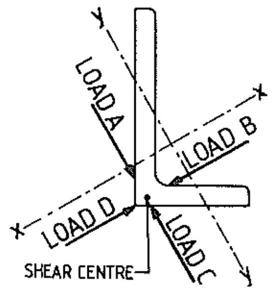


Designation: Leg Size $b_1 \times b_2$ (mm × mm)	Nominal Thickness (mm)	Mass per metre (kg/m)	Actual Thickness t (mm)	Root Radius r_1 (mm)	Toe Radius r_2 (mm)	$\frac{b_1-t}{t}$	$\frac{b_2-t}{t}$	Gross Section Area A_g (mm²)	p_B (mm)	n_L (mm)	I_x (10⁶mm⁴)	y_1 (mm)	Z_{x1} (10³mm³)	y_4 (mm)	Z_{x4} (10³mm³)	y_5 (mm)	Z_{x5} (10³mm³)	S_x (10³mm³)	r_x (mm)	I_y (10⁶mm⁴)	x_2 (mm)	Z_{y2} (10³mm³)	x_3 (mm)	Z_{y3} (10³mm³)	x_5 (mm)	Z_{y5} (10³mm³)	S_y (10³mm³)	r_y (mm)	Torsion constant J (10³mm⁴)	Tan α
150 x 100	12UA	22.5	12.0	10.0	5.0	11.5	7.33	2870	49.1	24.3	7.51	102	73.5	75.3	99.7	35.2	213	127	51.2	1.35	27.6	48.8	52.9	25.5	42.0	32.1	51.7	21.7	141	0.438
	10UA	18.0	9.5	10.0	5.0	14.8	9.53	2300	48.1	23.3	6.11	103	59.5	74.9	81.5	34.6	176	102	51.6	1.09	26.9	40.7	53.0	20.6	40.7	26.9	41.8	21.8	71.9	0.441
150 x 90	16UA	27.9	15.8	10.0	5.0	8.49	4.70	3550	52.5	22.7	8.80	99.5	88.4	71.9	122	41.9	210	154	49.8	1.32	24.6	53.8	49.9	26.5	38.9	34.0	55.9	19.3	300	0.353
	12UA	21.6	12.0	10.0	5.0	11.5	6.50	2750	51.0	21.2	6.97	100	69.4	71.2	97.8	40.8	171	120	50.4	1.04	23.4	44.5	50.1	20.8	37.2	28.0	43.8	19.5	136	0.359
	10UA	17.3	9.5	10.0	5.0	14.8	8.47	2200	50.0	20.2	5.66	101	56.1	70.7	80.1	40.1	141	96.6	50.7	0.847	22.6	37.5	50.4	16.8	36.1	23.5	35.4	19.6	69.0	0.363
	8UA	14.3	7.8	10.0	5.0	18.2	10.5	1820	49.2	19.6	4.73	101	46.7	70.3	67.3	39.5	120	80.1	51.0	0.710	22.0	32.2	50.6	14.0	35.2	20.2	30.0	19.7	39.0	0.364
125 x 75	12UA	17.7	12.0	8.0	5.0	9.42	5.25	2260	43.3	18.4	3.91	83.2	47.0	59.7	65.5	34.6	113	81.4	41.6	0.585	19.9	29.4	41.4	14.1	31.9	18.4	29.7	16.1	110	0.356
	10UA	14.2	9.5	8.0	5.0	12.2	6.89	1810	42.3	17.5	3.20	83.8	38.2	59.3	53.9	33.9	94.4	65.8	42.0	0.476	19.1	24.9	41.6	11.4	30.7	15.5	24.1	16.2	56.2	0.360
	8UA	11.8	7.8	8.0	5.0	15.0	8.62	1500	41.5	16.8	2.68	84.2	31.8	58.9	45.5	33.3	80.3	54.6	42.2	0.400	18.6	21.5	41.8	9.55	29.9	13.3	20.1	16.3	31.7	0.363
	6UA	9.16	6.0	8.0	5.0	19.8	11.5	1170	40.7	16.0	2.10	84.7	24.8	58.5	36.0	32.8	64.1	42.4	42.4	0.315	18.0	17.5	42.1	7.47	29.0	10.9	15.7	16.4	14.8	0.364
100 x 75	10UA	12.4	9.5	8.0	5.0	9.53	6.89	1580	31.8	19.4	1.89	69.2	27.3	54.5	34.6	18.6	101	46.5	34.6	0.402	22.3	18.0	36.4	11.0	32.2	12.5	21.2	16.0	49.1	0.546
	8UA	10.3	7.8	8.0	5.0	11.8	8.62	1310	31.1	18.7	1.59	69.4	22.9	54.3	29.2	18.2	87.0	38.7	34.8	0.337	21.8	15.4	36.4	9.26	31.3	10.7	17.8	16.1	27.8	0.549
	6UA	7.98	6.0	8.0	5.0	15.7	11.5	1020	30.3	17.9	1.25	69.7	17.9	54.0	23.1	17.9	69.9	30.1	35.1	0.266	21.4	12.4	36.5	7.28	30.3	8.76	13.9	16.2	13.0	0.550
75 x 50	8UA	7.23	7.8	7.0	3.0	8.62	5.41	921	25.2	12.8	0.586	50.8	11.5	37.8	15.5	18.0	32.5	20.0	25.2	0.106	14.2	7.47	26.4	4.02	21.7	4.88	8.19	10.7	19.5	0.430
	6UA	5.66	6.0	7.0	3.0	11.5	7.33	721	24.4	12.1	0.468	51.2	9.15	37.5	12.5	17.6	26.7	15.8	25.5	0.0843	13.6	6.18	26.5	3.18	20.8	4.05	6.48	10.8	9.21	0.435
	5UA	4.40	4.6	7.0	3.0	15.3	9.87	560	23.8	11.5	0.370	51.5	7.17	37.2	9.93	17.2	21.5	12.3	25.7	0.0667	13.2	5.05	26.6	2.50	20.1	3.32	5.09	10.9	4.32	0.437
65 x 50	8UA	6.59	7.8	6.0	3.0	7.33	5.41	840	21.1	13.6	0.421	44.9	9.37	36.3	11.6	11.6	36.4	16.1	22.4	0.0936	15.6	6.00	23.9	3.91	22.3	4.20	7.49	10.6	17.6	0.570
	6UA	5.16	6.0	6.0	3.0	9.83	7.33	658	20.4	12.9	0.338	45.2	7.48	36.1	9.35	11.2	30.2	12.7	22.7	0.0744	15.1	4.91	23.9	3.11	21.4	3.48	5.93	10.6	8.29	0.575
	5UA	4.02	4.6	6.0	3.0	13.1	9.87	512	19.8	12.4	0.267	45.4	5.89	35.9	7.43	10.9	24.4	9.92	22.8	0.0587	14.8	3.97	23.9	2.46	20.6	2.85	4.66	10.7	3.87	0.577

Note: The value of the warping constant, I_w, for angles is approximately zero.

TABLE 3.1-11(B)

UNEQUAL ANGLES
GRADE 300 & 250
PROPERTIES FOR ASSESSING SECTION CAPACITY

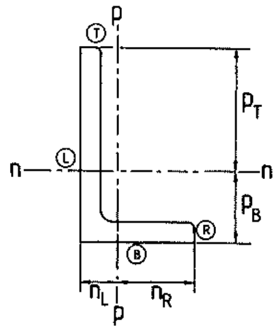


Designation	Yield Stress f_y	Form Factor k_f	About x-axis: Load A Z_{ex}	About x-axis: Load C Z_{ex}	About y-axis: Load B Z_{ey}	About y-axis: Load D Z_{ey}
	MPa		10^3mm^3	10^3mm^3	10^3mm^3	10^3mm^3
150 x 100 x 12UA	300	1.00	102	110	35.3	38.2
10UA	320	0.975	74.8	81.7	26.0	31.0
150 x 90 x 16UA	300	1.00	132	133	39.5	39.8
12UA	300	1.00	96.3	104	28.8	31.2
10UA	320	0.973	70.6	81.8	21.2	25.2
8UA	320	0.863	53.0	60.3	15.9	21.0
125 x 75 x 12UA	260	1.00	69.7	70.5	20.9	21.2
10UA	260	1.00	53.2	57.2	15.9	17.2
8UA	260	1.00	41.5	47.7	12.4	14.3
6UA	260	0.872	28.5	32.4	8.59	11.2
100 x 75 x 10UA	260	1.00	40.3	40.9	16.3	16.6
8UA	260	1.00	32.1	34.3	13.0	13.9
6UA	260	1.00	23.0	23.4	9.33	10.9
75 x 50 x 8UA	260	1.00	17.3	17.3	6.02	6.02
6UA	260	1.00	12.9	13.7	4.51	4.78
5UA	260	1.00	9.27	10.2	3.24	3.76
65 x 50 x 8UA	260	1.00	14.0	14.0	5.87	5.87
6UA	260	1.00	11.0	11.2	4.57	4.67
5UA	260	1.00	8.02	8.38	3.35	3.69

Notes: (1) For 150 x 90 angles and above: Grade 300.
(2) For 125 x 75 angles and below: Grade 250.
(3) For Grade 250 sections the tensile strength (f_u) is 410 MPa.
(4) For Grade 300 sections the tensile strength (f_u) is 440 MPa.
(5) The values of Z_{ex} and Z_{ey} depend on the direction of the bending moment. The appropriate value depends on the direction of the load (A, B, C or D) as shown in the diagram.
(6) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

TABLE 3.1-11(C)

UNEQUAL ANGLES
DIMENSIONS AND PROPERTIES
non-principal n- and p-axes



Designation	About n-axis							About p-axis							Product 2nd Moment of Area
	I_n	p_B	Z_{nB}	p_T	Z_{nT}	S_n	r_n	I_p	n_L	Z_{pL}	n_R	Z_{pR}	S_p	r_p	I_{np}
	10^6mm^4	mm	10^3mm^3	mm	10^3mm^3	10^3mm^3	mm	10^6mm^4	mm	10^3mm^3	mm	10^3mm^3	10^3mm^3	mm	10^6mm^4
150 x 100 x 12UA	6.52	49.1	133	101	64.6	117	47.7	2.34	24.3	96.2	75.7	30.9	56.0	28.6	-2.27
10UA	5.29	48.1	110	102	51.9	94.0	48.0	1.91	23.3	81.9	76.7	24.9	44.7	28.8	-1.85
150 x 90 x 16UA	7.97	52.5	152	97.5	81.7	145	47.4	2.15	22.7	94.9	67.3	32.0	59.6	24.6	-2.35
12UA	6.29	51.0	123	99.0	63.5	114	47.8	1.72	21.2	81.0	68.8	25.0	45.8	25.0	-1.89
10UA	5.10	50.0	102	100	51.0	91.5	48.2	1.41	20.2	69.5	69.8	20.2	36.5	25.3	-1.54
8UA	4.26	49.2	86.6	101	42.3	76.0	48.4	1.18	19.6	60.4	70.4	16.8	30.1	25.5	-1.29
125 x 75 x 12UA	3.54	43.3	81.8	81.7	43.3	77.3	39.6	0.958	18.4	52.0	56.6	16.9	31.4	20.6	-1.05
10UA	2.88	42.3	68.2	82.7	34.9	62.5	39.9	0.789	17.5	45.2	57.5	13.7	25.1	20.9	-0.867
8UA	2.41	41.5	58.1	83.5	28.9	52.0	40.1	0.664	16.8	39.6	58.2	11.4	20.7	21.0	-0.730
6UA	1.89	40.7	46.5	84.3	22.5	40.6	40.3	0.524	16.0	32.7	59.0	8.89	16.0	21.2	-0.575
100 x 75 x 10UA	1.55	31.8	48.6	68.2	22.6	41.3	31.3	0.743	19.4	38.3	55.6	13.4	24.3	21.7	-0.625
8UA	1.30	31.1	41.8	68.9	18.8	34.5	31.5	0.626	18.7	33.5	56.3	11.1	20.2	21.9	-0.527
6UA	1.02	30.3	33.7	69.7	14.6	26.9	31.7	0.494	17.9	27.5	57.1	8.67	15.7	22.0	-0.416
75 x 50 x 8UA	0.511	25.2	20.3	49.8	10.3	18.5	23.6	0.181	12.8	14.1	37.2	4.86	8.96	14.0	-0.174
6UA	0.407	24.4	16.7	50.6	8.05	14.6	23.8	0.145	12.1	12.0	37.9	3.84	6.99	14.2	-0.141
5UA	0.321	23.8	13.5	51.2	6.27	11.4	23.9	0.115	11.5	10.0	38.5	3.00	5.41	14.3	-0.111
65 x 50 x 8UA	0.341	21.1	16.2	43.9	7.75	14.1	20.1	0.174	13.6	12.7	36.4	4.78	8.74	14.4	-0.141
6UA	0.272	20.4	13.4	44.6	6.10	11.1	20.3	0.140	12.9	10.8	37.1	3.77	6.85	14.6	-0.114
5UA	0.215	19.8	10.9	45.2	4.75	8.71	20.5	0.111	12.4	8.96	37.6	2.95	5.32	14.7	-0.0903

TABLE 3.1-12

ROUND BARS
DIMENSIONS AND PROPERTIES

Diameter	Mass	A_g	Circumference	I	Z	Z_e	S	r
mm	kg/m	mm²	mm	10^6mm⁴	10^3mm³	10^3mm³	10^3mm³	mm
10	0.616	78.5	31.4	0.000491	0.0982	0.147	0.167	2.50
12	0.887	113	37.7	0.00102	0.170	0.254	0.288	3.00
14	1.21	154	44.0	0.00189	0.269	0.404	0.457	3.50
16	1.58	201	50.3	0.00322	0.402	0.603	0.683	4.00
18	2.00	254	56.5	0.00515	0.573	0.859	0.972	4.50
20	2.46	314	62.8	0.00785	0.785	1.18	1.33	5.00
22	2.98	380	69.1	0.0115	1.05	1.57	1.77	5.50
24	3.55	452	75.4	0.0163	1.36	2.04	2.30	6.00
26	4.17	531	81.7	0.0224	1.73	2.59	2.93	6.50
27	4.49	573	84.8	0.0261	1.93	2.90	3.28	6.75
30	5.55	707	94.2	0.0398	2.65	3.98	4.50	7.50
32	6.31	804	101	0.0515	3.22	4.83	5.46	8.00
33	6.71	855	104	0.0582	3.53	5.29	5.99	8.25
35	7.55	962	110	0.0737	4.21	6.31	7.15	8.75
36	7.99	1020	113	0.0824	4.58	6.87	7.78	9.00
38	8.90	1130	119	0.102	5.39	8.08	9.15	9.50
39	9.38	1190	123	0.114	5.82	8.74	9.89	9.75
42	10.9	1390	132	0.153	7.27	10.9	12.3	10.5
45	12.5	1590	141	0.201	8.95	13.4	15.2	11.2
48	14.2	1810	151	0.261	10.9	16.3	18.4	12.0

Diameter	Mass	A_g	Circumference	I	Z	Z_e	S	r
mm	kg/m	mm²	mm	10^6mm⁴	10^3mm³	10^3mm³	10^3mm³	mm
50	15.4	1960	157	0.307	12.3	18.4	20.8	12.5
56	19.3	2460	176	0.483	17.2	25.9	29.3	14.0
60	22.2	2830	188	0.636	21.2	31.8	36.0	15.0
63	24.5	3120	198	0.773	24.5	36.8	41.7	15.8
65	26.0	3320	204	0.876	27.0	40.4	45.8	16.2
70	30.2	3850	220	1.18	33.7	50.5	57.2	17.5
75	34.7	4420	236	1.55	41.4	62.1	70.3	18.8
80	39.5	5030	251	2.01	50.3	75.4	85.3	20.0
90	49.9	6360	283	3.22	71.6	107	122	22.5
100	61.7	7850	314	4.91	98.2	147	167	25.0
110	74.6	9500	346	7.19	131	196	222	27.5
120	88.8	11300	377	10.2	170	254	288	30.0
130	104	13300	408	14.0	216	324	366	32.5
140	121	15400	440	18.9	269	404	457	35.0
150	139	17700	471	24.9	331	497	562	37.5
160	158	20100	503	32.2	402	603	683	40.0
170	178	22700	534	41.0	482	723	819	42.5
180	200	25400	565	51.5	573	859	972	45.0
190	223	28400	597	64.0	673	1010	1140	47.5
200	247	31400	628	78.5	785	1180	1330	50.0
215	285	36300	675	105	976	1460	1660	53.8

Note: Not all the listed sizes are available in some grades and finishes. Check manufacturers' catalogues before specifying.

TABLE 3.1-13

SQUARE BARS
DIMENSIONS AND PROPERTIES

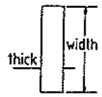
Width	Mass	A_g	I	Z	Z_e	S	r
mm	kg/m	mm²	10⁶mm⁴	10³mm³	10³mm³	10³mm³	mm
10	0.790	100	0.000833	0.167	0.250	0.250	2.89
12	1.13	144	0.00173	0.288	0.432	0.432	3.46
14	1.54	196	0.00320	0.457	0.686	0.686	4.04
16	2.01	256	0.00546	0.683	1.02	1.02	4.62
18	2.54	324	0.00875	0.972	1.46	1.46	5.20
20	3.14	400	0.0133	1.33	2.00	2.00	5.77
25	4.91	625	0.0326	2.60	3.91	3.91	7.22
28	6.15	784	0.0512	3.66	5.49	5.49	8.08
32	8.04	1020	0.0874	5.46	8.19	8.19	9.24
35	9.62	1220	0.125	7.15	10.7	10.7	10.1
40	12.5	1600	0.213	10.7	16.0	16.0	11.5

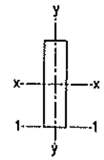
Notes: (1) Not all the listed sizes are available in some grades and finishes. Check manufacturers' catalogues before specifying.
(2) Value of section properties are about principal axes.

TABLE 3.1-14

SQUARE EDGE FLAT BARS

DIMENSIONS AND PROPERTIES





Width x Thickness	Mass per Metre	Cross-Section Area	Second Moment of Area About x-axis	Second Moment of Area About 1-axis	Second Moment of Area About y-axis
mm mm	kg/m	mm²	10^6 mm⁴	10^6 mm⁴	10^6 mm⁴
16 x 5	0.628	80.0	0.00171	0.00683	0.000167
16 x 6	0.754	96.0	0.00205	0.00819	0.000288
16 x 8	1.00	128	0.00273	0.0109	0.000683
16 x 10	1.26	160	0.00341	0.0137	0.00133
20 x 3	0.471	60.0	0.00200	0.00800	0.000045
20 x 5	0.785	100	0.00333	0.0133	0.000208
20 x 6	0.942	120	0.00400	0.0160	0.000360
20 x 10	1.57	200	0.00667	0.0267	0.00167
22 x 6	1.04	132	0.00532	0.0213	0.000396
25 x 3	0.589	75.0	0.00391	0.0156	0.000056
25 x 5	0.981	125	0.00651	0.0260	0.000260
25 x 6	1.18	150	0.00781	0.0312	0.000450
25 x 8	1.57	200	0.0104	0.0417	0.00107
25 x 10	1.96	250	0.0130	0.0521	0.00208
25 x 12	2.36	300	0.0156	0.0625	0.00360
32 x 3	0.754	96.0	0.00819	0.0328	0.000072
32 x 5	1.26	160	0.0137	0.0546	0.000333
32 x 6	1.51	192	0.0164	0.0655	0.000576
32 x 8	2.01	256	0.0218	0.0874	0.00137
32 x 10	2.51	320	0.0273	0.109	0.00267
32 x 12	3.01	384	0.0328	0.131	0.00461
40 x 3	0.942	120	0.0160	0.0640	0.000090
40 x 5	1.57	200	0.0267	0.107	0.000417
40 x 6	1.88	240	0.0320	0.128	0.000720
40 x 8	2.51	320	0.0427	0.171	0.00171
40 x 10	3.14	400	0.0533	0.213	0.00333
40 x 12	3.77	480	0.0640	0.256	0.00576
40 x 16	5.02	640	0.0853	0.341	0.0137
40 x 20	6.28	800	0.107	0.427	0.0267
45 x 5	1.77	225	0.0380	0.152	0.000469
45 x 6	2.12	270	0.0456	0.182	0.000810
45 x 8	2.83	360	0.0608	0.243	0.00192
45 x 10	3.53	450	0.0759	0.304	0.00375
45 x 12	4.24	540	0.0911	0.364	0.00648
50 x 3	1.18	150	0.0312	0.125	0.000112
50 x 5	1.96	250	0.0521	0.208	0.000521
50 x 6	2.36	300	0.0625	0.250	0.000900
50 x 8	3.14	400	0.0833	0.333	0.00213
50 x 10	3.92	500	0.104	0.417	0.00417
50 x 12	4.71	600	0.125	0.500	0.00720
50 x 16	6.28	800	0.167	0.667	0.0171
50 x 20	7.85	1000	0.208	0.833	0.0333
50 x 25	9.81	1250	0.260	1.04	0.0651
55 x 5	2.16	275	0.0693	0.277	0.000573
55 x 6	2.59	330	0.0832	0.333	0.000990
55 x 10	4.32	550	0.139	0.555	0.00458

Width x Thickness	Mass per Metre	Cross-Section Area	Second Moment of Area About x-axis	Second Moment of Area About 1-axis	Second Moment of Area About y-axis
mm mm	kg/m	mm²	10^6 mm⁴	10^6 mm⁴	10^6 mm⁴
65 x 3	1.53	195	0.0687	0.275	0.000146
65 x 5	2.55	325	0.114	0.458	0.000677
65 x 6	3.06	390	0.137	0.549	0.00117
65 x 8	4.08	520	0.183	0.732	0.00277
65 x 10	5.10	650	0.229	0.915	0.00542
65 x 12	6.12	780	0.275	1.10	0.00936
65 x 16	8.16	1040	0.366	1.46	0.0222
65 x 25	12.8	1620	0.572	2.29	0.0846
70 x 5	2.75	350	0.143	0.572	0.000729
75 x 5	2.94	375	0.176	0.703	0.000781
75 x 6	3.53	450	0.211	0.844	0.00135
75 x 8	4.71	600	0.281	1.12	0.00320
75 x 10	5.89	750	0.352	1.41	0.00625
75 x 12	7.06	900	0.422	1.69	0.0108
75 x 16	9.42	1200	0.562	2.25	0.0256
75 x 20	11.8	1500	0.703	2.81	0.0500
75 x 25	14.7	1880	0.879	3.52	0.0977
75 x 40	23.6	3000	1.41	5.62	0.400
90 x 6	4.24	540	0.364	1.46	0.00162
90 x 8	5.65	720	0.486	1.94	0.00384
90 x 10	7.06	900	0.608	2.43	0.00750
90 x 12	8.48	1080	0.729	2.92	0.0130
90 x 16	11.3	1440	0.972	3.89	0.0307
90 x 20	14.1	1800	1.22	4.86	0.0600
100 x 5	3.92	500	0.417	1.67	0.00104
100 x 6	4.71	600	0.500	2.00	0.00180
100 x 8	6.28	800	0.667	2.67	0.00427
100 x 10	7.85	1000	0.833	3.33	0.00833
100 x 12	9.42	1200	1.00	4.00	0.0144
100 x 16	12.6	1600	1.33	5.33	0.0341
100 x 20	15.7	2000	1.67	6.67	0.0667
100 x 25	19.6	2500	2.08	8.33	0.130
100 x 50	39.2	5000	4.17	16.70	1.04
110 x 5	4.32	550	0.555	2.22	0.00115
110 x 6	5.18	660	0.666	2.66	0.00198
110 x 8	6.91	880	0.887	3.55	0.00469
110 x 10	8.64	1100	1.11	4.44	0.00917
110 x 12	10.4	1320	1.33	5.32	0.0158
110 x 16	13.8	1760	1.77	7.10	0.0375
130 x 5	5.1	650	0.915	3.66	0.00135
130 x 6	6.12	780	1.10	4.39	0.00234
130 x 8	8.16	1040	1.46	5.86	0.00555
130 x 10	10.2	1300	1.83	7.32	0.0108
130 x 12	12.2	1560	2.20	8.79	0.0187
130 x 16	16.3	2080	2.93	11.70	0.0444
130 x 20	20.4	2600	3.66	14.60	0.0867
130 x 25	25.5	3250	4.58	18.30	0.169
130 x 40	40.8	5200	7.32	29.30	0.693

Width x Thickness	Mass per Metre	Cross-Section Area	Second Moment of Area About x-axis	Second Moment of Area About 1-axis	Second Moment of Area About y-axis
mm mm	kg/m	mm²	10^6 mm⁴	10^6 mm⁴	10^6 mm⁴
150 x 5	5.89	750	1.41	5.62	0.00156
150 x 6	7.06	900	1.69	6.75	0.00270
150 x 8	9.42	1200	2.25	9.00	0.00640
150 x 10	11.8	1500	2.81	11.2	0.0125
150 x 12	14.1	1800	3.38	13.5	0.0216
150 x 16	18.8	2400	4.50	18.0	0.0512
150 x 20	23.5	3000	5.62	22.5	0.100
150 x 25	29.4	3750	7.03	28.1	0.195
150 x 32	37.7	4800	9.00	36.0	0.410
150 x 40	47.1	6000	11.2	45.0	0.800
150 x 50	58.9	7500	14.1	56.3	1.56
160 x 5	6.28	800	1.71	6.83	0.00167
180 x 5	7.06	900	2.43	9.72	0.00188
180 x 6	8.48	1080	2.92	11.7	0.00324
180 x 10	14.1	1800	4.86	19.4	0.0150
180 x 12	17.0	2160	5.83	23.3	0.0259
180 x 20	28.3	3600	9.72	38.9	0.120
180 x 25	35.3	4500	12.2	48.6	0.234
190 x 5	7.46	950	2.86	11.4	0.00198
200 x 5	7.85	1000	3.33	13.3	0.00208
200 x 6	9.42	1200	4.00	16.0	0.00360
200 x 10	15.7	2000	6.67	26.7	0.0167
200 x 12	18.8	2400	8.00	32.0	0.0288
200 x 16	25.1	3200	10.7	42.7	0.0683
200 x 20	31.4	4000	13.3	53.3	0.133
200 x 25	39.2	5000	16.7	66.7	0.260
250 x 5	9.81	1250	6.51	26.0	0.00260
250 x 6	11.8	1500	7.81	31.2	0.00450
250 x 10	19.6	2500	13.0	52.1	0.0208
250 x 12	23.5	3000	15.6	62.5	0.0360
250 x 16	31.4	4000	20.8	83.3	0.0853
250 x 20	39.2	5000	26.0	104	0.167
250 x 25	49.1	6250	32.6	130	0.326
300 x 6	14.1	1800	13.5	54.0	0.00540
300 x 8	18.8	2400	18.0	72.0	0.0128
300 x 10	23.5	3000	22.5	90.0	0.0250
300 x 12	28.3	3600	27.0	108	0.0432

Only a limited range of the sizes listed is available as square edge flat bars — check manufacturer's catalogues for availability. Other sizes may be cut from plate.

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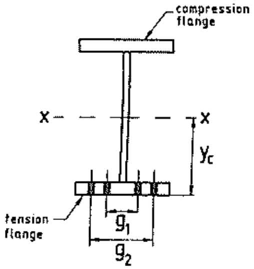
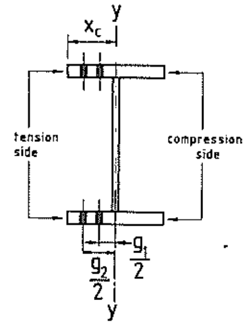


TABLE 3.1-15(1)

WELDED BEAMS
GRADE 300
SECTION PROPERTIES
two/four holes on tension flange



Designation	Holes Deducted: Gauges g_1	g_2	Diameter	A_n	About x-axis: y_c	Z_x (comp)	Z_x (tens)	Z_{ex}	S_x	About y-axis: x_c	Z_y (comp)	Z_y (tens)	Z_{ey}	S_y
	mm	mm	mm	mm²	mm	10³mm³	10³mm³	10³mm³	10³mm³	mm	10³mm³	10³mm³	10³mm³	10³mm³
1200WB455	140	—	26	55800	600	25600	25600	28200	28200	253	3330	3260	4890	4930
455*	140	280	26	53800	600	25600	25600	28200	28200	258	3220	3020	4530	4630
423	140	—	26	52000	596	23300	23300	25800	25800	253	2990	2930	4400	4440
423*	140	280	26	50200	596	23300	23300	25800	25800	258	2900	2720	4080	4180
392	140	—	26	48300	592	21100	21100	23400	23400	252	2660	2610	3910	3950
392*	140	280	26	46600	592	21100	21100	23400	23400	258	2570	2420	3630	3720
342	140	—	26	41900	592	17500	17500	19800	19800	203	1690	1640	2460	2510
342*	140	280	26	40200	640	16900	14300	17700	17700	209	1560	1430	2140	2280
317	140	—	26	38900	588	15700	15700	17900	17900	203	1480	1440	2160	2210
317*	140	280	26	37400	633	15100	13000	16100	16100	208	1360	1250	1880	2000
278	140	—	26	34100	585	13000	13000	15000	15000	178	1000	970	1450	1510
249	140	—	26	30400	585	10900	10900	12900	12900	140	597	572	858	926
1000WB322	140	—	26	39300	512	14600	14600	16400	16400	203	1690	1640	2460	2500
322*	140	280	26	37600	556	14100	11900	14600	14600	209	1560	1420	2130	2270
296	140	—	26	36300	508	13100	13100	14800	14800	203	1480	1440	2160	2200
296*	140	280	26	34800	549	12600	10700	13200	13200	209	1360	1250	1870	1990
258	140	—	26	31600	505	10700	10700	12300	12300	178	1000	968	1450	1500
215	140	—	26	26300	500	8120	8120	9570	9570	153	577	556	834	888
900WB282	140	—	26	34300	462	12400	12400	13600	13600	203	1690	1640	2450	2470
282*	140	280	26	32600	508	12000	9850	11900	11900	211	1570	1410	2110	2240
257	140	—	26	31300	458	11000	11000	12200	12200	203	1480	1430	2150	2170
257*	140	280	26	29800	501	10700	8820	10700	10700	210	1370	1240	1850	1960
218	140	—	26	26500	455	8930	8930	9960	9960	178	1000	964	1450	1470
175	140	—	26	21300	450	6580	6580	7500	7500	153	578	552	828	858
800WB192	140	—	26	22900	408	7290	7290	8060	8060	154	813	767	1150	1180
168	140	—	26	20100	405	6140	6140	6840	6840	142	601	562	843	873
146	140	—	26	17600	423	4970	4420	5270	5300	142	479	451	677	702
122	140	—	26	14800	418	3840	3440	4180	4210	129	309	290	433	461
700WB173	140	—	26	20500	358	5760	5760	6390	6390	142	674	627	941	973
150	140	—	26	17800	355	4810	4810	5370	5370	130	486	448	672	706
130	140	—	26	15600	373	3870	3400	4110	4110	130	388	360	540	568
115	140	—	26	13800	366	3230	2870	3490	3490	129	309	289	431	458

Notes: (1) Gauges and hole diameters are those recommended in "Standardised Structural Connections".
(2) * indicates four holes on flange.

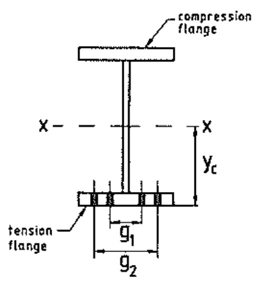
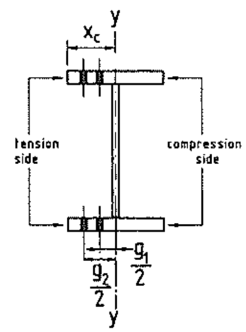


TABLE 3.1-15(2)

WELDED BEAMS GRADE 400

SECTION PROPERTIES two/four holes on tension flange



Designation	Holes Deducted Gauges g_1	g_2	Diameter	A_n	About x-axis y_c	Z_x (comp)	Z_x (tens)	Z_{ex}	S_x	About y-axis x_c	Z_y (comp)	Z_y (tens)	Z_{ey}	S_y
	mm	mm	mm	mm²	mm	10³mm³	10³mm³	10³mm³	10³mm³	mm	10³mm³	10³mm³	10³mm³	10³mm³
1200WB455	140	—	26	55800	600	25600	25600	28100	28200	253	3330	3260	4890	4930
455*	140	280	26	53800	645	24900	21400	25300	25500	258	3220	3020	4530	4630
423	140	—	26	52000	596	23300	23300	25700	25800	253	2990	2930	4390	4440
423*	140	280	26	50200	639	22700	19700	23200	23400	258	2900	2720	4070	4180
392	140	—	26	48300	592	21100	21100	23300	23400	252	2660	2610	3810	3950
392*	140	280	26	46600	633	20500	17900	21100	21400	258	2570	2420	3540	3720
342	140	—	26	41900	615	17200	15900	18600	18800	203	1690	1640	2460	2510
342*	140	280	26	40200	640	16900	14300	17500	17700	209	1560	1430	2140	2280
317	140	—	26	38900	610	15500	14400	16800	17000	203	1480	1440	2150	2210
317*	140	280	26	37400	633	15100	13000	15900	16100	208	1360	1250	1870	2000
278	140	—	26	34100	607	12700	11800	14100	14300	178	1000	970	1450	1510
249	140	—	26	30400	610	10600	9740	12000	12100	140	597	572	858	926
1000WB322	140	—	26	39300	533	14400	13200	15500	15500	203	1690	1640	2460	2500
322*	140	280	26	37600	556	14100	11900	14600	14600	209	1560	1420	2130	2270
296	140	—	26	36300	528	12900	11900	14000	14000	203	1480	1440	2140	2200
296*	140	280	26	34800	549	12600	10700	13200	13200	209	1360	1250	1860	1990
258	140	—	26	31600	525	10500	9700	11600	11600	178	1000	968	1450	1500
215	140	—	26	26300	519	7910	7320	9040	9040	153	577	556	819	888
900WB282	140	—	26	34300	484	12200	11100	12600	12800	203	1690	1640	2450	2470
282*	140	280	26	32600	508	12000	9850	11700	11900	211	1570	1410	2110	2240
257	140	—	26	31300	479	10900	9930	11300	11500	203	1480	1430	2130	2170
257*	140	280	26	29800	501	10700	8820	10500	10700	210	1370	1240	1840	1960
218	140	—	26	26500	477	8760	7960	9180	9350	178	1000	964	1440	1470
175	140	—	26	21300	472	6410	5830	6790	7020	153	578	552	811	858
800WB192	140	—	26	22900	433	7140	6320	7120	7440	154	813	767	1150	1180
168	140	—	26	20100	430	5980	5280	6010	6290	142	601	562	843	873
146	140	—	26	17600	423	4970	4420	4990	5300	142	479	451	674	702
122	140	—	26	14800	418	3840	3440	3940	4210	129	309	290	422	461
700WB173	140	—	26	20500	382	5630	4910	5830	5830	142	674	627	941	973
150	140	—	26	17800	380	4680	4060	4880	4880	130	486	448	672	706
130	140	—	26	15600	373	3870	3400	4110	4110	130	388	360	540	568
115	140	—	26	13800	366	3230	2870	3490	3490	129	309	289	421	458

Notes: (1) Gauges and hole diameters are those recommended in "Standardised Structural Connections".
(2) * indicates four holes on flange.

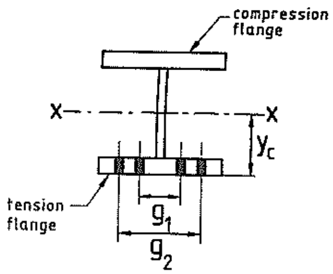
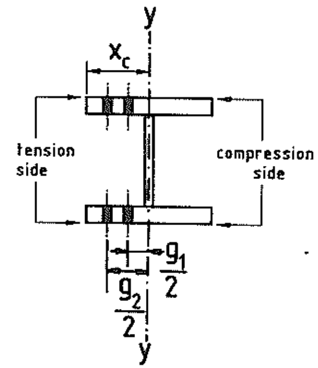


TABLE 3.1-16(1)

WELDED COLUMNS GRADE 300

SECTION PROPERTIES two/four holes on tension flange



Designation	Holes Deducted Gauges g_1	g_2	Diameter	A_n	About x-axis y_c	Z_x (comp)	Z_x (tens)	Z_{ex}	S_x	About y-axis x_c	Z_y (comp)	Z_y (tens)	Z_{ey}	S_y
	mm	mm	mm	mm²	mm	10^3mm³	10^3mm³	10^3mm³	10^3mm³	mm	10^3mm³	10^3mm³	10^3mm³	10^3mm³
500WC440	140	—	26	53900	240	8980	8980	10400	10400	253	3340	3260	4900	5010
440*	140	280	26	51800	240	8980	8980	10400	10400	258	3230	3020	4530	4710
414	140	—	26	50700	240	8800	8800	10100	10100	253	3330	3260	4890	4950
414*	140	280	26	48600	240	8800	8800	10100	10100	259	3230	3010	4510	4660
383	140	—	26	46900	236	7990	7990	9130	9130	253	3000	2930	4400	4470
383*	140	280	26	45100	236	7990	7990	9130	9130	259	2910	2710	4070	4200
340	140	—	26	41600	257	7980	7980	8980	8980	253	2660	2610	3910	3950
340*	140	280	26	39900	257	7980	7980	8980	8980	259	2580	2410	3610	3720
290	140	—	26	35500	253	6930	6930	7570	7700	253	2330	2280	3330	3440
290*	140	280	26	34100	253	6930	6930	7570	7700	259	2260	2100	3080	3240
267	140	—	26	32700	250	6250	6250	6700	6950	253	2080	2030	2900	3080
267*	140	280	26	31400	250	6250	6250	6700	6950	259	2020	1880	2680	2890
228	140	—	26	28000	245	5130	5130	5210	5710	253	1660	1630	2140	2470
228*	140	280	26	26900	263	5000	4310	4430	5170	258	1610	1510	1990	2320
400WC361	140	—	26	43900	215	6340	6340	7460	7460	203	2120	2050	3080	3190
361*	140	280	26	41800	234	6080	5070	6550	6550	210	1970	1770	2660	2890
328	140	—	26	39700	215	6140	6140	7100	7100	204	2120	2040	3070	3120
328*	140	280	26	37600	237	5920	4840	6130	6130	212	1970	1750	2630	2820
303	140	—	26	36700	211	5570	5570	6420	6420	204	1910	1840	2760	2820
303*	140	280	26	34900	232	5370	4410	5570	5570	211	1770	1580	2370	2550
270	140	—	26	32700	207	4950	4950	5660	5660	204	1700	1640	2450	2500
270*	140	280	26	31000	227	4780	3920	4910	4910	211	1570	1410	2110	2260
212	140	—	26	25700	200	3880	3880	4360	4360	204	1320	1280	1910	1940
212*	140	280	26	24400	220	3750	3070	3790	3790	211	1230	1100	1650	1760
181	140	—	26	22000	195	3180	3180	3410	3570	203	1060	1020	1450	1560
181*	140	280	26	20900	213	3060	2540	2890	3130	210	980	882	1250	1410
144	140	—	26	17600	191	2550	2550	2590	2830	203	846	819	1080	1240
144*	140	280	26	16700	209	2460	2030	2100	2480	210	783	706	929	1130
350WC280	140	—	26	33600	178	4210	4210	4940	4940	179	1610	1540	2300	2360
258	140	—	26	31000	174	3810	3810	4450	4450	179	1450	1380	2070	2130
230	140	—	26	27600	170	3380	3380	3910	3910	179	1290	1230	1840	1880
197	140	—	26	23600	166	2940	2940	3350	3350	179	1130	1070	1610	1640

Notes: (1) Gauges and hole diameters are those recommended in "Standardised Structural Connections".
(2) * indicates four holes on flange.

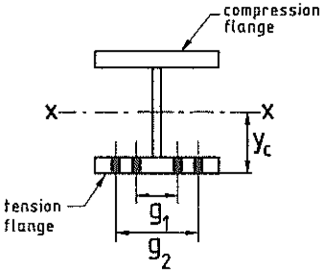
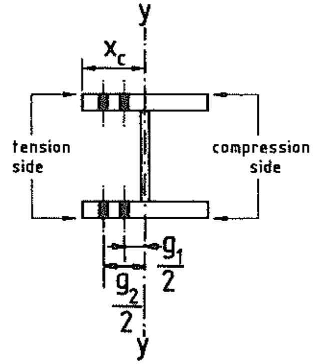


TABLE 3.1-16(2)

WELDED COLUMNS GRADE 400

SECTION PROPERTIES two/four holes on tension flange



Designation	Holes Deducted Gauges g_1	g_2	Diameter	A_n	About x-axis y_c	Z_x (comp)	Z_x (tens)	Z_{ex}	S_x	About y-axis x_c	Z_y (comp)	Z_y (tens)	Z_{ey}	S_y
	mm	mm	mm	mm²	mm	10³mm³	10³mm³	10³mm³	10³mm³	mm	10³mm³	10³mm³	10³mm³	10³mm³
500WC440	140	—	26	53900	240	8980	8980	10400	10400	253	3330	3260	4900	5010
440*	140	280	26	51800	258	8710	7520	9380	9380	258	3230	3020	4530	4710
414	140	—	26	50700	240	8800	8800	10100	10100	253	3330	3260	4890	4950
414*	140	280	26	48600	259	8560	7310	9030	9030	259	3230	3010	4510	4660
383	140	—	26	46900	236	7990	7990	9130	9130	253	3000	2930	4400	4470
383*	140	280	26	45100	254	7770	6660	8200	8200	259	2910	2710	4070	4200
340	140	—	26	41600	257	7980	7980	8830	8980	253	2660	2610	3820	3950
340*	140	280	26	39900	277	7770	6650	7850	8060	259	2580	2410	3530	3720
290	140	—	26	35500	253	6930	6930	7410	7700	253	2330	2280	3230	3440
290*	140	280	26	34100	273	6760	5750	6460	6900	259	2260	2100	2990	3240
267	140	—	26	32700	250	6250	6250	6540	6950	253	2080	2030	2800	3080
267*	140	280	26	31400	270	6100	5210	5640	6250	259	2020	1880	2590	2890
228	140	—	26	28000	254	5070	4720	4470	5450	253	1660	1630	2050	2470
228*	140	280	26	26900	263	5000	4310	4070	5170	258	1610	1510	1900	2320
400WC361	140	—	26	43900	224	6220	5710	7030	7030	203	2120	2050	3080	3190
361*	140	280	26	41800	234	6080	5070	6550	6550	210	1970	1770	2660	2890
328	140	—	26	39700	225	6040	5500	6650	6650	204	2120	2040	3070	3120
328*	140	280	26	37600	237	5920	4840	6130	6130	212	1970	1750	2630	2820
303	140	—	26	36700	221	5480	4990	6020	6020	204	1910	1840	2760	2820
303*	140	280	26	34900	232	5370	4410	5570	5570	211	1770	1580	2370	2550
270	140	—	26	32700	217	4870	4440	5310	5310	204	1700	1640	2450	2500
270*	140	280	26	31000	227	4780	3920	4910	4910	211	1570	1410	2110	2260
212	140	—	26	25700	209	3820	3470	3980	4100	204	1320	1280	1870	1940
212*	140	280	26	24400	220	3750	3070	3660	3790	211	1230	1100	1600	1760
181	140	—	26	22000	204	3130	2860	3050	3370	203	1060	1020	1400	1560
181*	140	280	26	20900	213	3060	2540	2760	3130	210	980	882	1210	1410
144	140	—	26	17600	200	2510	2290	2170	2670	203	846	819	1030	1240
144*	140	280	26	16700	209	2460	2030	1920	2480	210	783	706	887	1130
350WC280	140	—	26	33600	187	4120	3690	4570	4570	179	1610	1540	2300	2360
258	140	—	26	31000	183	3730	3350	4130	4130	179	1450	1380	2070	2130
230	140	—	26	27600	179	3320	2970	3630	3630	179	1290	1230	1840	1880
197	140	—	26	23600	175	2880	2580	3100	3100	179	1130	1070	1610	1640

Notes: (1) Gauges and hole diameters are those recommended in "Standardised Structural Connections".
(2) * indicates four holes on flange.

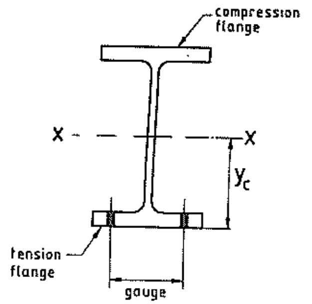
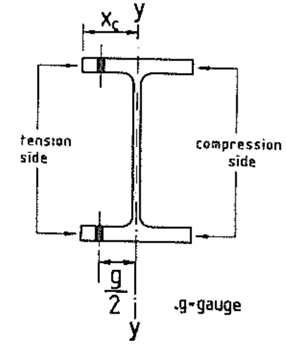


TABLE 3.1-17

UNIVERSAL BEAMS
GRADE 300
SECTION PROPERTIES
two holes on tension flange



Designation	Holes Deducted		A_n	About x-axis					About y-axis				
	Gauge	Diameter		y_c	Z_x (comp)	Z_x (tens)	Z_{ex}	S_x	x_c	Z_y (comp)	Z_y (tens)	Z_{ey}	S_y
	mm	mm	mm²	mm	10^3mm³	10^3mm³	10^3mm³	10^3mm³	mm	10^3mm³	10^3mm³	10^3mm³	10^3mm³
610UB125	140	22	15100	306	3230	3230	3680	3680	118	315	294	441	475
113	140	22	13700	304	2880	2880	3290	3290	118	275	257	385	416
101	140	22	12300	301	2530	2530	2900	2900	118	235	220	330	356
530UB 92.4	140	22	11100	282	2020	1790	2180	2180	109	202	186	278	307
82.0	140	22	9920	279	1750	1560	1910	1910	109	170	157	236	260
460UB 82.1	90	22	9760	246	1560	1360	1670	1670	98.7	185	173	259	271
74.6	90	22	8880	245	1420	1230	1510	1510	98.2	166	155	232	242
67.1	90	22	8020	242	1260	1100	1350	1350	98.1	145	136	203	212
410UB 59.7	90	22	7080	219	1030	881	1080	1080	92.6	126	117	175	184
53.7	90	22	6410	216	900	778	955	955	92.4	107	99.6	149	157
360UB 56.7	90	22	6670	194	867	734	903	903	89.9	119	109	163	172
50.7	90	22	5970	192	769	653	801	801	89.3	104	94.8	142	150
44.7	90	22	5300	190	665	568	687	697	89.1	87.3	80.2	119	127
310UB 46.2	90	22	5410	168	631	524	642	642	87.3	99.6	89.7	135	143
40.4	90	22	4760	166	549	457	558	558	86.7	84.8	76.5	115	122
32.0	90	22	3730	163	407	339	405	418	78.7	51.6	46.0	67.4	75.8
250UB 37.3	70	22	4270	142	417	336	418	418	76.9	72.2	64.8	97.3	102
31.4	70	22	3630	138	339	277	343	345	76.6	56.8	51.4	76.8	80.8
25.7	70	18	2980	136	274	227	281	281	65.4	36.7	32.9	49.4	53.4
200UB 29.8	70	22	3400	116	269	212	267	267	71.3	52.0	45.6	68.5	73.4
25.4	70	22	2890	113	221	176	220	221	70.7	41.4	36.5	54.5	58.7
22.3	70	22	2560	113	199	157	189	197	70.7	37.1	32.7	47.7	52.5
18.2	†												
180UB 22.2	†												
18.1	†												
16.1	†												
150UB 18.0	†												
14.0	†												

Notes: (1) Gauges and hole diameters are those recommended in "Standardised Structural Connections".
(2) † indicates flange too small for high strength structural bolts.
(3) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

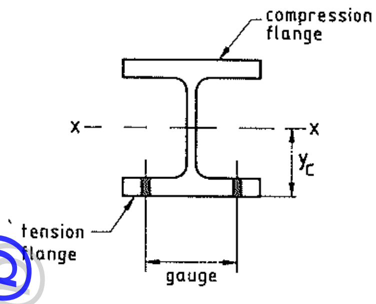
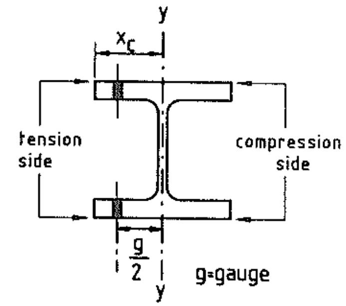


TABLE 3.1-18

UNIVERSAL COLUMNS GRADE 300

SECTION PROPERTIES
two holes on tension flange

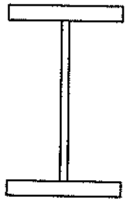


Designation	Holes Deducted			About x-axis					About y-axis				
	Gauge	Diameter	A_n	y_c	Z_x (comp)	Z_x (tens)	Z_{ex}	S_x	x_c	Z_y (comp)	Z_y (tens)	Z_{ey}	S_y
	mm	mm	mm²	mm	10³mm³	10³mm³	10³mm³	10³mm³	mm	10³mm³	10³mm³	10³mm³	10³mm³
310UC158	140	26	18800	164	2370	2370	2680	2680	160	787	740	1110	1140
137	140	26	16300	160	2050	2050	2300	2300	159	674	633	949	971
118	140	26	14000	157	1760	1760	1960	1960	158	572	537	806	824
96.8	140	26	11600	154	1450	1450	1560	1600	157	465	436	634	669
250UC 89.5	140	22	10600	130	1100	1100	1230	1230	133	361	334	500	521
72.9	140	22	8700	127	897	897	986	992	132	291	269	399	419
200UC 59.5	140	22	7000	114	569	482	584	584	109	177	157	235	259
52.2	140	22	6110	112	500	422	507	507	108	154	136	204	225
46.2	140	22	5420	110	440	372	437	445	108	134	118	175	196
150UC 37.2	90	22	4230	89.9	264	211	264	264	82.4	81.6	70.9	106	116
30.0	90	22	3450	87.7	215	172	212	212	81.9	65.6	56.9	85.4	93.0
23.4	90	22	2680	84.3	160	129	146	159	81.0	46.5	40.7	57.1	66.6
100UC 14.8	60	22	1580	57.3	61.3	42.5	55.7	55.7	55.4	18.1	14.3	21.4	25.7

Notes: (1) Gauges and hole diameters are those recommended in "Standardised Structural Connections".
(2) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

TABLE 3.2-1(A)

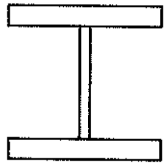
WELDED BEAMS SURFACE AREAS



Designation	Profile Distance	Profile Surface Area	Profile Surface Area	Profile Distance Less 1 Flange Face	Profile Surface Area Less 1 Flange Face	Profile Surface Area Less 1 Flange Face
	mm	m²/m	m²/tonne	mm	m²/m	m²/tonne
1200WB455	4370	4.37	9.61	3870	3.87	8.51
423	4350	4.35	10.3	3850	3.85	9.10
392	4340	4.34	11.1	3840	3.84	9.79
342	3940	3.94	11.5	3540	3.54	10.4
317	3920	3.92	12.4	3520	3.52	11.1
278	3710	3.71	13.3	3360	3.36	12.1
249	3410	3.41	13.7	3130	3.13	12.6
1000WB322	3620	3.62	11.2	3220	3.22	10.0
296	3600	3.60	12.1	3200	3.20	10.8
258	3390	3.39	13.1	3040	3.04	11.8
215	3170	3.17	14.8	2870	2.87	13.4
900WB282	3420	3.42	12.1	3020	3.02	10.7
257	3410	3.41	13.3	3010	3.01	11.7
218	3200	3.20	14.6	2850	2.85	13.0
175	2980	2.98	17.0	2680	2.68	15.3
800WB192	2810	2.81	14.7	2510	2.51	13.1
168	2700	2.70	16.1	2430	2.42	14.5
146	2680	2.68	18.4	2410	2.40	16.5
122	2560	2.56	20.9	2310	2.31	18.9
700WB173	2510	2.51	14.5	2240	2.24	13.0
150	2400	2.40	16.0	2150	2.15	14.3
130	2380	2.38	18.3	2130	2.13	16.3
115	2360	2.36	20.6	2110	2.11	18.4

TABLE 3.2-2(A)

WELDED COLUMNS SURFACE AREAS



Designation	Profile Distance	Profile Surface Area	Profile Surface Area	Profile Distance Less 1 Flange Face	Profile Surface Area Less 1 Flange Face	Profile Surface Area Less 1 Flange Face
	mm	m²/m	m²/tonne	mm	m²/m	m²/tonne
500WC440	2880	2.88	6.55	2380	2.38	5.41
414	2900	2.90	6.99	2400	2.40	5.78
383	2880	2.88	7.52	2380	2.38	6.21
340	2980	2.98	8.77	2480	2.48	7.30
290	2970	2.97	10.2	2470	2.47	8.51
267	2960	2.96	11.1	2460	2.46	9.22
228	2940	2.94	12.9	2440	2.44	10.7
400WC361	2380	2.38	6.59	1980	1.98	5.48
328	2400	2.40	7.33	2000	2.00	6.11
303	2390	2.39	7.88	1990	1.99	6.56
270	2380	2.38	8.82	1980	1.98	7.34
212	2360	2.36	11.1	1960	1.96	9.25
181	2340	2.34	13.0	1940	1.94	10.7
144	2330	2.33	16.1	1930	1.93	13.4
350WC280	2050	2.05	7.33	1700	1.70	6.08
258	2040	2.04	7.89	1690	1.69	6.54
230	2030	2.03	8.82	1680	1.68	7.30
197	2020	2.02	10.3	1670	1.67	8.49

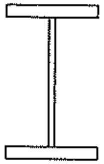
TABLE 3.2-1(B)

WELDED BEAMS

FIRE ENGINEERING DESIGN

exposed surface area to mass ratio (m^2/tonne)

1 = TOTAL PERIMETER, PROFILE-PROTECTED
2 = TOTAL PERIMETER, BOX-PROTECTED, NO GAP
3 = TOTAL PERIMETER, BOX-PROTECTED, 25mm GAP
4 = TOP FLANGE EXCLUDED, PROFILE-PROTECTED
5 = TOP FLANGE EXCLUDED, BOX-PROTECTED, NO GAP
6 = TOP FLANGE EXCLUDED, BOX-PROTECTED, 25mm GAP



Designation	1	2	3	4	5	6
1200WB455	9.61	7.48	7.92	8.51	6.38	6.60
423	10.3	7.99	8.47	9.10	6.81	7.05
392	11.1	8.59	9.11	9.79	7.32	7.57
342	11.5	9.27	9.86	10.4	8.10	8.39
317	12.4	9.96	10.6	11.1	8.69	9.01
278	13.3	10.9	11.7	12.1	9.67	10.0
249	13.7	11.6	12.4	12.6	10.5	10.9
1000WB322	11.2	8.86	9.48	10.0	7.61	7.92
296	12.1	9.55	10.2	10.8	8.20	8.54
258	13.1	10.5	11.3	11.8	9.19	9.58
215	14.8	12.1	13.0	13.4	10.7	11.2
900WB282	12.1	9.39	10.1	10.7	7.97	8.33
257	13.3	10.2	11.0	11.7	8.69	9.08
218	14.6	11.5	12.5	13.0	9.94	10.4
175	17.0	13.7	14.8	15.3	12.0	12.6
800WB192	14.7	11.7	12.7	13.1	10.1	10.6
168	16.1	12.9	14.1	14.5	11.3	11.9
146	18.4	14.7	16.1	16.5	12.8	13.5
122	20.9	17.0	18.7	18.9	15.0	15.8
700WB173	14.5	11.5	12.6	13.0	9.88	10.5
150	16.0	12.8	14.1	14.3	11.1	11.8
130	18.3	14.6	16.1	16.3	12.7	13.4
115	20.6	16.4	18.2	18.4	14.3	15.1

Note: See page 3-4 for details on cases of fire exposure considered.

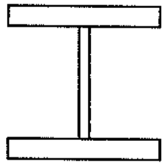
TABLE 3.2-2(B)

WELDED COLUMNS

FIRE ENGINEERING DESIGN

exposed surface area to mass ratio (m^2/tonne)

1 = TOTAL PERIMETER, PROFILE-PROTECTED
2 = TOTAL PERIMETER, BOX-PROTECTED, NO GAP
3 = TOTAL PERIMETER, BOX-PROTECTED, 25mm GAP
4 = TOP FLANGE EXCLUDED, PROFILE-PROTECTED
5 = TOP FLANGE EXCLUDED, BOX-PROTECTED, NO GAP
6 = TOP FLANGE EXCLUDED, BOX-PROTECTED, 25mm GAP

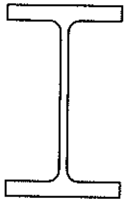


Designation	1	2	3	4	5	6
500WC440	6.55	4.46	4.91	5.41	3.32	3.55
414	6.99	4.73	5.21	5.78	3.52	3.76
383	7.52	5.07	5.60	6.21	3.77	4.03
340	8.77	5.97	6.56	7.30	4.50	4.80
290	10.2	6.93	7.62	8.51	5.21	5.55
267	11.1	7.49	8.24	9.22	5.62	5.99
228	12.9	8.70	9.58	10.7	6.50	6.94
400WC361	6.59	4.60	5.15	5.48	3.49	3.77
328	7.33	5.06	5.67	6.11	3.84	4.14
303	7.88	5.43	6.09	6.56	4.11	4.44
270	8.82	6.04	6.78	7.34	4.55	4.92
212	11.1	7.55	8.49	9.25	5.66	6.13
181	13.0	8.75	9.86	10.7	6.54	7.09
144	16.1	10.8	12.2	13.4	8.06	8.75
350WC280	7.33	5.03	5.74	6.08	3.78	4.14
258	7.89	5.40	6.17	6.54	4.04	4.43
230	8.82	6.00	6.87	7.30	4.47	4.91
197	10.3	6.91	7.93	8.49	5.14	5.64

Note: See page 3-4 for details on cases of fire exposure considered.

TABLE 3.2-3(A)

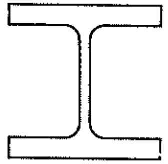
UNIVERSAL BEAMS SURFACE AREAS



Designation	Profile Distance	Profile Surface Area	Profile Surface Area	Profile Distance Less 1 Flange Face	Profile Surface Area Less 1 Flange Face	Profile Surface Area Less 1 Flange Face
	mm	m²/m	m²/tonne	mm	m²/m	m²/tonne
610UB125	2090	2.09	16.7	1860	1.86	14.9
113	2080	2.08	18.3	1850	1.85	16.3
101	2070	2.07	20.3	1840	1.84	18.1
530UB 92.4	1860	1.86	20.0	1650	1.65	17.8
82.0	1850	1.85	22.4	1640	1.64	19.9
460UB 82.1	1650	1.65	20.0	1450	1.45	17.7
74.6	1640	1.64	21.9	1450	1.45	19.4
67.1	1630	1.63	24.2	1440	1.44	21.4
410UB 59.7	1490	1.49	24.8	1310	1.31	21.9
53.7	1480	1.48	27.4	1300	1.30	24.1
360UB 56.7	1370	1.37	24.1	1200	1.20	21.1
50.7	1360	1.36	26.8	1190	1.19	23.4
44.7	1360	1.35	30.1	1180	1.18	26.3
310UB 46.2	1250	1.25	26.8	1080	1.08	23.2
40.4	1240	1.24	30.2	1070	1.07	26.2
32.0	1160	1.16	36.2	1010	1.01	31.5
250UB 37.3	1070	1.07	28.6	922	0.922	24.7
31.4	1060	1.06	33.7	914	0.914	29.0
25.7	961	0.961	37.5	837	0.837	32.6
200UB 29.8	922	0.922	30.7	788	0.788	26.3
25.4	912	0.912	35.9	779	0.779	30.7
22.3	910	0.910	40.4	777	0.777	34.5
18.2	764	0.764	42.0	665	0.665	36.6
180UB 22.2	691	0.691	31.2	601	0.601	27.1
18.1	685	0.685	37.9	595	0.595	32.9
16.1	682	0.682	42.5	592	0.592	36.9
150UB 18.0	584	0.584	32.4	509	0.509	28.3
14.0	576	0.576	41.1	501	0.501	35.8

TABLE 3.2-4(A)

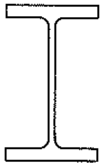
UNIVERSAL COLUMNS SURFACE AREAS



Designation	Profile Distance	Profile Surface Area	Profile Surface Area	Profile Distance Less 1 Flange Face	Profile Surface Area Less 1 Flange Face	Profile Surface Area Less 1 Flange Face
	mm	m²/m	m²/tonne	mm	m²/m	m²/tonne
310UC158	1840	1.84	11.6	1530	1.53	9.66
137	1820	1.82	13.3	1510	1.51	11.0
118	1810	1.81	15.3	1500	1.50	12.7
96.8	1790	1.79	18.4	1480	1.48	15.3
250UC 89.5	1500	1.50	16.8	1240	1.24	13.9
72.9	1480	1.48	20.3	1230	1.23	16.8
200UC 59.5	1220	1.22	20.2	1020	1.02	16.8
52.2	1190	1.19	22.8	989	0.989	18.9
46.2	1180	1.18	25.6	982	0.982	21.2
150UC 37.2	908	0.908	24.4	754	0.754	20.3
30.0	899	0.899	29.7	746	0.746	24.6
23.4	885	0.885	37.8	733	0.733	31.3
100UC 14.8	563	0.563	38.0	464	0.464	31.3

TABLE 3.2-3(B)

UNIVERSAL BEAMS
FIRE ENGINEERING DESIGN
exposed surface area to mass ratio (m^2/tonne)



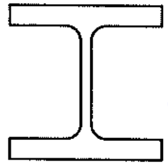
1 = TOTAL PERIMETER, PROFILE-PROTECTED
2 = TOTAL PERIMETER, BOX-PROTECTED, NO GAP
3 = TOTAL PERIMETER, BOX-PROTECTED, 25mm GAP
4 = TOP FLANGE EXCLUDED, PROFILE-PROTECTED
5 = TOP FLANGE EXCLUDED, BOX-PROTECTED, NO GAP
6 = TOP FLANGE EXCLUDED, BOX-PROTECTED, 25mm GAP

Designation	1	2	3	4	5	6
610UB125	16.7	13.4	15.0	14.9	11.6	12.4
113	18.3	14.7	16.5	16.3	12.7	13.6
101	20.3	16.3	18.2	18.1	14.0	15.0
530UB 92.4	20.0	16.0	18.2	17.8	13.8	14.8
82.0	22.4	17.9	20.3	19.9	15.3	16.6
460UB 82.1	20.0	15.9	18.3	17.7	13.5	14.8
74.6	21.9	17.3	20.0	19.4	14.8	16.1
67.1	24.2	19.1	22.1	21.4	16.3	17.8
410UB 59.7	24.8	19.5	22.8	21.9	16.5	18.2
53.7	27.4	21.5	25.2	24.1	18.2	20.0
360UB 56.7	24.1	18.7	22.2	21.1	15.6	17.4
50.7	26.8	20.7	24.7	23.4	17.4	19.3
44.7	30.1	23.3	27.7	26.3	19.5	21.7
310UB 46.2	26.8	20.3	24.6	23.2	16.8	18.9
40.4	30.2	22.9	27.8	26.2	18.9	21.4
32.0	36.2	27.9	34.2	31.5	23.3	26.4
250UB 37.3	28.6	21.6	26.9	24.7	17.7	20.3
31.4	33.7	25.3	31.6	29.0	20.6	23.8
25.7	37.5	29.0	36.8	32.6	24.2	28.1
200UB 29.8	30.7	22.7	29.4	26.3	18.3	21.6
25.4	35.9	26.5	34.4	30.7	21.3	25.2
22.3	40.4	29.7	38.6	34.5	23.8	28.3
18.2	42.0	32.6	43.6	36.6	27.2	32.7
180UB 22.2	31.2	24.3	33.3	27.1	20.2	24.7
18.1	37.9	29.3	40.4	32.9	24.3	29.9
16.1	42.5	32.8	45.3	36.9	27.2	33.4
150UB 18.0	32.4	25.5	36.6	28.3	21.4	26.9
14.0	41.1	32.1	46.4	35.8	26.8	33.9

Note: See page 3-4 for details on cases of fire exposure considered.

TABLE 3.2-4(B)

UNIVERSAL COLUMNS
FIRE ENGINEERING DESIGN
exposed surface area to mass ratio (m^2/tonne)



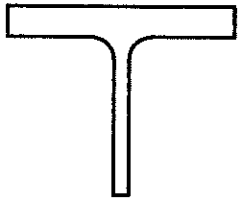
1 = TOTAL PERIMETER, PROFILE-PROTECTED
2 = TOTAL PERIMETER, BOX-PROTECTED, NO GAP
3 = TOTAL PERIMETER, BOX-PROTECTED, 25mm GAP
4 = TOP FLANGE EXCLUDED, PROFILE-PROTECTED
5 = TOP FLANGE EXCLUDED, BOX-PROTECTED, NO GAP
6 = TOP FLANGE EXCLUDED, BOX-PROTECTED, 25mm GAP

Designation	1	2	3	4	5	6
310UC158	11.6	8.08	9.34	9.66	6.11	6.74
137	13.3	9.18	10.6	11.0	6.93	7.66
118	15.3	10.5	12.2	12.7	7.94	8.79
96.8	18.4	12.6	14.7	15.3	9.48	10.5
250UC 89.5	16.8	11.5	13.8	13.9	8.68	9.80
72.9	20.3	13.9	16.6	16.8	10.4	11.8
200UC 59.5	20.2	14.0	17.3	16.8	10.6	12.3
52.2	22.8	15.7	19.5	18.9	11.8	13.7
46.2	25.6	17.5	21.9	21.2	13.2	15.3
150UC 37.2	24.4	17.0	22.4	20.3	12.9	15.5
30.0	29.7	20.5	27.1	24.6	15.4	18.7
23.4	37.8	26.0	34.6	31.3	19.5	23.8
100UC 14.8	38.0	26.5	40.0	31.3	19.8	26.5

Note: See page 3-4 for details on cases of fire exposure considered.

TABLE 3.2-5(A)

TEES CUT FROM UNIVERSAL BEAMS SURFACE AREAS



Designation	Profile Distance	Profile Surface Area	Profile Surface Area	Profile Distance Less 1 Flange Face	Profile Surface Area Less 1 Flange Face	Profile Surface Area Less 1 Flange Face
	mm	m^2/m	$m^2/tonne$	mm	m^2/m	$m^2/tonne$
305BT62.5	1060	1.06	16.9	827	0.827	13.2
56.5	1050	1.05	18.5	821	0.821	14.5
50.5	1040	1.04	20.5	816	0.816	16.0
265BT46.3	937	0.937	20.3	728	0.728	15.7
41.0	932	0.932	22.7	723	0.723	17.6
230BT41.1	831	0.831	20.3	640	0.640	15.6
37.3	826	0.826	22.1	636	0.636	17.0
33.6	822	0.822	24.5	632	0.632	18.8
205BT29.9	751	0.751	25.1	573	0.573	19.1
26.9	747	0.747	27.7	569	0.569	21.1
180BT28.4	691	0.691	24.3	519	0.519	18.3
25.4	686	0.686	27.1	515	0.515	20.3
22.4	682	0.682	30.4	511	0.511	22.8
155BT23.1	627	0.627	27.0	461	0.461	19.9
20.2	622	0.622	30.5	457	0.457	22.4
16.0	583	0.583	36.5	434	0.434	27.2
125BT18.7	539	0.539	29.0	393	0.393	21.1
15.7	534	0.534	34.0	388	0.388	24.7
12.9	484	0.484	37.8	360	0.360	28.2
100BT14.9	465	0.465	31.1	331	0.331	22.2
12.7	460	0.460	36.4	327	0.327	25.8
11.2	458	0.458	40.8	325	0.325	29.0
9.1	385	0.385	42.4	286	0.286	31.5
90BT11.1	349	0.349	31.7	259	0.295	23.5
9.1	345	0.345	38.4	255	0.255	28.4
8.1	343	0.343	43.0	253	0.253	31.7
75BT 9.0	296	0.296	33.0	221	0.221	24.7
7.0	291	0.291	41.8	216	0.216	31.0

TABLE 3.2-6(A)

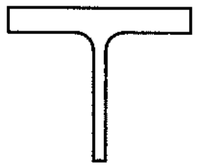
TEES CUT FROM UNIVERSAL COLUMNS SURFACE AREAS

Designation	Profile Distance	Profile Surface Area	Profile Surface Area	Profile Distance Less 1 Flange Face	Profile Surface Area Less 1 Flange Face	Profile Surface Area Less 1 Flange Face
	mm	m^2/m	$m^2/tonne$	mm	m^2/m	$m^2/tonne$
155CT79.0	933	0.933	11.8	622	0.622	7.88
68.5	922	0.922	13.5	613	0.613	8.96
59.0	912	0.912	15.5	605	0.605	10.3
48.4	902	0.902	18.6	597	0.597	12.3
125CT44.8	758	0.758	17.0	502	0.502	11.2
36.5	748	0.748	20.5	494	0.494	13.5
100CT29.8	608	0.608	20.4	403	0.403	13.5
26.1	603	0.603	23.1	399	0.399	15.3
23.1	598	0.598	25.9	395	0.395	17.1
75CT18.6	460	0.460	24.8	306	0.306	16.5
15.0	454	0.454	30.1	301	0.301	19.9
11.7	447	0.447	38.3	295	0.295	25.3
50CT 7.4	284	0.284	38.6	185	0.185	25.2

TABLE 3.2-5(B)

TEES CUT FROM UNIVERSAL BEAMS
FIRE ENGINEERING DESIGN
exposed surface area to mass ratio (m^2/tonne)

1 = TOTAL PERIMETER, PROFILE-PROTECTED
2 = TOTAL PERIMETER, BOX-PROTECTED, NO GAP
3 = TOTAL PERIMETER, BOX-PROTECTED, 25mm GAP
4 = TOP FLANGE EXCLUDED, PROFILE-PROTECTED
5 = TOP FLANGE EXCLUDED, BOX-PROTECTED, NO GAP
6 = TOP FLANGE EXCLUDED, BOX-PROTECTED, 25mm GAP



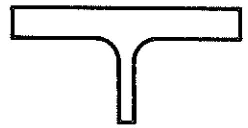
Designation	1	2	3	4	5	6
305BT62.5	16.9	17.1	20.3	13.2	13.4	15.0
56.5	18.5	18.7	22.2	14.5	14.7	16.5
50.5	20.5	20.8	24.7	16.0	16.3	18.2
265BT46.3	20.3	20.5	24.8	15.7	16.0	18.2
41.0	22.7	22.9	27.8	17.6	17.9	20.3
230BT41.1	20.3	20.5	25.4	15.6	15.8	18.3
37.3	22.1	22.4	27.8	17.0	17.3	20.0
33.6	24.5	24.8	30.7	18.8	19.1	22.1
205BT29.9	25.1	25.4	32.1	19.1	19.5	22.8
26.9	27.7	28.1	35.5	21.1	21.5	25.2
180BT28.4	24.3	24.7	31.7	18.3	18.6	22.2
25.4	27.1	27.4	35.3	20.3	20.7	24.6
22.4	30.4	30.9	39.8	22.8	23.2	27.7
155BT23.1	27.0	27.4	36.1	19.9	20.3	24.6
20.2	30.5	31.0	40.8	22.4	22.9	27.8
16.0	36.5	37.2	49.7	27.2	27.9	34.1
125BT18.7	29.0	29.4	40.1	21.1	21.5	26.9
15.7	34.0	34.5	47.3	24.7	25.2	31.6
12.9	37.8	38.6	54.3	28.1	28.9	36.8
100BT14.9	31.1	31.6	45.0	22.2	22.7	29.3
12.7	36.4	37.0	52.8	25.8	26.4	34.4
11.2	40.8	41.5	59.3	29.0	29.6	38.6
9.1	42.4	43.5	65.5	31.5	32.6	43.6
90BT11.1	31.7	32.4	50.5	23.5	24.2	33.3
9.1	38.4	39.2	61.4	28.4	29.2	40.3
8.1	43.0	44.0	69.0	31.7	32.7	45.2
75BT 9.0	33.0	33.8	56.1	24.7	25.4	36.6
7.0	41.8	42.8	71.5	31.0	32.0	46.4

Note: See page 3-4 for details on cases of fire exposure considered.

TABLE 3.2-6(B)

TEES CUT FROM UNIVERSAL COLUMNS
FIRE ENGINEERING DESIGN
exposed surface area to mass ratio (m^2/tonne)

1 = TOTAL PERIMETER, PROFILE-PROTECTED
2 = TOTAL PERIMETER, BOX-PROTECTED, NO GAP
3 = TOTAL PERIMETER, BOX-PROTECTED, 25mm GAP
4 = TOP FLANGE EXCLUDED, PROFILE-PROTECTED
5 = TOP FLANGE EXCLUDED, BOX-PROTECTED, NO GAP
6 = TOP FLANGE EXCLUDED, BOX-PROTECTED, 25mm GAP



Designation	1	2	3	4	5	6
155CT79.0	11.8	12.0	14.5	7.88	8.06	9.33
68.5	13.5	13.7	16.6	8.96	9.17	10.6
59.0	15.5	15.8	19.1	10.3	10.5	12.2
48.4	18.6	18.9	23.0	12.3	12.6	14.7
125CT44.8	17.0	17.3	21.7	11.3	11.5	13.8
36.5	20.5	20.8	26.3	13.5	13.9	16.6
100CT29.8	20.4	20.7	27.4	13.5	13.8	17.2
26.1	23.1	23.5	31.1	15.3	15.7	19.5
23.1	25.9	26.3	34.9	17.1	17.5	21.8
75CT18.6	24.8	25.3	36.1	16.5	16.9	22.3
15.0	30.1	30.6	43.8	19.9	20.4	27.1
11.7	38.3	39.0	56.1	25.3	25.9	34.5
50CT 7.4	38.6	39.8	66.9	25.2	26.3	39.9

Note: See page 3-4 for details on cases of fire exposure considered.

TABLE 3.2-7(A)

PARALLEL FLANGE CHANNELS
SURFACE AREAS

Designation	Mass per metre	Profile Distance	Profile Surface Area	Profile Surface Area	Profile Distance Less 1 Flange Face	Profile Surface Area Less 1 Flange Face	Profile Surface Area Less 1 Flange Face
	kg/m	mm	m²/m	m²/tonne	mm	m²/m	m²/tonne
380 PFC	55.2	1130	1.13	20.4	1030	1.03	18.6
300 PFC	40.1	932	0.932	23.2	842	0.842	21.0
250 PFC	35.5	834	0.834	23.5	744	0.744	21.0
230 PFC	25.1	737	0.737	29.3	662	0.662	26.3
200 PFC	22.9	678	0.678	29.6	603	0.603	26.3
180 PFC	20.9	638	0.638	30.5	563	0.563	26.9
150 PFC	17.7	579	0.579	32.7	504	0.504	28.5

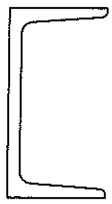


TABLE 3.2-8(A)

TAPER FLANGE CHANNELS
SURFACE AREAS

Designation	Mass per metre	Profile Distance	Profile Surface Area	Profile Surface Area	Profile Distance Less 1 Flange Face	Profile Surface Area Less 1 Flange Face	Profile Surface Area Less 1 Flange Face
	kg/m	mm	m²/m	m²/tonne	mm	m²/m	m²/tonne
125 TFC	13.4	480	0.480	35.7	415	0.415	30.9
100 TFC	9.34	374	0.374	40.0	324	0.324	34.6
75 TFC	6.65	286	0.286	43.0	246	0.246	37.0

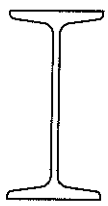


TABLE 3.2-9(A)

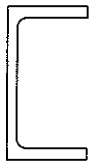
TAPER FLANGE BEAMS
SURFACE AREAS

Designation	Mass per metre	Profile Distance	Profile Surface Area	Profile Surface Area	Profile Distance Less 1 Flange Face	Profile Surface Area Less 1 Flange Face	Profile Surface Area Less 1 Flange Face
	kg/m	mm	m²/m	m²/tonne	mm	m²/m	m²/tonne
125 TFB	13.1	470	0.470	35.7	405	0.405	30.8
100 TFB	7.20	349	0.349	48.5	304	0.304	42.2

TABLE 3.2-7(B)

PARALLEL FLANGE CHANNELS
FIRE ENGINEERING DESIGN
exposed surface area to mass ratio (m^2/tonne)

1 = TOTAL PERIMETER, PROFILE-PROTECTED
2 = TOTAL PERIMETER, BOX-PROTECTED, NO GAP
3 = TOTAL PERIMETER, BOX-PROTECTED, 25mm GAP
4 = TOP FLANGE EXCLUDED, PROFILE-PROTECTED
5 = TOP FLANGE EXCLUDED, BOX-PROTECTED, NO GAP
6 = TOP FLANGE EXCLUDED, BOX-PROTECTED, 25mm GAP



Designation	kg/m	1	2	3	4	5	6
380 PFC	55.2	20.4	17.4	21.0	18.6	15.6	17.4
300 PFC	40.1	23.2	19.5	24.4	21.0	17.2	19.7
250 PFC	35.5	23.5	19.2	24.8	21.0	16.6	19.4
230 PFC	25.1	29.3	24.3	32.2	26.3	21.3	25.3
200 PFC	22.9	29.6	24.0	32.7	26.3	20.7	25.1
180 PFC	20.9	30.5	24.4	34.0	26.9	20.8	25.6
150 PFC	17.7	32.7	25.4	36.7	28.5	21.2	26.8

Note: See page 3-4 for details on cases of fire exposure considered.

TABLE 3.2-8(B)

TAPER FLANGE CHANNELS
FIRE ENGINEERING DESIGN
exposed surface area to mass ratio (m^2/tonne)

1 = TOTAL PERIMETER, PROFILE-PROTECTED
2 = TOTAL PERIMETER, BOX-PROTECTED, NO GAP
3 = TOTAL PERIMETER, BOX-PROTECTED, 25mm GAP
4 = TOP FLANGE EXCLUDED, PROFILE-PROTECTED
5 = TOP FLANGE EXCLUDED, BOX-PROTECTED, NO GAP
6 = TOP FLANGE EXCLUDED, BOX-PROTECTED, 25mm GAP

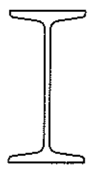
Designation	kg/m	1	2	3	4	5	6
125 TFC	13.4	35.7	28.3	43.2	30.9	23.5	30.9
100 TFC	9.34	40.0	32.1	53.4	34.6	26.7	37.4
75 TFC	6.65	43.0	34.6	64.7	37.0	28.6	43.6

Note: See page 3-4 for details on cases of fire exposure considered.

TABLE 3.2-9(B)

TAPER FLANGE BEAMS
FIRE ENGINEERING DESIGN
exposed surface area to mass ratio (m^2/tonne)

1 = TOTAL PERIMETER, PROFILE-PROTECTED
2 = TOTAL PERIMETER, BOX-PROTECTED, NO GAP
3 = TOTAL PERIMETER, BOX-PROTECTED, 25mm GAP
4 = TOP FLANGE EXCLUDED, PROFILE-PROTECTED
5 = TOP FLANGE EXCLUDED, BOX-PROTECTED, NO GAP
6 = TOP FLANGE EXCLUDED, BOX-PROTECTED, 25mm GAP

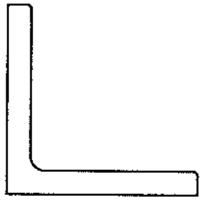


Designation	kg/m	1	2	3	4	5	6
125 TFB	13.1	35.7	28.9	44.1	30.8	24.0	31.6
100 TFB	7.20	48.5	40.3	68.1	42.2	34.1	47.9

Note: See page 3-4 for details on cases of fire exposure considered.

TABLE 3.2-10(A)

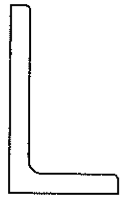
EQUAL ANGLES
SURFACE AREAS



Designation	Mass per metre	Profile Distance	Profile Surface Area	Profile Surface Area
	kg/m	mm	m²/m	m²/tonne
200 x 200 x 26EA	76.8	788	0.788	10.3
20EA	60.1	788	0.788	13.1
18EA	54.4	788	0.788	14.5
16EA	48.7	788	0.788	16.2
13EA	40.0	788	0.788	19.7
150 x 150 x 19EA	42.1	590	0.590	14.0
16EA	35.4	590	0.590	16.6
12EA	27.3	590	0.590	21.6
10EA	21.9	590	0.590	27.0
125 x 125 x 16EA	29.1	491	0.491	16.9
12EA	22.5	491	0.491	21.8
10EA	18.0	491	0.491	27.3
8EA	14.9	491	0.491	32.9
100 x 100 x 12EA	17.7	392	0.392	22.1
10EA	14.2	392	0.392	27.6
8EA	11.8	392	0.392	33.3
6EA	9.16	392	0.392	42.8
90 x 90 x 10EA	12.7	352	0.352	27.7
8EA	10.6	352	0.352	33.3
6EA	8.22	352	0.352	42.9
75 x 75 x 10EA	10.5	292	0.292	27.8
8EA	8.73	292	0.292	33.5
6EA	6.81	292	0.292	42.9
5EA	5.27	292	0.292	55.4
65 x 65 x 10EA	9.02	255	0.255	28.3
8EA	7.51	255	0.255	33.9
6EA	5.87	255	0.255	43.4
5EA	4.56	255	0.255	55.9
55 x 55 x 6EA	4.93	215	0.215	43.6
5EA	3.84	215	0.215	56.0
50 x 50 x 8EA	5.68	195	0.195	34.3
6EA	4.46	195	0.195	43.7
5EA	3.48	195	0.195	56.1
3EA	2.31	195	0.195	84.2
45 x 45 x 6EA	3.97	175	0.175	44.2
5EA	3.10	175	0.175	56.6
3EA	2.06	175	0.175	85.1
40 x 40 x 6EA	3.50	155	0.155	44.4
5EA	2.73	155	0.155	56.8
3EA	1.83	155	0.155	85.1
30 x 30 x 6EA	2.56	115	0.115	45.1
5EA	2.01	115	0.115	57.3
3EA	1.35	115	0.115	85.1
25 x 25 x 6EA	2.08	95.3	0.0953	45.7
5EA	1.65	95.3	0.0953	57.7
3EA	1.12	95.3	0.0953	85.2

TABLE 3.2-11(A)

UNEQUAL ANGLES
SURFACE AREAS



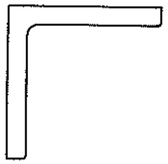
Designation	Mass per metre	Profile Distance	Profile Surface Area	Profile Surface Area
	kg/m	mm	m²/m	m²/tonne
150 x 100 x 12UA	22.5	491	0.491	21.8
10UA	18.0	491	0.491	27.3
150 x 90 x 16UA	27.9	471	0.471	16.9
12UA	21.6	471	0.471	21.9
10UA	17.3	471	0.471	27.3
8UA	14.3	471	0.471	33.0
125 x 75 x 12UA	17.7	392	0.392	22.1
10UA	14.2	392	0.392	27.6
8UA	11.8	392	0.392	33.3
6UA	9.16	392	0.392	42.8
100 x 75 x 10UA	12.4	342	0.342	27.7
8UA	10.3	342	0.342	33.4
6UA	7.98	342	0.342	42.9
75 x 50 x 8UA	7.23	244	0.244	33.8
6UA	5.66	244	0.244	43.2
5UA	4.40	244	0.244	55.6
65 x 50 x 8UA	6.59	225	0.225	34.1
6UA	5.16	225	0.225	43.5
5UA	4.02	225	0.225	56.0

TABLE 3.2.-10(B)

EQUAL ANGLES

FIRE ENGINEERING DESIGN

exposed surface area to mass ratio (m^2/tonne)



1 = TOTAL PERIMETER PROFILE—PROTECTED
2 = TOTAL PERIMETER BOX-PROTECTED, NO GAP
3 = TOTAL PERIMETER, BOX-PROTECTED, 25mm GAP
4 = TOP FLANGE EXCLUDED, PROFILE—PROTECTED
5 = TOP FLANGE EXCLUDED, BOX—PROTECTED NO GAP
6 = TOP FLANGE EXCLUDED, BOX-PROTECTED 25mm GAP

Designation		1	2	3	4	5	6
200 x 200 x	26EA	10.3	10.4	13.0	7.66	7.81	9.12
	20EA	13.1	13.3	16.6	9.78	9.98	11.6
	18EA	14.5	14.7	18.4	10.8	11.0	12.9
	16EA	16.2	16.4	20.5	12.1	12.3	14.4
	13EA	19.7	20.0	25.0	14.7	15.0	17.5
150 x 150 x	19EA	14.0	14.2	19.0	10.5	10.7	13.1
	16EA	16.6	16.9	22.6	12.4	12.7	15.5
	12EA	21.6	22.0	29.3	16.1	16.5	20.1
	10EA	27.0	27.4	36.6	20.1	20.6	25.2
125 x 125 x	16EA	16.9	17.2	24.0	12.6	12.9	16.3
	12EA	21.8	22.2	31.1	16.3	16.7	21.1
	10EA	27.3	27.7	38.8	20.3	20.8	26.4
	8EA	32.9	33.5	46.9	24.6	25.1	31.8
100 x 100 x	12EA	22.1	22.6	33.8	16.5	16.9	22.6
	10EA	27.6	28.1	42.2	20.5	21.1	28.1
	8EA	33.3	33.9	50.9	24.8	25.4	33.9
	6EA	42.8	43.7	65.5	31.9	32.7	43.7
90 x 90 x	10EA	27.7	28.3	44.0	20.6	21.2	29.0
	8EA	33.3	34.1	53.0	24.8	25.6	35.0
	6EA	42.9	43.8	68.1	31.9	32.9	45.0
75 x 75 x	10EA	27.8	28.6	47.6	20.7	21.4	30.9
	8EA	33.5	34.4	57.3	24.9	25.8	37.2
	6EA	42.9	44.1	73.5	31.9	33.1	47.8
	5EA	55.4	56.9	94.8	41.2	42.7	61.6
65 x 65 x	10EA	28.3	28.8	51.0	21.1	21.6	32.7
	8EA	33.9	34.6	61.2	25.3	26.0	39.3
	6EA	43.4	44.3	78.4	32.3	33.2	50.2
	5EA	55.9	57.0	101	41.6	42.8	64.7
55 x 55 x	6EA	43.6	44.6	85.2	32.4	33.5	53.8
	5EA	56.0	57.3	109	41.7	43.0	69.1
50 x 50 x	8EA	34.3	35.2	70.5	25.5	26.4	44.0
	6EA	43.7	44.9	89.7	32.5	33.6	56.1
	5EA	56.1	57.6	115	41.7	43.2	71.9
	3EA	84.2	86.4	173	62.6	64.8	108
45 x 45 x	6EA	44.2	45.4	95.8	32.8	34.0	59.2
	5EA	56.6	58.1	123	42.1	43.6	75.9
	3EA	85.1	87.4	184	63.2	65.5	114
40 x 40 x	6EA	44.4	45.8	103	33.0	34.3	62.9
	5EA	56.8	58.5	132	42.2	43.9	80.5
	3EA	85.1	87.7	197	63.2	65.7	121
30 x 30 x	6EA	45.1	47.0	125	33.4	35.2	74.4
	5EA	57.3	59.6	159	42.4	44.7	94.4
	3EA	85.1	88.6	236	63.0	66.5	140
25 x 25 x	6EA	45.7	48.0	144	33.7	36.0	84.0
	5EA	57.7	60.6	182	42.6	45.4	106
	3EA	85.2	89.4	268	62.8	67.0	156

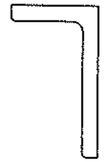
Note: See page 3-4 for details on cases of fire exposure considered.

TABLE 3.2-11(B)

UNEQUAL ANGLES

FIRE ENGINEERING DESIGN

exposed surface area to mass ratio (m^2/tonne)



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5 = TOP FLANGE EXCLUDED, BOX-PROTECTED, NO GAP
6 = TOP FLANGE EXCLUDED, BOX-PROTECTED, 25mm GAP

Designation		1	2	3	4	5	6
150 x 100 x	12UA	21.8	22.2	31.1	17.4	17.8	22.2
	10UA	27.3	27.7	38.8	21.7	22.2	27.7
150 x 90 x	16UA	16.9	17.2	24.4	13.7	14.0	17.6
	12UA	21.9	22.3	31.5	17.7	18.1	22.7
	10UA	27.3	27.8	39.4	22.1	22.6	28.4
	8UA	33.0	33.6	47.5	26.7	27.3	34.3
125 x 75 x	12UA	22.1	22.6	33.8	17.9	18.3	24.0
	10UA	27.6	28.1	42.2	22.3	22.8	29.9
	8UA	33.3	33.9	50.9	26.9	27.6	36.0
	6UA	42.8	43.7	65.5	34.6	35.5	46.4
100 x 75 x	10UA	27.7	28.3	44.5	21.6	22.2	30.3
	8UA	33.4	34.1	53.6	26.0	26.8	36.5
	6UA	42.9	43.8	68.9	33.5	34.4	47.0
75 x 50 x	8UA	33.8	34.6	62.3	26.9	27.7	41.5
	6UA	43.2	44.2	79.5	34.4	35.4	53.0
	5UA	55.6	56.8	102	44.2	45.5	68.2
65 x 50 x	8UA	34.1	34.9	65.2	26.5	27.3	42.5
	6UA	43.5	44.5	83.3	33.9	34.9	54.2
	5UA	56.0	57.3	107	43.5	44.8	69.7

Note: See page 3-4 for details on cases of fire exposure considered.

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PART 4 METHODS OF STRUCTURAL ANALYSIS

TABLES

PART 4 METHODS OF STRUCTURAL ANALYSIS

4.1 Methods of Determining Design Action Effects

This section provides guidance on calculating design action effects as required by AS 4100. The methods of analysis recognised by AS 4100 are:

(a) first-order elastic analysis with moment amplification (Clause 4.4.2 of AS 4100),

(b) second-order elastic analysis (Appendix E of AS 4100),

(c) plastic analysis with moment amplification (Clause 4.5 of AS 4100), and

(d) advanced analysis (Appendix D of AS 4100).

These four methods consider the interaction of load and deformation that produce second-order effects. For members subject to bending and axial force, second-order effects (known as P-Δ and P-δ effects) can increase the design bending moment.

Structural analysis methods (a) and (b) are most commonly used. However (b) can only be effectively used via computer methods. This method, together with methods (c) and (d) are beyond the scope of this publication. Hence, tables are presented which will assist designers with method (a) above.

4.2 Moment Amplification for First-Order Elastic Analyses

For a member subjected to combined bending and axial force, the bending moments are *amplified* by the presence of axial force. This occurs to both isolated, statically determinate members, and members in a statically indeterminant frame. A first-order elastic analysis alone does not consider second-order effects, however *moment amplification* accounts for the second-order effects. The moment amplification factor is calculated differently for braced and sway members as shown below.

4.2.1 Braced Members

In a braced member the transverse displacement of one end of the member relative to the other is effectively prevented. The moment amplification factor for a braced member is δ_b.

If a first-order elastic analysis is carried out then δ_b is used to amplify the bending moments between the ends of the member (Clause 4.4.2.2 of AS 4100). If δ_b is greater than 1.4, a second-order elastic analysis must be carried out in accordance with Appendix E of AS 4100.

δ_b is calculated from the flow chart in Figure 4.1. The design bending moment is given by:

$M^* = M^*_m$ (for braced members subject to axial tension or with zero axial force)

$M^* = \delta_b M^*_m$ (for braced members subject to compression)

where M^*_m is the maximum design bending moment calculated using a first-order analysis.

4.2.2 Sway Members

In a sway member the transverse displacement of one end of the member relative to the other is not effectively prevented. The moment amplification factor for a sway member is δ_s .

The bending moments calculated from a first-order elastic analysis are modified by the moment amplification factor (δ_m) which is the greater of δ_b and δ_s (Clause 4.4.2.3 of AS 4100). If δ_m is greater than 1.4 a second-order elastic analysis must be used in accordance with Appendix E of AS 4100.

δ_b and δ_s are calculated using the flow charts shown in Figures 4.1 and 4.2 and the design bending moment is given by:

$$M^* = \delta_m M_m^*$$

4.2.3 Values of c_m

The factor for unequal moments (c_m) is used in the calculation of δ_b . If a braced member is subject *only to end moments* then:

$$c_m = 0.6 - 0.4\,\beta_m \leq 1.0 \qquad \text{(Clause 4.4.2.2 of AS 4100)}$$

where β_m is the ratio of the smaller to the larger bending moment at the ends of the member, taken as positive when the member is bent in reverse curvature.

If the member is subjected to transverse loading, β_m is calculated as follows:

(a) $\beta_m = -1.0$ (conservative), (Clause 4.4.2.2(a) of AS 4100)

(b) β_m is obtained by matching the moment distribution options shown in Figure 4.4.2.2 of AS 4100,

(c) β_m is based on the midspan deflection. (Clause 4.4.2.2(c) of AS 4100)

4.2.4 Elastic Flexural Buckling Loads

Elastic flexural buckling loads (N_{om}) are required for the calculation of δ_b and δ_m . Values of N_{om} for various effective lengths (L_e) are given in Tables 4-1 to 4-11 determined using Clause 4.6.2 of AS 4100 as:

$$N_{om} = \frac{\pi^2 EI}{(k_e L)^2}$$

where $k_e L = L_e$ = effective length

There are two series of tables. Each (A) series table lists elastic flexural buckling loads for buckling about the *x*-axis (N_{omx}) and is immediately followed by a (B) series table for buckling about the *y*-axis (N_{omy}).

k_e is given in Table 6.2 for members with idealised end restraints. For braced or sway members in frames, k_e depends on the ratio (γ) of the compression member stiffness to the end restraint stiffness, calculated at each end of the member. Example 2 in Section 4.3 provides a sample calculation of k_e for a simple unbraced plane frame.

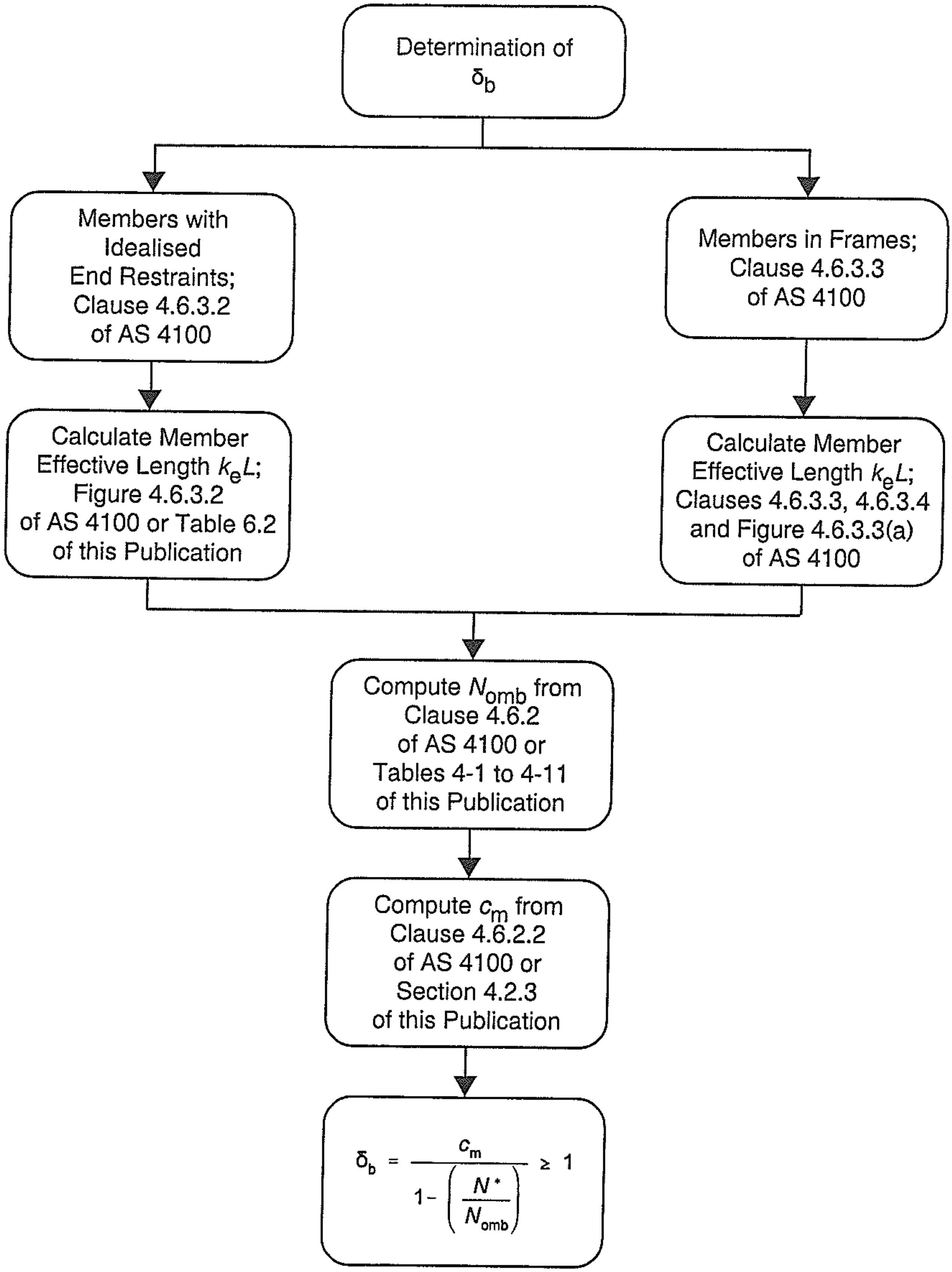


Figure 4.1: Flow Chart for Determination of δ_b

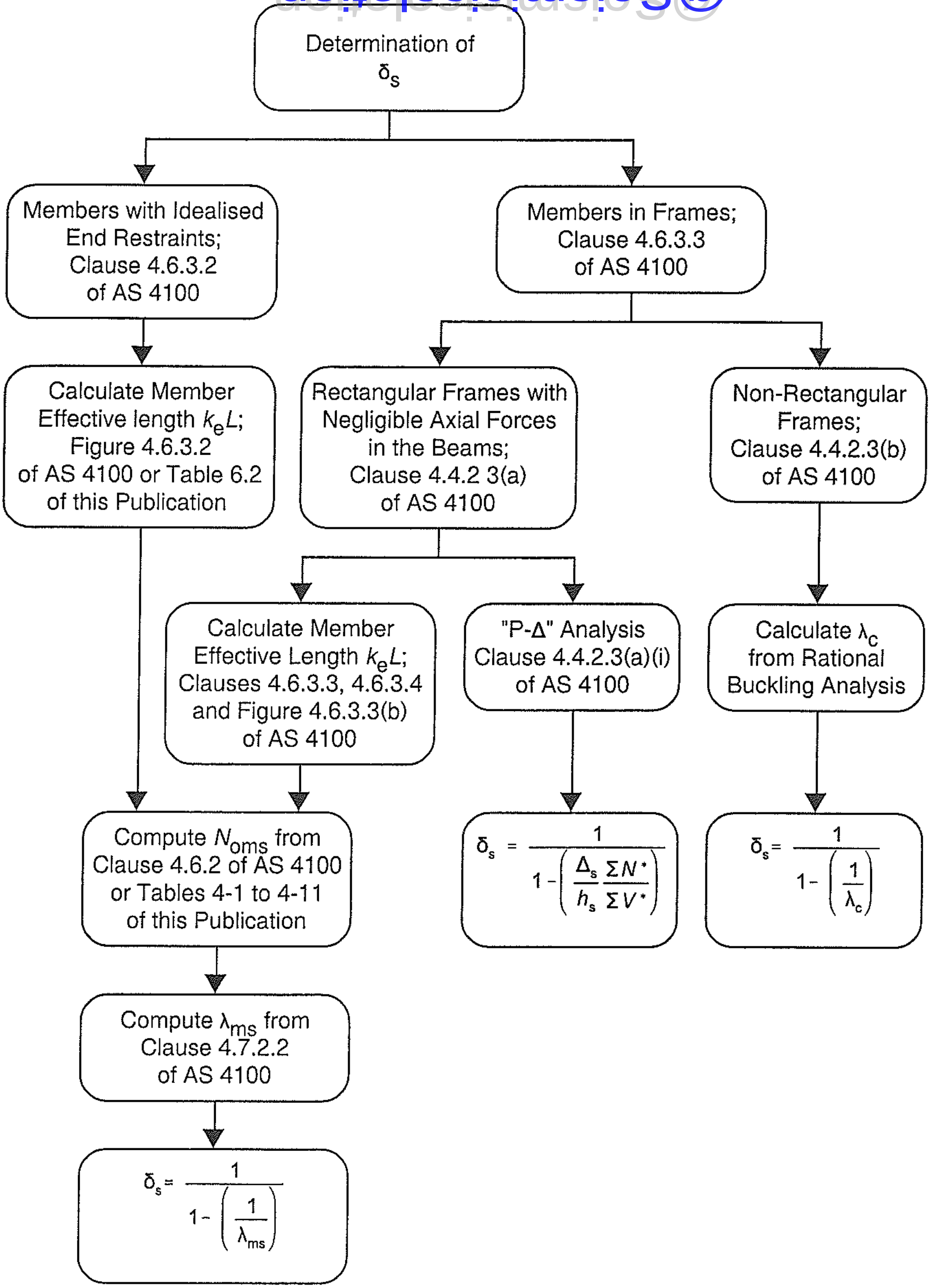
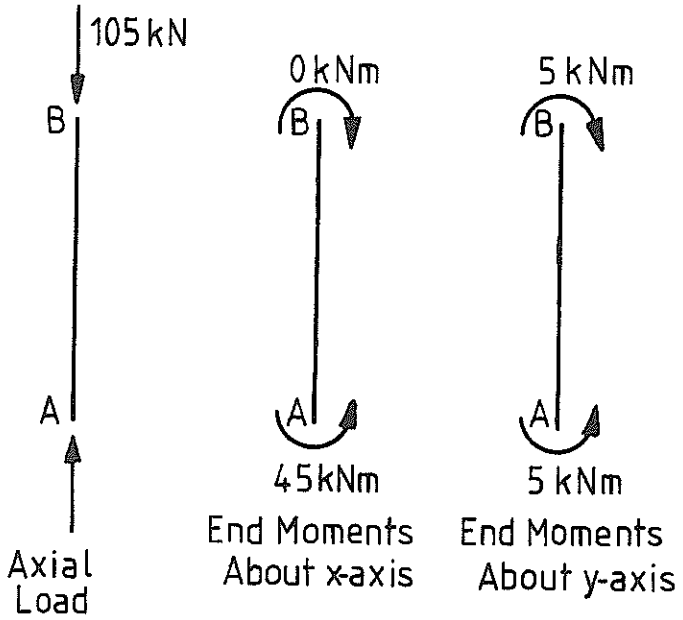


Figure 4.2: Flow Chart for Determination of δ_s

4.3 Examples

1. Braced Beam Column

Determine the design action effects for an isolated beam column below. A braced member is subjected to design actions as shown.



Design Data:

Section:	200UB29.8 Grade 300 steel
Effective lengths:	Flexural buckling (*x*-axis) = 4.0 m Flexural buckling (*y*-axis) = 4.0 m

Solution:

N^*	=	105 kN	
N_{ombx}	=	3590 kN	from Table 4-3(A) for L_{ex} = 4.0 m
N_{omby}	=	476 kN	from Table 4-3(B) for L_{ey} = 4.0 m
M^*_{mx}	=	45 kNm	maximum at End A
M^*_{my}	=	5.0 kNm	maximum at Ends A and B
c_{mx}	=	0.60	from Section 4.2.3 for $\beta_{mx} = 0$
c_{my}	=	1.00	from Section 4.2.3 for $\beta_{my} = -1.0$

From Figure 4.1 the moment amplification factor (δ_b) is given by:

$$\delta_b = \frac{c_m}{1 - \left(\frac{N^*}{N_{omb}}\right)}$$

Considering flexural buckling about *x*-axis: $\delta_{bx} = 0.618(<1)\ (\Rightarrow \delta_{bx} = 1)$

∴ Maximum moment occurs at the ends, i.e. at End A $M^*_x = 45$ kNm

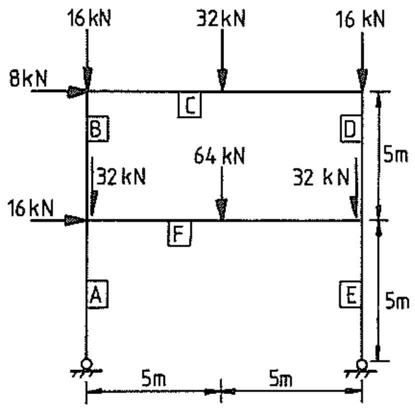
Considering flexural buckling about *y*-axis: $\delta_{by} = 1.28$

∴ Maximum moment occurs between ends, i.e. in span $M^*_y = 1.28 \times 5.0 = 6.40$ kNm

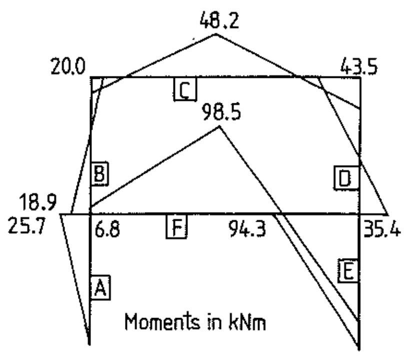
2. Unbraced plane frame

Calculate the design action effects using first-order elastic analysis and moment magnification for the columns of the unbraced frame below. This is based on Example 4.5 of *Worked Examples for Steel Structures*, 2nd Edition, M.A. Bradford, R.Q. Bridge & N.S. Trahair, published by AISC 1992.

The design loads on a frame and the results of a first-order elastic analysis are shown below.



Member	Section
A, E	200UC52.2
B, D	150UC30.0
C	200UB25.4
F	310UB40.4



Design moments

Member	Section	N^* (kN)
A	200UC52.2	−80.0
B	150UC30.0	−29.6
C	200UB25.4	−15.8
D	150UC30.0	−34.4
E	200UC52.2	−112.0
F	310UB40.4	−3.1

Design axial forces

Solution:

(i) Calculation of elastic flexural buckling loads for the columns:

The braced and sway effective length factors (k_{eb} and k_{es}) are required for the determination of the elastic flexural buckling loads (N_{omb} and N_{oms} respectively).

Since the restraining beams are rigidly connected at their far ends to the columns, $\beta_e = 1.0$ (Table 4.6.3.4 of AS 4100).

a) Upper storey columns (Clause 4.6.3.4 of AS 4100)

$$\gamma = \frac{\sum\left(\frac{I}{L}\right)_c}{\sum\beta_e\left(\frac{I}{L}\right)_b}$$

γ_T = (17.6 / 5.0)/(1.0 × 23.6 / 10.0) = 1.49

γ_B = ((17.6 + 52.8) / 5.0)/(1.0 × 86.4 / 10.0)) = 1.63

Using Figures 4.6.3.3(b) and (a) of AS 4100, k_{es} = 1.47 k_{eb} = 0.83

∴ L_{es} = 1.47 × 5.0 = 7.35 m L_{eb} = 0.83 × 5.0 = 4.15 m

From Table 4-4(A) for L_e = 8 m, N_{om} = 543 kN

For L_e = 7.35 m, the elastic buckling loads for the upper storey columns are

N_{oms} = 543 × $(8 / 7.35)^2$ = 643 kN N_{omb} = 543 × $(8/4.15)^2$ = 2020 kN

b) Lower storey columns (Clause 4.6.3.4 of AS 4100)

γ_T = ((17.6 + 52.8)/ 5.0)/(1.0 × 86.4 / 10.0) = 1.63

γ_B = 10 (pinned base)

Using Figures 4.6.3.3(b) and (a) of AS 4100, k_{es} = 2.1 k_{eb} = 0.89

∴ L_{es} = 2.1 × 5.0 = 10.5 m L_{eb} = 0.89 × 5.0 = 4.45 m

From Table 4-4(A) for L_e = 10 m, N_{om} = 1040 kN

For L_e = 10.5 m, the elastic buckling loads for the upper storey columns are

N_{oms} = 1040 × $(10 / 10.5)^2$ = 943 kN N_{omb} = 1040 × $(10/4.45)^2$ = 5250 kN

(ii) Calculation of moment amplification factor δ_b (consider each column separately)

From Figure 4.1 the moment amplification factor δ_b is given by:

$$\delta_b = \frac{c_m}{1 - \left(\frac{N^*}{N_{omb}}\right)}$$

Column A:

c_{mA} = 0.60 (Section 4.2.3 for β_{mA} = 0)

$$\therefore \quad \delta_{bA} = \frac{0.60}{1 - \frac{80.0}{5250}} = 0.609 \qquad (< 1.0)$$

Column B:

c_{mB} = 0.222 (Section 4.2.3 for β_{mB} = 0.95)

$$\therefore \quad \delta_{bB} = \frac{0.222}{1 - \frac{29.6}{2020}} = 0.225 \qquad (< 1.0)$$

Column D:

c_{mD} = 0.274 (Section 4.2.3 for β_{mD} = 0.81)

$$\therefore \quad \delta_{bD} = \frac{0.274}{1 - \frac{34.4}{2020}} = 0.278 \qquad (< 1.0)$$

Column E:

$$c_{mE} = 0.60 \qquad \text{(Section 4.2.3 for } \beta_{mE} = 0\text{)}$$

$$\therefore \quad \delta_{bE} = \frac{0.60}{1 - \frac{112}{5250}} = 0.613 \qquad (< 1.0)$$

Clause 4.4.2.2 of AS 4100 states that $\delta_b \geq 1.0$.

$$\therefore \quad \delta_b = 1.0 \quad \text{for the upper storey}$$

$$\delta_b = 1.0 \quad \text{for the lower storey}$$

(iii) Calculation of sway moment amplification factor δ_s

From Figure 4.2 for a rectangular frame with negligible axial force in the beams, the sway moment amplification factor δ_s for each storey is given by

$$\delta_s = \frac{1}{1 - \left(\frac{1}{\lambda_{ms}}\right)}$$

where
$$\lambda_{ms} = \frac{\sum\left(\frac{N_{oms}}{L}\right)}{\sum\left(\frac{N^*}{L}\right)}$$

a) Upper storey (Clause 4.7.2.2 of AS 4100)

$$\lambda_{ms} = \frac{2 \times 643/5.0}{(29.6 + 34.4)/5.0} = 20.1$$

$$\therefore \quad \delta_s = 1.052 \qquad (< 1.4)$$

b) Lower storey (Clause 4.7.2.2 of AS 4100)

$$\lambda_{ms} = \frac{2 \times 943/5.0}{(80.0 + 112)/5.0} = 9.82$$

$$\therefore \quad \delta_s = 1.113 \qquad (< 1.4)$$

(iv) Determination of δ_m

$$\delta_m = \max[\delta_b, \delta_s] = 1.052 \quad \text{for the upper storey}$$

$$\delta_m = \max[\delta_b, \delta_s] = 1.113 \quad \text{for the lower storey}$$

Therefore the design bending moments are:

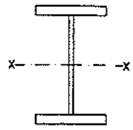
$$M^* = 43.5 \times 1.052 = 45.8 \text{ kNm} \quad \text{for the upper storey}$$

$$M^* = 94.3 \times 1.113 = 105 \text{ kNm} \quad \text{for the lower storey}$$

TABLE 4-1(A)

WELDED BEAMS

ELASTIC FLEXURAL BUCKLING LOADS
buckling about x-axis

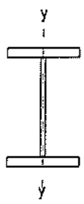


Designation	Elastic Flexural Buckling Loads N_{om} (MN) Effective Length (L_e) in metres														
	0	2	4	6	8	10	12	15	18	21	24	27	30	33	36
1200WB455	∞	7570	1890	841	473	303	210	135	93.4	68.6	52.6	41.5	33.6	27.8	23.4
423	∞	6860	1720	762	429	274	191	122	84.7	62.2	47.6	37.6	30.5	25.2	21.2
392	∞	6160	1540	685	385	247	171	110	76.1	55.9	42.8	33.8	27.4	22.6	19.0
342	∞	5120	1280	569	320	205	142	91.0	63.2	46.4	35.5	28.1	22.7	18.8	15.8
317	∞	4570	1140	507	285	183	127	81.2	56.4	41.4	31.7	25.1	20.3	16.8	14.1
278	∞	3760	939	417	235	150	104	66.8	46.4	34.1	26.1	20.6	16.7	13.8	11.6
249	∞	3150	787	350	197	126	87.5	56.0	38.9	28.6	21.9	17.3	14.0	11.6	9.72
1000WB322	∞	3690	923	410	231	148	103	65.6	45.6	33.5	25.6	20.3	16.4	13.6	11.4
296	∞	3280	820	364	205	131	91.1	58.3	40.5	29.8	22.8	18.0	14.6	12.0	10.1
258	∞	2680	669	297	167	107	74.4	47.6	33.1	24.3	18.6	14.7	11.9	9.83	8.26
215	∞	2000	501	223	125	80.2	55.7	35.6	24.7	18.2	13.9	11.0	8.91	7.36	6.19
900WB282	∞	2830	707	314	177	113	78.6	50.3	34.9	25.6	19.6	15.5	12.6	10.4	8.73
257	∞	2490	623	277	156	99.7	69.3	44.3	30.8	22.6	17.3	13.7	11.1	9.16	7.70
218	∞	2010	501	223	125	80.2	55.7	35.6	24.8	18.2	13.9	11.0	8.91	7.37	6.19
175	∞	1460	365	162	91.3	58.4	40.6	26.0	18.0	13.2	10.1	8.01	6.49	5.36	4.51
800WB192	∞	1470	367	163	91.8	58.7	40.8	26.1	18.1	13.3	10.2	8.06	6.52	5.39	4.53
168	∞	1230	307	136	76.6	49.0	34.1	21.8	15.1	11.1	8.52	6.73	5.45	4.50	3.78
146	∞	1010	252	112	62.9	40.3	28.0	17.9	12.4	9.13	6.99	5.52	4.47	3.70	3.11
122	∞	775	194	86.1	48.4	31.0	21.5	13.8	9.57	7.03	5.38	4.25	3.44	2.85	2.39
700WB173	∞	1020	255	113	63.6	40.7	28.3	18.1	12.6	9.23	7.07	5.59	4.52	3.74	3.14
150	∞	842	211	93.6	52.6	33.7	23.4	15.0	10.4	7.64	5.85	4.62	3.74	3.09	2.60
130	∞	689	172	76.5	43.1	27.6	19.1	12.2	8.50	6.25	4.78	3.78	3.06	2.53	2.13
115	∞	569	142	63.3	35.6	22.8	15.8	10.1	7.03	5.16	3.95	3.12	2.53	2.09	1.76

TABLE 4-1(B)

WELDED BEAMS

ELASTIC FLEXURAL BUCKLING LOADS
buckling about y-axis

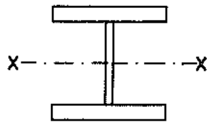


Designation	Elastic Flexural Buckling Loads N_{om} (MN) Effective Length (L_e) in metres														
	0	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	10.0
1200WB455	∞	1650	731	411	263	183	134	103	81.3	65.8	45.7	33.6	25.7	20.3	16.5
423	∞	1480	658	370	237	165	121	92.6	73.1	59.2	41.1	30.2	23.1	18.3	14.8
392	∞	1320	585	329	211	146	107	82.3	65.0	52.7	36.6	26.9	20.6	16.3	13.2
342	∞	675	300	169	108	74.9	55.1	42.2	33.3	27.0	18.7	13.8	10.5	8.33	6.75
317	∞	590	262	148	94.4	65.6	48.2	36.9	29.2	23.6	16.4	12.0	9.22	7.29	5.90
278	∞	353	157	88.3	56.5	39.3	28.8	22.1	17.5	14.1	9.82	7.21	5.52	4.36	3.53
249	∞	172	76.4	43.0	27.5	19.1	14.0	10.7	8.48	6.87	4.77	3.51	2.68	2.12	1.72
1000WB322	∞	674	300	169	108	74.9	55.1	42.2	33.3	27.0	18.7	13.8	10.5	8.33	6.74
296	∞	590	262	148	94.4	65.6	48.2	36.9	29.1	23.6	16.4	12.0	9.22	7.29	5.90
258	∞	353	157	88.3	56.5	39.3	28.8	22.1	17.4	14.1	9.81	7.21	5.52	4.36	3.53
215	∞	178	79.2	44.6	28.5	19.8	14.6	11.1	8.80	7.13	4.95	3.64	2.79	2.20	1.78
900WB282	∞	674	300	169	108	74.9	55.0	42.1	33.3	27.0	18.7	13.8	10.5	8.32	6.74
257	∞	590	262	147	94.4	65.5	48.1	36.9	29.1	23.6	16.4	12.0	9.22	7.28	5.90
218	∞	353	157	88.2	56.5	39.2	28.8	22.1	17.4	14.1	9.80	7.20	5.51	4.36	3.53
175	∞	178	79.1	44.5	28.5	19.8	14.5	11.1	8.79	7.12	4.94	3.63	2.78	2.20	1.78
800WB192	∞	249	111	62.2	39.8	27.6	20.3	15.6	12.3	9.95	6.91	5.08	3.89	3.07	2.49
168	∞	171	76.1	42.8	27.4	19.0	14.0	10.7	8.45	6.85	4.75	3.49	2.67	2.11	1.71
146	∞	137	60.9	34.2	21.9	15.2	11.2	8.56	6.76	5.48	3.80	2.80	2.14	1.69	1.37
122	∞	82.4	36.6	20.6	13.2	9.15	6.72	5.15	4.07	3.29	2.29	1.68	1.29	1.02	0.824
700WB173	∞	192	85.2	47.9	30.7	21.3	15.6	12.0	9.47	7.67	5.32	3.91	3.00	2.37	1.92
150	∞	129	57.2	32.2	20.6	14.3	10.5	8.04	6.35	5.14	3.57	2.62	2.01	1.59	1.29
130	∞	103	45.7	25.7	16.5	11.4	8.40	6.43	5.08	4.12	2.86	2.10	1.61	1.27	1.03
115	∞	82.4	36.6	20.6	13.2	9.15	6.72	5.15	4.07	3.29	2.29	1.68	1.29	1.02	0.824

TABLE 4-2(A)

WELDED COLUMNS

ELASTIC FLEXURAL BUCKLING LOADS
buckling about x-axis

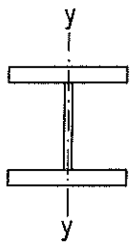


Designation	Elastic Flexural Buckling Loads N_{om} (MN) Effective Length (L_e) in metres														
	0	2	4	6	8	10	12	15	18	21	24	27	30	33	36
500WC440	∞	1060	266	118	66.5	42.5	29.5	18.9	13.1	9.64	7.38	5.83	4.73	3.91	3.28
414	∞	1040	261	116	65.1	41.7	29.0	18.5	12.9	9.45	7.24	5.72	4.63	3.83	3.22
383	∞	930	233	103	58.2	37.2	25.8	16.5	11.5	8.44	6.46	5.11	4.14	3.42	2.87
340	∞	1010	253	112	63.3	40.5	28.1	18.0	12.5	9.18	7.03	5.55	4.50	3.72	3.12
290	∞	865	216	96.1	54.1	34.6	24.0	15.4	10.7	7.85	6.01	4.75	3.84	3.18	2.67
267	∞	771	193	85.7	48.2	30.9	21.4	13.7	9.52	7.00	5.36	4.23	3.43	2.83	2.38
228	∞	620	155	68.9	38.8	24.8	17.2	11.0	7.66	5.63	4.31	3.40	2.76	2.28	1.91
400WC361	∞	673	168	74.8	42.1	26.9	18.7	12.0	8.31	6.11	4.67	3.69	2.99	2.47	2.08
328	∞	652	163	72.4	40.7	26.1	18.1	11.6	8.05	5.91	4.53	3.58	2.90	2.39	2.01
303	∞	580	145	64.5	36.3	23.2	16.1	10.3	7.16	5.26	4.03	3.18	2.58	2.13	1.79
270	∞	506	127	56.2	31.6	20.2	14.1	9.00	6.25	4.59	3.51	2.78	2.25	1.86	1.56
212	∞	383	95.7	42.5	23.9	15.3	10.6	6.80	4.73	3.47	2.66	2.10	1.70	1.41	1.18
181	∞	306	76.4	34.0	19.1	12.2	8.49	5.44	3.77	2.77	2.12	1.68	1.36	1.12	0.944
144	∞	240	60.0	26.7	15.0	9.60	6.66	4.26	2.96	2.18	1.67	1.32	1.07	0.881	0.740
350WC280	∞	369	92.1	40.9	23.0	14.7	10.2	6.55	4.55	3.34	2.56	2.02	1.64	1.35	1.14
258	∞	326	81.5	36.2	20.4	13.0	9.06	5.80	4.02	2.96	2.26	1.79	1.45	1.20	1.01
230	∞	283	70.7	31.4	17.7	11.3	7.86	5.03	3.49	2.56	1.96	1.55	1.26	1.04	0.873
197	∞	240	59.9	26.6	15.0	9.59	6.66	4.26	2.96	2.17	1.66	1.32	1.07	0.881	0.740

TABLE 4-2(B)

WELDED COLUMNS

ELASTIC FLEXURAL BUCKLING LOADS
buckling about y-axis

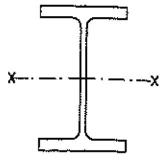


Designation	Elastic Flexural Buckling Loads N_{om} (MN) Effective Length (L_e) in metres														
	0	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	10.0
500WC440	∞	1650	733	412	264	183	135	103	81.4	66.0	45.8	33.7	25.8	20.4	16.5
414	∞	1650	732	412	264	183	134	103	81.3	65.9	45.8	33.6	25.7	20.3	16.5
383	∞	1480	659	371	237	165	121	92.7	73.2	59.3	41.2	30.3	23.2	18.3	14.8
340	∞	1320	585	329	211	146	108	82.3	65.0	52.7	36.6	26.9	20.6	16.3	13.2
290	∞	1150	512	288	184	128	94.0	72.0	56.9	46.1	32.0	23.5	18.0	14.2	11.5
267	∞	1030	457	257	165	114	84.0	64.3	50.8	41.1	28.6	21.0	16.1	12.7	10.3
228	∞	823	366	206	132	91.5	67.2	51.4	40.6	32.9	22.9	16.8	12.9	10.2	8.23
400WC361	∞	846	376	211	135	94.0	69.1	52.9	41.8	33.8	23.5	17.3	13.2	10.4	8.46
328	∞	843	375	211	135	93.7	68.9	52.7	41.7	33.7	23.4	17.2	13.2	10.4	8.43
303	∞	759	337	190	121	84.4	62.0	47.5	37.5	30.4	21.1	15.5	11.9	9.37	7.59
270	∞	675	300	169	108	75.0	55.1	42.2	33.3	27.0	18.7	13.8	10.5	8.33	6.75
212	∞	527	234	132	84.3	58.5	43.0	32.9	26.0	21.1	14.6	10.8	8.23	6.50	5.27
181	∞	422	187	105	67.5	46.8	34.4	26.3	20.8	16.9	11.7	8.60	6.59	5.20	4.22
144	∞	337	150	84.3	53.9	37.5	27.5	21.1	16.6	13.5	9.36	6.88	5.27	4.16	3.37
350WC280	∞	565	251	141	90.4	62.8	46.1	35.3	27.9	22.6	15.7	11.5	8.83	6.98	5.65
258	∞	509	226	127	81.4	56.5	41.5	31.8	25.1	20.4	14.1	10.4	7.95	6.28	5.09
230	∞	452	201	113	72.3	50.2	36.9	28.3	22.3	18.1	12.6	9.23	7.06	5.58	4.52
197	∞	395	176	98.8	63.2	43.9	32.3	24.7	19.5	15.8	11.0	8.07	6.18	4.88	3.95

TABLE 4-3(A)

UNIVERSAL BEAMS

ELASTIC FLEXURAL BUCKLING LOADS
buckling about x-axis



Designation	Elastic Flexural Buckling Loads N_{om} (MN) Effective Length (L_e) in metres														
	0	2	4	6	8	10	12	15	18	21	24	27	30	33	36
610UB125	∞	487	122	54.1	30.4	19.5	13.5	8.65	6.01	4.41	3.38	2.67	2.16	1.79	1.50
113	∞	432	108	48.0	27.0	17.3	12.0	7.67	5.33	3.91	3.00	2.37	1.92	1.59	1.33
101	∞	376	93.9	41.7	23.5	15.0	10.4	6.68	4.64	3.41	2.61	2.06	1.67	1.38	1.16
530UB 92.4	∞	274	68.4	30.4	17.1	10.9	7.60	4.86	3.38	2.48	1.90	1.50	1.22	1.00	0.844
82.0	∞	236	58.9	26.2	14.7	9.42	6.54	4.19	2.91	2.14	1.64	1.29	1.05	0.865	0.727
460UB 82.1	∞	183	45.9	20.4	11.5	7.34	5.10	3.26	2.26	1.66	1.27	1.01	0.815	0.674	0.566
74.6	∞	165	41.3	18.4	10.3	6.61	4.59	2.94	2.04	1.50	1.15	0.907	0.735	0.607	0.510
67.1	∞	146	36.5	16.2	9.11	5.83	4.05	2.59	1.80	1.32	1.01	0.800	0.648	0.536	0.450
410UB 59.7	∞	107	26.7	11.9	6.67	4.27	2.97	1.90	1.32	0.969	0.742	0.586	0.475	0.392	0.330
53.7	∞	92.7	23.2	10.3	5.79	3.71	2.57	1.65	1.14	0.841	0.644	0.508	0.412	0.340	0.286
360UB 56.7	∞	79.5	19.9	8.83	4.97	3.18	2.21	1.41	0.982	0.721	0.552	0.436	0.353	0.292	0.245
50.7	∞	70.0	17.5	7.78	4.37	2.80	1.94	1.24	0.864	0.635	0.486	0.384	0.311	0.257	0.216
44.7	∞	59.9	15.0	6.65	3.74	2.40	1.66	1.06	0.739	0.543	0.416	0.329	0.266	0.220	0.185
310UB 46.2	∞	49.5	12.4	5.51	3.10	1.98	1.38	0.881	0.612	0.449	0.344	0.272	0.220	0.182	
40.4	∞	42.6	10.7	4.74	2.67	1.71	1.18	0.758	0.527	0.387	0.296	0.234	0.190	0.157	
32.0	∞	31.2	7.79	3.46	1.95	1.25	0.866	0.554	0.385	0.283	0.217	0.171	0.139	0.115	
250UB 37.3	∞	27.5	6.87	3.05	1.72	1.10	0.763	0.488	0.339	0.249	0.191				
31.4	∞	22.0	5.49	2.44	1.37	0.879	0.610	0.391	0.271	0.199	0.153				
25.7	∞	17.5	4.36	1.94	1.09	0.698	0.485	0.310	0.215	0.158	0.121				
200UB 29.8	∞	14.4	3.59	1.60	0.899	0.575	0.399	0.256	0.178	0.130					
25.4	∞	11.6	2.91	1.29	0.727	0.465	0.323	0.207	0.144	0.106					
22.3	∞	10.3	2.59	1.15	0.646	0.414	0.287	0.184	0.128	0.094					
18.2	∞	7.80	1.96	0.867	0.488	0.312	0.217	0.139	0.096	0.071					
180UB 22.2	∞	7.54	1.89	0.838	0.471	0.302	0.210	0.134							
18.1	∞	5.99	1.50	0.665	0.374	0.239	0.166	0.106							
16.1	∞	5.23	1.31	0.581	0.327	0.209	0.145	0.093							
150UB 18.0	∞	4.47	1.12	0.496	0.279	0.179	0.124								
14.0	∞	3.29	0.822	0.365	0.205	0.131	0.091								

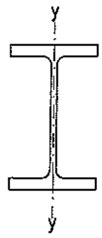


TABLE 4-3(B)

UNIVERSAL BEAMS

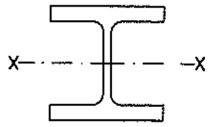
ELASTIC FLEXURAL BUCKLING LOADS
buckling about y-axis

Designation	Elastic Flexural Buckling Loads N_{om} (MN) Effective Length (L_e) in metres														
	0	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	10.0
610UB125	∞	77.6	34.5	19.4	12.4	8.62	6.34	4.85	3.83	3.10	2.16	1.58	1.21	0.958	0.776
113	∞	67.6	30.1	16.9	10.8	7.51	5.52	4.23	3.34	2.70	1.88	1.38	1.06	0.835	0.676
101	∞	57.8	25.7	14.5	9.26	6.43	4.72	3.62	2.86	2.31	1.61	1.18	0.904	0.714	0.578
530UB 92.4	∞	47.0	20.9	11.7	7.51	5.22	3.83	2.94	2.32	1.88	1.30	0.958	0.734	0.580	0.470
82.0	∞	39.7	17.7	9.94	6.36	4.42	3.24	2.48	1.96	1.59	1.10	0.811	0.621	0.491	0.397
460UB 82.1	∞	36.8	16.3	9.19	5.88	4.08	3.00	2.30	1.82	1.47	1.02	0.750	0.574	0.454	0.368
74.6	∞	32.8	14.6	8.20	5.25	3.64	2.68	2.05	1.62	1.31	0.911	0.669	0.512	0.405	0.328
67.1	∞	28.7	12.8	7.18	4.59	3.19	2.34	1.79	1.42	1.15	0.798	0.586	0.449	0.354	0.287
410UB 59.7	∞	23.8	10.6	5.95	3.81	2.64	1.94	1.49	1.17	0.952	0.661	0.485	0.372	0.294	0.238
53.7	∞	20.3	9.01	5.07	3.24	2.25	1.65	1.27	1.00	0.810	0.563	0.413	0.317	0.250	0.203
360UB 56.7	∞	21.8	9.69	5.45	3.49	2.42	1.78	1.36	1.08	0.872	0.606	0.445	0.341	0.269	0.218
50.7	∞	18.9	8.42	4.74	3.03	2.11	1.55	1.18	0.936	0.758	0.526	0.387	0.296	0.234	0.189
44.7	∞	16.0	7.10	4.00	2.56	1.78	1.30	0.999	0.789	0.639	0.444	0.326	0.250	0.197	0.160
310UB 46.2	∞	17.8	7.90	4.45	2.84	1.98	1.45	1.11	0.878	0.711	0.494	0.363	0.278	0.220	
40.4	∞	15.1	6.71	3.77	2.41	1.68	1.23	0.943	0.745	0.604	0.419	0.308	0.236	0.186	
32.0	∞	8.72	3.88	2.18	1.40	0.969	0.712	0.545	0.431	0.349	0.242	0.178	0.136	0.108	
250UB 37.3	∞	11.2	4.97	2.79	1.79	1.24	0.912	0.698	0.552	0.447	0.310	0.228	0.175		
31.4	∞	8.82	3.92	2.20	1.41	0.908	0.720	0.551	0.435	0.353	0.245	0.180	0.138		
25.7	∞	5.03	2.24	1.26	0.805	0.559	0.411	0.314	0.248	0.201	0.140	0.103	0.079		
200UB 29.8	∞	7.61	3.38	1.90	1.22	0.846	0.621	0.476	0.376	0.304	0.211	0.155			
25.4	∞	6.05	2.69	1.51	0.967	0.672	0.494	0.378	0.299	0.242	0.168	0.123			
22.3	∞	5.42	2.41	1.36	0.868	0.603	0.443	0.339	0.268	0.217	0.151	0.111			
18.2	∞	2.24	0.997	0.561	0.359	0.249	0.183	0.140	0.111	0.090	0.062	0.046			
180UB 22.2	∞	2.41	1.07	0.602	0.385	0.268	0.197	0.150	0.119	0.096					
18.1	∞	1.92	0.856	0.481	0.308	0.214	0.157	0.120	0.095	0.077					
16.1	∞	1.68	0.748	0.421	0.269	0.187	0.137	0.105	0.083	0.067					
150UB 18.0	∞	1.33	0.589	0.332	0.212	0.147	0.108	0.083	0.065						
14.0	∞	0.977	0.434	0.244	0.156	0.109	0.080	0.061	0.048						

TABLE 4-4(A)

UNIVERSAL COLUMNS

ELASTIC FLEXURAL BUCKLING LOADS
buckling about x-axis

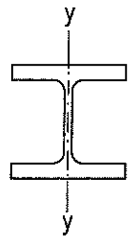


Designation	Elastic Flexural Buckling Loads N_{om} (MN) Effective Length (L_e) in metres													
	0	2	4	6	8	10	12	14	16	18	20	22	24	26
310UC158	∞	191	47.9	21.3	12.0	7.66	5.32	3.91	2.99	2.36	1.91	1.58	1.33	1.13
137	∞	162	40.6	18.0	10.1	6.49	4.51	3.31	2.54	2.00	1.62	1.34	1.13	0.960
118	∞	137	34.2	15.2	8.54	5.47	3.80	2.79	2.14	1.69	1.37	1.13	0.949	0.809
96.8	∞	110	27.5	12.2	6.88	4.40	3.06	2.25	1.72	1.36	1.10	0.910	0.764	0.651
250UC 89.5	∞	70.4	17.6	7.82	4.40	2.82	1.96	1.44	1.10	0.869	0.704	0.582	0.489	0.417
72.9	∞	56.2	14.0	6.24	3.51	2.25	1.56	1.15	0.878	0.694	0.562	0.464	0.390	0.333
200UC 59.5	∞	30.2	7.56	3.36	1.89	1.21	0.840	0.617	0.472	0.373	0.302	0.250	0.210	0.179
52.2	∞	26.1	6.52	2.90	1.63	1.04	0.724	0.532	0.408	0.322	0.261	0.216	0.181	0.154
46.2	∞	22.6	5.66	2.52	1.41	0.906	0.629	0.462	0.354	0.279	0.226	0.187	0.157	0.134
150UC 37.2	∞	10.9	2.73	1.21	0.683	0.437	0.304	0.223	0.171	0.135				
30.0	∞	8.68	2.17	0.965	0.543	0.347	0.241	0.177	0.136	0.107				
23.4	∞	6.23	1.56	0.693	0.390	0.249	0.173	0.127						
100UC 14.8	∞	1.57	0.393	0.175	0.098									

TABLE 4-4(B)

UNIVERSAL COLUMNS

ELASTIC FLEXURAL BUCKLING LOADS
buckling about y-axis



Designation	Elastic Flexural Buckling Loads N_{om} (MN) Effective Length (L_e) in metres														
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
310UC158	∞	248	61.9	27.5	15.5	9.91	6.88	5.05	3.87	3.06	2.48	2.05	1.72	1.47	1.26
137	∞	211	52.7	23.4	13.2	8.43	5.86	4.30	3.29	2.60	2.11	1.74	1.46	1.25	1.08
118	∞	178	44.5	19.8	11.1	7.13	4.95	3.64	2.78	2.20	1.78	1.47	1.24	1.05	0.909
96.8	∞	144	36.0	16.0	8.99	5.75	4.00	2.94	2.25	1.78	1.44	1.19	0.999	0.851	0.734
250UC 89.5	∞	95.6	23.9	10.6	5.97	3.82	2.65	1.95	1.49	1.18	0.956	0.790	0.664	0.565	0.488
72.9	∞	76.6	19.1	8.51	4.79	3.06	2.13	1.56	1.20	0.946	0.766	0.633	0.532	0.453	0.391
200UC 59.5	∞	40.3	10.1	4.48	2.52	1.61	1.12	0.822	0.629	0.497	0.403	0.333	0.280	0.238	0.206
52.2	∞	34.9	8.73	3.88	2.18	1.40	0.971	0.713	0.546	0.431	0.349	0.289	0.243	0.207	0.178
46.2	∞	30.3	7.57	3.37	1.89	1.21	0.842	0.618	0.473	0.374	0.303	0.250	0.210	0.179	0.155
150UC 37.2	∞	13.8	3.46	1.54	0.865	0.553	0.384	0.282	0.216						
30.0	∞	11.1	2.77	1.23	0.693	0.443	0.308	0.226	0.173						
23.4	∞	7.87	1.97	0.874	0.492	0.315	0.218	0.161	0.123						
100UC 14.8	∞	2.24	0.560	0.249	0.140	0.090									

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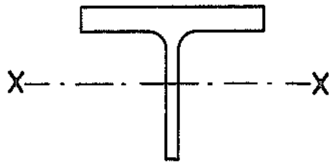
TABLE 4-5(A)

TEES CUT FROM UNIVERSAL BEAMS
ELASTIC FLEXURAL BUCKLING LOADS
buckling about x-axis



Designation	Elastic Flexural Buckling Loads N_{om} (MN) Effective Lengths (L_e) in metres														
	0	1	2	3	4	5	6	7	8	9	10	11	12	14	16
305BT62.5	∞	135	33.7	15.0	8.42	5.39	3.74	2.75	2.11	1.66	1.35	1.11	0.936	0.688	0.526
56.5	∞	123	30.8	13.7	7.70	4.93	3.42	2.51	1.92	1.52	1.23	1.02	0.855	0.628	0.481
50.5	∞	112	28.0	12.4	7.00	4.48	3.11	2.29	1.75	1.38	1.12	0.926	0.778	0.571	0.437
265BT46.3	∞	76.4	19.1	8.49	4.78	3.06	2.12	1.56	1.19	0.944	0.764	0.632	0.531	0.390	0.299
41.0	∞	69.0	17.2	7.67	4.31	2.76	1.92	1.41	1.08	0.852	0.690	0.570	0.479	0.352	0.269
230BT41.1	∞	48.4	12.1	5.38	3.03	1.94	1.34	0.988	0.757	0.598	0.484	0.400	0.336	0.247	0.189
37.3	∞	43.9	11.0	4.88	2.74	1.76	1.22	0.896	0.686	0.542	0.439	0.363	0.305	0.224	0.171
33.6	∞	39.8	9.96	4.43	2.49	1.59	1.11	0.813	0.623	0.492	0.398	0.329	0.277	0.203	0.156
205BT29.9	∞	27.0	6.74	3.00	1.69	1.08	0.749	0.550	0.421	0.333	0.270	0.223	0.187	0.138	
26.9	∞	25.0	6.26	2.78	1.56	1.00	0.695	0.511	0.391	0.309	0.250	0.207	0.174	0.128	
180BT28.4	∞	19.1	4.78	2.12	1.19	0.764	0.531	0.390	0.299	0.236	0.191	0.158	0.133		
25.4	∞	17.1	4.27	1.90	1.07	0.683	0.474	0.348	0.267	0.211	0.171	0.141	0.119		
22.4	∞	15.5	3.86	1.72	0.966	0.618	0.429	0.315	0.241	0.191	0.155	0.128	0.107		
155BT23.1	∞	10.5	2.62	1.16	0.654	0.419	0.291	0.214	0.164	0.129					
20.2	∞	9.26	2.32	1.03	0.579	0.371	0.257	0.189	0.145	0.114					
16.0	∞	7.62	1.91	0.847	0.476	0.305	0.212	0.156	0.119	0.094					
125BT18.7	∞	5.73	1.43	0.637	0.358	0.229	0.159	0.117							
15.7	∞	5.09	1.27	0.565	0.318	0.204	0.141	0.104							
12.9	∞	4.01	1.00	0.445	0.251	0.160	0.111	0.082							
100BT14.9 *	∞	2.94	0.735	0.327	0.184	0.118									
12.7 *	∞	2.55	0.638	0.283	0.159	0.102									
11.2 *	∞	2.20	0.549	0.244	0.137	0.088									
9.1	∞	1.80	0.450	0.200	0.112	0.072									
90BT11.1	∞	1.69	0.423	0.188	0.106	0.068									
9.1	∞	1.35	0.337	0.150	0.084	0.054									
8.1	∞	1.19	0.297	0.132	0.074	0.047									
75BT 9.0	∞	1.05	0.263	0.117	0.066	0.042									
7.0	∞	0.809	0.202	0.090	0.051	0.032									

Note: * indicates buckling about y-axis for the axis shown in the diagram.

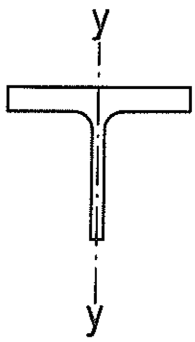


TABLE 4-5(B)

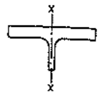
TEES CUT FROM UNIVERSAL BEAMS

ELASTIC FLEXURAL BUCKLING LOADS
buckling about y-axis

Designation	Elastic Flexural Buckling Loads N_{om} (MN) Effective Length (L_e) in metres														
	0	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	10.0
305BT62.5	∞	38.8	17.2	9.70	6.21	4.31	3.17	2.43	1.92	1.55	1.08	0.792	0.606	0.479	0.388
56.5	∞	33.8	15.0	8.45	5.41	3.76	2.76	2.11	1.67	1.35	0.939	0.690	0.528	0.417	0.338
50.5	∞	28.9	12.9	7.23	4.63	3.21	2.36	1.81	1.43	1.16	0.803	0.590	0.452	0.357	0.289
265BT46.3	∞	23.5	10.4	5.87	3.76	2.61	1.92	1.47	1.16	0.939	0.652	0.479	0.367	0.290	0.235
41.0	∞	19.9	8.83	4.97	3.18	2.21	1.62	1.24	0.981	0.795	0.552	0.406	0.310	0.245	0.199
230BT41.1	∞	18.4	8.17	4.59	2.94	2.04	1.50	1.15	0.908	0.735	0.511	0.375	0.287	0.227	0.184
37.3	∞	16.4	7.29	4.10	2.62	1.82	1.34	1.02	0.809	0.656	0.455	0.335	0.256	0.202	0.164
33.6	∞	14.4	6.38	3.59	2.30	1.60	1.17	0.897	0.709	0.574	0.399	0.293	0.224	0.177	0.144
205BT25.5	∞	11.9	5.29	2.97	1.90	1.32	0.971	0.743	0.587	0.476	0.330	0.243	0.186	0.147	0.119
26.9	∞	10.1	4.50	2.53	1.62	1.13	0.827	0.633	0.500	0.405	0.281	0.207	0.158	0.125	0.101
180BT28.4	∞	10.9	4.84	2.73	1.74	1.21	0.890	0.681	0.538	0.436	0.303	0.222	0.170	0.135	0.109
25.4	∞	9.47	4.21	2.37	1.52	1.05	0.773	0.592	0.468	0.379	0.263	0.193	0.148	0.117	0.095
22.4	∞	7.99	3.55	2.00	1.28	0.888	0.652	0.499	0.395	0.320	0.222	0.163	0.125	0.099	0.080
155BT23.1	∞	8.89	3.95	2.22	1.42	0.988	0.726	0.556	0.439	0.356	0.247	0.181	0.139	0.110	
20.2	∞	7.55	3.35	1.89	1.21	0.838	0.616	0.472	0.373	0.302	0.210	0.154	0.118	0.093	
16.0	∞	4.36	1.94	1.09	0.698	0.485	0.356	0.273	0.215	0.174	0.121	0.089	0.068	0.054	
125BT18.7	∞	5.59	2.48	1.40	0.894	0.621	0.456	0.349	0.276	0.223	0.155	0.114	0.087		
15.7	∞	4.41	1.96	1.10	0.705	0.490	0.360	0.276	0.218	0.176	0.122	0.090	0.069		
12.9	∞	2.52	1.12	0.629	0.402	0.279	0.205	0.157	0.124	0.101	0.070	0.051	0.039		
100BT14.9*	∞	3.81	1.69	0.951	0.609	0.423	0.311	0.238	0.188	0.152	0.106				
12.7*	∞	3.02	1.34	0.756	0.484	0.336	0.247	0.189	0.149	0.121	0.084				
11.2*	∞	2.71	1.21	0.678	0.434	0.301	0.221	0.170	0.134	0.108	0.075				
9.1	∞	1.12	0.498	0.280	0.179	0.125	0.091	0.070	0.055	0.045	0.031				
90BT11.1	∞	1.20	0.535	0.301	0.193	0.134	0.098								
9.1	∞	0.962	0.428	0.241	0.154	0.107	0.079								
8.1	∞	0.842	0.374	0.210	0.135	0.094	0.069								
75BT 9.0	∞	0.663	0.295	0.166	0.106	0.074	0.054								
7.0	∞	0.488	0.217	0.122	0.078	0.054	0.040								

Note: * indicates buckling about x-axis for the axis shown in the diagram.

TABLE 4-6(A)

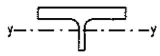


TEES CUT FROM UNIVERSAL COLUMNS

ELASTIC FLEXURAL BUCKLING LOADS
buckling about x-axis

Designation	Elastic Flexural Buckling Loads N_{om} (MN) Effective Length (L_e) in metres														
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
155CT79.0	∞	124	31.0	13.8	7.74	4.95	3.44	2.53	1.93	1.53	1.24	1.02	0.860	0.733	0.632
68.5	∞	105	26.4	11.7	6.59	4.22	2.93	2.15	1.65	1.30	1.05	0.871	0.732	0.624	0.538
59.0	∞	89.1	22.3	9.90	5.57	3.56	2.47	1.82	1.39	1.10	0.891	0.736	0.619	0.527	0.454
48.4	∞	71.9	18.0	7.99	4.49	2.88	2.00	1.47	1.12	0.888	0.719	0.594	0.499	0.426	0.367
125CT44.8	∞	47.8	11.9	5.31	2.99	1.91	1.33	0.975	0.747	0.590	0.478	0.395	0.332	0.283	0.244
36.5	∞	38.3	9.57	4.26	2.39	1.53	1.06	0.782	0.598	0.473	0.383	0.317	0.266	0.227	0.195
100CT29.8	∞	20.1	5.04	2.24	1.26	0.806	0.559	0.411	0.315	0.249	0.201	0.166	0.140		
26.1	∞	17.5	4.37	1.94	1.09	0.699	0.485	0.357	0.273	0.216	0.175	0.144	0.121		
23.1	∞	15.1	3.79	1.68	0.947	0.606	0.421	0.309	0.237	0.187	0.151	0.125	0.105		
75CT18.6	∞	6.92	1.73	0.769	0.432	0.277	0.192	0.141							
15.0	∞	5.54	1.39	0.616	0.346	0.222	0.154	0.113							
11.7	∞	3.93	0.983	0.437	0.246	0.157	0.109	0.080							
50CT 7.4	∞	1.12	0.280	0.124	0.070										

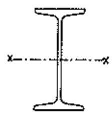
TABLE 4-6(B)



buckling about y-axis

Designation	Elastic Flexural Buckling Loads N_{om} (MN) Effective Lengths L_e in metres														
	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0
155CT79.0	∞	118	29.6	13.2	7.40	4.73	3.29	2.42	1.85	1.46	1.18	0.978	0.822	0.700	0.604
68.5	∞	99.9	25.0	11.1	6.24	4.00	2.77	2.04	1.56	1.23	0.999	0.825	0.694	0.591	0.510
59.0	∞	83.2	20.8	9.24	5.20	3.33	2.31	1.70	1.30	1.03	0.832	0.687	0.578	0.492	0.424
48.4	∞	66.5	16.6	7.39	4.16	2.66	1.85	1.36	1.04	0.821	0.665	0.550	0.462	0.394	0.339
125CT44.8	∞	41.0	10.2	4.55	2.56	1.64	1.14	0.836	0.640	0.506	0.410	0.339	0.284	0.242	0.209
36.5	∞	32.1	8.03	3.57	2.01	1.28	0.892	0.655	0.502	0.396	0.321	0.265	0.223	0.190	0.164
100CT29.8	∞	18.6	4.66	2.07	1.16	0.745	0.517	0.380	0.291	0.230	0.186	0.154			
26.1	∞	15.6	3.90	1.73	0.976	0.624	0.434	0.319	0.244	0.193	0.156	0.129			
23.1	∞	13.8	3.45	1.53	0.862	0.551	0.383	0.281	0.215	0.170	0.138	0.114			
75CT18.6	∞	7.18	1.79	0.798	0.449	0.287	0.199	0.147							
15.0	∞	5.58	1.40	0.620	0.349	0.223	0.155	0.114							
11.7	∞	4.64	1.16	0.516	0.290	0.186	0.129	0.095							
50CT 7.4	∞	0.940	0.235	0.104	0.059										

TABLE 4-7(A)



TAPER FLANGE BEAMS

ELASTIC FLEXURAL BUCKLING LOADS
buckling about x-axis

Designation	Elastic Flexural Buckling Loads N_{om} (MN) Effective Lengths (L_e) in metres									
	0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0
125 TFB	∞	8.57	2.14	0.952	0.535	0.343	0.238	0.175	0.134	0.106
100 TFB	∞	2.88	0.720	0.320	0.180	0.115				

TABLE 4-7(B)

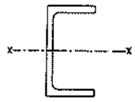
buckling about y-axis

Designation	Elastic Flexural Buckling Loads N_{om} (MN) Effective Length (L_e) in metres												
	0	0.25	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.25	2.5	2.75	3.0
125 TFB	∞	10.6	2.66	1.18	0.665	0.425	0.296	0.217	0.166	0.131	0.106		
100 TFB	∞	2.51	0.628	0.279	0.157	0.100	0.070						

TABLE 4-8(A)

PARALLEL FLANGE CHANNELS

ELASTIC FLEXURAL BUCKLING LOADS
buckling about x-axis

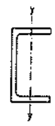


Designation	Elastic Flexural Buckling Loads N_{om} (MN) Effective Length (L_e) in metres													
	0	1	2	3	4	5	6	7	8	9	10	12	14	16
380 PFC	∞	299	74.9	33.3	18.7	12.0	8.32	6.11	4.68	3.70	2.99	2.08	1.53	1.17
300 PFC	∞	143	35.7	15.9	8.93	5.72	3.97	2.92	2.23	1.76	1.43	0.993	0.729	0.558
250 PFC	∞	89.1	22.3	9.90	5.57	3.56	2.47	1.82	1.39	1.10	0.891	0.619	0.455	0.348
230 PFC	∞	52.8	13.2	5.87	3.30	2.11	1.47	1.08	0.825	0.652	0.528	0.367	0.270	0.206
200 PFC	∞	37.7	9.43	4.19	2.36	1.51	1.05	0.770	0.589	0.466	0.377	0.262	0.192	0.147
180 PFC	∞	27.9	6.97	3.10	1.74	1.12	0.775	0.569	0.436	0.344	0.279	0.194	0.142	0.109
150 PFC	∞	16.5	4.12	1.83	1.03	0.658	0.457	0.336	0.257	0.203	0.165	0.114		

TABLE 4-8(B)

PARALLEL FLANGE CHANNELS

ELASTIC FLEXURAL BUCKLING LOADS
buckling about y-axis

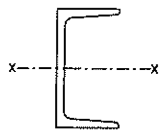


Designation	Elastic Flexural Buckling Loads N_{om} (MN) Effective Length (L_e) in metres													
	0	0.25	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.25	2.5	3.0	3.5	4.0	4.5
380 PFC	∞	205	51.2	22.7	12.8	8.19	5.69	4.18	3.20	2.53	2.05	1.42	1.04	0.800	0.632
300 PFC	∞	128	31.9	14.2	7.98	5.11	3.55	2.61	2.00	1.58	1.28	0.887	0.652	0.499	0.394
250 PFC	∞	115	28.8	12.8	7.19	4.60	3.20	2.35	1.80	1.42	1.15	0.799	0.587	0.449	0.355
230 PFC	∞	55.6	13.9	6.18	3.48	2.22	1.54	1.13	0.869	0.687	0.556	0.386	0.284	0.217	0.172
200 PFC	∞	52.3	13.1	5.81	3.27	2.09	1.45	1.07	0.817	0.645	0.523	0.363	0.267	0.204	0.161
180 PFC	∞	47.7	11.9	5.30	2.98	1.91	1.32	0.972	0.745	0.588	0.477	0.331	0.243	0.186	0.147
150 PFC	∞	40.6	10.2	4.51	2.54	1.62	1.13	0.829	0.634	0.501	0.406	0.282	0.207	0.159	0.125

TABLE 4-9(A)

TAPER FLANGE CHANNELS

ELASTIC FLEXURAL BUCKLING LOADS
buckling about x-axis



Designation	Elastic Flexural Buckling Loads N_{om} (MN) Effective Length (L_e) in metres									
	0	1	2	3	4	5	6	7	8	9
125 TFC	∞	8.36	2.09	0.929	0.523	0.335	0.232	0.171	0.131	0.103
100 TFC	∞	3.71	0.929	0.413	0.232	0.149	0.103			
75 TFC	∞	1.42	0.356	0.158	0.089					

TABLE 4-9(B)

TAPER FLANGE CHANNELS

ELASTIC FLEXURAL BUCKLING LOADS
buckling about y-axis

Designation	Elastic Flexural Buckling Loads N_{om} (MN) Effective Length (L_e) in metres											
	0	0.25	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.25	2.5	3.0
125 TFC	∞	19.5	4.88	2.17	1.22	0.780	0.542	0.398	0.305	0.241	0.195	0.135
100 TFC	∞	8.22	2.05	0.913	0.514	0.329	0.228	0.168	0.128			
75 TFC	∞	3.62	0.904	0.402	0.226	0.145	0.100	0.074				

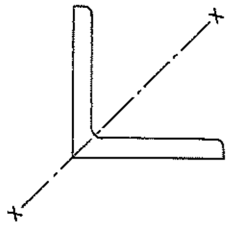


TABLE 4-10(A)

EQUAL ANGLES
ELASTIC FLEXURAL BUCKLING LOADS
buckling about x-axis

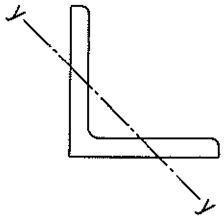
Designation	Elastic Flexural Buckling Loads N_{om} (MN) for Effective Lengths (L_e) in metres										
	0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	6.0	8.0
200×200×26EA	∞	448	112	49.8	28.0	17.9	12.5	7.01	4.48	3.11	1.75
20EA	∞	361	90.2	40.1	22.5	14.4	10.0	5.63	3.61	2.50	1.41
18EA	∞	329	82.3	36.6	20.6	13.2	9.15	5.15	3.29	2.29	1.29
16EA	∞	297	74.3	33.0	18.6	11.9	8.25	4.64	2.97	2.06	1.16
13EA	∞	247	61.7	27.4	15.4	9.87	6.35	3.85	2.47	1.71	0.963
150×150×19EA	∞	139	34.6	15.4	8.66	5.54	3.85	2.17	1.39	0.962	0.541
16EA	∞	119	29.7	13.2	7.43	4.76	3.30	1.86	1.19	0.826	0.465
12EA	∞	93.7	23.4	10.4	5.85	3.75	2.60	1.46	0.937	0.650	0.366
10EA	∞	75.9	19.0	8.43	4.74	3.03	2.11	1.19	0.759	0.527	0.296
125×125×16EA	∞	66.6	16.6	7.40	4.16	2.66	1.85	1.04	0.666	0.462	0.260
12EA	∞	52.8	13.2	5.87	3.30	2.11	1.47	0.825	0.528	0.367	0.206
10EA	∞	43.0	10.7	4.78	2.69	1.72	1.19	0.671	0.430	0.298	0.168
8EA	∞	35.9	8.98	3.99	2.24	1.44	0.998	0.561	0.359	0.249	0.140
100×100×12EA	∞	26.0	6.50	2.89	1.63	1.04	0.723	0.406	0.260	0.181	
10EA	∞	21.3	5.33	2.37	1.33	0.853	0.592	0.333	0.213	0.148	
8EA	∞	17.9	4.47	1.99	1.12	0.716	0.497	0.280	0.179	0.124	
6EA	∞	14.1	3.51	1.56	0.878	0.562	0.390	0.220	0.141	0.098	
90× 90×10EA	∞	15.3	3.82	1.70	0.954	0.611	0.424	0.238	0.153		
8EA	∞	12.8	3.21	1.43	0.803	0.514	0.357	0.201	0.128		
6EA	∞	10.1	2.53	1.12	0.632	0.404	0.281	0.158	0.101		
75× 75×10EA	∞	8.53	2.13	0.947	0.533	0.341	0.237	0.133			
8EA	∞	7.21	1.80	0.801	0.451	0.288	0.200	0.113			
6EA	∞	5.70	1.43	0.634	0.356	0.228	0.158	0.089			
5EA	∞	4.45	1.11	0.494	0.278	0.178	0.124	0.069			
65× 65×10EA	∞	5.46	1.36	0.606	0.341	0.218	0.152				
8EA	∞	4.65	1.16	0.517	0.291	0.186	0.129				
6EA	∞	3.72	0.930	0.413	0.232	0.149	0.103				
5EA	∞	2.93	0.733	0.326	0.183	0.117	0.062				
55× 55× 6EA	∞	2.19	0.548	0.243	0.137						
5EA	∞	1.74	0.434	0.193	0.109						
50× 50× 8EA	∞	2.00	0.500	0.222	0.125						
6EA	∞	1.62	0.404	0.180	0.101						
5EA	∞	1.29	0.321	0.143							
3EA	∞	0.868	0.217	0.096							
45× 45× 6EA	∞	1.15	0.288	0.128							
5EA	∞	0.920	0.230	0.102							
3EA	∞	0.624	0.156	0.069							
40× 40× 6EA	∞	0.787	0.197								
5EA	∞	0.632	0.158								
3EA	∞	0.430	0.108								
30× 30× 6EA	∞	0.306	0.076								
5EA	∞	0.249	0.062								
3EA	∞	0.172	0.043								
25× 25× 6EA	∞	0.166	0.041								
5EA	∞	0.137	0.034								
3EA	∞	0.095	0.024								

TABLE 4-10(B)

EQUAL ANGLES

ELASTIC FLEXURAL BUCKLING LOADS

buckling about y-axis



Designation	Elastic Flexural Buckling Loads N_{om} (MN) Effective Lengths (L_e) in metres										
	0	0.25	0.5	0.75	1.0	1.25	1.5	2.0	2.5	3.0	4.0
200×200×26EA	∞	471	118	52.3	29.4	18.8	13.1	7.36	4.71	3.27	1.84
20EA	∞	374	93.6	41.6	23.4	15.0	10.4	5.85	3.74	2.60	1.46
18EA	∞	341	85.3	37.9	21.3	13.6	9.47	5.33	3.41	2.37	1.33
16EA	∞	307	76.8	34.1	19.2	12.3	8.53	4.80	3.07	2.13	1.20
13EA	∞	255	63.8	28.4	16.0	10.2	7.09	3.99	2.55	1.77	0.997
150×150×19EA	∞	145	36.3	16.1	9.07	5.81	4.03	2.27	1.45	1.01	0.567
16EA	∞	123	30.9	13.7	7.71	4.94	3.43	1.93	1.23	0.857	0.482
12EA	∞	96.7	24.2	10.7	6.04	3.87	2.68	1.51	0.967	0.671	0.378
10EA	∞	78.4	19.6	8.71	4.90	3.13	2.18	1.22	0.784	0.544	0.306
125×125×16EA	∞	69.6	17.4	7.73	4.35	2.78	1.93	1.09	0.696	0.483	0.272
12EA	∞	54.5	13.6	6.06	3.41	2.18	1.51	0.852	0.545	0.379	0.213
10EA	∞	44.2	11.1	4.91	2.76	1.77	1.23	0.691	0.442	0.307	0.173
8EA	∞	37.0	9.24	4.11	2.31	1.48	1.03	0.577	0.370	0.257	0.144
100×100×12EA	∞	27.1	6.77	3.01	1.69	1.08	0.752	0.423	0.271	0.188	0.106
10EA	∞	22.0	5.49	2.44	1.37	0.879	0.610	0.343	0.220	0.153	0.086
8EA	∞	18.4	4.60	2.04	1.15	0.735	0.511	0.287	0.184	0.128	0.072
6EA	∞	14.5	3.61	1.61	0.903	0.578	0.402	0.226	0.145	0.100	0.056
90× 90×10EA	∞	15.8	3.95	1.76	0.988	0.632	0.439	0.247	0.158	0.110	
8EA	∞	13.2	3.31	1.47	0.828	0.530	0.368	0.207	0.132	0.092	
6EA	∞	10.4	2.61	1.16	0.652	0.417	0.290	0.163	0.104	0.072	
75× 75×10EA	∞	8.92	2.23	0.991	0.558	0.357	0.248	0.139			
8EA	∞	7.49	1.87	0.832	0.468	0.299	0.208	0.117			
6EA	∞	5.91	1.48	0.657	0.369	0.236	0.164	0.092			
5EA	∞	4.63	1.16	0.515	0.290	0.185	0.129	0.072			
65× 65×10EA	∞	5.78	1.44	0.642	0.361	0.231	0.160				
8EA	∞	4.85	1.21	0.539	0.303	0.194	0.135				
6EA	∞	3.85	0.962	0.427	0.240	0.154	0.107				
5EA	∞	3.03	0.757	0.337	0.189	0.121	0.084				
55× 55× 6EA	∞	2.28	0.571	0.254	0.143						
5EA	∞	1.80	0.451	0.200	0.113						
50× 50× 8EA	∞	2.13	0.533	0.237	0.133						
6EA	∞	1.69	0.423	0.188	0.106						
5EA	∞	1.34	0.335	0.149	0.084						
3EA	∞	0.913	0.228	0.101	0.057						
45× 45× 6EA	∞	1.21	0.303	0.135							
5EA	∞	0.956	0.239	0.106							
3EA	∞	0.650	0.163	0.072							
40× 40× 6EA	∞	0.836	0.209	0.093							
5EA	∞	0.660	0.165	0.073							
3EA	∞	0.450	0.112	0.050							
30× 30× 6EA	∞	0.337	0.084								
5EA	∞	0.265	0.066								
3EA	∞	0.181	0.045								
25× 25× 6EA	∞	0.189	0.047								
5EA	∞	0.148	0.037								
3EA	∞	0.101	0.025								

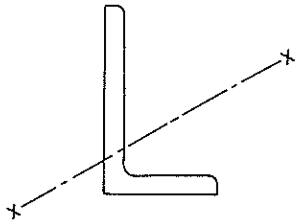


TABLE 4-11(A)

UNEQUAL ANGLES
ELASTIC FLEXURAL BUCKLING LOADS
buckling about x-axis

Designation	Elastic Flexural Buckling Loads N_{om} (MN) Effective Lengths (L_e) in metres										
	0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	6.0	8.0
150×100×12UA	∞	59.3	14.8	6.59	3.71	2.37	1.65	0.927	0.593	0.412	0.232
10UA	∞	48.2	12.1	5.36	3.01	1.93	1.34	0.753	0.482	0.335	0.188
150× 90×16UA	∞	69.5	17.4	7.72	4.34	2.78	1.93	1.09	0.695	0.482	0.271
12UA	∞	55.0	13.7	6.11	3.44	2.20	1.53	0.859	0.550	0.382	0.215
10UA	∞	44.7	11.2	4.97	2.79	1.79	1.24	0.699	.0447	0.311	0.175
8UA	∞	37.4	9.34	4.15	2.34	1.49	1.04	0.584	0.374	0.259	0.146
125× 75×12UA	∞	30.9	7.72	3.43	1.93	1.24	0.858	0.483	0.309	0.214	0.121
10UA	∞	25.2	6.31	2.80	1.58	1.01	0.701	0.394	0.252	0.175	0.099
8UA	∞	21.2	5.29	2.35	1.32	0.846	0.588	0.331	0.212	0.147	0.083
6UA	∞	16.6	4.15	1.84	1.04	0.664	0.461	0.259	0.166	0.115	0.065
100× 75×10UA	∞	14.9	3.72	1.65	0.931	0.596	0.414	0.233	0.149	0.103	
8UA	∞	12.5	3.13	1.39	0.783	0.501	0.348	0.196	0.125	0.087	
6UA	∞	9.87	2.47	1.10	0.617	0.395	0.274	0.154	0.099	0.068	
75× 50× 8UA	∞	4.63	1.16	0.514	0.289	0.185	0.129	0.072			
6UA	∞	3.70	0.925	0.411	0.231	0.148	0.103	0.058			
5UA	∞	2.92	0.729	0.324	0.182	0.117	0.081	0.046			
65× 50× 8UA	∞	3.32	0.831	0.369	0.208	0.133	0.092				
6UA	∞	2.67	0.667	0.296	0.167	0.107	0.074				
5UA	∞	2.11	0.527	0.234	0.132	0.084	0.059				

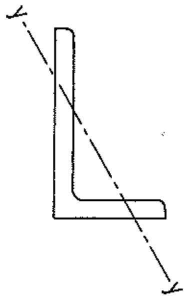


TABLE 4-11(B)

UNEQUAL ANGLES
ELASTIC FLEXURAL BUCKLING LOADS
buckling about y-axis

Designation	Elastic Flexural Buckling Loads N_{om} (MN) Effective Lengths (L_e) in metres										
	0	0.25	0.5	0.75	1.0	1.25	1.5	2.0	2.5	3.0	4.0
150×100×12UA	∞	42.5	10.6	4.73	2.66	1.70	1.18	0.665	0.425	0.295	0.166
10UA	∞	34.6	8.64	3.84	2.16	1.38	0.960	0.540	0.346	0.240	0.135
150× 90×16UA	∞	41.8	10.5	4.64	2.61	1.67	1.16	0.653	0.418	0.290	0.163
12UA	∞	32.9	8.22	3.65	2.06	1.32	0.914	0.514	0.329	0.228	0.128
10UA	∞	26.8	6.69	2.97	1.67	1.07	0.743	0.418	0.268	0.186	0.105
8UA	∞	22.4	5.61	2.49	1.40	0.897	0.623	0.350	0.224	0.156	0.088
125× 75×12UA	∞	18.5	4.62	2.05	1.16	0.739	0.513	0.289	0.185	0.128	
10UA	∞	15.0	3.76	1.67	0.940	0.602	0.418	0.235	0.150	0.104	
8UA	∞	12.6	3.15	1.40	0.789	0.505	0.351	0.197	0.126	0.088	
6UA	∞	9.94	2.49	1.10	0.621	0.398	0.276	0.155	0.099		
100× 75×10UA	∞	12.7	3.17	1.41	0.793	0.507	0.352	0.198	0.127		
8UA	∞	10.6	2.66	1.18	0.665	0.425	0.295	0.166	0.106		
6UA	∞	8.39	2.10	0.932	0.524	0.335	0.233	0.131	0.084		
75× 50× 8UA	∞	3.34	0.836	0.372	0.209	0.134	0.093				
6UA	∞	2.66	0.666	0.296	0.166	0.106	0.074				
5UA	∞	2.11	0.527	0.234	0.132	0.084	0.058				
65× 50× 8UA	∞	2.96	0.739	0.328	0.185	0.118					
6UA	∞	2.35	0.587	0.261	0.147	0.094					
5UA	∞	1.86	0.464	0.206	0.116	0.074					

PART 5 MEMBERS SUBJECT TO BENDING

TABLES

PART 5 MEMBERS SUBJECT TO BENDING

5.1 Maximum Design Loads for Beams with Full Lateral Restraint Subject to Uniformly Distributed Loading

NOTE: ***BEAM SELF WEIGHT: For Tables 5.1-1 to 5.1-13, the self weight of the beam has <u>NOT</u> been deducted. The designer must include the self weight as part of the dead load when determining the maximum design load W^*_L or W^*_S.***

Tables 5.1-1 to 5.1-13 give values of the maximum design loads for single-span simply-supported beams with full lateral restraint subject to uniformly distributed loads as shown in Figure 5.1.

Designers should assess maximum design loads for the strength and serviceability separately as different load combinations apply to these cases (AS 1170).

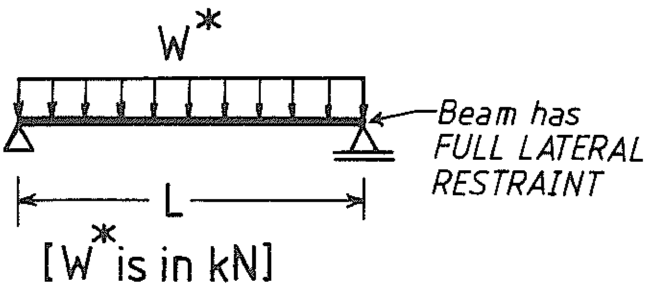


Figure 5.1

Tables 5.1-1 to 5.1-13 also list the maximum segment length for full lateral restraint (FLR) for each section.

For angles subject to bending, reference should be made to Part 8 of this publication.

5.1.1 Strength Limit State Design

For the beam configuration in Figure 5.1, the maximum strength limit state design load (W^*_L) is the *lesser* of the maximum design load (W^*_{L1}) associated with the design section moment capacity (ϕM_{sx}) and the maximum design load (W^*_{L2}) associated with the design shear capacity (ϕV_v).

The designer must ensure that the strength limit state design load (W^*) is less than or equal to the maximum design load W^*_L, i.e.

$$W^* \leq W^*_L$$

where $W^*_L = \min\,[W^*_{L1};\ W^*_{L2}]$

W^*_{L1} and W^*_{L2} are listed in **bold** within the first row of entries for each section in Tables 5.1-1 to 5.1-13.

For the beam configuration shown in Figure 5.1, the strength of the beam is not controlled by the interaction of bending moment and shear force (Clause 5.12 of AS 4100).

5.1.1.1 W^*_{L1} - based on Design Moment Capacity

The derivation of the design section moment capacity is given in Section 5.2.2.1, and listed in Tables 5.2-1 to 5.2-11.

For a single-span simply-supported beam subject to uniformly distributed loading (see Figure 5.1), the maximum bending moment (M_{max}) is given by:

$$M_{max} = \frac{WL}{8}$$

where W = total load on the beam
L = length of the beam

The design moment capacity for the beam in Figure 5.1 is ϕM_{sx}. Therefore, substituting ϕM_{sx} for M_{max}, and rearranging the above equation gives:

$$W^*_{L1} = \frac{8\phi M_{sx}}{L}$$

where W^*_{L1} is the *Maximum Design Load* based on the design moment capacity of the beam.

5.1.1.2 W^*_{L2} - based on Design Shear Capacity

The derivation of the design shear capacity (ϕV_v) is given in Section 5.2.2.3 and listed in Tables 5.2-1 to 5.2-11.

For a single-span simply-supported beam subject to uniformly distributed loading (see Figure 5.1), the maximum shear force (V_{max}) is given by:

$$V_{max} = \frac{W}{2}$$

Therefore, substituting ϕV_v for V_{max} and rearranging the equation gives:

$$W^*_{L2} = 2\phi V_v$$

where W^*_{L2} is the *Maximum Design Load* based on the design shear capacity of the beam.

5.1.2 Serviceability Limit State Design

The value of serviceability load (W^*_S) given in the tables is the lesser of the maximum design load (W^*_{S1}) which will achieve a **calculated total elastic deflection** of L / 250 (where L is the span of the beam) and the load at which first yield occurs (W^*_{YL}).

W^*_{S1} - based on a Deflection Limit of L / 250 (simply supported beam)

The maximum *elastic* deflection (Δ_{max}) of the beam shown in Figure 5.1 is given by:

$$\Delta_{max} = \frac{5WL^3}{384EI_x}$$

where E = 200×10^3 MPa
I_x = second moment of area about the major principal x-axis

Therefore, substituting $\Delta_{max} = L / 250$ and rearranging the equation gives the maximum design load for serviceability based on deflection (W^*_{S1}):

$$W^*_{S1} = \frac{384EI_x}{1250L^2}$$

For deflection limits other than span / 250, the value of the maximum design load based on another deflection limit (W^*_{S2}) may be calculate using the principles outlined above.

W^*_{YL} - based on first yield load

The load at which first yield occurs in the member is given by

$$W^*_{YL} = \frac{8 Z_{xmin} f_y}{L}$$

The serviceability limit state maximum design load (W^*_S) is given by:

$$W^*_S = \min [W^*_{S1} \; ; \; W^*_{YL}]$$

W^*_S is listed in *italics* within the second row for each section in Tables 5.1-1 to 5.1-13. Serviceability loads governed by yielding are shaded.

5.1.3 Full Lateral Restraint

Full lateral restraint may be achieved for a beam by: (a) continuous lateral restraint, or (b) full or partial restraint provided at sufficient locations along the beam. The distance between the locations in (b) is termed the segment length. The maximum value of segment length to maintain the full lateral restraint condition is generally listed under "FLR" in Tables 5.1-1 to 5.1-13.

Formulae for calculating FLR are given in Clause 5.3.2.4 of AS 4100 and Section 5.2.2.2. For the beam configuration shown in Figure 5.1, the ratio β_m is equal to -0.8.

5.1.4 Additional Design Checks

Where loads are transmitted into the webs at supports or at load points, the capacity of the web to resist such forces should be checked in accordance with Section 5.2.2.4, and the values of these web capacities listed in Tables 5.2-1 to 5.2-11.

5.1.5 Other Load Conditions

The values given in Tables 5.1-1 to 5.1-13 are for single span, simply supported beams subject to uniformly distributed loads (Figure 5.1). However, the information presented in these tables may be used for beams with full lateral restraint and other loading situations using the equivalent uniform design loads given in Table 5.1 and the following procedure:

(1) Calculate the equivalent uniformly distributed maximum design load for moment (W^*_{EM}) using Table 5.1.

(2) Based on W^*_{EM} select a section with an adequate maximum design load (W^*_{L1}) associated with the design moment capacity from Tables 5.1-1 to 5.1-13.

(3) Calculate equivalent uniformly distributed maximum design load for shear (W^*_{EV}) using Table 5.1.

(4) Check that the section selected in (2) has an adequate maximum design load (W^*_{L2}) associated with the design shear capacity to resist W^*_{EV}. If not, select a new section size which can resist W^*_{EV}.

(5) Check shear and bending interaction in accordance with Section 5.2.2.3. A check is not necessary if $V^* < 0.6\,\phi V_v$ or $M^* < 0.75\,\phi M_s$.

(6) Calculate equivalent uniformly distributed serviceability load (W^*_{ES}) from Table 5.1.

(7) Check that the section selected in (4) has an adequate maximum serviceability design load (W^*_{S1}) to resist W^*_{ES}. If not, select a new section size which can resist W^*_{ES}.

This procedure is shown in Example 2 of Section 5.1.6.

5.1.6 Examples

1. A simply supported beam of 4 metres span is subjected to uniformly distributed loads of:

G (Dead Load)	= 50 kN	(total load)
Q (Live Load)	= 64 kN	(short term total load)

The beam is continuously laterally restrained. The total deflection of the beam under serviceability load must not exceed $L / 250$. Select an appropriate Universal Beam section in Grade 300 steel to resist these loadings.

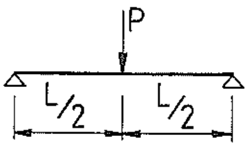
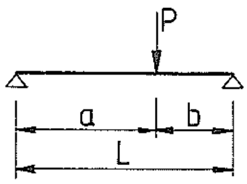
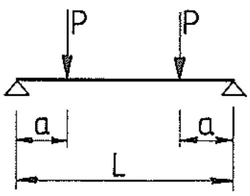
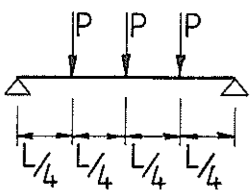
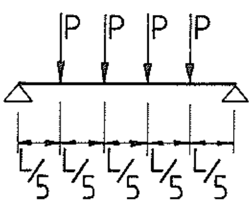
<u>Solution:</u>

(a) Calculation of maximum design loads:

Strength limit state $\quad W^*_L = 1.25G + 1.5Q$
$\quad = 159$ kN

Serviceability limit state $\quad W^*_S = G + 0.7Q \quad$ (short term live load)
$\quad = 94.8$ kN

TABLE 5.1: Table of Equivalent Uniform Design Loads

Loading	Equivalent Strength Maximum Design Loads		Equivalent Serviceability Maximum Design Load
	Moment W^*_{EM}	Shear W^*_{EV}	W^*_{ES}
	$2P$	P	$\frac{8P}{5}$
 for $a > b$	$\frac{8abP}{L^2}$	$\frac{2Pa}{L}$	$\frac{8P}{5}\left[3\left(\frac{a}{L}\right)-4\left(\frac{a}{L}\right)^3\right]$ at midspan
	$\frac{8aP}{L}$	$2P$	$\frac{16P}{5}\left[3\left(\frac{a}{L}\right)-4\left(\frac{a}{L}\right)^3\right]$
	$4P$	$3P$	$\frac{19P}{5}$
	$\frac{24P}{5}$	$4P$	$\frac{3024P}{625}$

(b) Use of the Tables:

Strength Limit State - Select a section from the Tables such that the maximum design loads W^*_{L1} and W^*_{L2} are greater than or equal to W^*_L. It can be seen from Table 5.1-5(2) that for a 250UB25.7 - Grade 300, the **maximum** design loads are:

$$W^*_{L1} = 184 \text{ kN}$$

$$W^*_{L2} = 429 \text{ kN}$$

$$\therefore \quad W^*_L = \min [W^*_{L1}, W^*_{L2}]$$

$$= 184 \text{ kN} \qquad (> 159 \text{ kN})$$

Therefore, a 250UB25.7 satisfies the strength limit state.

Serviceability Limit State - From Table 5.1-5(2) it can be seen that for a 250UB25.7 - Grade 300, the serviceability load for a deflection limit of $L/250$ is:

$$W^*_S = 136 \text{ kN} \qquad (> 94.8 \text{ kN})$$

2. A beam which is simply supported has a span of 6.0 metres with full lateral restraint. The beam is subjected to nominal central dead and short term live loads of 40 kN and 25 kN respectively. Design a suitable Universal Beam in Grade 300 steel with a limit on deflection of span / 250.

<u>Solution:</u>

(1) Calculate equivalent uniformly distributed maximum design load for moment (W^*_{EM})

From Table 5.1 W^*_{EM} associated with the central dead and live loads is:

$$W^*_{EM} = 2P$$

$$= 2(1.25 \times 40 + 1.5 \times 25)$$

$$= 175 \text{ kN}$$

(2) Based on W^*_{EM} select a section with an adequate maximum design load (W^*_{L1}) based on design moment capacity

From Table 5.1-5(2), a 310UB32.0 has adequate maximum design load with W^*_{L1} = 179 kN.

(3) Calculate equivalent uniformly distributed maximum design load for shear (W^*_{EV})

From Table 5.1 W^*_{EV} for the central dead and live loads is:

$$W^*_{EV} = P$$

$$= 1.25 \times 40 + 1.5 \times 25$$

$$= 87.5 \text{ kN}$$

(4) Check that the section selected in Step 2 has an adequate maximum design load (W^*_{L2}) based on shear capacity

From Table 5.1-5(2), a 310UB32.0 has adequate maximum design load with W^*_{L2} = 566 kN.

(5) Check if a shear and bending interaction check is necessary.

W^*_{L2} = 566 kN for a 250UB25.7. (Table 5.1-5(2))

ϕV_v = 283 kN (Table 5.2-5)

$0.6\,\phi V_v = 0.6 \times 283$

$= 170$ kN

> 43.8 kN ($V^* = W^*_{EV} / 2$)

Therefore no shear and bending interaction check is necessary.

(6) Calculate equivalent uniformly distributed serviceability load (W^*_{ES})

From Table 5.1 W^*_{ES} for the central dead and live loads is:

$$W^*_{ES} = \frac{8P}{5}$$

$$= \frac{8}{5}(40 + 0.7 \times 25)$$

$$= 92 \text{ kN}$$

(7) From Table 5.1-5(2), a 310UB32.0 has adequate maximum serviceability design load W^*_{S1} = 109 kN.

∴ Adopt a 310UB32.0 - Grade 300 section.

Note: In this example the self weight of the beam is not taken into consideration. The calculation should be repeated to include self weight if significant.

5.2 Design Section Moment and Web Capacities

5.2.1 Scope

Tables 5.2-1 to 5.2-11 contain values of design section moment capacities about the principal x- & y-axes (ϕM_{sx} , ϕM_{sy}) and the design shear capacity (ϕV_v) for shear forces acting in the principal y-axis direction (note that such a shear force is related to bending about the *x-axis*). Design section moment capacities are given for I- sections with holes in the tension flange ($\phi M'_{sx}$, $\phi M''_{sx}$). Standard bolt hole diameters and gauge lengths are used on the flanges (refer to Tables 3.1-15(1) to 3.1-18 for details). These values provide basic information necessary for checking shear/bending interaction.

Also listed are the maximum segment lengths for full lateral restraint (FLR) to ensure that the maximum design section moment capacity can be achieved for bending about the x-axis. The Tables give values of design web bearing yield capacity per unit length ($\phi R_{by} / b_{bf}$) and design web bearing buckling capacity per unit length ($\phi R_{bb} / b_b$) for all sections except Structural Tees.

5.2.2 Method

5.2.2.1 Design Section Moment Capacity

The design section moment capacity (ϕM_s) is determined from Clauses 5.1 and 5.2.1 of AS 4100 using

$$\phi M_s = \phi \, f_y \, Z_e$$

where ϕ = 0.9 (Table 3.4 of AS 4100)

f_y = yield stress used in design (for a section where the web and flange yield stresses (f_{yw} & f_{yf}) are different the ***lower*** value is used)

Z_e = effective section modulus (Section 3.2.2.2)

Design section moment capacities are listed for bending about both principal axes. For bending about the x-axis, the design <u>member</u> moment capacity (ϕM_b) equals the design <u>section</u> moment capacity for members which are fully restrained against flexural-torsional buckling . For bending about the y-axis, flexural-torsional buckling does not occur, and the design member moment capacity equals the design section moment capacity.

For asymmetric sections (Structural Tees, Channels and Angles) bending about the asymmetric axis, the value of the design section moment capacity depends on the direction of the bending moment.

5.2.2.2 Segment Length for Full Lateral Restraint (FLR)

For I- sections and Channels, a segment with full or partial restraints at each end may be considered to have full lateral restraint if its length satisfies Clause 5.3.2.4 of AS 4100, i.e.

$$\text{FLR} \le r_y \,(K_1 + K_2\,\beta_m) \sqrt{\left(\frac{250}{f_y}\right)}$$

where FLR = maximum segment length for full lateral restraint

K_1 = 80 (for equal flanged I- sections) or 60 (for equal flanged Channels)

K_2 = 50 (for equal flanged I- sections) or 40 (for equal flanged Channels)

$$r_y = \sqrt{\left(\frac{I_y}{A_g}\right)}$$

The FLR values listed in Tables 5.2-1 to 5.2-11 are calculated using $\beta_m = -1.0$ which is the most conservative case. However $\beta_m = -0.8$ may be used for segments with transverse loads (as in the case of Tables 5.1-1 to 5.1-13), or β_m may be taken as the ratio of the smaller to larger end moments in the length (L) for segments without transverse loads (positive when the segment is bent in reverse curvature).

For Structural Tees cut from Universal Beams the values of maximum segment length have been determined by calculating the maximum effective length for which the design member moment capacity equals the design section moment capacity assuming $\alpha_m = 1.0$. For Tees cut from Universal Beams bending about the *x*-axis that causes compression in the stem, there is no effective length for which the design member moment capacity equals the design section moment capacity. Structural Tees cut from Universal Columns and some BTs bent about the *y*-axis do not buckle laterally and hence no value of effective length is given.

5.2.2.3 Design Shear Capacity of a Web

For I- sections and channels the shear stress distribution in the web is approximately uniform and the design shear capacity ϕV_v can be taken as (Clause 5.11 of AS 4100):

$$\phi V_v = \phi(0.6 f_{yw} A_w) \qquad \text{for} \quad \frac{d_1}{t_w}\sqrt{\left(\frac{f_{yw}}{250}\right)} \le 82$$

$$\phi V_v = \phi(0.6 f_{yw} A_w)\left[\frac{82}{\left(\frac{d_1}{t_w}\right)\sqrt{\left(\frac{f_{yw}}{250}\right)}}\right]^2 \qquad \text{for} \quad \frac{d_1}{t_w}\sqrt{\left(\frac{f_{yw}}{250}\right)} > 82$$

where ϕ = 0.9
d_1 = clear depth of the web
A_w = area of the web $= d\,t_w$ (for hot-rolled sections)
$= d_1\,t_w$ (for welded sections)
f_{yw} = yield stress of the **web**

For Structural Tees the shear stress distribution is non-uniform and the web shear capacity is given by

$$\phi V_v = \min\left[\phi V_u,\ \frac{2\phi V_u}{0.9 + \left(\frac{f^*_{vm}}{f^*_{va}}\right)}\right]$$

where f^*_{vm}, f^*_{va} = the maximum and average design shear stresses determined from an elastic analysis.

ϕV_u = the design shear capacity assuming a uniform shear stress distribution

For interaction of shear and bending the design shear capacity in the presence of bending moment (ϕV_{vm}) is

$$\phi V_{vm} = \phi V_v \qquad \text{for } M^* \le 0.75\,\phi M_s$$

$$\text{or} \quad \phi V_{vm} = \phi V_v\left[2.2 - \left(\frac{1.6M^*}{\phi M_s}\right)\right] \qquad \text{for } 0.75\,\phi M_s \le M^* \le \phi M_s$$

Interaction need only be checked if $V^* \ge 0.6\,(\phi V_v)$ **and** $M^* \ge 0.75\,(\phi M_s)$.

Note for Welded Sections: Clause 9.2 of AS 3679.2 states that the flange-web welded joint for welded sections shall develop the minimum tensile strength of the web (for $t_w \le$ 16 mm), or the minimum tensile strength of a 16 mm web (for $t_w >$ 16 mm), therefore

$$\phi v_{wj} = \phi f_u t_w \quad \text{(for } t_w \le 16 \text{ mm)}$$
$$= 16\,\phi f_u \quad \text{(for } t_w > 16 \text{ mm)}$$

where ϕ = 0.8 (Table 3.4 of AS 4100)
ϕv_{wj} = the design capacity of the welded joint
t_w = web thickness

For some Welded Columns the design shear capacity (ϕV_v) is governed by the capacity of the welded joint.

The adjacent table lists the design capacity of the welded joints for the range of web thicknesses of Welded Beams and Welded Columns.

Steel Grade (AS 3679.2)	Web Thickness t_w	Web Tensile Strength f_u	Design Capacity of Welded Joint ϕv_{wj}
	mm	MPa	kN/mm
300	10	430	3.44
300	12	430	4.13
300	≥ 16	430	5.50
400	10	480	3.84
400	12	480	4.61
400	≥16	480	6.14

Note: ϕv_{wj} includes the welds on **both** sides of the web.

5.2.2.4 Design Web Bearing Capacities

The design bearing yield capacity of a web (ϕR_{by}) is calculated in accordance with Clause 5.13.3 of AS 4100 by

$$\frac{\phi R_{by}}{b_{bf}} = \phi(1.25\, t_w\, f_{yw})$$

where b_{bf} is shown in Figure 5.1. and ϕ = 0.9 (Table 3.4 of AS 4100).

The design bearing buckling capacity (ϕR_{bb}) is determined using Clause 5.13.4 of AS 4100. This is equal to the design axial compression capacity of a member with area $t_w\, b_b$ and slenderness, $L_e / r = 2.5\, d_1 / t_w$ with $\alpha_b = 0.5$ and $k_f = 1.0$ (Section 6 of AS 4100).

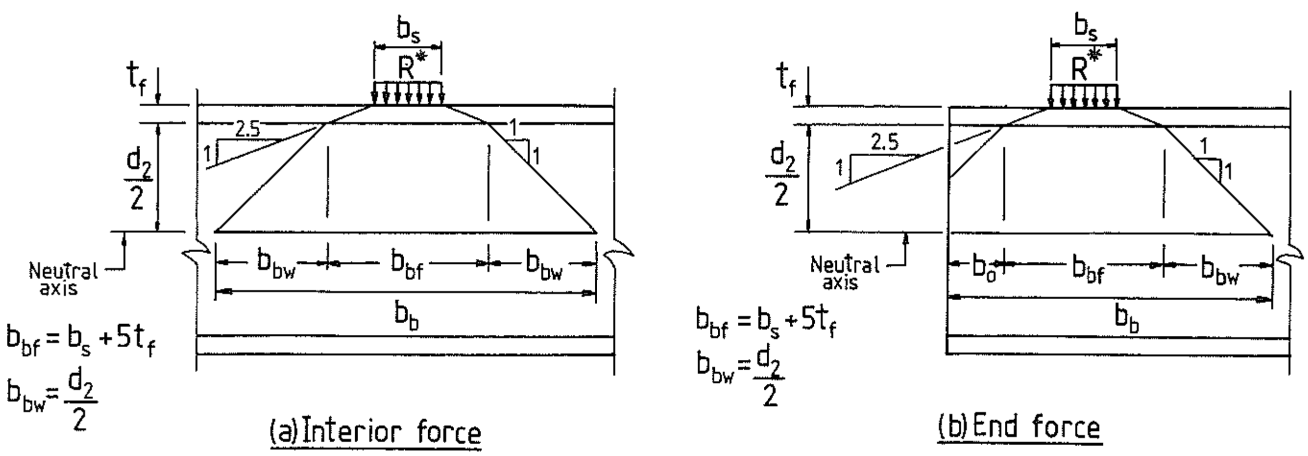
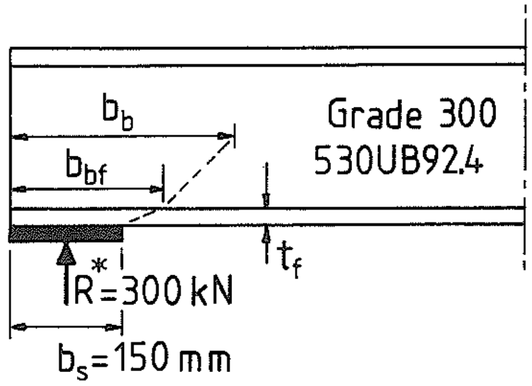


Figure 5.1 b_{bf} and b_b for Dispersions of Force Through Flange and Web
(Reproduced by courtesy of Standards Australia)

5.2.3 Example

A 530UB92.4 - Grade 300 steel beam is subjected to an end reaction of $R^* = 300$ kN. Check the bearing capacity of this section to resist this force.



Solution:

(1) Check shear capacity

V^*	$= R^*$	$= 300$ kN
ϕV_v	$= 939$ kN	(Table 5.2-5)
	$> V^*$ $\therefore$ O.K.	

(2) Check bearing capacity

(a) Design bearing yield capacity (ϕR_{by})

$b_{bf} = b_s + 2.5\, t_f = 150 + 2.5 \times 15.6 = 189$ mm

$\dfrac{\phi R_{bb}}{b_{bb}} = 3.67$ (Table 5.2-5)

$\therefore\ \phi R_{by} = 3.67 \times 189 = 694$ kN

(b) Design bearing buckling capacity (ϕR_{bb})

$b_b = b_{bf} + b_{bw} = 189 + 250.9 = 440$ mm

$\dfrac{\phi R_{by}}{b_{bf}} = 0.903$ (Table 5.2-5)

$\therefore\ \phi R_{bb} = 0.903 \times 440 = 397$ kN

Hence $\phi R_b = \min\,[\phi R_{bb}, \phi R_{by}] = 397$ kN $> R^*$ $\therefore$ O.K.

5.3 Design Moment Capacity for Members Without Full Lateral Restraint

5.3.1 Scope

Values of design member moment capacity (ϕM_b) are given in Tables 5.3-1 to 5.3-11 for various values of effective length (L_e) based on the uniform moment case ($\alpha_m = 1.0$) for members bending about the *x*-axis *without full lateral restraint*. Many tables are supplemented by graphs immediately following. The design section moment capacity (ϕM_{sx}) is also listed to allow easy calculation of ϕM_b for other moment distributions, as well as the design shear capacity (ϕV_v) for calculation of bending shear interaction.

5.3.2 Design Member Moment Capacity

The values of design moment capacity (ϕM_b) are determined in accordance with Clause 5.6.1.4 of AS 4100 as:

$$\phi M_b = \phi\, \alpha_m\, \alpha_s\, M_s \leq \phi M_s$$

where ϕ = 0.9 (Table 3.4 of AS 4100)

α_m = moment modification factor (Clause 5.6.1.1 of AS 4100)

= 1.0 **(Assumed for all tables and graphs - based on uniform moment case)**

$$\alpha_s = 0.6\left\{\sqrt{\left[\left(\frac{M_s}{M_{oa}}\right)^2 + 3\right]} - \left(\frac{M_s}{M_{oa}}\right)\right\} \quad \text{(Equation 5.6.1.1(2) of AS 4100)}$$

M_{oa} = M_o - reference buckling moment (Clause 5.6.1.1(a)(iv)(A) of AS 4100)

$$= \sqrt{\left(\frac{\pi^2 E I_y}{L_e^2}\right)\left(GJ + \frac{\pi^2 E I_w}{L_e^2}\right)} \quad \text{(Equation 5.6.1.1(3) of AS 4100)}$$

L_e = effective length

For Structural Tees there is an additional term, the monosymmetry section constant (β_x), in the formula for the reference buckling moment, M_o, to account for the asymmetry about the *x*-axis. For more details refer to Clause 5.6.1.2 of AS 4100.

5.3.3 Effective Length

The value of ϕM_b depends on the effective length (L_e) of the flexural member. L_e is determined by:

$$L_e = k_t\, k_l\, k_r\, L \qquad \text{(Clause 5.6.3 of AS 4100)}$$

where k_t = twist restraint factor (Table 5.6.3(1) of AS 4100)

k_l = load height factor (Table 5.6.3(2) of AS 4100)

k_r = lateral rotation restraint factor (Table 5.6.3(3) of AS 4100)

L = length of segment

The article *Design of Unbraced Beams* in the AISC technical journal, "Steel Construction", Vol 27, No 1, February 1993, provides guidance on the restraint conditions provided by many common connections. Reference can also be made to the article *Design of Unbraced Cantilevers*, in "Steel Construction", Vol 27, No 3, August 1993.

5.3.4 Other Loading and Restraint Conditions

The design moment capacities presented in these tables can be used for other loading conditions. For these situations the effective length (L_e) corresponding to the actual length and restraint conditions must be assessed and the appropriate value of α_m determined in accordance with Clause 5.6.1.1(a) of AS 4100. The design moment capacity (ϕM_b) can then be determined as the *lesser* of:

$\phi M_{sx} = \phi \, Z_{ex} \, f_y$

and $\phi M_b = \phi \, \alpha_m \, \alpha_s \, Z_{ex} \, f_y$

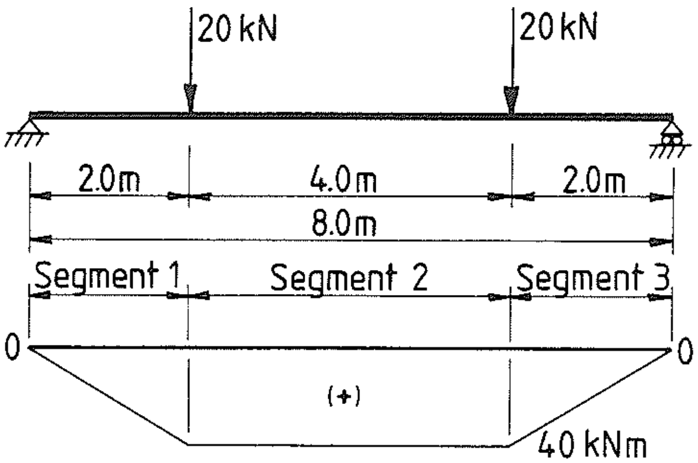
where $\phi = 0.9$ (Table 3.4 of AS 4100)

$\phi M_b = \alpha_m$ times the value of ϕM_b ($= \phi \, \alpha_s \, Z_{ex} \, f_y$) given in Tables 5.3-1 to 5.3-11

Tables 5.3-1 to 5.3-11 are based on the most critical moment distribution - i.e. uniform moment over the beam entire segment (α_m = 1.0). For other values of α_m, designers should use the *lesser* of ϕM_{sx} and $\alpha_m(\phi M_b)$ where ϕM_b is the value given in the appropriate table for the same effective length.

5.3.5 Examples

1. A simply supported beam shown below has two concentrated loads applied to the top flange. Full restraint is provided at the load points and the supports. The calculated design load at each point is 20 kN and includes an allowance for self weight. What size Universal Beam is required to support these loads?



Bending Moment Diagram

Design Data:

Design bending moment	M^*	= 40 kNm	
Design shear force	V^*	= 20 kN	

Solution:

For beam segment 2:

End restraint condition		= FF	(fully restrained at both ends of the segment)
Twist restraint factor	k_t	= 1.0	(Table 5.6.3(1) of AS 4100)
Load Height Factor	k_l	= 1.0	(Table 5.6.3(2) of AS 4100) (Top flange loading at segment end)
Lateral rotation restraint factor	k_r	= 1.0	(Table 5.6.3(3) of AS 4100) (conservative)
∴ Effective length	L_e	$= k_t \, k_l \, k_r \, L$	
		$= 1.0 \times 1.0 \times 1.0 \times 4.0$	
		= 4.0 m	

As a uniform bending moment is applied to segment 2, $\alpha_m = 1.0$ (Table 5.6.1 of AS 4100). Thus alternatives can be read directly from Table 5.3-5 for a uniform bending moment of 40 kNm on segment 2 with an effective length ($L_e = 4.0$ m).

$\therefore$ Choose 200UB29.8 - Grade 300 $\phi M_b = 47.6$ kNm $> M^*$

$\phi V_v = 225$ kN $> V^*$ (Note also $0.6\,\phi V_v > V^*$)

Beam segments 1 and 3 do not have to be checked because they have the same design bending moment (i.e. the maximum segment moment) and end restraints but a shorter effective length compared with the middle segment. Additionally the bending moment distribution is different in the end segments ($\alpha_m = 1.75$ (Table 5.6.1 of AS 4100)). As the end segments have a smaller effective length and a larger moment modification factor, the design member moment capacity of these segments cannot be less than that of the central (critical) segment.

Designers should also make checks for bearing (for the strength limit state), and deflection.

2. Considering the simply supported beam in Example 1 above, redesign the beam assuming that full restraint is **not** provided at the load points.

Design Data:

Design bending moment	M^*	$= 40$ kNm	
Design shear force	V^*	$= 20$ kN	

Solution:

For entire beam:

End restraint condition		= FF	(fully restrained at both ends of the segment)
Twist restraint factor	k_t	= 1.0	(Table 5.6.3(1) of AS 4100)
Load Height Factor	k_l	= 1.4	(Table 5.6.3(2) of AS 4100) (For top flange loading within segment)
Lateral rotation restraint factor	k_r	= 1.0	(Table 5.6.3(3) of AS 4100)
$\therefore$ Effective length	L_e	$= k_t\, k_l\, k_r\, L$ $= 1.0 \times 1.4 \times 1.0 \times 8.0$ $= 11.2$ m	
Moment modification factor	α_m	= 1.088	(Table 5.6.1 of AS 4100)
To satisfy the strength limit state	M^*	$\leq \phi M_b = \phi \alpha_m \alpha_s M_{sx}$ $(\leq \phi M_{sx})$	
This can be rewritten as	M^*/α_m	$= 40/1.088 = 36.8$ kNm $\leq \phi(1.0)\alpha_s M_{sx}$	

The right hand side is the value of ϕM_b (based on $\alpha_m = 1.0$) that is found in Tables 5.3-1 to 5.3-11.

To design this beam M^* (= 40 kNm) $< \phi M_{sx}$ and M^*/α_m (= 36.8 kNm) $< \phi M_b$.

An appropriate section can then be read directly from the table using an *adjusted* design bending moment of M^*/α_m.

For a 310UB46.2 - Grade 300

$\phi M_{sx} = 197$ kNm $(> M^*)$ (Table 5.3-5)

$\phi M_b = 40.0$ kNm (Table 5.3-5 for $L_e = 12$ m and $\alpha_m = 1$)

$\therefore \phi M_b = 1.088 \times 40.0 = 43.5$ kNm $(> M^*)$

$\phi V_v = 356$ kN

A shear/bending interaction check is not necessary and a 310UB46.2 Grade 300 section is adequate.

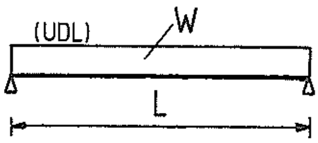
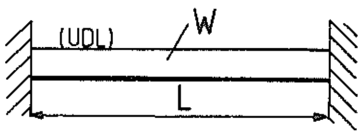
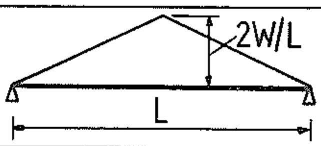
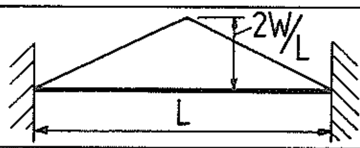
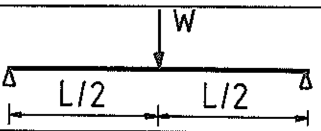
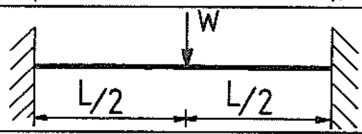
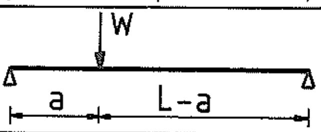
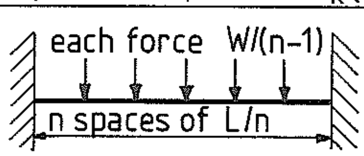
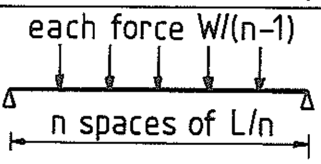
5.4 Calculation of Beam Deflections

Common methods for calculating the elastic deflection of a beam include:-

(i) integration of M/EI diagram;
(ii) moment area;
(iii) slope deflection;
(iv) published solutions for particular cases;
(v) approximate or numerical methods (e.g. finite elements)

Table 5.3 gives the more commonly used beam deflection formulae. Due to the large range of loading configurations and support conditions considered for beams in design, a comprehensive set of beam deflection formulae is published in the AISC technical journal "Steel Construction", Vol. 26 No. 1, (February 1992).

TABLE 5.3: Beam Deflection Formulae

SIMPLY SUPPORTED BEAMS		BUILT-IN BEAMS	
	$\Delta = \frac{5}{384}\frac{WL^3}{EI}$		$\Delta = \frac{1}{384}\frac{WL^3}{EI}$
	$\Delta = \frac{1}{60}\frac{WL^3}{EI}$		$\Delta = \frac{1.4}{384}\frac{WL^3}{EI}$
	$\Delta = \frac{1}{48}\frac{WL^3}{EI}$		$\Delta = \frac{1}{192}\frac{WL^3}{EI}$
	$\Delta = \frac{WL^3}{48EI}\left[\frac{3a}{L} - 4\left(\frac{a}{L}\right)^3\right]$		$\Delta = \frac{k}{192\,(n-1)}\frac{WL^3}{EI}$
	$\Delta = \frac{k}{192\,(n-1)}\frac{WL^3}{EI}$		

Simply supported beams:

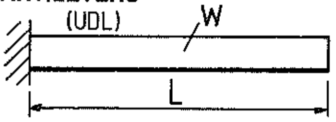
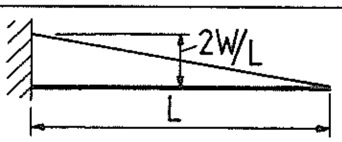
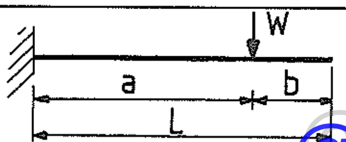
n odd, $k = [n - \frac{1}{n}]\,[3 - \frac{1}{2}(1 - \frac{1}{n^2})]$

n even, $k = n\,[3 - \frac{1}{2}(1 + \frac{4}{n^2})]$

Built-in beams:

n odd, $k = [n - \frac{1}{n}]\,[1 - \frac{1}{2}(1 - \frac{1}{n^2})]$

n even, $k = [3 - \frac{1}{2}(1 + \frac{4}{n^2})] \times n - [2(n - \frac{1}{n})]$

CANTILEVERS	
	$\Delta = \frac{1}{8}\frac{WL^3}{EI}$
	$\Delta = \frac{1}{15}\frac{WL^3}{EI}$
	$\Delta = \frac{Wa^3}{EI}\,\frac{1}{3}\,[1 + \frac{3b}{2a}]$

Where:
Δ = maximum deflection
W = total load on beam
L = span of beam
E = Young's modulus of elasticity
I = second moment of area of cross-section

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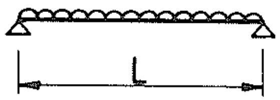
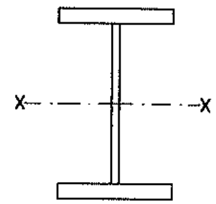
TABLE 5.1-1

WELDED BEAMS
GRADE 300

MAXIMUM DESIGN LOADS FOR BEAMS WITH FULL LATERAL RESTRAINT
bending about x-axis





W^*_{L1}: Maximum Design Load based on Moment
W^*_{L2}: Maximum Design Load based on Shear
W^*_{L}: Maximum Design Load is LESSER of W^*_{L1} and W^*_{L2}
W^*_{S}: Serviceability Load based on Deflection Limit of Span/250 or First Yield

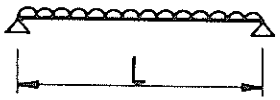
Designation	W^*_{L1} (kN) / *W^*_S (kN)* Span in metres															W^*_{L2}	FLR
	3	3.5	4	5	6	7	8	9	10	12	14	16	18	20	22	kN	m
1200WB455	19000	16300	14200	11400	9480	8130	7110	6320	5690	4740	4060	3560	3160	2840	2590	5810	4.53
	19100	*16400*	*14300*	*11400*	*9540*	*8180*	*7160*	*6360*	*5720*	*4770*	*4090*	*3580*	*2910*	*2360*	*1950*		
1200WB423	17400	14900	13000	10400	8680	7440	6510	5780	5210	4340	3720	3250	2890	2600	2370	5810	4.46
	17400	*14900*	*13100*	*10500*	*8710*	*7470*	*6530*	*5810*	*5230*	*4350*	*3730*	*3270*	*2640*	*2140*	*1770*		
1200WB392	15800	13500	11800	9450	7880	6750	5910	5250	4730	3940	3380	2950	2630	2360	2150	5810	4.37
	15800	*13500*	*11800*	*9450*	*7880*	*6750*	*5910*	*5250*	*4730*	*3940*	*3380*	*2950*	*2370*	*1920*	*1590*		
1200WB342	13300	11400	9960	7970	6640	5690	4980	4430	3980	3320	2850	2490	2210	1990	1810	5810	3.35
	13100	*11200*	*9810*	*7850*	*6540*	*5600*	*4900*	*4360*	*3920*	*3270*	*2800*	*2450*	*1970*	*1590*	*1320*		
1200WB317	12000	10300	9010	7210	6010	5150	4500	4000	3600	3000	2570	2250	2000	1800	1640	5810	3.26
	11800	*10100*	*8810*	*7050*	*5860*	*5040*	*4410*	*3920*	*3530*	*2940*	*2520*	*2200*	*1760*	*1420*	*1170*		
1200WB278	10100	8660	7580	6060	5050	4330	3790	3370	3030	2530	2170	1890	1680	1520	1380	5810	2.69
	9710	*8330*	*7280*	*5830*	*4860*	*4160*	*3640*	*3240*	*2910*	*2430*	*2080*	*1820*	*1440*	*1170*	*966*		
1200WB249	8660	7420	6500	5200	4330	3710	3250	2890	2600	2170	1860	1620	1440	1300	1180	5810	1.98
	8140	*6980*	*6110*	*4890*	*4070*	*3490*	*3050*	*2710*	*2440*	*2040*	*1750*	*1530*	*1210*	*980*	*810*		
1000WB322	11000	9440	8260	6610	5510	4720	4130	3670	3300	2750	2360	2060	1840	1650	1500	4980	3.45
	10900	*9350*	*8180*	*6540*	*5450*	*4670*	*4090*	*3640*	*3270*	*2730*	*2340*	*1800*	*1420*	*1150*	*950*		
1000WB296	9910	8500	7440	5950	4960	4250	3720	3300	2970	2480	2120	1860	1650	1490	1350	4980	3.36
	9770	*8370*	*7330*	*5860*	*4890*	*4190*	*3660*	*3260*	*2930*	*2440*	*2080*	*1600*	*1260*	*1020*	*844*		
1000WB258	8270	7090	6200	4960	4130	3540	3100	2760	2480	2070	1770	1550	1380	1240	1130	4980	2.79
	8020	*6880*	*6020*	*4810*	*4010*	*3440*	*3010*	*2670*	*2410*	*2010*	*1700*	*1300*	*1030*	*833*	*689*		
1000WB215	6890	5900	5170	4130	3440	2950	2580	2300	2070	1720	1480	1290	1150	1030	939	4980	2.10
	6500	*5570*	*4870*	*3900*	*3250*	*2780*	*2440*	*2170*	*1950*	*1620*	*1270*	*975*	*770*	*624*	*516*		
900WB282	9160	7850	6870	5500	4580	3930	3440	3050	2750	2290	1960	1720	1530	1370	1250	3460	3.69
	9260	*7940*	*6950*	*5560*	*4630*	*3970*	*3470*	*3090*	*2780*	*2320*	*1800*	*1380*	*1090*	*880*	*727*		
900WB257	8170	7010	6130	4900	4090	3500	3070	2720	2450	2040	1750	1530	1360	1230	1110	3460	3.61
	8240	*7060*	*6180*	*4940*	*4120*	*3530*	*3090*	*2750*	*2470*	*2060*	*1580*	*1210*	*958*	*776*	*641*		
900WB218	6690	5740	5020	4020	3350	2870	2510	2230	2010	1670	1430	1260	1120	1000	913	3460	3.03
	6670	*5720*	*5000*	*4000*	*3330*	*2860*	*2500*	*2220*	*2000*	*1670*	*1270*	*975*	*771*	*624*	*516*		
900WB175	5400	4630	4050	3240	2700	2310	2020	1800	1620	1350	1160	1010	900	810	736	3460	2.32
	5260	*4510*	*3950*	*3160*	*2630*	*2250*	*1970*	*1750*	*1580*	*1260*	*928*	*710*	*561*	*455*	*376*		
800WB192	5420	4640	4060	3250	2710	2320	2030	1810	1630	1350	1160	1020	903	813	739	2390	2.72
	5440	*4670*	*4080*	*3270*	*2720*	*2330*	*2040*	*1810*	*1630*	*1270*	*933*	*714*	*564*	*457*	*378*		
800WB168	4600	3940	3450	2760	2300	1970	1720	1530	1380	1150	985	862	766	690	627	2390	2.41
	4580	*3930*	*3440*	*2750*	*2290*	*1960*	*1720*	*1530*	*1370*	*1060*	*779*	*596*	*471*	*382*	*315*		
800WB146	4110	3520	3080	2470	2060	1760	1540	1370	1230	1030	881	771	685	617	561	2390	2.23
	4080	*3500*	*3060*	*2450*	*2040*	*1750*	*1530*	*1360*	*1220*	*870*	*639*	*489*	*387*	*313*	*259*		
800WB122	3260	2790	2440	1960	1630	1400	1220	1090	978	815	698	611	543	489	444	2390	1.89
	3170	*2720*	*2380*	*1900*	*1590*	*1360*	*1190*	*1060*	*952*	*670*	*492*	*377*	*298*	*241*	*199*		
700WB173	4290	3680	3220	2580	2150	1840	1610	1430	1290	1070	920	805	715	644	585	2210	2.51
	4300	*3690*	*3230*	*2580*	*2150*	*1840*	*1610*	*1430*	*1270*	*880*	*647*	*495*	*391*	*317*	*262*		
700WB150	3610	3090	2710	2170	1800	1550	1350	1200	1080	902	773	677	601	541	492	2210	2.21
	3590	*3080*	*2690*	*2150*	*1790*	*1540*	*1350*	*1200*	*1050*	*728*	*535*	*410*	*324*	*262*	*217*		
700WB130	3230	2770	2420	1940	1620	1390	1210	1080	970	808	693	606	539	485	441	2210	2.05
	3190	*2730*	*2390*	*1910*	*1600*	*1370*	*1200*	*1060*	*858*	*596*	*438*	*335*	*265*	*214*	*177*		
700WB115	2730	2340	2050	1640	1370	1170	1020	910	819	683	585	512	455	410	372	2210	1.95
	2670	*2290*	*2000*	*1600*	*1330*	*1140*	*1000*	*875*	*709*	*492*	*362*	*277*	*219*	*177*	*146*		

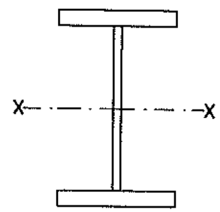
Notes: (1) FLR, segment length for full lateral restraint, based on transverse load case ($\beta_m = -0.8$).
(2) Shading indicates serviceability loads governed by yielding.

TABLE 5.1-2

WELDED BEAMS
GRADE 400

MAXIMUM DESIGN LOADS FOR BEAMS WITH FULL LATERAL RESTRAINT
bending about x-axis





W^*_{L1}: Maximum Design Load based on Moment
W^*_{L2}: Maximum Design Load based on Shear
W^*_{L}: Maximum Design Load is LESSER of W^*_{L1} and W^*_{L2}
W^*_{S}: Serviceability Load based on Deflection Limit of Span/250 or First Yield

Designation	W^*_{L1} (kN)/W^*_S (kN) Span in metres															W^*_{L2}	FLR
	3	3.5	4	5	6	7	8	9	10	12	14	16	18	20	22	kN	m
1200WB455	24200	20800	18200	14500	12100	10400	9090	8080	7270	6060	5190	4550	4040	3640	3310	6640	4.00
	24500	21000	18400	14700	12300	10500	9200	8180	7360	6130	4810	3680	2910	2360	1950		
1200WB423	22200	19000	16600	13300	11100	9510	8320	7390	6650	5550	4750	4160	3700	3330	3020	6640	3.93
	22400	19200	16800	13400	11200	9600	8400	7470	6720	5600	4360	3340	2640	2140	1770		
1200WB392	20100	17300	15100	12100	10100	8630	7550	6710	6040	5030	4320	3780	3360	3020	2750	6640	3.85
	20300	17400	15200	12200	10100	8680	7600	6750	6080	5060	3920	3000	2370	1920	1590		
1200WB342	17000	14500	12700	10200	8480	7270	6360	5650	5090	4240	3630	3180	2830	2540	2310	6640	2.95
	16800	14400	12600	10100	8410	7210	6310	5600	5040	4200	3250	2490	1970	1590	1320		
1200WB317	15300	13100	11500	9200	7670	6570	5750	5110	4600	3830	3290	2870	2560	2300	2090	6640	2.87
	15100	13000	11300	9070	7560	6480	5670	5040	4530	3780	2900	2220	1760	1420	1170		
1200WB278	12900	11000	9660	7730	6440	5520	4830	4300	3870	3220	2760	2420	2150	1930	1760	6640	2.37
	12500	10700	9370	7490	6240	5350	4680	4160	3750	3120	2390	1830	1440	1170	966		
1200WB249	11000	9460	8270	6620	5520	4730	4140	3680	3310	2760	2360	2070	1840	1650	1500	6640	1.75
	10500	8970	7850	6280	5240	4490	3930	3490	3140	2620	2000	1530	1210	980	810		
1000WB322	14200	12100	10600	8490	7080	6070	5310	4720	4250	3540	3030	2650	2360	2120	1930	6300	3.04
	14000	12000	10500	8410	7010	6010	5260	4670	4210	3190	2340	1800	1420	1150	950		
1000WB296	12700	10900	9560	7650	6370	5460	4780	4250	3820	3190	2730	2390	2120	1910	1740	6300	2.97
	12600	10800	9420	7540	6280	5380	4710	4190	3770	2840	2080	1600	1260	1020	844		
1000WB258	10600	9110	7970	6380	5320	4560	3990	3540	3190	2660	2280	1990	1770	1590	1450	6300	2.46
	10300	8840	7740	6190	5160	4420	3870	3440	3090	2310	1700	1300	1030	833	689		
1000WB215	8720	7480	6540	5230	4360	3740	3270	2910	2620	2180	1870	1640	1450	1310	1190	6300	1.86
	8230	7050	6170	4940	4120	3530	3090	2740	2470	1730	1270	975	770	624	516		
900WB282	11700	9990	8740	6990	5830	4990	4370	3880	3500	2910	2500	2180	1940	1750	1590	3650	3.25
	11900	10200	8930	7140	5950	5100	4470	3970	3520	2450	1800	1380	1090	880	727		
900WB257	10400	8910	7790	6230	5200	4450	3900	3460	3120	2600	2230	1950	1730	1560	1420	3650	3.19
	10600	9080	7940	6360	5300	4540	3970	3530	3100	2160	1580	1210	958	776	641		
900WB218	8500	7290	6370	5100	4250	3640	3190	2830	2550	2120	1820	1590	1420	1270	1160	3650	2.67
	8570	7350	6430	5140	4290	3670	3220	2860	2500	1730	1270	975	771	624	516		
900WB175	6680	5720	5010	4010	3340	2860	2500	2230	2000	1670	1430	1250	1110	1000	910	3650	2.06
	6650	5710	5000	4000	3330	2860	2500	2220	1820	1260	928	710	561	455	376		
800WB192	6780	5810	5090	4070	3390	2910	2540	2260	2030	1700	1450	1270	1130	1020	925	2390	2.40
	7000	6000	5250	4200	3500	3000	2620	2260	1830	1270	933	714	564	457	378		
800WB168	5740	4920	4310	3440	2870	2460	2150	1910	1720	1440	1230	1080	957	861	783	2390	2.12
	5890	5050	4420	3530	2940	2520	2210	1880	1530	1060	779	596	471	382	315		
800WB146	5020	4310	3770	3010	2510	2150	1880	1670	1510	1260	1080	942	837	754	685	2390	1.98
	5170	4430	3870	3100	2580	2210	1940	1550	1250	870	639	489	387	313	259		
800WB122	3960	3390	2970	2380	1980	1700	1480	1320	1190	990	848	742	660	594	540	2390	1.68
	4020	3440	3010	2410	2010	1720	1510	1190	965	670	492	377	298	241	199		
700WB173	5520	4730	4140	3310	2760	2360	2070	1840	1660	1380	1180	1030	920	828	752	2750	2.21
	5530	4740	4150	3320	2770	2370	1980	1560	1270	880	647	495	391	317	262		
700WB150	4640	3980	3480	2780	2320	1990	1740	1550	1390	1160	994	870	773	696	633	2750	1.95
	4610	3950	3460	2770	2310	1980	1640	1290	1050	728	535	410	324	262	217		
700WB130	4090	3510	3070	2460	2050	1750	1540	1360	1230	1020	877	768	682	614	558	2750	1.82
	4040	3460	3030	2420	2020	1730	1340	1060	858	596	438	335	265	214	177		
700WB115	3460	2970	2590	2080	1730	1480	1300	1150	1040	865	741	649	577	519	472	2750	1.73
	3380	2900	2530	2030	1690	1450	1110	875	709	492	362	277	219	177	146		

Notes: (1) FLR, segment length for full lateral restraint, based on transverse load case (β_m=-0.8)
(2) Shading indicates serviceability loads governed by yielding.

TABLE 5.1-3

WELDED COLUMNS
GRADE 300

MAXIMUM DESIGN LOADS FOR BEAMS WITH FULL LATERAL RESTRAINT
bending about x-axis

W^*_{L1}: Maximum Design Load based on Moment
W^*_{L2}: Maximum Design Load based on Shear
W^*_{L}: Maximum Design Load is LESSER of W^*_{L1} and W^*_{L2}
W^*_{S}: Serviceability Load based on Deflection Limit of Span/250 or First Yield

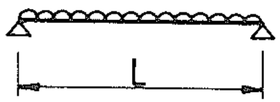
Designation	W^*_{L1} (kN) / W^*_S (kN) Span in metres															W^*_{L2}	FLR
	3	3.5	4	5	6	7	8	9	10	12	14	16	18	20	22	kN	m
500WC440	6990	5990	5240	4190	3490	3000	2620	2330	2100	1750	1500	1310	1160	1050	953	4840	4.62
	5700	*5750*	*5030*	*4020*	*3350*	*2700*	*2070*	*1630*	*1320*	*919*	*675*	*517*	*409*	*331*	*274*		
500WC414	6770	5810	5080	4060	3390	2900	2540	2260	2030	1690	1450	1270	1130	1020	924	3870	4.75
	6570	*5630*	*4930*	*3940*	*3290*	*2650*	*2030*	*1600*	*1300*	*901*	*662*	*507*	*400*	*324*	*268*		
500WC383	6130	5260	4600	3680	3070	2630	2300	2040	1840	1530	1310	1150	1020	920	836	3870	4.69
	5970	*5110*	*4470*	*3580*	*2980*	*2360*	*1810*	*1430*	*1160*	*804*	*591*	*453*	*358*	*290*	*239*		
500WC340	6030	5170	4520	3620	3020	2590	2260	2010	1810	1510	1290	1130	1010	905	823	3400	4.69
	5960	*5110*	*4470*	*3580*	*2980*	*2550*	*1970*	*1560*	*1260*	*875*	*643*	*492*	*389*	*315*	*260*		
500WC290	5080	4360	3810	3050	2540	2180	1910	1690	1530	1270	1090	953	847	763	693	2920	4.75
	5170	*4430*	*3880*	*3100*	*2590*	*2200*	*1680*	*1330*	*1080*	*748*	*550*	*421*	*332*	*269*	*223*		
500WC267	4500	3860	3380	2700	2250	1930	1690	1500	1350	1130	965	844	750	675	614	2920	4.68
	4670	*4000*	*3500*	*2800*	*2330*	*1960*	*1500*	*1190*	*961*	*667*	*490*	*375*	*296*	*240*	*198*		
500WC228	3750	3220	2820	2250	1880	1610	1410	1250	1130	938	804	704	626	563	512	2920	4.38
	4100	*3520*	*3080*	*2460*	*2050*	*1580*	*1210*	*953*	*772*	*536*	*394*	*302*	*238*	*193*	*160*		
400WC361	5020	4300	3760	3010	2510	2150	1880	1670	1500	1250	1070	941	836	752	684	4230	3.65
	4740	*4060*	*3550*	*2840*	*2330*	*1710*	*1310*	*1030*	*838*	*582*	*428*	*327*	*259*	*210*	*173*		
400WC328	4770	4090	3580	2860	2380	2040	1790	1590	1430	1190	1020	894	795	715	650	2960	3.82
	4590	*3930*	*3440*	*2750*	*2250*	*1660*	*1270*	*1000*	*812*	*564*	*414*	*317*	*251*	*203*	*168*		
400WC303	4310	3700	3230	2590	2160	1850	1620	1440	1290	1080	924	808	719	647	588	2960	3.77
	4160	*3570*	*3120*	*2500*	*2010*	*1470*	*1130*	*892*	*722*	*502*	*369*	*282*	*223*	*181*	*149*		
400WC270	3800	3260	2850	2280	1900	1630	1430	1270	1140	950	814	713	633	570	518	2650	3.77
	3700	*3170*	*2770*	*2220*	*1750*	*1290*	*984*	*778*	*630*	*438*	*321*	*246*	*194*	*158*	*130*		
400WC212	2930	2510	2200	1760	1460	1260	1100	976	879	732	628	549	488	439	399	2270	3.76
	2900	*2480*	*2170*	*1740*	*1320*	*973*	*745*	*588*	*477*	*331*	*243*	*186*	*147*	*119*	*98.5*		
400WC181	2460	2110	1840	1470	1230	1050	922	819	737	615	527	461	410	369	335	2270	3.52
	2540	*2180*	*1910*	*1520*	*1060*	*777*	*595*	*470*	*381*	*264*	*194*	*149*	*117*	*95.2*	*78.7*		
400WC144	1860	1600	1400	1120	931	798	698	621	559	465	399	349	310	279	254	1810	3.52
	2040	*1750*	*1530*	*1190*	*830*	*610*	*467*	*369*	*299*	*207*	*152*	*117*	*92.2*	*74.7*	*61.7*		
350WC280	3320	2850	2490	1990	1660	1420	1240	1110	996	830	711	622	553	498	453	2330	3.38
	3140	*2690*	*2360*	*1840*	*1270*	*936*	*717*	*566*	*459*	*319*	*234*	*179*	*142*	*115*	*94.8*		
350WC258	2990	2560	2240	1790	1490	1280	1120	996	897	747	641	560	498	448	408	2330	3.35
	2840	*2440*	*2130*	*1620*	*1130*	*828*	*634*	*501*	*406*	*282*	*207*	*159*	*125*	*101*	*83.9*		
350WC230	2630	2250	1970	1580	1310	1130	986	876	788	657	563	493	438	394	358	2080	3.34
	2520	*2160*	*1890*	*1410*	*978*	*719*	*550*	*435*	*352*	*244*	*180*	*138*	*109*	*88*	*72.7*		
350WC197	2250	1930	1690	1350	1120	964	844	750	675	562	482	422	375	337	307	1780	3.38
	2190	*1880*	*1640*	*1190*	*829*	*609*	*466*	*368*	*298*	*207*	*152*	*117*	*92.1*	*74.6*	*61.7*		

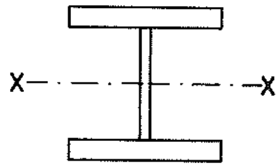
Notes: (1) FLR, segment length for full lateral restraint, based on transverse load case ($\beta_m = -0.8$).
(2) Shading indicates serviceability loads governed by yielding.

TABLE 5.1-4

WELDED COLUMNS
GRADE 400

MAXIMUM DESIGN LOADS FOR BEAMS WITH FULL LATERAL RESTRAINT
bending about x-axis





W^*_{L1}: Maximum Design Load based on Moment
W^*_{L2}: Maximum Design Load based on Shear
W^*_L: Maximum Design Load is LESSER of W^*_{L1} and W^*_{L2}
W^*_S: Serviceability Load based on Deflection Limit of Span/250 or First Yield

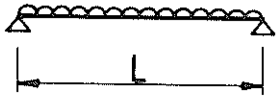
Designation	W^*_{L1} (kN) / W^*_S (kN) Span in metres															W^*_{L2}	FLR
	3	3.5	4	5	6	7	8	9	10	12	14	16	18	20	22	kN	m
500WC440	8990	7700	6740	5390	4490	3850	3370	3000	2700	2250	1930	1680	1500	1350	1230	6020*	4.07
	8620	7390	6460	5170	3680	2700	2070	1630	1320	919	675	517	409	331	274		
500WC414	8710	7460	6530	5230	4350	3730	3270	2900	2610	2180	1870	1630	1450	1310	1190	4980	4.19
	8450	7240	6340	5070	3600	2650	2030	1600	1300	901	662	507	400	324	268		
500WC383	7890	6760	5910	4730	3940	3380	2960	2630	2370	1970	1690	1480	1310	1180	1080	4980	4.14
	7670	6570	5750	4600	3220	2360	1810	1430	1160	804	591	453	358	290	239		
500WC340	7630	6540	5720	4580	3810	3270	2860	2540	2290	1910	1630	1430	1270	1140	1040	4370	4.14
	7660	6570	5750	4600	3500	2570	1970	1560	1260	875	643	492	389	315	260		
500WC290	6400	5490	4800	3840	3200	2740	2400	2130	1920	1600	1370	1200	1070	960	873	3690	4.19
	6850	5700	4990	3990	2990	2200	1680	1330	1080	748	550	421	332	269	223		
500WC267	5650	4840	4240	3390	2830	2420	2120	1880	1700	1410	1210	1060	942	848	771	3690	4.13
	6000	5150	4500	3600	2670	1960	1500	1190	961	667	490	375	296	240	198		
500WC228	4430	3800	3320	2660	2210	1900	1660	1480	1330	1110	949	830	738	664	604	3690	3.89
	5200	4460	3900	3090	2150	1580	1210	953	772	536	394	302	238	193	160		
400WC361	6450	5530	4840	3870	3220	2760	2420	2150	1930	1610	1380	1210	1070	967	880	5370*	3.22
	6090	5220	4570	3350	2330	1710	1310	1030	838	582	428	327	259	210	173		
400WC328	6130	5260	4600	3680	3070	2630	2300	2040	1840	1530	1310	1150	1020	920	836	3810	3.37
	5900	5060	4420	3250	2250	1660	1270	1000	812	564	414	317	251	203	168		
400WC303	5540	4750	4160	3330	2770	2380	2080	1850	1660	1390	1190	1040	924	832	756	3810	3.33
	5350	4590	4010	2890	2010	1470	1130	892	722	502	369	282	223	181	149		
400WC270	4890	4190	3660	2930	2440	2090	1830	1630	1470	1220	1050	916	814	733	666	3400	3.33
	4760	4080	3570	2520	1750	1290	984	778	630	438	321	246	194	158	130		
400WC212	3690	3160	2770	2210	1850	1580	1380	1230	1110	923	791	692	615	554	503	2870	3.31
	3720	3190	2790	1910	1320	973	745	588	477	331	243	186	147	119	98.5		
400WC181	3040	2600	2280	1820	1520	1300	1140	1010	911	759	650	569	506	455	414	2870	3.13
	3220	2760	2380	1520	1060	777	595	470	381	264	194	149	117	95.2	78.7		
400WC144	2200	1880	1650	1320	1100	941	824	732	659	549	471	412	366	329	300	2300	3.13
	2580	2210	1870	1190	830	610	467	369	299	207	152	117	92.2	74.7	61.7		
350WC280	4270	3660	3200	2560	2130	1830	1600	1420	1280	1070	914	800	711	640	582	2990	2.99
	4040	3460	2870	1840	1270	936	717	566	459	319	234	179	142	115	94.8		
350WC258	3840	3290	2880	2310	1920	1650	1440	1280	1150	961	824	721	641	576	524	2990	2.95
	3660	3130	2540	1620	1130	828	634	501	406	282	207	159	125	101	83.9		
350WC230	3380	2900	2530	2030	1690	1450	1270	1130	1010	845	724	634	563	507	461	2670	2.95
	3250	2780	2200	1410	978	719	550	435	352	244	180	138	109	88	72.7		
350WC197	2890	2480	2170	1740	1450	1240	1080	964	868	723	620	542	482	434	394	2260	2.98
	2820	2420	1870	1190	829	609	466	368	298	207	152	117	92.1	74.6	61.7		

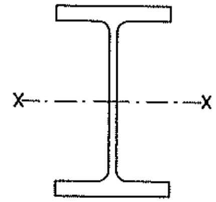
Notes: (1) FLR, segment length for full lateral restraint, based on transverse load case ($\beta_m = -0.8$).
(2) Shading indicates serviceability loads governed by yielding.
(3) * indicates shear capacity governed by the shear capacity of the weld.

TABLE 5.1-5(1)

UNIVERSAL BEAMS GRADE 300

MAXIMUM DESIGN LOADS FOR BEAMS WITH FULL LATERAL RESTRAINT bending about x-axis





W^*_{L1}: Maximum Design Load based on Moment
W^*_{L2}: Maximum Design Load based on Shear
W^*_L: Maximum Design Load is LESSER of W^*_{L1} and W^*_{L2}
W^*_S: Serviceability Load based on Deflection Limit of Span/250 or First Yield

Designation	W^*_{L1} (kN) / W^*_S (kN) Span in metres															W^*_{L2}	FLR
	3	3.5	4	5	6	7	8	9	10	12	14	16	18	20	22	kN	m
610UB125	2470	2120	1850	1480	1240	1060	927	824	742	618	530	464	412	371	337	2360	1.88
	2410	2060	1810	1440	1200	1030	903	748	606	421	309	237	187	151	125		
610UB113	2210	1900	1660	1330	1110	948	829	737	663	553	474	415	369	332	302	2200	1.84
	2150	1840	1610	1290	1080	922	807	663	537	373	274	210	166	134	111		
610UB101	2090	1790	1560	1250	1040	894	782	695	626	522	447	391	348	313	284	2210	1.73
	2020	1730	1520	1210	1010	867	731	577	468	325	239	183	144	117	96.6		
530UB 92.4	1710	1460	1280	1020	853	732	640	569	512	427	366	320	284	256	233	1880	1.64
	1660	1430	1250	998	832	695	532	420	341	236	174	133	105	85.1	70.4		
530UB 82.0	1490	1280	1120	893	744	638	558	496	446	372	319	279	248	223	203	1750	1.60
	1450	1240	1080	868	723	599	458	362	293	204	150	115	90.5	73.3	60.6		
460UB 82.1	1320	1130	991	793	661	567	496	441	397	330	283	248	220	198	180	1580	1.54
	1290	1110	959	775	634	466	357	282	228	159	117	89.2	70.5	57.1	47.2		
460UB 74.6	1200	1030	897	718	598	513	449	399	359	299	256	224	199	179	163	1440	1.53
	1170	1000	879	703	572	420	322	254	206	143	105	80.4	63.5	51.4	42.5		
460UB 67.1	1060	912	798	638	532	456	399	355	319	266	228	200	177	160	145	1330	1.50
	1040	893	781	625	504	371	284	224	182	126	92.6	70.9	56.0	45.4	37.5		
410UB 59.7	864	741	648	519	432	370	324	288	259	216	185	162	144	130	118	1100	1.45
	852	730	639	511	369	271	208	164	133	92.3	67.8	51.9	41.0	33.2	27.5		
410UB 53.7	811	695	609	487	406	348	304	270	243	203	174	152	135	122	111	1060	1.37
	796	682	597	462	320	235	180	142	115	80.1	58.9	45.1	35.6	28.8	23.8		
360UB 56.7	729	625	547	437	364	312	273	243	219	182	156	137	121	109	99.4	991	1.43
	719	616	539	396	275	202	155	122	99.0	68.7	50.5	38.7	30.6	24.7	20.5		
360UB 50.7	646	553	484	387	323	277	242	215	194	161	138	121	108	96.9	88.1	897	1.41
	638	547	479	349	242	178	136	108	87.1	60.5	44.5	34.0	26.9	21.8	18.0		
360UB 44.7	591	507	443	355	296	253	222	197	177	148	127	111	98.5	88.7	80.6	839	1.33
	588	504	441	298	207	152	116	92.0	74.6	51.8	38.0	29.1	23.0	18.6	15.4		

Notes: (1) FLR, segment length for full lateral restraint, based on transverse load case ($\beta_m = -0.8$).
(2) Shading indicates serviceability loads governed by yielding.
(3) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

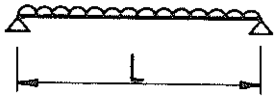
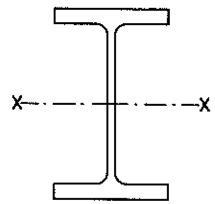


TABLE 5.1-5(2)

UNIVERSAL BEAMS
GRADE 300

MAXIMUM DESIGN LOADS FOR BEAMS WITH FULL LATERAL RESTRAINT
bending about x-axis



W^*_{L1}: Maximum Design Load based on Moment
W^*_{L2}: Maximum Design Load based on Shear
W^*_{L}: Maximum Design Load is LESSER of W^*_{L1} and W^*_{L2}
W^*_{S}: Serviceability Load based on Deflection Limit of Span/250 or First Yield

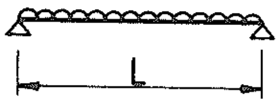
Designation	W^*_{L1} (kN) / W^*_S (kN) Span in metres															W^*_{L2}	FLR
	0.5	0.75	1	1.25	1.5	2	3	4	5	6	7	8	10	12	15	kN	m
310UB 46.2	3150	2100	1570	1260	1050	787	525	394	315	262	225	197	157	131	105	711	1.42
	3140	*2090*	*1570*	*1260*	*1050*	*784*	*523*	*386*	*247*	*171*	*126*	*96.4*	*61.7*	*42.8*	*27.4*		
310UB 40.4	2920	1940	1460	1170	972	729	486	364	292	243	208	182	146	121	97.2	641	1.35
	2910	*1940*	*1460*	*1160*	*970*	*728*	*485*	*332*	*212*	*147*	*108*	*83.0*	*53.1*	*36.9*	*23.6*		
310UB 32.0	2150	1430	1080	860	717	538	358	269	215	179	154	134	108	89.6	71.7	566	1.16
	2170	*1450*	*1090*	*868*	*724*	*543*	*362*	*243*	*155*	*108*	*79.2*	*60.7*	*38.8*	*27.0*	*17.3*		
250UB 37.3	2240	1490	1120	896	747	560	373	280	224	187	160	140	112	93.3	74.7	567	1.22
	2230	*1480*	*1110*	*890*	*742*	*556*	*371*	*214*	*137*	*95.0*	*69.8*	*53.5*	*34.2*	*23.8*	*15.2*		
250UB 31.4	1820	1210	911	729	607	456	304	228	182	152	130	114	91.1	75.9	60.7	530	1.18
	1810	*1210*	*906*	*725*	*604*	*453*	*302*	*171*	*109*	*76.0*	*55.8*	*42.8*	*27.4*	*19.0*	*12.2*		
250UB 25.7	1470	981	736	589	491	368	245	184	147	123	105	92.0	73.6	61.3	49.1	429	0.987
	1460	*974*	*730*	*584*	*487*	*365*	*241*	*136*	*86.9*	*60.4*	*44.4*	*34.0*	*21.7*	*15.1*	*9.66*		
200UB 29.8	1450	970	727	582	485	364	242	182	145	121	104	90.9	72.7	60.6	48.5	451	1.12
	1440	*961*	*721*	*577*	*480*	*360*	*199*	*112*	*71.6*	*49.7*	*36.5*	*28.0*	*17.9*	*12.4*	*7.96*		
200UB 25.4	1190	796	597	478	398	298	199	149	119	99.5	85.3	74.6	59.7	49.7	39.8	407	1.09
	1190	*792*	*594*	*475*	*396*	*297*	*161*	*90.5*	*57.9*	*40.2*	*29.6*	*22.6*	*14.5*	*10.1*	*6.44*		
200UB 22.3	1050	697	523	418	349	261	174	131	105	87.1	74.7	65.3	52.3	43.6	34.9	348	1.09
	1060	*710*	*532*	*426*	*355*	*266*	*143*	*80.5*	*51.5*	*35.8*	*26.3*	*20.1*	*12.9*	*8.94*	*5.72*		
200UB 18.2	828	552	414	331	276	207	138	104	82.8	69.0	59.2	51.8	41.4	34.5	27.6	308	0.783
	818	*545*	*409*	*327*	*273*	*204*	*108*	*60.7*	*38.9*	*27.0*	*19.8*	*15.2*	*9.72*	*6.75*	*4.32*		
180UB 22.2	900	600	450	360	300	225	150	112	90.0	75.0	64.3	56.2	45.0	37.5	30.0	371	0.735
	874	*583*	*437*	*350*	*291*	*219*	*104*	*58.7*	*37.6*	*26.1*	*19.2*	*14.7*	*9.39*	*6.52*	*4.17*		
180UB 18.1	724	483	362	290	241	181	121	90.5	72.4	60.3	51.7	45.2	36.2	30.2	24.1	302	0.728
	710	*473*	*355*	*284*	*237*	*177*	*82.8*	*46.6*	*29.8*	*20.7*	*15.2*	*11.6*	*7.45*	*5.18*	*3.31*		
180UB 16.1	637	425	319	255	212	159	106	79.7	63.7	53.1	45.5	39.8	31.9	26.6	21.2	269	0.722
	628	*418*	*314*	*251*	*209*	*157*	*72.4*	*40.7*	*26.1*	*18.1*	*13.3*	*10.2*	*6.51*	*4.52*	*2.89*		
150UB 18.0	622	415	311	249	207	156	104	77.8	62.2	51.9	44.5	38.9	31.1	25.9	20.7	321	0.605
	598	*399*	*299*	*239*	*199*	*139*	*61.8*	*34.8*	*22.2*	*15.4*	*11.3*	*8.69*	*5.56*	*3.86*	*2.47*		
150UB 14.0	469	313	235	188	156	117	78.2	58.7	46.9	39.1	33.5	29.3	23.5	19.6	15.6	259	0.589
	455	*303*	*227*	*182*	*152*	*102*	*45.5*	*25.6*	*16.4*	*11.4*	*8.35*	*6.39*	*4.09*	*2.84*	*1.82*		

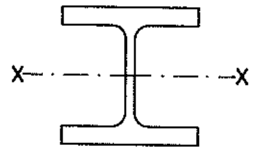
Notes: (1) FLR, segment length for full lateral restraint, based on transverse load case ($\beta_m = -0.8$).
(2) Shading indicates serviceability loads governed by yielding.
(3) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

TABLE 5.1-6

UNIVERSAL COLUMNS
GRADE 300

MAXIMUM DESIGN LOADS FOR BEAMS WITH FULL LATERAL RESTRAINT
bending about x-axis





W^*_{L1}: Maximum Design Load based on Moment
W^*_{L2}: Maximum Design Load based on Shear
W^*_L: Maximum Design Load is LESSER of W^*_{L1} and W^*_{L2}
W^*_S: Serviceability Load based on Deflection Limit of Span/250 or First Yield

Designation	W^*_{L1} (kN) / *W^*_S (kN)* Span in metres															W^*_{L2}	FLR
	3	3.5	4	5	6	7	8	9	10	12	14	16	18	20	22	kN	m
310UC158	1800	1550	1350	1080	901	773	676	601	541	451	386	338	300	270	246	1660	2.98
	1770	*1520*	*1330*	*953*	*662*	*486*	*372*	*294*	*238*	*166*	*122*	*93.1*	*73.6*	*59.6*	*49.2*		
310UC137	1550	1330	1160	928	773	663	580	515	464	387	331	290	258	232	211	1430	2.96
	1530	*1310*	*1150*	*808*	*561*	*412*	*316*	*249*	*202*	*140*	*103*	*78.9*	*62.4*	*50.5*	*41.7*		
310UC118	1320	1130	987	790	658	564	494	439	395	329	282	247	219	197	180	1210	2.93
	1320	*1130*	*986*	*681*	*473*	*347*	*266*	*210*	*170*	*118*	*86.8*	*66.5*	*52.5*	*42.6*	*35.2*		
310UC 96.8	1130	966	845	676	563	483	422	375	338	282	241	211	188	169	154	1050	2.80
	1160	*993*	*857*	*548*	*381*	*280*	*214*	*169*	*137*	*95.2*	*69.9*	*53.5*	*42.3*	*34.3*	*28.3*		
250UC 89.5	824	707	618	495	412	353	309	275	247	206	177	155	137	124	112	943	2.46
	820	*703*	*548*	*351*	*244*	*179*	*137*	*108*	*87.7*	*60.9*	*44.7*	*34.2*	*27.1*	*21.9*	*18.1*		
250UC 72.9	710	608	532	426	355	304	266	237	213	177	152	133	118	106	96.8	754	2.36
	718	*571*	*437*	*280*	*194*	*143*	*109*	*86.4*	*70.0*	*48.6*	*35.7*	*27.3*	*21.6*	*17.5*	*14.5*		
200UC 59.5	472	405	354	283	236	202	177	157	142	118	101	88.5	78.7	70.8	64.4	674	1.89
	418	*307*	*235*	*151*	*105*	*76.8*	*58.8*	*46.5*	*37.6*	*26.1*	*19.2*	*14.7*	*11.6*	*9.41*	*7.78*		
200UC 52.2	410	352	308	246	205	176	154	137	123	103	88.0	77.0	68.4	61.6	56.0	571	1.88
	361	*265*	*203*	*130*	*90.2*	*66.3*	*50.7*	*40.1*	*32.5*	*22.5*	*16.6*	*12.7*	*10.0*	*8.12*	*6.71*		
200UC 46.2	356	305	267	214	178	153	133	119	107	89.0	76.3	66.7	59.3	53.4	48.5	513	1.86
	313	*230*	*176*	*113*	*78.3*	*57.5*	*44.0*	*34.8*	*28.2*	*19.6*	*14.4*	*11.0*	*8.70*	*7.05*	*5.82*		
150UC 37.2	223	191	167	134	112	95.6	83.6	74.3	66.9	55.8	47.8	41.8	37.2	33.5	30.4	453	1.40
	151	*111*	*85.1*	*54.5*	*37.8*	*27.8*	*21.3*	*16.8*	*13.6*	*9.45*	*6.95*	*5.32*	*4.20*	*3.40*	*2.81*		
150UC 30.0	192	164	144	115	95.8	82.1	71.9	63.9	57.5	47.9	41.1	35.9	31.9	28.7	26.1	359	1.35
	120	*88.2*	*67.6*	*43.2*	*30.0*	*22.1*	*16.9*	*13.3*	*10.8*	*7.51*	*5.52*	*4.22*	*3.34*	*2.70*	*2.23*		
150UC 23.4	135	116	101	81.1	67.6	58.0	50.7	45.1	40.6	33.8	29.0	25.4	22.5	20.3	18.4	321	1.29
	86.2	*63.4*	*48.5*	*31.0*	*21.6*	*15.8*	*12.1*	*9.58*	*7.76*	*5.39*	*3.96*	*3.03*	*2.40*	*1.94*	*1.60*		
100UC 14.8	57.1	48.9	42.8	34.3	28.6	24.5	21.4	19.0	17.1	14.3	12.2	10.7	9.52	8.57	7.79	168	0.867
	21.7	*16.0*	*12.2*	*7.82*	*5.43*	*3.99*	*3.06*	*2.41*	*1.96*	*1.36*	*0.998*	*0.764*	*0.604*	*0.489*	*0.404*		

Notes: (1) FLR, segment length for full lateral restraint, based on transverse load case ($\beta_m = -0.8$).
(2) Shading indicates serviceability loads governed by yielding.
(3) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

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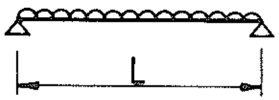
TABLE 5.1-7(1)

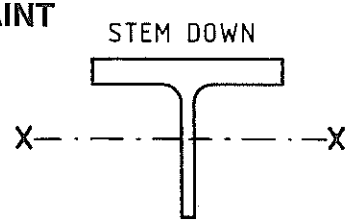
TEES CUT FROM UNIVERSAL BEAMS GRADE 300



MAXIMUM DESIGN LOADS FOR BEAMS WITH FULL LATERAL RESTRAINT

bending about x-axis

stem down — flange in compression



W^*_{L1}: Maximum Design Load based on Moment
W^*_{L2}: Maximum Design Load based on Shear
W^*_{L}: Maximum Design Load is LESSER of W^*_{L1} and W^*_{L2}
W^*_{S}: Serviceability Load based on Deflection Limit of Span/250 or First Yield

Designation	W^*_{L1} (kN) / W^*_S (kN) Span in metres													W^*_{L2}	Effective Length
	1	1.25	1.5	1.75	2	2.5	3	3.5	4	5	6	7	8	kN	m
305BT62.5	897	718	598	513	449	359	299	256	224	179	150	128	112	1040	2.27
	665	*532*	*443*	*380*	*332*	*266*	*222*	*190*	*166*	*133*	*111*	*85.6*	*65.5*		
305BT56.5	831	665	554	475	416	333	277	238	208	166	139	119	104	973	2.17
	616	*493*	*411*	*352*	*308*	*246*	*205*	*176*	*154*	*123*	*103*	*78.2*	*59.9*		
305BT50.5	826	661	551	472	413	330	275	236	206	165	138	118	103	975	1.98
	612	*489*	*408*	*350*	*306*	*245*	*204*	*175*	*153*	*122*	*96.8*	*71.1*	*54.5*		
265BT46.3	627	501	418	358	313	251	209	179	157	125	104	89.5	78.3	828	1.94
	464	*371*	*310*	*265*	*232*	*186*	*155*	*133*	*116*	*92.9*	*66.1*	*48.6*	*37.2*		
265BT41.0	577	462	385	330	289	231	192	165	144	115	96.2	82.5	72.1	773	1.84
	428	*342*	*285*	*244*	*214*	*171*	*143*	*122*	*107*	*85.5*	*59.6*	*43.8*	*33.6*		
230BT41.1	455	364	303	260	227	182	152	130	114	90.9	75.8	64.9	56.8	693	1.90
	337	*269*	*224*	*192*	*168*	*135*	*112*	*96.2*	*84.2*	*60.3*	*41.9*	*30.8*	*23.5*		
230BT37.3	414	331	276	237	207	166	138	118	104	82.8	69.0	59.2	51.8	632	1.85
	307	*245*	*205*	*175*	*153*	*123*	*102*	*87.7*	*76.7*	*54.6*	*37.9*	*27.9*	*21.3*		
230BT33.6	381	305	254	218	190	152	127	109	95.2	76.2	63.5	54.4	47.6	586	1.78
	282	*226*	*188*	*161*	*141*	*113*	*94.1*	*80.6*	*70.6*	*49.6*	*34.5*	*25.3*	*19.4*		
205BT29.9	283	226	188	162	141	113	94.2	80.8	70.7	56.5	47.1	40.4	35.3	480	1.79
	209	*168*	*140*	*120*	*105*	*83.8*	*69.8*	*59.8*	*52.4*	*33.6*	*23.3*	*17.1*	*13.1*		
205BT26.9	287	229	191	164	143	115	95.6	81.9	71.7	57.3	47.8	41.0	35.8	464	1.61
	212	*170*	*142*	*121*	*106*	*84.9*	*70.8*	*60.7*	*48.7*	*31.2*	*21.6*	*15.9*	*12.2*		
180BT28.4	225	180	150	129	113	90.2	75.1	64.4	56.4	45.1	37.6	32.2	28.2	433	1.83
	167	*134*	*111*	*95.4*	*83.5*	*66.8*	*55.7*	*47.7*	*37.2*	*23.8*	*16.5*	*12.1*	*9.29*		
180BT25.4	203	163	135	116	102	81.3	67.7	58.0	50.8	40.6	33.9	29.0	25.4	392	1.76
	150	*120*	*100*	*86.0*	*75.2*	*60.2*	*50.2*	*43.0*	*33.2*	*21.3*	*14.8*	*10.8*	*8.30*		
180BT22.4	195	156	130	111	97.4	77.9	64.9	55.7	48.7	39.0	32.5	27.8	24.4	367	1.61
	148	*119*	*98.9*	*84.8*	*74.2*	*59.3*	*49.4*	*39.3*	*30.1*	*19.2*	*13.4*	*9.82*	*7.52*		

Notes: (1) Shading indicates serviceability load governed by yielding.
(2) The Effective Length for Tees is the maximum effective length of a segment for which $\phi M_b = \phi M_{sx}$ assuming $\alpha_m = 1.0$.
(3) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

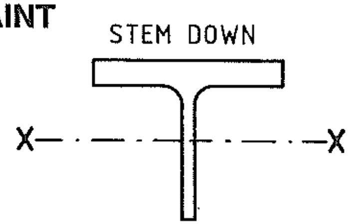
TABLE 5.1-7(2)

TEES CUT FROM UNIVERSAL BEAMS GRADE 300

MAXIMUM DESIGN LOADS FOR BEAMS WITH FULL LATERAL RESTRAINT

bending about x-axis

stem down — flange in compression



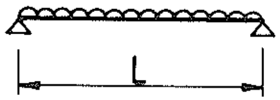
W^*_{L1}: Maximum Design Load based on Moment
W^*_{L2}: Maximum Design Load based on Shear
W^*_{L}: Maximum Design Load is LESSER of W^*_{L1} and W^*_{L2}
W^*_{S}: Serviceability Load based on Deflection Limit of Span/250 or First Yield

Designation	W^*_{L1} (kN) / *W^*_S (kN)* Span in metres													W^*_{L2}	Effective Length
	1	1.25	1.5	1.75	2	2.5	3	3.5	4	5	6	7	8	kN	m
155BT23.1	140	112	93.7	80.3	70.2	56.2	46.8	40.1	35.1	28.1	23.4	20.1	17.6	308	1.95
	104	*83.2*	*69.4*	*59.5*	*52.0*	*41.6*	*34.7*	*26.6*	*20.4*	*13.0*	*9.05*	*6.65*	*5.09*		
155BT20.2	134	107	89.5	76.7	67.1	53.7	44.7	38.3	33.5	26.8	22.4	19.2	16.8	278	1.77
	99.4	*79.5*	*66.3*	*56.8*	*49.7*	*39.8*	*32.0*	*23.5*	*18.0*	*11.5*	*8.01*	*5.88*	*4.51*		
155BT16.0	109	87.1	72.6	62.2	54.4	43.6	36.3	31.1	27.2	21.8	18.1	15.6	13.6	246	1.47
	95.3	*68.3*	*56.9*	*48.8*	*42.7*	*34.1*	*26.4*	*19.4*	*14.8*	*9.49*	*6.59*	*4.84*	*3.71*		
125BT18.7	98.8	79.0	65.8	56.4	49.4	39.5	32.9	28.2	24.7	19.8	16.5	14.1	12.3	246	1.69
	73.2	*58.5*	*48.8*	*41.8*	*36.6*	*28.6*	*19.8*	*14.6*	*11.2*	*7.14*	*4.96*	*3.64*	*2.79*		
125BT15.7	89.8	71.8	59.8	51.3	44.9	35.9	29.9	25.6	22.4	18.0	15.0	12.8	11.2	231	1.49
	67.1	*53.7*	*44.8*	*38.4*	*33.6*	*25.3*	*17.6*	*12.9*	*9.90*	*6.34*	*4.40*	*3.23*	*2.48*		
125BT12.9	72.3	57.8	48.2	41.3	36.1	28.9	24.1	20.6	18.1	14.5	12.0	10.3	9.03	185	1.28
	53.5	*42.8*	*35.7*	*30.6*	*26.8*	*20.0*	*13.9*	*10.2*	*7.80*	*4.99*	*3.47*	*2.55*	*1.95*		
100BT14.9*	62.9	50.3	41.9	35.9	31.4	25.2	21.0	18.0	15.7	12.6	10.5	8.98	7.86	195	***
	46.6	*37.3*	*31.1*	*26.6*	*22.9*	*14.7*	*10.2*	*7.47*	*5.72*	*3.66*	*2.54*	*1.87*	*1.43*		
100BT12.7*	55.4	44.3	36.9	31.6	27.7	22.2	18.5	15.8	13.8	11.1	9.23	7.91	6.92	176	***
	41.5	*33.2*	*27.6*	*23.7*	*19.9*	*12.7*	*8.82*	*6.48*	*4.96*	*3.18*	*2.21*	*1.62*	*1.24*		
100BT11.2*	45.0	36.0	30.0	25.7	22.5	18.0	15.0	12.8	11.2	8.99	7.49	6.42	5.62	150	***
	35.6	*28.5*	*23.7*	*20.3*	*17.1*	*10.9*	*7.59*	*5.58*	*4.27*	*2.73*	*1.90*	*1.39*	*1.07*		
100BT 9.1	40.9	32.7	27.3	23.4	20.5	16.4	13.6	11.7	10.2	8.18	6.82	5.84	5.11	133	1.03
	30.3	*24.2*	*20.2*	*17.3*	*14.0*	*8.96*	*6.22*	*4.57*	*3.50*	*2.24*	*1.55*	*1.14*	*0.875*		
90BT11.1	43.2	34.5	28.8	24.7	21.6	17.3	14.4	12.3	10.8	8.64	7.20	6.17	5.40	161	1.10
	32.0	*25.6*	*21.3*	*17.2*	*13.2*	*8.43*	*5.85*	*4.30*	*3.29*	*2.11*	*1.46*	*1.07*	*0.823*		
90BT 9.1	34.9	28.0	23.3	20.0	17.5	14.0	11.6	9.98	8.74	6.99	5.82	4.99	4.37	131	1.02
	25.9	*20.7*	*17.3*	*13.7*	*10.5*	*6.72*	*4.67*	*3.43*	*2.62*	*1.68*	*1.17*	*0.857*	*0.656*		
90BT 8.1	31.0	24.8	20.6	17.7	15.5	12.4	10.3	8.85	7.74	6.19	5.16	4.42	3.87	116	0.980
	22.9	*18.4*	*15.3*	*12.1*	*9.23*	*5.91*	*4.10*	*3.01*	*2.31*	*1.48*	*1.03*	*0.753*	*0.577*		
75BT 9.0	31.7	25.3	21.1	18.1	15.8	12.7	10.6	9.04	7.91	6.33	5.28	4.52	3.96	139	0.920
	23.4	*18.8*	*14.6*	*10.7*	*8.19*	*5.24*	*3.64*	*2.67*	*2.05*	*1.31*	*0.910*	*0.669*	*0.512*		
75BT 7.0	25.1	20.1	16.7	14.3	12.5	10.0	8.36	7.17	6.27	5.02	4.18	3.58	3.14	112	0.801
	18.6	*14.9*	*11.2*	*8.22*	*6.29*	*4.03*	*2.80*	*2.05*	*1.57*	*1.01*	*0.699*	*0.514*	*0.393*		

Notes:
(1) * indicates bending about minor principal y- axis for the axis shown in the diagram.
(2) The effective Length for Tees is the maximum effective length of a segment for which $\phi M_b = \phi M_{sx}$ assuming $\alpha_m = 1.0$.
(3) *** these sections which are bent about the y axis do not buckle laterally, and have no requirements for the maximum segment length to achieve the full section capacity.
(4) Shading indicates serviceability load governed by yielding.
(5) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

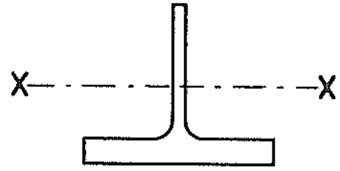
TABLE 5.1-8(1)

TEES CUT FROM UNIVERSAL BEAMS GRADE 300



MAXIMUM DESIGN LOADS FOR BEAMS WITH FULL LATERAL RESTRAINT
bending about x-axis
stem up — stem in compression

STEM UP



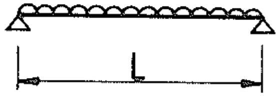
W^*_{L1}: Maximum Design Load based on Moment
W^*_{L2}: Maximum Design Load based on Shear
W^*_L: Maximum Design Load is LESSER of W^*_{L1} and W^*_{L2}
W^*_S: Serviceability Load based on Deflection Limit of Span/250 or First Yield

Designation	W^*_{L1} (kN) / *W^*_S (kN)* Span in metres													W^*_{L2}	Effective Length
	1	1.25	1.5	1.75	2	2.5	3	3.5	4	5	6	7	8	kN	m
305BT62.5	581	465	388	332	291	233	194	166	145	116	96.9	83.0	72.7	1040	0.00
	665	*532*	*443*	*380*	*332*	*266*	*222*	*190*	*166*	*133*	*111*	*85.6*	*65.5*		
305BT56.5	477	382	318	273	239	191	159	136	119	95.4	79.5	68.1	59.6	973	0.00
	616	*493*	*411*	*352*	*308*	*246*	*205*	*176*	*154*	*123*	*103*	*78.2*	*59.9*		
305BT50.5	396	317	264	226	198	158	132	113	99.0	79.2	66.0	56.6	49.5	975	0.00
	612	*489*	*408*	*350*	*306*	*245*	*204*	*175*	*153*	*122*	*96.8*	*71.1*	*54.5*		
265BT46.3	363	290	242	207	181	145	121	104	90.6	72.5	60.4	51.8	45.3	828	0.00
	464	*371*	*310*	*265*	*232*	*185*	*155*	*133*	*116*	*92.9*	*66.1*	*48.6*	*37.2*		
265BT41.0	296	237	197	169	148	118	98.6	84.5	73.9	59.2	49.3	42.3	37.0	773	0.00
	428	*342*	*285*	*244*	*214*	*171*	*143*	*122*	*107*	*85.5*	*59.6*	*43.8*	*33.6*		
230BT41.1	316	253	211	181	158	127	105	90.4	79.1	63.3	52.7	45.2	39.5	693	0.00
	337	*269*	*224*	*192*	*168*	*135*	*112*	*96.2*	*84.2*	*60.3*	*41.9*	*30.8*	*23.5*		
230BT37.3	262	210	175	150	131	105	87.3	74.9	65.5	52.4	43.7	37.4	32.7	632	0.00
	307	*245*	*205*	*175*	*153*	*123*	*102*	*87.7*	*76.7*	*54.6*	*37.9*	*27.9*	*21.3*		
230BT33.6	210	168	140	120	105	84.1	70.1	60.1	52.6	42.1	35.0	30.0	26.3	586	0.00
	282	*226*	*188*	*161*	*141*	*113*	*94.1*	*80.6*	*70.6*	*49.6*	*34.5*	*25.3*	*19.4*		
205BT29.9	166	133	111	95.1	83.2	66.6	55.5	47.6	41.6	33.3	27.7	23.8	20.8	480	0.00
	209	*169*	*140*	*120*	*105*	*83.8*	*69.8*	*59.8*	*52.4*	*33.6*	*23.3*	*17.1*	*13.1*		
205BT26.9	150	120	100	85.9	75.1	60.1	50.1	42.9	37.6	30.1	25.0	21.5	18.8	464	0.00
	212	*170*	*142*	*121*	*106*	*84.9*	*70.8*	*60.7*	*48.7*	*31.2*	*21.6*	*15.9*	*12.2*		
180BT28.4	161	129	108	92.2	80.7	64.6	53.8	46.1	40.3	32.3	26.9	23.1	20.2	433	0.00
	167	*134*	*111*	*95.4*	*83.5*	*66.8*	*55.7*	*47.7*	*37.2*	*23.8*	*16.5*	*12.1*	*9.29*		
180BT25.4	136	109	90.8	77.9	68.1	54.5	45.4	38.9	34.1	27.2	22.7	19.5	17.0	392	0.00
	150	*120*	*100*	*86.0*	*75.2*	*60.2*	*50.2*	*43.0*	*33.2*	*21.3*	*14.8*	*10.8*	*8.30*		
180BT22.4	114	90.9	75.7	64.9	56.8	45.4	37.9	32.5	28.4	22.7	18.9	16.2	14.2	367	0.00
	148	*119*	*98.9*	*84.8*	*74.2*	*59.3*	*49.4*	*39.3*	*30.1*	*19.2*	*13.4*	*9.82*	*7.52*		

Notes: (1) The effective Length for Tees is the maximum effective length of a segment for which $\phi M_b = \phi M_{SX}$ assuming $\alpha_m = 1.0$. For all sections there is no segment length for which the the full section section capacity can be attained.
(2) Shading indicates serviceability load governed by yielding.
(3) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

TABLE 5.1-8(2)

TEES CUT FROM UNIVERSAL BEAMS GRADE 300

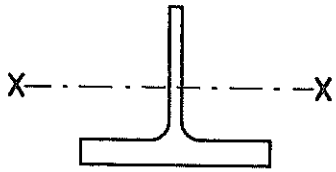


MAXIMUM DESIGN LOADS FOR BEAMS WITH FULL LATERAL RESTRAINT

bending about x-axis

stem up — stem in compression

STEM UP



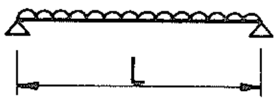
W^*_{L1}: Maximum Design Load based on Moment
W^*_{L2}: Maximum Design Load based on Shear
W^*_{L}: Maximum Design Load is LESSER of W^*_{L1} and W^*_{L2}
W^*_{S}: Serviceability Load based on Deflection Limit of Span/250 or First Yield

Designation	W^*_{L1} (kN) / *W^*_S (kN)* Span in metres													W^*_{L2}	Effective Length
	1	1.25	1.5	1.75	2	2.5	3	3.5	4	5	6	7	8	kN	m
155BT23.1	99.4	79.6	66.3	56.8	49.7	39.8	33.1	28.4	24.9	19.9	16.6	14.2	12.4	308	0.00
	104	*83.2*	*69.4*	*59.5*	*52.0*	*41.6*	*34.7*	*26.6*	*20.4*	*13.0*	*9.05*	*6.65*	*5.09*		
155BT20.2	82.0	65.6	54.7	46.9	41.0	32.8	27.3	23.4	20.5	16.4	13.7	11.7	10.2	278	0.00
	98.4	*79.5*	*66.3*	*56.8*	*49.7*	*39.8*	*32.0*	*23.5*	*18.0*	*11.5*	*8.01*	*5.88*	*4.51*		
155BT16.0	57.9	46.3	38.6	33.1	28.9	23.1	19.3	16.5	14.5	11.6	9.64	8.27	7.23	246	0.00
	85.3	*68.3*	*56.9*	*48.8*	*42.7*	*34.1*	*26.4*	*19.4*	*14.8*	*9.49*	*6.59*	*4.84*	*3.71*		
125BT18.7	75.0	60.0	50.0	42.9	37.5	30.0	25.0	21.4	18.8	15.0	12.5	10.7	9.38	246	0.00
	73.2	*58.5*	*48.8*	*41.8*	*35.6*	*28.6*	*19.8*	*14.6*	*11.2*	*7.14*	*4.96*	*3.64*	*2.79*		
125BT15.7	66.9	53.6	44.6	38.3	33.5	26.8	22.3	19.1	16.7	13.4	11.2	9.56	8.37	231	0.00
	67.1	*53.7*	*44.8*	*38.4*	*33.6*	*25.3*	*17.6*	*12.9*	*9.90*	*6.34*	*4.40*	*3.23*	*2.48*		
125BT12.9	44.5	35.6	29.6	25.4	22.2	17.8	14.8	12.7	11.1	8.89	7.41	6.35	5.56	185	0.00
	53.5	*42.8*	*35.7*	*30.6*	*26.8*	*20.0*	*13.9*	*10.2*	*7.80*	*4.99*	*3.47*	*2.55*	*1.95*		
100BT14.9*	52.8	42.3	35.2	30.2	26.4	21.1	17.6	15.1	13.2	10.6	8.80	7.55	6.60	195	***
	46.6	*37.3*	*31.1*	*26.6*	*22.9*	*14.7*	*10.2*	*7.47*	*5.72*	*3.66*	*2.54*	*1.87*	*1.43*		
100BT12.7*	45.4	36.3	30.2	25.9	22.7	18.1	15.1	13.0	11.3	9.07	7.56	6.48	5.67	176	***
	41.5	*33.2*	*27.6*	*23.7*	*19.9*	*12.7*	*8.82*	*6.48*	*4.96*	*3.18*	*2.21*	*1.62*	*1.24*		
100BT11.2*	36.0	28.8	24.0	20.6	18.0	14.4	12.0	10.3	9.01	7.21	6.00	5.15	4.50	150	***
	35.6	*28.5*	*23.7*	*20.3*	*17.1*	*10.9*	*7.59*	*5.58*	*4.27*	*2.73*	*1.90*	*1.39*	*1.07*		
100BT 9.1	29.1	23.3	19.4	16.6	14.5	11.6	9.69	8.31	7.27	5.82	4.85	4.15	3.64	133	0.00
	30.3	*24.2*	*20.2*	*17.3*	*14.0*	*8.96*	*6.22*	*4.57*	*3.50*	*2.24*	*1.55*	*1.14*	*0.875*		
90BT11.1	38.0	30.4	25.3	21.7	19.0	15.2	12.7	10.8	9.49	7.59	6.33	5.42	4.75	161	0.00
	32.0	*25.6*	*21.3*	*17.2*	*13.2*	*8.43*	*5.85*	*4.30*	*3.29*	*2.11*	*1.46*	*1.07*	*0.823*		
90BT 9.1	28.6	22.8	19.0	16.3	14.3	11.4	9.52	8.16	7.14	5.71	4.76	4.08	3.57	131	0.00
	25.9	*20.7*	*17.3*	*13.7*	*10.5*	*6.72*	*4.67*	*3.43*	*2.62*	*1.68*	*1.17*	*0.857*	*0.656*		
90BT 8.1	24.0	19.2	16.0	13.7	12.0	9.62	8.01	6.87	6.01	4.81	4.01	3.43	3.01	116	0.00
	22.9	*18.4*	*15.3*	*12.1*	*9.23*	*5.91*	*4.10*	*3.01*	*2.31*	*1.48*	*1.03*	*0.753*	*0.577*		
75BT 9.0	29.3	23.4	19.5	16.7	14.6	11.7	9.75	8.36	7.32	5.85	4.88	4.18	3.66	139	0.00
	23.4	*18.8*	*14.6*	*10.7*	*8.19*	*5.24*	*3.64*	*2.67*	*2.05*	*1.31*	*0.910*	*0.669*	*0.512*		
75BT 7.0	21.9	17.5	14.6	12.5	10.9	8.75	7.29	6.25	5.47	4.37	3.65	3.12	2.73	112	0.00
	18.6	*14.9*	*11.2*	*8.22*	*6.29*	*4.03*	*2.80*	*2.05*	*1.57*	*1.01*	*0.699*	*0.514*	*0.393*		

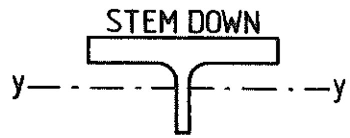
Notes: (1) * indicates bending about minor principal y- axis for the axis shown in the diagram.
(2) The effective Length for Tees is the maximum effective length of a segment for which $\phi M_b = \phi M_{sx}$ assuming $\alpha_m = 1.0$. *** these sections which are bent about the y axis do not buckle laterally, and have no requirements for the maximum segment length to achieve the full section capacity. For other sections there is no segment length for which the the full section section capacity can be attained.
(3) Shading indicates serviceability loads governed by yielding.

TABLE 5.1-9

TEES CUT FROM UNIVERSAL COLUMNS
GRADE 300



MAXIMUM DESIGN LOADS FOR BEAMS WITH FULL LATERAL RESTRAINT
bending about y-axis
stem down — flange in compression



W^*_{L1}: Maximum Design Load based on Moment
W^*_{L2}: Maximum Design Load based on Shear
W^*_{L}: Maximum Design Load is LESSER of W^*_{L1} and W^*_{L2}
W^*_{S}: Serviceability Load based on Deflection Limit of Span/250 or First Yield

Designation	W^*_{L1} (kN) / W^*_S (kN) Span in metres													W^*_{L2}
	1	1.25	1.5	1.75	2	2.5	3	3.5	4	5	6	7	8	kN
155CT79.0	342	274	228	195	171	137	114	97.7	85.5	68.4	57.0	48.9	42.7	715
	253	*203*	*169*	*145*	*127*	*101*	*84.4*	*72.4*	*57.6*	*36.8*	*25.6*	*18.8*	*14.4*	
155CT68.5	292	234	195	167	146	117	97.3	83.4	73.0	58.4	48.7	41.7	36.5	615
	216	*173*	*144*	*124*	*108*	*85.5*	*72.1*	*61.8*	*48.6*	*31.1*	*21.6*	*15.9*	*12.1*	
155CT59.0	245	196	164	140	123	98.2	81.8	70.1	61.4	49.1	40.9	35.1	30.7	520
	182	*145*	*121*	*104*	*90.9*	*72.7*	*60.6*	*52.0*	*40.5*	*25.9*	*18.0*	*13.2*	*10.1*	
155CT48.4	198	158	132	113	98.8	79.1	65.9	56.5	49.4	39.5	32.9	28.2	24.7	451
	158	*126*	*105*	*90.1*	*78.8*	*63.0*	*52.5*	*42.3*	*32.4*	*20.7*	*14.4*	*10.6*	*8.09*	
125CT44.8	147	117	97.8	83.8	73.3	58.7	48.9	41.9	36.7	29.3	24.4	21.0	18.3	403
	109	*86.9*	*72.4*	*62.1*	*54.3*	*43.5*	*35.4*	*26.0*	*19.9*	*12.8*	*8.86*	*6.51*	*4.98*	
125CT36.5	122	97.5	81.3	69.6	60.9	48.8	40.6	34.8	30.5	24.4	20.3	17.4	15.2	322
	92.3	*73.9*	*61.6*	*52.8*	*46.2*	*36.9*	*27.8*	*20.4*	*15.6*	*9.99*	*6.94*	*5.10*	*3.90*	
100CT29.8	89.6	71.6	59.7	51.2	44.8	35.8	29.9	25.6	22.4	17.9	14.9	12.8	11.2	289
	66.3	*53.1*	*44.2*	*37.9*	*33.2*	*23.2*	*16.1*	*11.8*	*9.06*	*5.80*	*4.03*	*2.96*	*2.26*	
100CT26.1	75.5	60.4	50.3	43.1	37.8	30.2	25.2	21.6	18.9	15.1	12.6	10.8	9.44	244
	55.9	*44.7*	*37.3*	*32.0*	*28.0*	*19.4*	*13.5*	*9.92*	*7.59*	*4.86*	*3.37*	*2.48*	*1.90*	
100CT23.1	65.0	52.0	43.4	37.2	32.5	26.0	21.7	18.6	16.3	13.0	10.8	9.29	8.13	219
	49.9	*39.9*	*33.3*	*28.5*	*25.0*	*17.2*	*11.9*	*8.76*	*6.70*	*4.29*	*2.98*	*2.19*	*1.68*	
75CT18.6	45.5	36.4	30.4	26.0	22.8	18.2	15.2	13.0	11.4	9.11	7.59	6.50	5.69	194
	33.7	*27.0*	*22.5*	*18.2*	*14.0*	*8.94*	*6.21*	*4.56*	*3.49*	*2.23*	*1.55*	*1.14*	*0.873*	
75CT15.0	38.2	30.6	25.5	21.8	19.1	15.3	12.7	10.9	9.56	7.65	6.37	5.46	4.78	154
	28.3	*22.7*	*18.9*	*14.2*	*10.9*	*6.95*	*4.83*	*3.55*	*2.71*	*1.74*	*1.21*	*0.886*	*0.679*	
75CT11.7	28.3	22.6	18.9	16.2	14.1	11.3	9.43	8.08	7.07	5.66	4.71	4.04	3.53	138
	24.6	*19.7*	*16.1*	*11.8*	*9.03*	*5.78*	*4.01*	*2.95*	*2.26*	*1.44*	*1.00*	*0.737*	*0.564*	
50CT 7.4	10.6	8.51	7.09	6.08	5.32	4.25	3.54	3.04	2.66	2.13	1.77	1.52	1.33	70.8
	7.32	*4.68*	*3.25*	*2.39*	*1.83*	*1.17*	*0.813*	*0.597*	*0.457*	*0.293*	*0.203*	*0.149*	*0.114*	

Notes: (1) Structural Tees cut symmetrically from Universal Columns which are bent about y-axis do not buckle laterally and have no requirements for maximum segment length to achieve the full nominal section capacity.
(2) Shading indicates serviceability loads governed by yielding.
(3) Grade 300 refers to BHP 300PLUS™. See Note (1) on page 2-2.

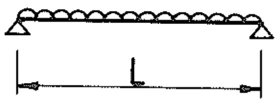
TABLE 5.1-10

TEES CUT FROM UNIVERSAL COLUMNS GRADE 300

MAXIMUM DESIGN LOADS FOR BEAMS WITH FULL LATERAL RESTRAINT

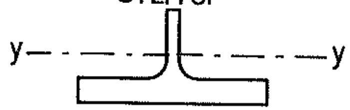
bending about y-axis

stem up — stem in compression



W^*_{L1}: Maximum Design Load based on Moment
W^*_{L2}: Maximum Design Load based on Shear
W^*_{L}: Maximum Design Load is LESSER of W^*_{L1} and W^*_{L2}
W^*_{S}: Serviceability Load based on Deflection Limit of Span/250 or First Yield

STEM UP



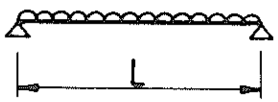
Designation	W^*_{L1} (kN) / W^*_S (kN) Span in metres													W^*_{L2}
	1	1.25	1.5	1.75	2	2.5	3	3.5	4	5	6	7	8	kN
155CT79.0	340	272	227	194	170	136	113	97.1	85.0	68.0	56.7	48.6	42.5	715
	253	*203*	*169*	*145*	*127*	*101*	*84.4*	*72.4*	*57.6*	*36.8*	*25.6*	*18.8*	*14.4*	
155CT68.5	283	226	188	161	141	113	94.2	80.7	70.6	56.5	47.1	40.4	35.3	615
	216	*173*	*144*	*124*	*108*	*86.5*	*72.1*	*61.8*	*48.6*	*31.1*	*21.6*	*15.9*	*12.1*	
155CT59.0	229	183	153	131	114	91.6	76.3	65.4	57.2	45.8	38.2	32.7	28.6	520
	182	*145*	*121*	*104*	*90.9*	*72.7*	*60.6*	*52.0*	*40.5*	*25.9*	*18.0*	*13.2*	*10.1*	
155CT48.4	185	148	123	106	92.6	74.1	61.7	52.9	46.3	37.0	30.9	26.5	23.1	451
	158	*126*	*105*	*90.1*	*78.8*	*63.0*	*52.5*	*42.3*	*32.4*	*20.7*	*14.4*	*10.6*	*8.09*	
125CT44.8	140	112	93.2	79.9	69.9	55.9	46.6	39.9	34.9	28.0	23.3	20.0	17.5	403
	109	*85.9*	*72.4*	*62.1*	*54.3*	*43.5*	*35.4*	*26.0*	*19.9*	*12.8*	*8.86*	*6.51*	*4.98*	
125CT36.5	111	88.9	74.0	63.5	55.5	44.4	37.0	31.7	27.8	22.2	18.5	15.9	13.9	322
	92.3	*73.9*	*61.6*	*52.8*	*46.2*	*35.9*	*27.8*	*20.4*	*15.6*	*9.99*	*6.94*	*5.10*	*3.90*	
100CT29.8	86.6	69.3	57.8	49.5	43.3	34.7	28.9	24.8	21.7	17.3	14.4	12.4	10.8	289
	66.3	*53.1*	*44.2*	*37.9*	*33.2*	*23.2*	*16.1*	*11.8*	*9.06*	*5.80*	*4.03*	*2.96*	*2.26*	
100CT26.1	70.3	56.3	46.9	40.2	35.2	28.1	23.4	20.1	17.6	14.1	11.7	10.0	8.79	244
	55.9	*44.7*	*37.3*	*32.0*	*28.0*	*19.4*	*13.5*	*9.92*	*7.59*	*4.86*	*3.37*	*2.48*	*1.90*	
100CT23.1	61.2	48.9	40.8	34.9	30.6	24.5	20.4	17.5	15.3	12.2	10.2	8.74	7.64	219
	48.9	*39.9*	*33.3*	*28.5*	*25.0*	*17.2*	*11.9*	*8.76*	*6.70*	*4.29*	*2.98*	*2.19*	*1.68*	
75CT18.6	45.3	36.2	30.2	25.9	22.6	18.1	15.1	12.9	11.3	9.06	7.55	6.47	5.66	194
	33.7	*27.0*	*22.5*	*18.2*	*14.0*	*8.94*	*6.21*	*4.56*	*3.49*	*2.23*	*1.55*	*1.14*	*0.873*	
75CT15.0	36.1	28.8	24.0	20.6	18.0	14.4	12.0	10.3	9.01	7.21	6.01	5.15	4.51	154
	28.3	*22.7*	*18.9*	*14.2*	*10.9*	*6.95*	*4.83*	*3.55*	*2.71*	*1.74*	*1.21*	*0.886*	*0.679*	
75CT11.7	30.7	24.6	20.5	17.5	15.3	12.3	10.2	8.77	7.67	6.14	5.11	4.38	3.84	138
	24.6	*19.7*	*16.1*	*11.8*	*9.03*	*5.78*	*4.01*	*2.95*	*2.26*	*1.44*	*1.00*	*0.737*	*0.564*	
50CT 7.4	10.6	8.48	7.06	6.05	5.30	4.24	3.53	3.03	2.65	2.12	1.77	1.51	1.32	70.8
	7.32	*4.68*	*3.25*	*2.39*	*1.83*	*1.17*	*0.813*	*0.597*	*0.457*	*0.293*	*0.203*	*0.149*	*0.114*	

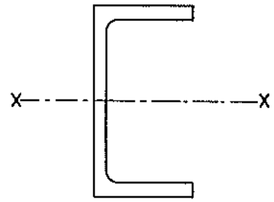
Notes: (1) Structural Tees cut symmetrically from Universal Columns which are bent about y-axis do not buckle laterally and have no requirements for maximum segment length to achieve the full nominal section capacity.
(2) Shading indicates serviceability loads governed by yielding.
(3) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

TABLE 5.1-11

PARALLEL FLANGE CHANNELS GRADE 300

MAXIMUM DESIGN LOADS FOR BEAMS WITH FULL LATERAL RESTRAINT bending about x-axis





W^*_{L1}: Maximum Design Load based on Moment
W^*_{L2}: Maximum Design Load based on Shear
W^*_L: Maximum Design Load is LESSER of W^*_{L1} and W^*_{L2}
W^*_S: Serviceability Load based on Deflection Limit of Span/250 or First Yield

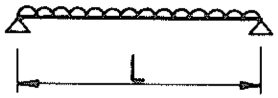
Designation	Mass per metre	W^*_{L1} (kN) / W^*_S (kN) Span in metres															W^*_{L2}	FLR
	kg/m	1	1.25	1.5	1.75	2	2.5	3	3.5	4	5	6	7	8	9	10	kN	m
380 PFC	55.2	1910	1530	1270	1090	954	763	636	545	477	382	318	273	238	212	191	1310	0.803
		1790	*1430*	*1190*	*1020*	*894*	*715*	*596*	*511*	*447*	*358*	*259*	*190*	*146*	*115*	*93.2*		
300 PFC	40.1	1220	974	812	696	609	487	406	348	304	243	203	174	152	135	122	829	0.719
		1160	*927*	*772*	*662*	*579*	*463*	*386*	*331*	*278*	*178*	*124*	*90.8*	*69.5*	*54.9*	*44.5*		
250 PFC	35.5	909	727	606	519	454	363	303	260	227	182	151	130	114	101	90.9	691	0.726
		867	*693*	*578*	*495*	*433*	*347*	*289*	*226*	*173*	*111*	*77.0*	*56.6*	*43.3*	*34.2*	*27.7*		
230 PFC	25.1	586	469	391	335	293	234	195	167	147	117	97.7	83.7	73.3	65.1	58.6	517	0.600
		559	*447*	*372*	*319*	*279*	*223*	*183*	*134*	*103*	*65.8*	*45.7*	*33.6*	*25.7*	*20.3*	*16.4*		
200 PFC	22.9	477	382	318	273	239	191	159	136	119	95.4	79.5	68.2	59.7	53.0	47.7	415	0.609
		458	*367*	*306*	*262*	*229*	*183*	*130*	*95.8*	*73.4*	*46.9*	*32.6*	*24.0*	*18.3*	*14.5*	*11.7*		
180 PFC	20.9	392	314	261	224	196	157	131	112	98.1	78.4	65.4	56.0	49.0	43.6	39.2	373	0.609
		377	*301*	*251*	*215*	*188*	*139*	*96.5*	*70.9*	*54.3*	*34.7*	*24.1*	*17.7*	*13.6*	*10.7*	*8.68*		
150 PFC	17.7	296	237	197	169	148	118	98.7	84.6	74.1	59.2	49.4	42.3	37.0	32.9	29.6	311	0.591
		285	*228*	*190*	*163*	*128*	*82.0*	*56.9*	*41.8*	*32.0*	*20.5*	*14.2*	*10.5*	*8.01*	*6.33*	*5.12*		

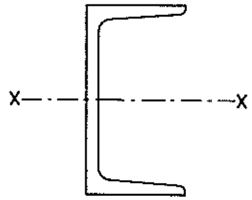
Notes: (1) FLR, segment length for full lateral restraint, based on transverse load case ($\beta_m = -0.8$).
(2) Shading indicates serviceability loads governed by yielding.
(3) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

TABLE 5.1-12

TAPER FLANGE CHANNELS
GRADE 250

MAXIMUM DESIGN LOADS FOR BEAMS WITH FULL LATERAL RESTRAINT
bending about x-axis





W^*_{L1}: Maximum Design Load based on Moment
W^*_{L2}: Maximum Design Load based on Shear
W^*_{L}: Maximum Design Load is LESSER of W^*_{L1} and W^*_{L2}
W^*_{S}: Serviceability Load based on Deflection Limit of Span/250 or First Yield

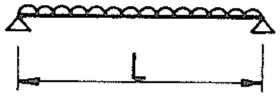
Designation	Mass per metre	W^*_{L1}(kN) / W^*_S (kN) Span in metres															W^*_{L2}	FLR
	kg/m	1	1.25	1.50	1.75	2	2.5	3	3.5	4	5	6	7	8	9	10	kN	m
125 TFC	13.4	149	119	99.0	84.9	74.3	59.4	49.5	42.4	37.1	29.7	24.8	21.2	18.6	16.5	14.9	211	0.522
		141	*113*	*94.0*	*80.6*	*65.1*	*41.6*	*28.9*	*21.2*	*16.3*	*10.4*	*7.23*	*5.31*	*4.07*	*3.21*	*2.60*		
100 TFC	9.34	82.9	66.3	55.3	47.4	41.4	33.2	27.6	23.7	20.7	16.6	13.8	11.8	10.4	9.21	8.29	140	0.406
		78.3	*62.6*	*51.4*	*37.8*	*28.9*	*18.5*	*12.8*	*9.44*	*7.23*	*4.62*	*3.21*	*2.36*	*1.81*	*1.43*	*1.16*		
75 TFC	6.65	43.1	34.5	28.7	24.6	21.6	17.2	14.4	12.3	10.8	8.62	7.19	6.16	5.39	4.79	4.31	105	0.319
		40.0	*28.4*	*19.7*	*14.5*	*11.1*	*7.09*	*4.92*	*3.62*	*2.77*	*1.77*	*1.23*	*0.904*	*0.692*	*0.547*	*0.443*		

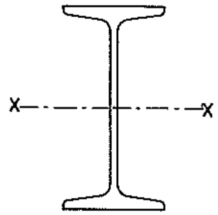
Notes: (1) FLR, segment length for full lateral restraint, based on transverse load case ($\beta_m = -0.8$).
(2) Shading indicates serviceability loads governed by yielding.

TABLE 5.1-13

TAPER FLANGE BEAMS
GRADE 250

MAXIMUM DESIGN LOADS FOR BEAMS WITH FULL LATERAL RESTRAINT
bending about x-axis





W^*_{L1}: Maximum Design Load based on Moment
W^*_{L2}: Maximum Design Load based on Shear
W^*_{L}: Maximum Design Load is LESSER of W^*_{L1} and W^*_{L2}
W^*_{S}: Serviceability Load based on Deflection Limit of Span/250 or First Yield

Designation	Mass per metre	W^*_{L1}(kN) / W^*_S (kN) Span in metres															W^*_{L2}	FLR
	kg/m	1	1.25	1.5	1.75	2	2.5	3	3.5	4	5	6	7	8	9	10	kN	m
125 TFB	13.1	150	120	100	85.9	75.1	60.1	50.1	42.9	37.6	30.1	25.0	21.5	18.8	16.7	15.0	176	0.556
		144	*116*	*95.3*	*82.5*	*66.7*	*42.7*	*29.6*	*21.8*	*16.7*	*10.7*	*7.41*	*5.44*	*4.17*	*3.29*	*2.67*		
100 TFB	7.20	63.8	51.0	42.5	36.5	31.9	25.5	21.3	18.2	16.0	12.8	10.6	9.11	7.98	7.09	6.38	112	0.365
		60.7	*48.5*	*39.8*	*29.3*	*22.4*	*14.3*	*9.96*	*7.32*	*5.60*	*3.59*	*2.49*	*1.83*	*1.40*	*1.11*	*0.896*		

Notes: (1) FLR, segment length for full lateral restraint, based on transverse load case ($\beta_m = -0.8$).
(2) Shading indicates serviceability loads governed by yielding.

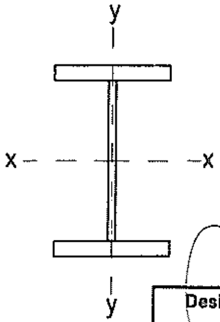


TABLE 5.2-1

WELDED BEAMS
GRADE 300
DESIGN SECTION MOMENT AND WEB CAPACITIES

Designation	Design Section Moment Capacities: About x-axis ϕM_{sx}	$\phi M'_{sx}$	$\phi M''_{sx}$	FLR	About y-axis ϕM_{sy}	Design Web Capacities: ϕV_v	$\frac{\phi R_{bb}}{b_b}$	$\frac{\phi R_{by}}{b_{bf}}$
	kNm	kNm	kNm	m	kNm	kN	kN/mm	kN/mm
1200WB455	7110	7110	7110	3.40	1260	2900	0.783	5.40
423	6510	6510	6510	3.34	1130	2900	0.783	5.40
392	5910	5910	5910	3.28	1010	2900	0.783	5.40
342	4980	4980	4450	2.51	646	2900	0.783	5.40
317	4500	4500	4050	2.44	565	2900	0.783	5.40
278	3790	3790		2.02	387	2900	0.783	5.40
249	3250	3250		1.49	239	2900	0.783	5.40
1000WB322	4130	4130	3670	2.59	646	2490	1.02	5.40
296	3720	3720	3320	2.52	565	2490	1.02	5.40
258	3100	3100		2.09	387	2490	1.02	5.40
215	2580	2580		1.57	244	2490	1.02	5.40
900WB282	3440	3440	3000	2.76	645	1730	0.566	4.18
257	3070	3070	2700	2.71	565	1730	0.566	4.18
218	2510	2510		2.27	386	1730	0.566	4.18
175	2020	2020		1.74	243	1730	0.566	4.18
800WB192	2030	2030		2.04	318	1190	0.425	3.49
168	1720	1720		1.81	238	1190	0.425	3.49
146	1540	1420		1.67	204	1190	0.425	3.49
122	1220	1130		1.42	135	1190	0.425	3.49
700WB173	1610	1610		1.88	267	1100	0.544	3.49
150	1350	1350		1.66	197	1100	0.544	3.49
130	1210	1110		1.53	169	1100	0.544	3.49
115	1020	944		1.46	134	1100	0.544	3.49

Notes: (1) FLR based on most conservative case ($\beta_m = -1$).
(2) $\phi M'_{sx}$ — for sections with two holes on tension flange.
(3) $\phi M''_{sx}$ — for sections with four holes on tension flange.

TABLE 5.2-2

WELDED BEAMS
GRADE 400
DESIGN SECTION MOMENT AND WEB CAPACITIES

Designation	Design Section Moment Capacities: About x-axis ϕM_{sx}	$\phi M'_{sx}$	$\phi M''_{sx}$	FLR	About y-axis ϕM_{sy}	Design Web Capacities: ϕV_v	$\frac{\phi R_{bb}}{b_b}$	$\frac{\phi R_{by}}{b_{bf}}$
	kNm	kNm	kNm	m	kNm	kN	kN/mm	kN/mm
1200WB455	9090	9090	8190	3.00	1620	3320	0.806	6.84
423	8320	8320	7520	2.95	1460	3320	0.806	6.84
392	7550	7550	6850	2.89	1260	3320	0.806	6.84
342	6360	6020	5660	2.22	830	3320	0.806	6.84
317	5750	5460	5150	2.15	723	3320	0.806	6.84
278	4830	4570		1.78	497	3320	0.806	6.84
249	4140	3880		1.31	308	3320	0.806	6.84
1000WB322	5310	5030	4720	2.28	830	3150	1.06	6.84
296	4780	4540	4270	2.22	723	3150	1.06	6.84
258	3990	3770		1.85	497	3150	1.06	6.84
215	3270	3090		1.40	303	3150	1.06	6.84
900WB282	4370	4090	3780	2.44	830	1820	0.583	5.40
257	3900	3660	3390	2.39	721	1820	0.583	5.40
218	3190	2980		2.00	495	1820	0.583	5.40
175	2500	2320		1.55	302	1820	0.583	5.40
800WB192	2540	2310		1.80	408	1190	0.437	4.50
168	2150	1950		1.59	307	1190	0.437	4.50
146	1880	1710		1.49	258	1190	0.437	4.50
122	1480	1350		1.26	166	1190	0.437	4.50
700WB173	2070	1890		1.66	343	1380	0.562	4.50
150	1740	1580		1.46	253	1380	0.562	4.50
130	1540	1410		1.36	214	1380	0.562	4.50
115	1300	1200		1.30	166	1380	0.562	4.50

Notes: (1) FLR based on most conservative case ($\beta_m = -1$).
(2) $\phi M'_{sx}$ — for sections with two holes on tension flange.
(3) $\phi M''_{sx}$ — for sections with four holes on tension flange.

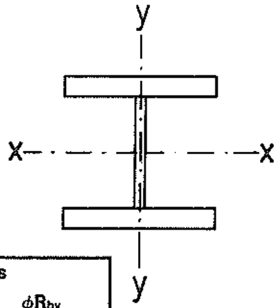


TABLE 5.2-3

WELDED COLUMNS
GRADE 300
DESIGN SECTION MOMENT AND WEB CAPACITIES

Designation	Design Section Moment Capacities					Design Web Capacities		
	About x-axis				About y-axis			
	ϕM_{sx}	$\phi M'_{sx}$	$\phi M''_{sx}$	FLR	ϕM_{sy}	ϕV_v	$\frac{\phi R_{bb}}{b_b}$	$\frac{\phi R_{by}}{b_{bf}}$
	kNm	kNm	kNm	m	kNm	kN	kN/mm	kN/mm
500WC440	2620	2620	2620	3.46	1260	2420	9.42	12.6
414	2540	2540	2540	3.56	1260	1940	7.27	10.1
383	2300	2300	2300	3.52	1140	1940	7.27	10.1
340	2260	2260	2260	3.52	1010	1700	5.18	7.87
290	1910	1910	1910	3.56	860	1460	3.97	6.75
267	1690	1690	1690	3.51	747	1460	3.97	6.75
228	1410	1410	1200	3.28	593	1460	3.97	6.75
400WC361	1880	1880	1650	2.74	810	2120	9.59	12.6
328	1790	1790	1550	2.87	808	1480	6.36	8.82
303	1620	1620	1400	2.83	727	1480	6.36	8.82
270	1430	1430	1240	2.83	646	1320	5.55	7.87
212	1100	1100	954	2.82	504	1130	4.43	6.75
181	922	922	781	2.64	408	1130	4.43	6.75
144	698	698	566	2.64	303	907	3.23	5.40
350WC280	1240	1240		2.54	618	1160	6.61	8.82
258	1120	1120		2.51	557	1160	6.61	8.82
230	986	986		2.51	495	1040	5.81	7.87
197	844	844		2.53	433	891	4.74	6.75

Notes: (1) FLR based on most conservative case ($\beta_m = -1$).
(2) $\phi M'_{sx}$ — for sections with two holes on tension flange.
(3) $\phi M''_{sx}$ — for sections with four holes on tension flange.

TABLE 5.2-4

WELDED COLUMNS
GRADE 400
DESIGN SECTION MOMENT AND WEB CAPACITIES

Designation	Design Section Moment Capacities					Design Web Capacities		
	About x-axis				About y-axis			
	ϕM_{sx}	$\phi M'_{sx}$	$\phi M''_{sx}$	FLR	ϕM_{sy}	ϕV_v	$\frac{\phi R_{bb}}{b_b}$	$\frac{\phi R_{by}}{b_{bf}}$
	kNm	kNm	kNm	m	kNm	kN	kN/mm	kN/mm
500WC440	3370	3370	3040	3.05	1620	3010*	11.9	16.2
414	3270	3270	2930	3.14	1620	2490	9.10	13.0
383	2960	2960	2660	3.10	1460	2490	9.10	13.0
340	2860	2860	2540	3.11	1270	2190	6.35	10.1
290	2400	2400	2090	3.14	1070	1850	4.68	8.55
267	2120	2120	1830	3.10	928	1850	4.68	8.55
228	1660	1530	1390	2.92	717	1850	4.68	8.55
400WC361	2420	2280	2120	2.41	1040	2690*	12.1	16.2
328	2300	2160	1990	2.53	1040	1910	7.97	11.3
303	2080	1950	1800	2.50	935	1910	7.97	11.3
270	1830	1720	1590	2.49	831	1700	6.91	10.1
212	1380	1290	1180	2.49	631	1440	5.36	8.55
181	1140	1040	945	2.34	499	1440	5.36	8.55
144	824	741	657	2.34	367	1150	3.82	6.84
350WC280	1600	1480		2.24	795	1500	8.34	11.3
258	1440	1340		2.21	716	1500	8.34	11.3
230	1270	1180		2.21	636	1340	7.30	10.1
197	1080	1000		2.23	556	1130	5.82	8.55

Notes: (1) FLR based on most conservative case ($\beta_m = -1$).
(2) $\phi M'_{sx}$ — for sections with two holes on tension flange.
(3) $\phi M''_{sx}$ — for sections with four holes on tension flange.
(4) * indicates shear capacity governed by the shear capacity of the weld.

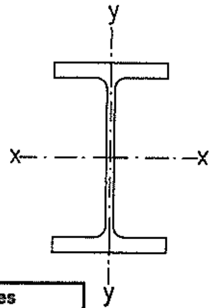


TABLE 5.2-5

UNIVERSAL BEAMS
GRADE 300
DESIGN SECTION MOMENT AND WEB CAPACITIES

Designation	Design Section Moment Capacities				Design Web Capacities		
	About x-axis			About y-axis			
	ϕM_{sx}	$\phi M'_{sx}$	FLR	ϕM_{sy}	ϕV_v	$\frac{\phi R_{bb}}{b_b}$	$\frac{\phi R_{by}}{b_{bf}}$
	kNm	kNm	m	kNm	kN	kN/mm	kN/mm
610UB125	927	927	1.41	130	1180	1.07	4.02
113	829	829	1.38	114	1100	0.921	3.78
101	782	782	1.30	104	1100	0.810	3.82
530UB 92.4	640	589	1.23	92.2	939	0.903	3.67
82.0	558	515	1.20	78.0	876	0.773	3.46
460UB 82.1	496	450	1.16	79.0	788	1.06	3.56
74.6	449	407	1.14	70.8	719	0.861	3.28
67.1	399	363	1.13	62.0	667	0.724	3.06
410UB 59.7	324	291	1.09	54.9	548	0.698	2.81
53.7	304	275	1.02	49.8	529	0.654	2.74
360UB 56.7	273	244	1.07	52.0	496	0.907	2.88
50.7	242	216	1.05	45.5	449	0.725	2.63
44.7	222	198	0.997	40.4	420	0.630	2.48
310UB 46.2	197	173	1.07	44.0	356	0.740	2.41
40.4	182	161	1.02	40.0	320	0.588	2.20
32.0	134	117	0.873	25.0	283	0.456	1.98
250UB 37.3	140	120	0.915	33.5	283	0.857	2.30
31.4	114	98.8	0.885	26.3	265	0.769	2.20
25.7	92.0	80.8	0.741	17.8	214	0.484	1.80
200UB 29.8	90.0	76.9	0.842	24.9	225	1.06	2.27
25.4	74.6	63.3	0.816	19.8	204	0.897	2.09
22.3	65.3	54.5	0.821	17.4	174	0.650	1.80
18.2	51.8	†	0.587	9.92	154	0.522	1.62
180UB 22.2	56.2	†	0.551	11.7	186	1.12	2.16
18.1	45.2	†	0.546	9.36	151	0.788	1.80
16.1	39.8	†	0.542	8.19	135	0.630	1.62
150UB 18.0	38.9	†	0.454	7.74	161	1.24	2.16
14.0	29.3	†	0.441	5.70	130	0.912	1.80

Notes:
(1) FLR based on most conservative case ($\beta_m = -1$).
(2) $\phi M'_{sx}$ — for sections with two holes on tension flange.
(3) † indicates flange too small for high strength structural bolts.
(4) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

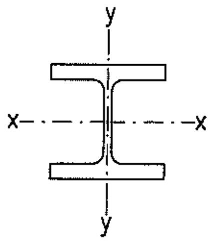


TABLE 5.2-6

UNIVERSAL COLUMNS
GRADE 300
DESIGN SECTION MOMENT AND WEB CAPACITIES

Designation	Design Section Moment Capacities				Design Web Capacities		
	About x-axis			About y-axis			
	ϕM_{sx}	$\phi M'_{sx}$	FLR	ϕM_{sy}	ϕV_v	$\frac{\phi R_{bb}}{b_b}$	$\frac{\phi R_{by}}{b_{bf}}$
	kNm	kNm	m	kNm	kN	kN/mm	kN/mm
310UC158	676	676	2.24	305	832	3.47	5.30
137	580	580	2.22	261	717	2.90	4.66
118	494	494	2.20	222	606	2.32	4.02
96.8	422	422	2.10	187	527	1.76	3.56
250UC 89.5	309	309	1.85	143	472	2.24	3.78
72.9	266	266	1.77	123	377	1.62	3.10
200UC 59.5	177	158	1.42	80.6	337	2.08	3.35
52.2	154	137	1.41	70.3	285	1.66	2.88
46.2	133	118	1.40	60.3	257	1.43	2.63
150UC 37.2	83.6	71.2	1.05	36.9	226	1.91	2.92
30.0	71.9	61.2	1.01	31.7	180	1.42	2.38
23.4	50.7	41.9	0.969	21.2	161	1.26	2.20
100UC 14.8	21.4	16.1	0.650	9.91	83.8	1.19	1.80

Notes:
(1) FLR based on most conservative case ($\beta_m = -1$).
(2) $\phi M'_{sx}$ — for sections with two holes on tension flange.
(3) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

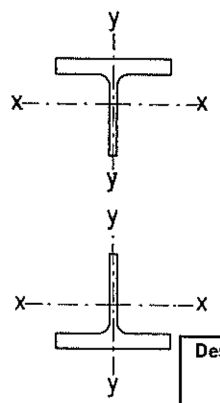


TABLE 5.2-7

TEES CUT FROM UNIVERSAL BEAMS GRADE 300

DESIGN SECTION MOMENT AND WEB CAPACITIES

Designation	Design Section Moment Capacities					Design Shear Capacity
	About x-axis				About y-axis	
	Stem Down		Stem Up			
	ϕM_{sxf}	Effective Length	ϕM_{sxs}	Effective Length	ϕM_{sy}	ϕV_v
	kNm	m	kNm	m	kNm	kN
305BT62.5	112	2.27	72.7	0.00	64.9	520
56.5	104	2.17	59.6	0.00	56.8	486
50.5	103	1.98	49.5	0.00	52.1	488
265BT46.3	78.3	1.94	45.3	0.00	46.1	414
41.0	72.1	1.84	37.0	0.00	39.0	387
230BT41.1	56.8	1.90	39.5	0.00	39.5	346
37.3	51.8	1.85	32.7	0.00	35.4	316
33.6	47.6	1.78	26.3	0.00	31.0	293
205BT29.9	35.3	1.79	20.8	0.00	27.4	240
26.9	35.8	1.61	18.8	0.00	24.9	232
180BT28.4	28.2	1.83	20.2	0.00	26.0	217
25.4	25.4	1.76	17.0	0.00	22.7	196
22.4	24.4	1.61	14.2	0.00	20.2	184
155BT23.1	17.6	1.96	12.4	0.00	22.0	154
20.2	16.8	1.76	10.2	0.00	20.0	139
16.0	13.6	1.47	7.23	0.00	12.5	123
125BT18.7	12.3	1.69	9.38	0.00	16.7	123
15.7	11.2	1.49	8.37	0.00	13.2	115
12.9	9.03	1.28	5.56	0.00	8.88	92.5
100BT14.9 *	7.86	***	6.60	***	12.4	97.4
12.7 *	6.92	***	5.67	***	9.90	88.2
11.2 *	5.62	***	4.50	***	8.68	75.2
9.1	5.11	1.03	3.64	0.00	4.96	66.3
90BT11.1	5.40	1.10	4.75	0.00	5.85	80.4
9.1	4.37	1.01	3.57	0.00	4.68	65.3
8.1	3.92	3.87	3.01	0.00	4.09	58.0
75BT 9.0	3.96	0.920	3.66	0.00	3.87	69.7
7.0	3.14	0.801	2.73	0.00	2.85	56.2

Notes: (1) Stem Down and ϕM_{sxf} is for bending about the x-axis which causes compression in the flange.
(2) Stem Up and ϕM_{sxs} is for bending about the x-axis which causes compression in the stem.
(3) * indicates x- and y-axes are interchanged from that shown on the diagram.
(4) The Effective Length for Tees is the maximum effective length of a segment for which $\phi M_b = \phi M_{sx}$ assuming $\alpha_m = 1.0$.
(5) *** indicates that bending is about y-axis and there is no maximum segment length required to achieve the full section moment capacity.
(6) For other sections bending about the x-axis (stem up) there is no unrestrained segment length for which the full section moment capacity can be achieved.
(7) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

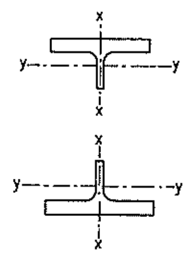


TABLE 5.2-8

TEES CUT FROM UNIVERSAL COLUMNS GRADE 300

DESIGN SECTION MOMENT AND WEB CAPACITIES

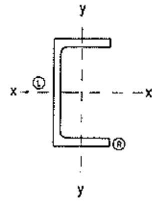
Designation	Design Section Moment Capacities			Design Shear Capacity
	About y-axis		About x-axis	
	Stem Down	Stem Up		
	ϕM_{syf}	ϕM_{sys}	ϕM_{sx}	ϕV_v
	kNm	kNm	kNm	kN
155CT79.0	42.7	42.5	152	357
68.5	36.5	35.3	131	308
59.0	30.7	28.6	111	260
48.4	24.7	23.1	93.7	226
125CT44.8	18.3	17.5	71.5	202
36.5	15.2	13.9	61.3	161
100CT29.8	11.2	10.8	40.3	144
26.1	9.44	8.79	35.1	122
23.1	8.13	7.64	30.1	110
75CT18.6	5.69	5.66	18.4	96.9
15.0	4.78	4.51	15.9	76.8
11.7	3.53	3.84	10.6	68.9
50CT 7.4	1.33	1.32	4.95	35.4

Notes: (1) Stem Down and ϕM_{syf} is for bending about the y-axis which causes compression in the flange.
(2) Stem Up and ϕM_{sys} is for bending about the y-axis which causes compression in the stem.
(3) For all sections bending about the y-axis there is no maximum segment length required to achieve the full section moment capacity.
(4) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

TABLE 5.2-9

PARALLEL FLANGE CHANNELS GRADE 300

DESIGN SECTION MOMENT AND WEB CAPACITIES



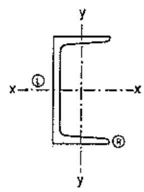
Designation	Mass per metre	Design Section Moment Capacities				Design Web Capacities		
		About x-axis		About y-axis				
		ϕM_{sx}	FLR	ϕM_{syR}	ϕM_{syL}	ϕV_v	$\frac{\phi R_{bb}}{b_b}$	$\frac{\phi R_{by}}{b_{bf}}$
	kg/m	kNm	m	kNm	kNm	kN	kN/mm	kN/mm
380 PFC	55.2	238	0.574	33.8	28.9	657	1.44	3.60
300 PFC	40.1	152	0.514	26.1	22.2	415	1.19	2.88
250 PFC	35.5	114	0.518	24.0	24.0	346	1.45	2.88
230 PFC	25.1	73.3	0.428	13.6	12.2	258	1.03	2.34
200 PFC	22.9	59.7	0.435	13.2	12.6	207	1.02	2.16
180 PFC	20.9	49.0	0.435	12.1	12.1	187	1.12	2.16
150 PFC	17.7	37.0	0.422	11.1	11.1	156	1.27	2.16

Notes: (1) FLR based on most conservative case ($\beta_m = -1$).
(2) ϕM_{syR} — For bending about the y-axis that causes compression in the toe R.
(3) ϕM_{syL} — For bending about the y-axis that causes compression in the web L.
(4) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

TABLE 5.2-10

TAPER FLANGE CHANNELS GRADE 250

DESIGN SECTION MOMENT AND WEB CAPACITIES



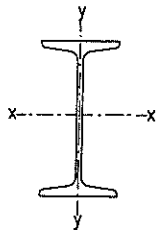
Designation	Mass per metre	Design Section Moment Capacities				Design Web Capacities		
		About x-axis		About y-axis				
		ϕM_{sx}	FLR	ϕM_{syR}	ϕM_{syL}	ϕV_v	$\frac{\phi R_{bb}}{b_b}$	$\frac{\phi R_{by}}{b_{bf}}$
	kg/m	kNm	m	kNm	kNm	kN	kN/mm	kN/mm
125 TFC	13.4	18.6	0.373	4.72	4.72	105	1.16	1.75
100 TFC	9.34	10.4	0.290	2.64	2.64	70.2	0.990	1.46
75 TFC	6.65	5.39	0.228	1.46	1.46	52.7	1.06	1.46

Notes: (1) FLR based on most conservative case ($\beta_m = -1$).
(2) ϕM_{syR} — For bending about the y-axis that causes compression in the toe R.
(3) ϕM_{syL} — For bending about the y-axis that causes compression in the web L.

TABLE 5.2-11

TAPER FLANGE BEAMS GRADE 250

DESIGN SECTION MOMENT AND WEB CAPACITIES



Designation	Mass per metre	Design Section Moment Capacities			Design Web Capacities		
		About x-axis		About y-axis			
		ϕM_{sx}	FLR	ϕM_{sy}	ϕV_v	$\frac{\phi R_{bb}}{b_b}$	$\frac{\phi R_{by}}{b_{bf}}$
	kg/m	kNm	m	kNm	kN	kN/mm	kN/mm
125 TFB	13.1	18.8	0.417	3.64	87.8	0.909	1.46
100 TFB	7.20	8.03	0.274	1.24	56.2	0.772	1.17

Note: FLR based on most conservative case ($\beta_m = -1$).

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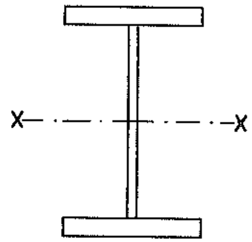
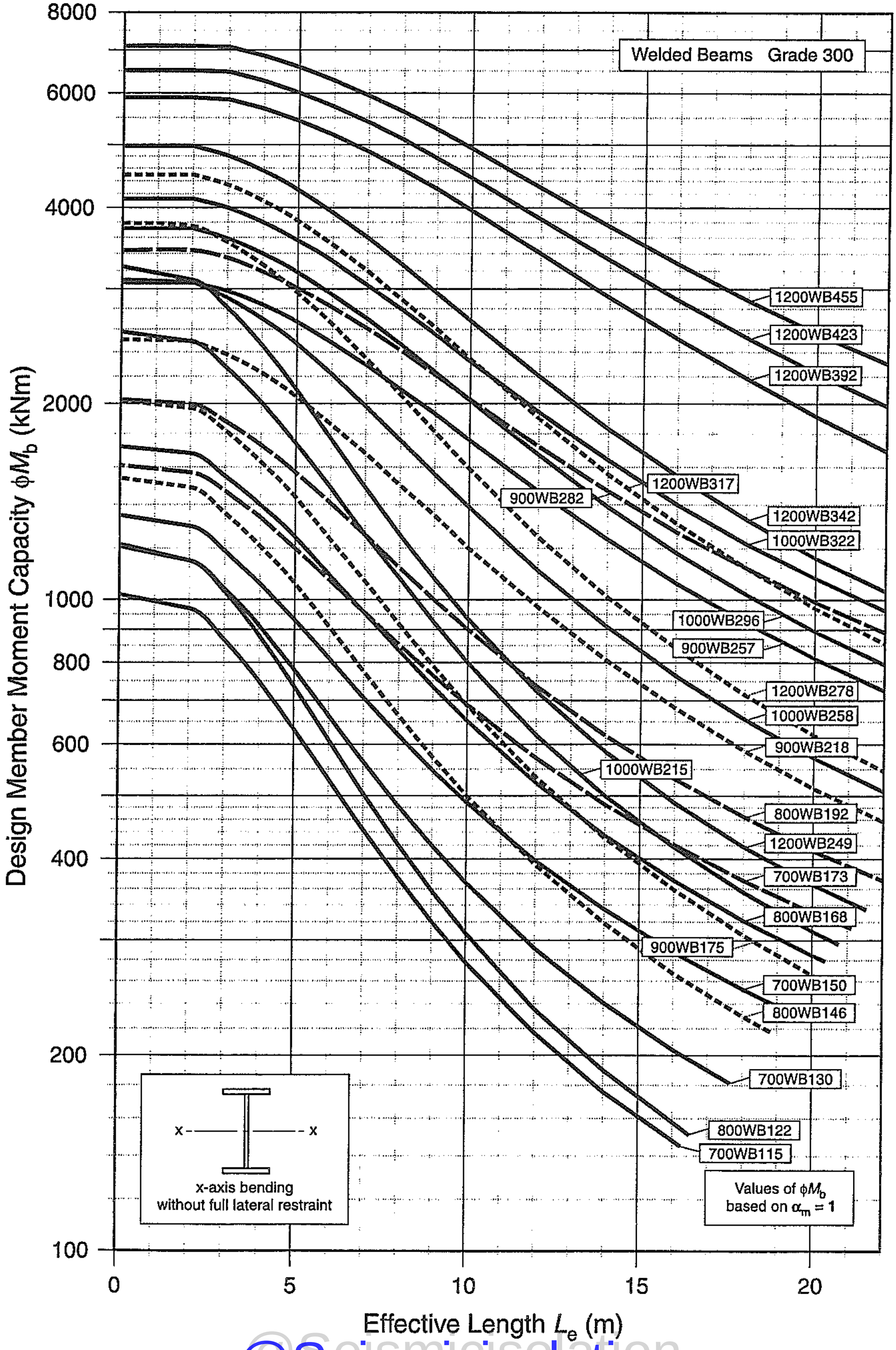
TABLE 5.3-1

WELDED BEAMS
GRADE 300
DESIGN MOMENT CAPACITIES FOR MEMBERS WITHOUT FULL LATERAL RESTRAINT
bending about x-axis



Designation	ϕM_{sx}	ϕV_v	Design Member Moment Capacities, ϕM_b (kNm) Effective Length (L_e) in metres													
	kNm	kN	2	3	4	5	6	7	8	9	10	12	14	16	18	20	22
1200WB455	7110	2900	7110	7080	6860	6590	6280	5950	5610	5270	4930	4290	3740	3270	2880	2560	2300
423	6510	2900	6510	6480	6270	6010	5720	5410	5090	4760	4440	3840	3320	2880	2520	2220	1980
392	5910	2900	5910	5870	5680	5440	5170	4880	4570	4270	3960	3400	2910	2510	2180	1910	1690
342	4980	2900	4980	4810	4560	4260	3930	3600	3270	2960	2680	2200	1830	1550	1330	1160	1030
317	4500	2900	4500	4340	4100	3820	3510	3200	2890	2610	2340	1900	1560	1310	1120	971	856
278	3790	2900	3750	3540	3270	2960	2650	2340	2060	1810	1590	1250	1010	842	715	620	546
249	3250	2900	3100	2810	2460	2100	1770	1490	1260	1080	934	724	585	488	418	366	325
1000WB322	4130	2490	4130	4000	3800	3560	3310	3040	2790	2550	2320	1940	1640	1400	1220	1080	962
296	3720	2490	3720	3590	3400	3180	2940	2700	2460	2230	2020	1670	1390	1180	1020	894	794
258	3100	2490	3080	2910	2700	2470	2220	1980	1760	1560	1390	1110	910	764	656	573	508
215	2580	2490	2490	2270	2010	1740	1490	1260	1080	924	800	620	500	417	356	310	275
900WB282	3440	1730	3440	3350	3190	3010	2810	2610	2410	2210	2030	1720	1470	1270	1120	992	890
257	3070	1730	3070	2980	2840	2670	2480	2290	2100	1930	1760	1470	1240	1060	923	813	725
218	2510	1730	2500	2380	2230	2050	1860	1680	1500	1350	1200	976	807	682	587	514	457
175	2020	1730	1970	1820	1630	1440	1240	1070	917	791	688	535	431	359	306	266	235
800WB192	2030	1190	2000	1880	1730	1570	1410	1260	1120	1000	900	737	619	531	465	412	371
168	1720	1190	1680	1550	1400	1250	1090	955	836	736	652	524	435	371	322	285	256
146	1540	1190	1490	1360	1210	1060	907	775	665	574	500	392	319	267	230	201	179
122	1220	1190	1150	1030	880	737	610	505	423	358	308	236	190	158	135	118	105
700WB173	1610	1100	1570	1470	1340	1200	1070	956	853	765	690	572	485	421	371	331	300
150	1350	1100	1300	1190	1060	932	812	708	621	548	489	398	335	288	253	225	203
130	1210	1100	1150	1040	911	781	664	565	484	420	368	292	241	204	177	157	141
115	1020	1100	970	868	750	634	531	445	376	321	278	217	176	148	127	112	99.6

Note: Values of ϕM_b based on $\alpha_m = 1$ (uniform moment over entire segment).
For other moment distributions use the appropriate value of α_m obtained from AS 4100 Table 5.6.1 or 5.6.2 and use the minimum of $\alpha_m \phi M_b$ and ϕM_{sx} given above.

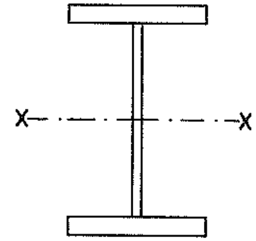


Welded Beams Grade 300
Design Member Moment Capacity ϕM_b (kNm)
8000
6000
4000
2000
1000
800
600
400
200
100
Effective Length L_e (m)
0
5
10
15
20
1200WB455
1200WB423
1200WB392
1200WB317
900WB282
1200WB342
1000WB322
1000WB296
900WB257
1200WB278
1000WB258
900WB218
1000WB215
800WB192
1200WB249
700WB173
800WB168
900WB175
700WB150
800WB146
700WB130
800WB122
700WB115
x
x
x-axis bending without full lateral restraint
Values of ϕM_b based on $\alpha_m = 1$

TABLE 5.3-2

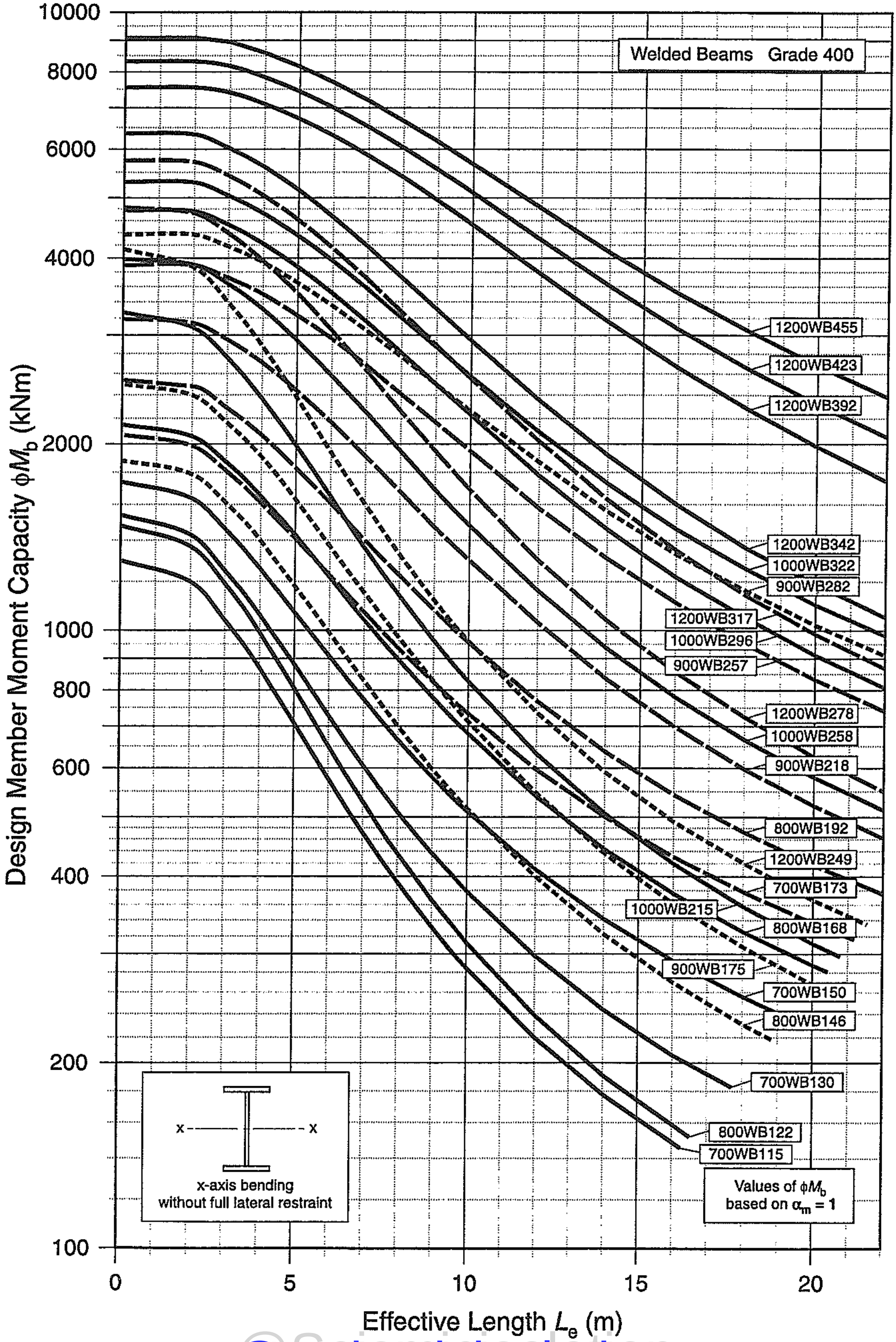
WELDED BEAMS
GRADE 400

DESIGN MOMENT CAPACITIES FOR MEMBERS WITHOUT FULL LATERAL RESTRAINT
bending about x-axis



Designation	ϕM_{sx}	ϕV_v	Design Member Moment Capacities, ϕM_b (kNm) Effective Length (L_e) in metres														
	kNm	kN	2	3	4	5	6	7	8	9	10	12	14	16	18	20	22
1200WB455	9090	3320	9090	8950	8590	8160	7680	7180	6660	6160	5670	4810	4090	3510	3050	2680	2380
423	8320	3320	8320	8180	7840	7440	6990	6510	6030	5550	5100	4280	3610	3070	2650	2320	2050
392	7550	3320	7550	7410	7100	6720	6300	5850	5400	4950	4530	3770	3150	2660	2280	1980	1740
342	6360	3320	6340	6020	5620	5150	4660	4180	3720	3310	2940	2350	1920	1600	1360	1190	1050
317	5750	3320	5720	5430	5040	4610	4150	3700	3270	2890	2550	2020	1630	1350	1140	987	867
278	4830	3320	4730	4390	3960	3510	3050	2630	2260	1950	1690	1300	1040	857	724	626	550
249	4140	3320	3870	3400	2880	2380	1940	1600	1330	1120	961	737	592	492	421	367	326
1000WB322	5310	3150	5300	5040	4720	4350	3960	3570	3200	2870	2570	2090	1730	1460	1260	1100	981
296	4780	3150	4760	4530	4220	3870	3510	3150	2810	2500	2230	1780	1460	1220	1050	912	807
258	3990	3150	3910	3640	3310	2940	2580	2250	1950	1690	1480	1160	938	781	666	580	513
215	3270	3150	3090	2760	2370	1990	1650	1360	1140	964	827	633	507	420	358	312	276
900WB282	4370	1820	4370	4180	3940	3650	3350	3050	2770	2500	2260	1870	1560	1330	1160	1020	911
257	3900	1820	3900	3720	3500	3230	2960	2680	2410	2170	1950	1580	1310	1110	952	833	740
218	3190	1820	3140	2950	2710	2440	2170	1910	1680	1470	1300	1030	836	699	598	522	462
175	2500	1820	2400	2170	1910	1630	1370	1150	974	828	713	547	437	362	308	268	236
800WB192	2540	1190	2480	2290	2070	1830	1610	1400	1230	1080	956	769	638	543	473	418	375
168	2150	1190	2060	1870	1650	1430	1220	1040	897	778	682	540	444	376	326	288	257
146	1880	1190	1790	1610	1400	1180	992	830	700	597	516	400	323	270	231	202	180
122	1480	1190	1370	1190	993	807	651	530	437	367	313	239	191	159	136	118	105
700WB173	2070	1380	1990	1810	1610	1410	1230	1070	935	825	734	597	501	431	378	337	303
150	1740	1380	1640	1460	1260	1070	910	775	666	580	511	411	342	293	256	227	205
130	1540	1380	1430	1250	1060	882	728	606	510	437	379	298	244	206	179	158	141
115	1300	1380	1200	1040	870	710	577	472	393	332	285	220	178	149	128	112	100

Note: Values of ϕM_b based on $\alpha_m = 1$ (uniform moment over entire segment).
For other moment distributions use the appropriate value of α_m obtained from AS 4100 Table 5.6.1 or 5.6.2 and use the minimum of $\alpha_m \phi M_b$ and ϕM_{sx} given above.

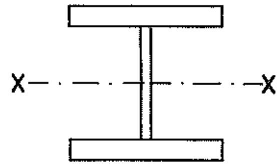


Welded Beams Grade 400
Design Member Moment Capacity ϕM_b (kNm)
10000
8000
6000
4000
2000
1000
800
600
400
200
100
Effective Length L_e (m)
0
5
10
15
20
1200WB455
1200WB423
1200WB392
1200WB342
1000WB322
900WB282
1200WB317
1000WB296
900WB257
1200WB278
1000WB258
900WB218
800WB192
1200WB249
700WB173
1000WB215
800WB168
900WB175
700WB150
800WB146
700WB130
800WB122
700WB115
x
x
x-axis bending
without full lateral restraint
Values of ϕM_b
based on $\alpha_m = 1$

TABLE 5.3-3

WELDED COLUMNS
GRADE 300

DESIGN MOMENT CAPACITIES FOR MEMBERS WITHOUT FULL LATERAL RESTRAINT
bending about x-axis



Designation	ϕM_{sx}	ϕV_v	Design Member Moment Capacities, ϕM_b (kNm) Effective Length (L_e) in metres														
	kNm	kN	2	3	4	5	6	7	8	9	10	12	14	16	18	20	22
500WC440	2620	2420	2620	2620	2560	2500	2430	2360	2290	2230	2170	2050	1940	1840	1750	1660	1590
414	2540	1940	2540	2540	2480	2420	2350	2280	2210	2150	2080	1970	1860	1760	1660	1580	1500
383	2300	1940	2300	2300	2250	2180	2120	2050	1990	1920	1860	1750	1640	1550	1460	1380	1310
340	2260	1700	2260	2260	2200	2130	2060	1980	1900	1830	1750	1620	1500	1390	1290	1210	1130
290	1910	1460	1910	1910	1860	1790	1730	1660	1590	1520	1460	1330	1220	1120	1040	962	895
267	1690	1460	1690	1690	1640	1590	1530	1460	1400	1340	1280	1160	1060	969	890	821	761
228	1410	1460	1410	1400	1360	1310	1260	1200	1140	1080	1030	923	829	749	680	621	570
400WC361	1880	2120	1880	1850	1800	1740	1690	1640	1590	1540	1490	1410	1330	1260	1190	1130	1070
328	1790	1480	1790	1760	1710	1650	1600	1540	1490	1440	1400	1310	1230	1160	1090	1030	978
303	1620	1480	1620	1590	1540	1490	1430	1380	1330	1280	1240	1150	1080	1010	951	895	845
270	1430	1320	1430	1400	1350	1300	1250	1200	1150	1110	1060	983	913	850	795	744	699
212	1100	1130	1100	1080	1030	990	943	897	854	812	773	703	642	589	543	503	468
181	922	1130	922	899	860	818	774	731	689	650	613	549	494	447	408	375	346
144	698	907	698	682	652	618	583	547	512	480	449	395	350	312	282	256	234
350WC280	1240	1160	1240	1220	1180	1140	1110	1080	1040	1010	983	928	877	830	787	747	710
258	1120	1160	1120	1090	1060	1020	989	957	926	896	868	815	767	723	683	647	613
230	986	1040	986	960	926	892	859	827	797	769	742	693	648	607	571	538	508
197	844	891	844	820	788	755	723	693	665	638	612	566	525	489	456	427	401

Note: Values of ϕM_b based on $\alpha_m = 1$ (uniform moment over entire segment).
For other moment distributions use the appropriate value of α_m obtained from AS 4100 Table 5.6.1 or 5.6.2 and use the minimum of $\alpha_m \phi M_b$ and ϕM_{sx} given above.

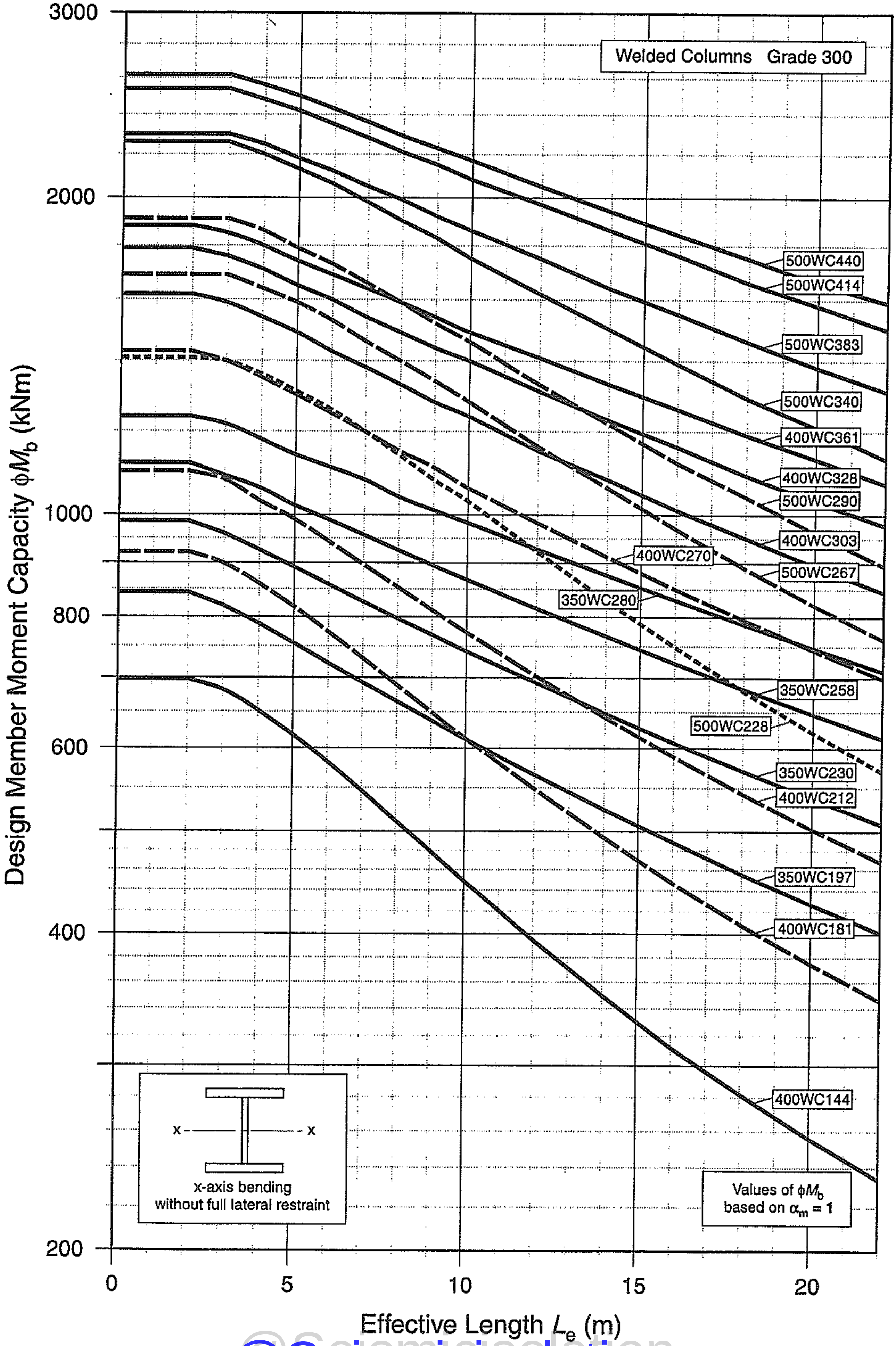
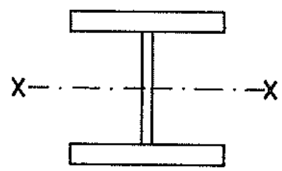

Welded Columns Grade 300
Design Member Moment Capacity ϕM_b (kNm)
3000
2000
1000
800
600
400
200
Effective Length L_e (m)
0
5
10
15
20
500WC440
500WC414
500WC383
500WC340
400WC361
400WC328
500WC290
400WC303
400WC270
500WC267
350WC280
350WC258
500WC228
350WC230
400WC212
350WC197
400WC181
400WC144
x
x
x-axis bending
without full lateral restraint
Values of ϕM_b
based on $\alpha_m = 1$

TABLE 5.3-4

WELDED COLUMNS
GRADE 400
DESIGN MOMENT CAPACITIES FOR MEMBERS WITHOUT FULL LATERAL RESTRAINT
bending about x-axis



Designation	ϕM_{sx}	ϕV_v	Design Member Moment Capacities, ϕM_b (kNm) Effective Length (L_e) in metres														
	kNm	kN	2	3	4	5	6	7	8	9	10	12	14	16	18	20	22
500WC440	3370	3010*	3370	3340	3240	3130	3020	2910	2810	2710	2610	2440	2280	2130	2000	1890	1780
414	3270	2490	3270	3240	3140	3030	2920	2810	2710	2610	2510	2330	2170	2030	1900	1780	1680
383	2960	2490	2960	2930	2840	2730	2630	2520	2420	2330	2230	2060	1910	1770	1650	1550	1450
340	2860	2190	2860	2830	2730	2620	2510	2390	2280	2170	2060	1870	1700	1550	1430	1320	1220
290	2400	1850	2400	2380	2300	2200	2100	2000	1900	1800	1700	1530	1370	1240	1130	1040	958
267	2120	1850	2120	2100	2030	1940	1850	1760	1660	1570	1480	1320	1180	1070	967	882	810
228	1660	1850	1660	1640	1590	1520	1450	1370	1290	1220	1140	1010	894	798	717	650	593
400WC361	2420	2690*	2420	2350	2260	2170	2080	2000	1920	1850	1780	1650	1540	1440	1350	1260	1190
328	2300	1910	2300	2230	2150	2060	1970	1880	1800	1730	1660	1530	1420	1320	1230	1150	1080
303	2080	1910	2080	2010	1930	1840	1760	1680	1600	1530	1460	1340	1240	1140	1060	988	924
270	1830	1700	1830	1770	1690	1610	1530	1450	1380	1310	1250	1130	1040	952	878	814	758
212	1380	1440	1380	1340	1270	1200	1130	1060	1000	941	886	790	710	643	586	537	496
181	1140	1440	1140	1090	1040	974	910	848	790	737	688	604	535	478	432	393	361
144	824	1150	824	795	755	709	662	615	570	528	489	423	370	327	293	264	241
350WC280	1600	1500	1600	1540	1480	1420	1370	1310	1260	1220	1170	1090	1020	950	891	837	788
258	1440	1500	1440	1380	1330	1270	1210	1160	1120	1070	1030	952	884	823	768	719	675
230	1270	1340	1260	1210	1160	1100	1050	1000	956	914	874	802	739	684	635	592	554
197	1080	1130	1080	1030	982	931	881	835	792	752	715	649	592	544	501	465	432

Notes: (1) Values of ϕM_b based on $\alpha_m = 1$ (uniform moment over entire segment).
For other moment distributions use the appropriate value of α_m obtained from AS 4100 Table 5.6.1 or 5.6.2 and use the minimum of $\alpha_m \phi M_b$ and ϕM_{sx} given above.
(2) * indicates shear capacity governed by shear capacity of the weld.

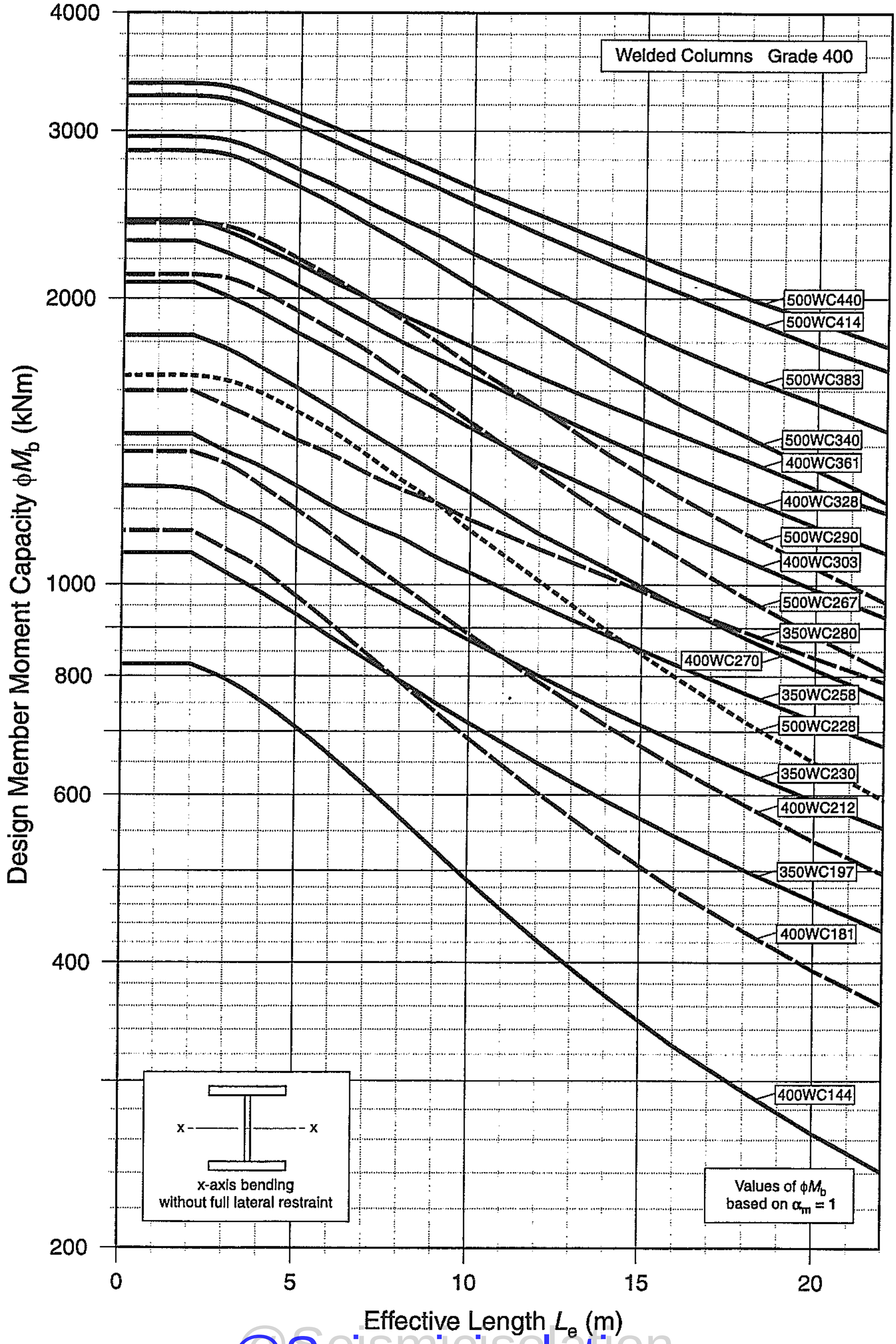
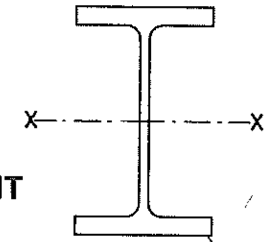

Welded Columns Grade 400
Design Member Moment Capacity ϕM_b (kNm)
4000
3000
2000
1000
800
600
400
200
500WC440
500WC414
500WC383
500WC340
400WC361
400WC328
500WC290
400WC303
500WC267
350WC280
400WC270
350WC258
500WC228
350WC230
400WC212
350WC197
400WC181
400WC144
x
x
x-axis bending
without full lateral restraint
Values of ϕM_b
based on $\alpha_m = 1$
0
5
10
15
20
Effective Length L_e (m)

TABLE 5.3-5

UNIVERSAL BEAMS
GRADE 300

DESIGN MOMENT CAPACITIES FOR MEMBERS WITHOUT FULL LATERAL RESTRAINT
bending about x-axis



Designation		ϕM_{sx}	ϕV_v	Design Member Moment Capacities, ϕM_b (kNm) Effective Length (L_e) in metres												
		kNm	kN	2	3	4	5	6	7	8	9	10	11	12	14	16
610UB	125	927	1180	872	778	675	577	492	423	367	322	286	257	232	195	168
	113	829	1100	777	689	593	502	424	361	310	270	238	212	192	160	137
	101	782	1100	725	634	535	444	367	307	260	224	195	173	155	128	109
530UB	92.4	640	939	584	504	422	349	290	244	209	181	160	143	129	108	92.7
	82.0	558	876	507	434	359	292	240	199	169	145	127	113	101	84.2	71.9
460UB	82.1	496	788	445	380	316	262	219	186	161	141	126	113	103	87.1	75.5
	74.6	449	719	401	340	280	230	190	160	138	120	106	95.3	86.4	72.7	62.8
	67.1	399	667	355	299	244	197	161	135	114	99.1	87.2	77.8	70.2	58.7	50.5
410UB	59.7	324	548	285	238	193	157	129	108	92.8	81.0	71.7	64.3	58.3	49.1	42.5
	53.7	304	529	262	214	169	134	108	89.2	75.5	65.3	57.4	51.2	46.2	38.7	33.3
360UB	56.7	273	496	239	200	164	135	113	96.1	83.3	73.4	65.6	59.2	54.0	45.8	39.8
	50.7	242	449	211	174	141	114	94.3	79.5	68.4	59.8	53.2	47.8	43.4	36.7	31.8
	44.7	222	420	189	153	121	95.4	77.1	64.0	54.3	47.1	41.5	37.1	33.6	28.2	24.3
310UB	46.2	197	356	172	144	118	97.5	81.9	70.1	61.1	54.0	48.4	43.8	40.0	34.0	29.7
	40.4	182	320	156	127	102	81.9	67.4	56.7	48.8	42.7	38.0	34.2	31.1	26.3	22.8
	32.0	134	283	109	84.1	64.1	49.9	40.1	33.3	28.4	24.7	21.8	19.6	17.8	15.0	13.0
250UB	37.3	140	283	116	93.6	75.3	61.8	51.8	44.4	38.8	34.4	30.9	28.1	25.7	21.9	19.2
	31.4	114	265	92.7	73.0	57.1	45.5	37.4	31.6	27.3	24.0	21.4	19.3	17.6	14.9	13.0
	25.7	92.0	214	68.3	50.6	38.1	29.9	24.4	20.5	17.7	15.6	13.9	12.6	11.5	9.74	8.48
200UB	29.8	90.9	225	73.2	58.9	47.6	39.4	33.4	28.9	25.4	22.6	20.4	18.6	17.0	14.6	12.8
	25.4	74.6	204	58.9	46.0	36.2	29.2	24.4	20.8	18.1	16.0	14.4	13.0	11.9	10.2	8.90
	22.3	65.3	174	51.5	39.8	30.9	24.6	20.3	17.2	14.9	13.1	11.7	10.6	9.68	8.25	7.18
	18.2	51.8	154	33.6	23.8	17.8	14.1	11.6	9.91	8.62	7.63	6.84	6.21	5.68	4.85	4.24
180UB	22.2	56.2	186	37.9	29.0	23.1	19.1	16.2	14.0	12.4	11.1	9.99	9.11	8.37	7.19	6.31
	18.1	45.2	151	29.0	21.2	16.4	13.3	11.1	9.56	8.37	7.45	6.71	6.10	5.60	4.80	4.20
	16.1	39.8	135	24.8	17.7	13.4	10.7	8.91	7.62	6.66	5.91	5.31	4.82	4.42	3.78	3.31
150UB	18.0	38.9	161	24.2	18.4	14.7	12.1	10.3	8.94	7.89	7.05	6.37	5.81	5.34	4.59	4.03
	14.0	29.3	130	16.6	12.0	9.20	7.45	6.24	5.37	4.71	4.19	3.78	3.44	3.15	2.70	2.37

Notes: (1) Values of ϕM_b based on $\alpha_m = 1$ (uniform moment over entire segment).
For other moment distributions use the appropriate value of α_m obtained from AS 4100 Table 5.6.1 or 5.6.2 and use the minimum of $\alpha_m \phi M_b$ and ϕM_{sx} given above.
(2) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

@Seismicisolation

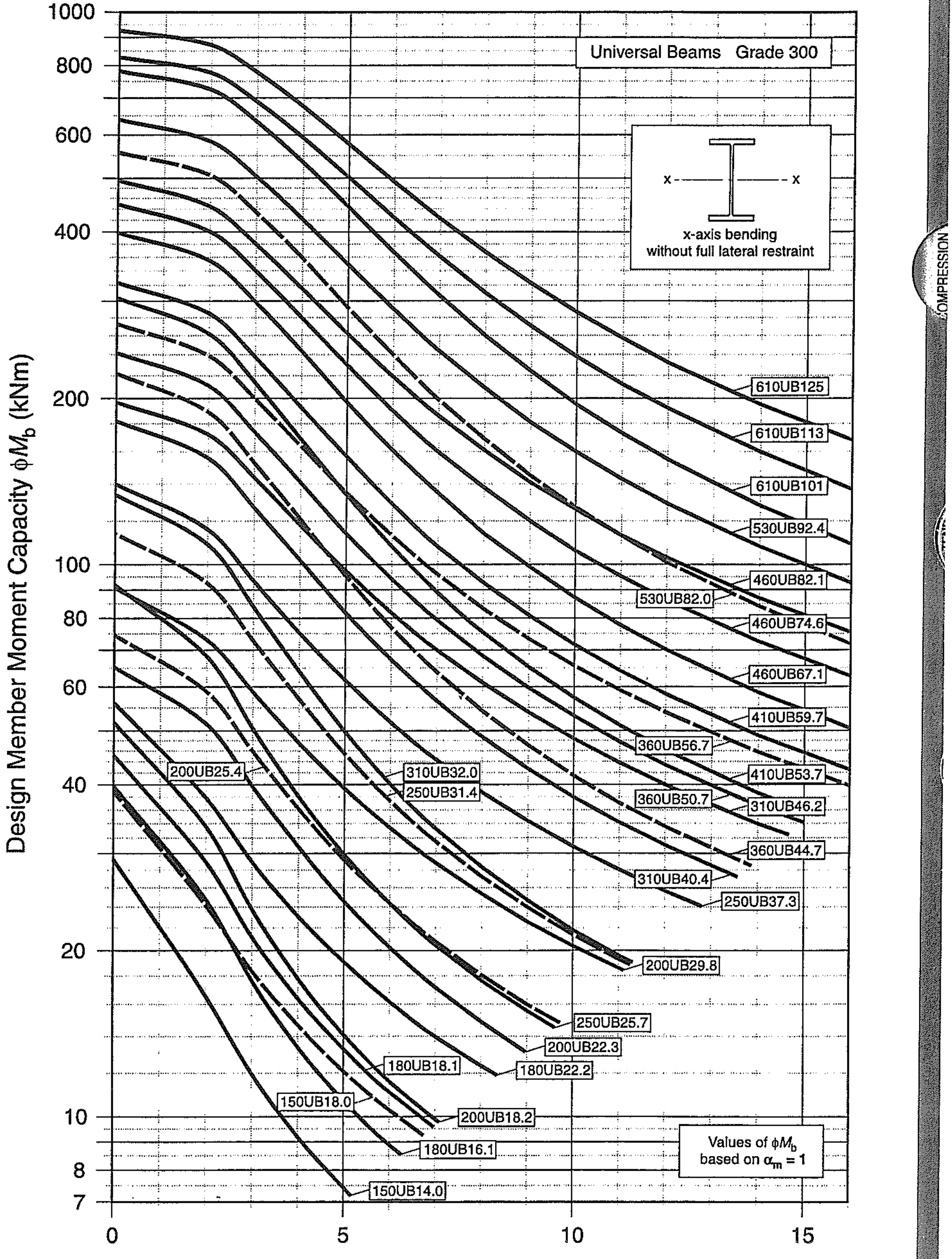
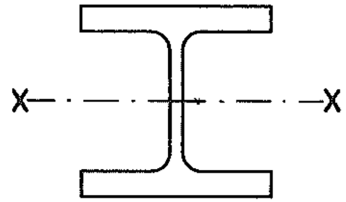

Universal Beams Grade 300
x-axis bending
without full lateral restraint
x
x
Design Member Moment Capacity ϕM_b (kNm)
1000
800
600
400
200
100
80
60
40
20
10
8
7
0
5
10
15
Effective Length L_e (m)
610UB125
610UB113
610UB101
530UB92.4
460UB82.1
530UB82.0
460UB74.6
460UB67.1
410UB59.7
360UB56.7
410UB53.7
360UB50.7
310UB46.2
360UB44.7
310UB40.4
250UB37.3
200UB25.4
310UB32.0
250UB31.4
200UB29.8
250UB25.7
200UB22.3
180UB22.2
180UB18.1
150UB18.0
200UB18.2
180UB16.1
150UB14.0
Values of ϕM_b
based on $\alpha_m = 1$
COMPRESSION

TABLE 5.3-6

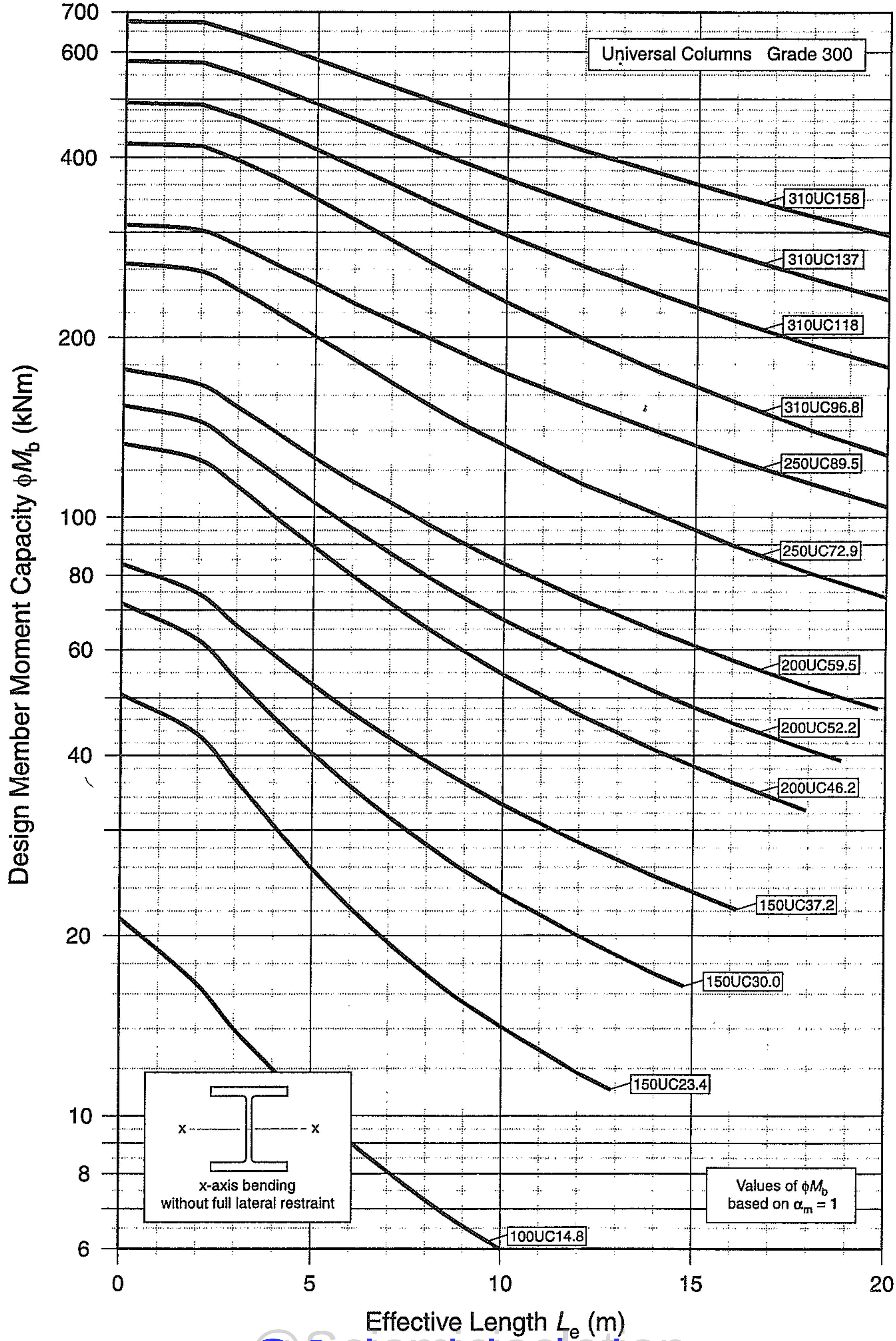
UNIVERSAL COLUMNS
GRADE 300

DESIGN MOMENT CAPACITIES FOR MEMBERS WITHOUT FULL LATERAL RESTRAINT
bending about x-axis



Designation	ϕM_{sx}	ϕV_v	Design Member Moment Capacities, ϕM_b (kNm) Effective Length (L_e) in metres														
	kNm	kN	2	3	4	5	6	7	8	9	10	12	14	16	18	20	22
310UC158	676	832	674	645	614	582	552	524	498	473	451	410	376	345	319	296	276
137	580	717	577	551	521	491	463	436	411	389	368	331	300	274	251	231	215
118	494	606	490	467	440	412	385	360	336	315	296	263	236	213	194	178	164
96.8	422	527	418	395	369	341	315	290	267	247	229	199	175	156	140	127	117
250UC 89.5	309	472	302	284	264	246	228	213	199	186	174	155	139	125	114	104	96.3
72.9	266	377	258	240	220	201	184	168	154	142	132	114	101	89.7	80.8	73.4	67.2
200UC 59.5	177	337	167	153	139	126	115	106	97.3	90.0	83.6	73.0	64.5	57.7	52.1	47.5	43.5
52.2	154	285	145	131	118	106	95.9	87.1	79.5	73.0	67.4	58.2	51.1	45.4	40.9	37.1	34.0
46.2	133	257	125	113	100	89.4	80.0	72.0	65.2	59.5	54.6	46.8	40.8	36.1	32.3	29.3	26.7
150UC 37.2	83.6	226	74.6	66.1	58.8	52.6	47.3	42.9	39.1	35.9	33.1	28.6	25.1	22.3	20.1	18.2	16.7
30.0	71.9	180	62.5	53.8	46.4	40.4	35.5	31.6	28.4	25.7	23.5	20.0	17.3	15.3	13.7	12.4	11.3
23.4	50.7	161	43.5	36.5	30.6	25.9	22.3	19.5	17.3	15.5	14.1	11.8	10.2	8.92	7.94	7.16	6.51
100UC 14.8	21.4	83.8	16.7	14.0	12.0	10.4	9.09	8.08	7.25	6.56	5.99	5.09	4.41	3.89	3.48	3.15	2.87

Notes: (1) Values of ϕM_b based on $\alpha_m = 1$ (uniform moment over entire segment).
For other moment distributions use the appropriate value of α_m obtained from AS 4100 Table 5.6.1 or 5.6.2 and use the minimum of $\alpha_m \phi M_b$ and ϕM_{sx} given above.
(2) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.


Universal Columns Grade 300
Design Member Moment Capacity ϕM_b (kNm)
Effective Length L_e (m)
700
600
400
200
100
80
60
40
20
10
8
6
0
5
10
15
20
310UC158
310UC137
310UC118
310UC96.8
250UC89.5
250UC72.9
200UC59.5
200UC52.2
200UC46.2
150UC37.2
150UC30.0
150UC23.4
100UC14.8
x-axis bending
without full lateral restraint
Values of ϕM_b based on $\alpha_m = 1$

STEM DOWN

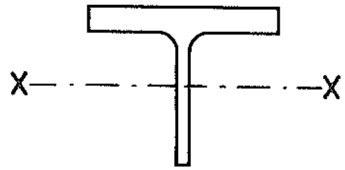


TABLE 5.3-7

TEES CUT FROM UNIVERSAL BEAMS
GRADE 300

DESIGN MOMENT CAPACITIES FOR MEMBERS WITHOUT FULL LATERAL RESTRAINT
bending about x- axis
stem down — flange in compression

Designation	ϕM_{sx}	ϕV_v	Design Member Moment Capacities, ϕM_b (kNm) Effective Length (L_e) in metres											
	kNm	kN	1	2	3	4	5	6	7	8	10	12	14	16
305BT62.5	112	520	112	112	110	106	102	97.4	93.4	89.6	82.3	75.7	69.8	64.5
56.5	104	486	104	104	101	96.9	92.6	88.4	84.3	80.3	72.9	66.3	60.5	55.4
50.5	103	488	103	103	98.9	94.1	89.0	84.0	79.1	74.5	66.1	58.9	52.7	47.5
265BT46.3	78.3	414	78.3	78.2	75.1	71.6	68.1	64.6	61.3	58.1	52.3	47.2	42.8	39.0
41.0	72.1	387	72.1	71.7	68.4	64.8	61.0	57.4	53.9	50.6	44.7	39.7	35.5	32.0
230BT41.1	56.8	346	56.8	56.6	54.4	52.1	49.8	47.5	45.3	43.2	39.4	36.0	32.9	30.3
37.3	51.8	316	51.8	51.5	49.4	47.1	44.8	42.5	40.4	38.3	34.6	31.4	28.5	26.1
33.6	47.6	293	47.6	47.2	45.0	42.7	40.3	38.0	35.9	33.8	30.1	27.0	24.3	22.0
205BT29.9	35.3	240	35.3	35.1	33.6	32.0	30.4	28.8	27.4	26.0	23.5	21.2	19.3	17.7
26.9	35.8	232	35.8	35.2	33.3	31.3	29.3	27.4	25.7	24.0	21.1	18.7	16.7	15.0
180BT28.4	28.2	217	28.2	28.0	26.9	25.8	24.7	23.6	22.6	21.6	19.8	18.2	16.8	15.5
25.4	25.4	196	25.4	25.2	24.1	23.0	21.9	20.8	19.8	18.8	17.1	15.5	14.2	13.0
22.4	24.4	184	24.4	23.9	22.7	21.4	20.1	18.9	17.8	16.7	14.8	13.2	11.8	10.7
155BT23.1	17.6	154	17.6	17.5	16.9	16.3	15.8	15.2	14.6	14.1	13.1	12.2	11.3	10.6
20.2	16.8	139	16.8	16.6	16.0	15.3	14.6	13.9	13.3	12.7	11.6	10.6	9.73	8.96
16.0	13.6	123	13.6	13.3	12.5	11.7	11.0	10.3	9.66	9.07	8.01	7.13	6.39	5.77
125BT18.7	12.3	123	12.3	12.2	11.7	11.3	10.8	10.4	9.99	9.60	8.87	8.21	7.61	7.08
15.7	11.2	115	11.2	11.0	10.4	9.88	9.36	8.87	8.40	7.97	7.18	6.50	5.91	5.40
12.9	9.03	92.5	9.03	8.67	8.14	7.63	7.14	6.69	6.27	5.88	5.21	4.64	4.17	3.77
100BT14.9*	7.86	97.4	7.86	7.86	7.86	7.86	7.86	7.86	7.86	7.86	7.86	7.86	7.86	7.86
12.7*	6.92	88.2	6.92	6.92	6.92	6.92	6.92	6.92	6.92	6.92	6.92	6.92	6.92	6.92
11.2*	5.62	75.2	5.62	5.62	5.62	5.62	5.62	5.62	5.62	5.62	5.62	5.62	5.62	5.62
9.1	5.11	66.3	5.11	4.79	4.45	4.13	3.83	3.56	3.31	3.09	2.71	2.40	2.14	1.93
90BT11.1	5.40	80.4	5.40	5.15	4.88	4.62	4.38	4.16	3.94	3.75	3.39	3.08	2.81	2.58
9.1	4.37	65.3	4.37	4.11	3.85	3.61	3.38	3.17	2.98	2.80	2.49	2.23	2.01	1.83
8.1	3.87	58.0	3.87	3.61	3.36	3.12	2.90	2.70	2.52	2.36	2.07	1.84	1.65	1.48
75BT 9.0	3.96	69.7	3.94	3.70	3.48	3.27	3.08	2.90	2.73	2.58	2.31	2.08	1.88	1.71
7.0	3.14	56.2	3.09	2.85	2.62	2.41	2.23	2.06	1.91	1.77	1.54	1.36	1.21	1.08

Notes: (1) * indicates bending about minor principal y-axis, for the axis shown in the diagram. These sections cannot buckle laterally when bending about the y-axis.
(2) Values of ϕM_b based on $\alpha_m = 1$ (uniform moment over entire segment).
For other moment distributions use the appropriate value of α_m obtained from AS 4100 Table 5.6.1 or 5.6.2 and use the minimum of $\alpha_m(\phi M_b)$ & ϕM_{sx} given above.
(3) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

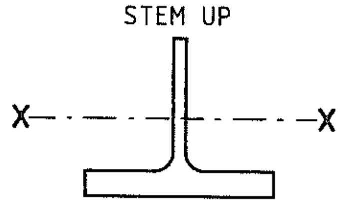
TABLE 5.3-8

TEES CUT FROM UNIVERSAL BEAMS GRADE 300

DESIGN MOMENT CAPACITIES FOR MEMBERS WITHOUT FULL LATERAL RESTRAINT

bending about x-axis

stem up — stem in compression



Designation	ϕM_{sx}	ϕV_v	Design Member Moment Capacities, ϕM_b (kNm) Effective Length (L_e) in metres											
	kNm	kN	1	2	3	4	5	6	7	8	10	12	14	16
305BT62.5	72.7	520	64.0	63.1	61.8	60.4	58.9	57.4	55.9	54.4	51.6	48.9	46.3	44.0
56.5	59.6	486	51.5	50.8	49.8	48.7	47.5	46.2	45.0	43.8	41.5	39.3	37.2	35.3
50.5	49.5	488	41.3	40.7	39.9	39.0	38.0	37.0	36.0	35.0	33.0	31.2	29.5	27.9
265BT46.3	45.3	414	39.3	38.7	37.8	36.8	35.7	34.7	33.7	32.7	30.7	28.9	27.3	25.8
41.0	37.0	387	31.0	30.5	29.8	29.0	28.1	27.3	26.4	25.6	24.0	22.5	21.2	20.0
230BT41.1	39.5	346	35.4	34.7	33.7	32.7	31.7	30.7	29.7	28.8	27.0	25.4	23.8	22.5
37.3	32.7	316	28.9	28.4	27.6	26.8	26.0	25.2	24.4	23.6	22.1	20.8	19.5	18.4
33.6	26.3	293	22.8	22.4	21.8	21.2	20.5	19.9	19.3	18.7	17.5	16.4	15.4	14.5
205BT29.9	20.8	240	18.7	18.4	17.9	17.4	16.9	16.4	15.9	15.4	14.5	13.7	12.9	12.2
26.9	18.8	232	16.2	15.9	15.5	15.0	14.5	14.0	13.5	13.0	12.2	11.4	10.6	9.99
180BT28.4	20.2	217	18.6	18.2	17.7	17.2	16.6	16.1	15.6	15.1	14.2	13.4	12.6	11.9
25.4	17.0	196	15.4	15.0	14.6	14.2	13.7	13.3	12.8	12.4	11.6	10.9	10.2	9.61
22.4	14.2	184	12.4	12.1	11.8	11.4	11.0	10.6	10.2	9.86	9.18	8.56	8.00	7.49
155BT23.1	12.4	154	11.8	11.6	11.3	11.0	10.8	10.5	10.2	9.93	9.43	8.95	8.50	8.09
20.2	10.2	139	9.58	9.39	9.15	8.91	8.67	8.42	8.19	7.96	7.52	7.11	6.73	6.38
16.0	7.23	123	6.53	6.38	6.18	5.98	5.78	5.58	5.39	5.21	4.86	4.55	4.26	4.00
125BT18.7	9.38	123	8.96	8.74	8.49	8.24	7.99	7.75	7.51	7.29	6.86	6.46	6.10	5.76
15.7	8.37	115	7.66	7.42	7.15	6.87	6.61	6.35	6.10	5.86	5.43	5.03	4.68	4.36
12.9	5.56	92.5	5.12	4.95	4.77	4.58	4.40	4.22	4.06	3.90	3.60	3.34	3.10	2.89
100BT14.9*	6.60	97.4	6.60	6.60	6.60	6.60	6.60	6.60	6.60	6.60	6.60	6.60	6.60	6.60
12.7*	5.67	88.2	5.67	5.67	5.67	5.67	5.67	5.67	5.67	5.67	5.67	5.67	5.67	5.67
11.2*	4.50	75.2	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50
9.1	3.64	66.3	3.35	3.19	3.03	2.87	2.72	2.59	2.46	2.33	2.12	1.93	1.77	1.62
90BT11.1	4.75	80.4	4.55	4.35	4.15	3.96	3.78	3.60	3.44	3.29	3.01	2.77	2.55	2.36
9.1	3.57	65.3	3.36	3.19	3.03	2.87	2.73	2.59	2.46	2.34	2.12	1.93	1.77	1.63
8.1	3.01	58.0	2.79	2.65	2.50	2.36	2.24	2.12	2.00	1.90	1.72	1.56	1.42	1.30
75BT 9.0	3.66	69.7	3.49	3.30	3.11	2.94	2.78	2.63	2.49	2.36	2.13	1.93	1.76	1.62
7.0	2.73	56.2	2.52	2.35	2.19	2.04	1.90	1.77	1.66	1.56	1.38	1.23	1.11	1.00

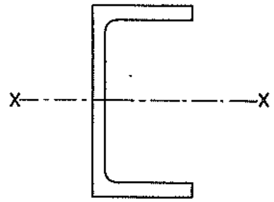
Notes: (1) * indicates bending about minor principal y-axis, for the axis shown in the diagram. These sections cannot buckle laterally when bending about the y-axis.
(2) Values of ϕM_b based on $\alpha_m = 1$ (uniform moment over entire segment).
For other moment distributions use the appropriate value of α_m obtained from AS 4100 Table 5.6.1 or 5.6.2 and use the minimum of $\alpha_m(\phi M_b)$ & ϕM_{sx} given above.
(3) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

TABLE 5.3-9

PARALLEL FLANGE CHANNELS
GRADE 300

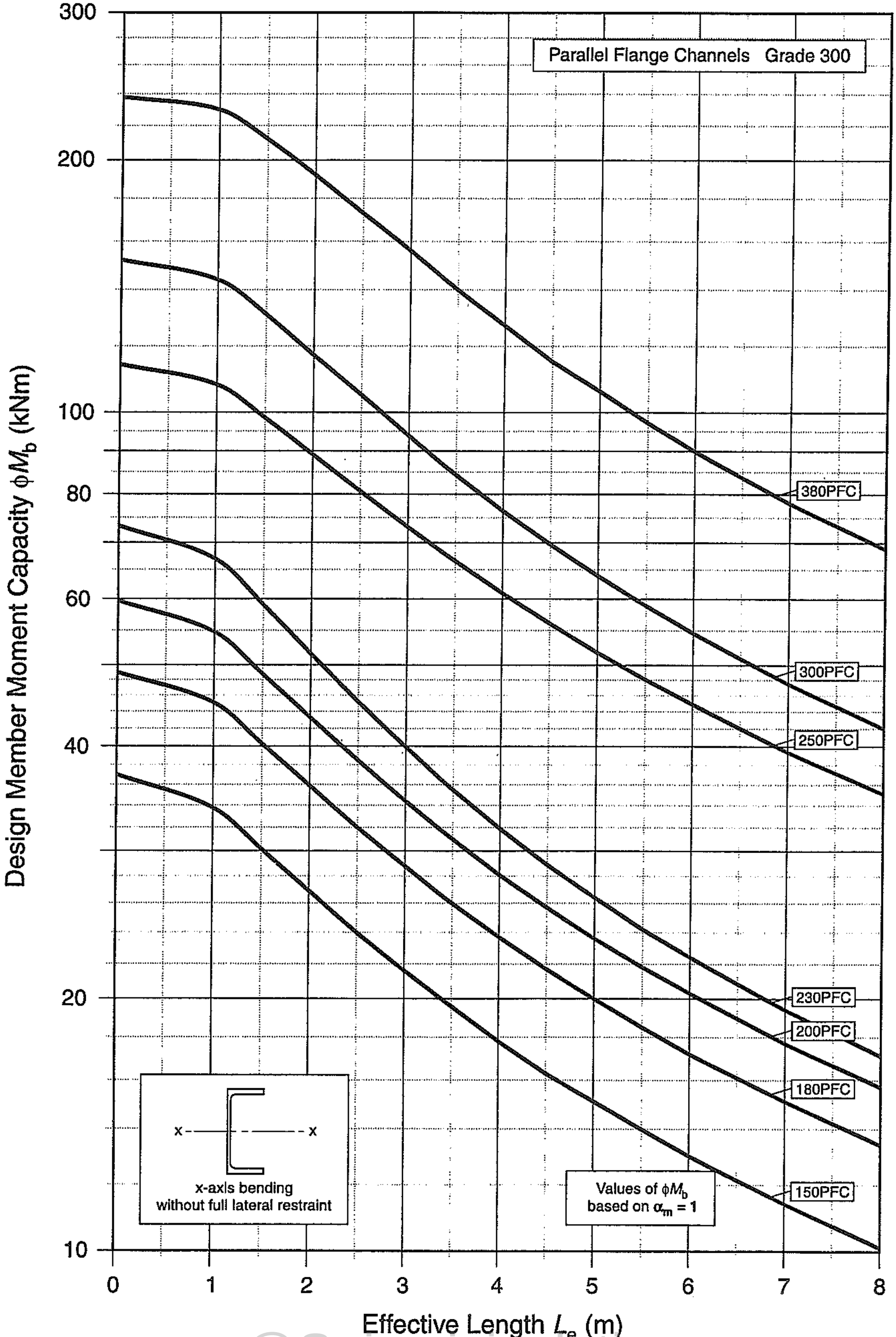
re-exam at 1.0

DESIGN MOMENT CAPACITIES FOR MEMBERS WITHOUT FULL LATERAL RESTRAINT
bending about x-axis



Designation	Mass per metre	ϕM_{sx}	ϕV_v	Design Member Moment Capacities, ϕM_b (kNm) Effective Length (L_e) in metres												
	kg/m	kNm	kN	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	7.0	8.0
380 PFC	55.2	238	657	230	212	192	173	156	140	127	115	106	97.2	89.9	78.0	68.8
300 PFC	40.1	152	415	144	131	117	105	93.8	84.4	76.4	69.7	63.9	58.9	54.6	47.5	42.0
250 PFC	35.5	114	346	108	98.6	89.2	80.7	73.1	66.6	61.0	56.1	51.8	48.1	44.9	39.4	35.1
230 PFC	25.1	73.3	258	67.0	59.1	51.6	45.2	39.9	35.5	31.9	28.9	26.4	24.2	22.4	19.4	17.1
200 PFC	22.9	59.7	207	54.8	48.8	43.3	38.5	34.4	31.0	28.1	25.7	23.6	21.8	20.3	17.7	15.7
180 PFC	20.9	49.0	187	45.1	40.3	35.9	32.0	28.8	26.0	23.7	21.7	20.0	18.5	17.2	15.1	13.4
150 PFC	17.7	37.0	156	33.8	30.2	26.9	24.0	21.6	19.6	17.8	16.3	15.1	14.0	13.0	11.4	10.1

Notes: (1) Values of ϕM_b based on $\alpha_m = 1$ (uniform moment over entire segment).
For other moment distributions use the appropriate value of α_m obtained from AS 4100 Table 5.6.1 or 5.6.2 and use the minimum of $\alpha_m \phi M_b$ & ϕM_s given above.
(2) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

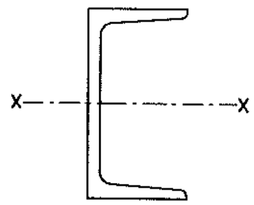


Parallel Flange Channels Grade 300
Design Member Moment Capacity ϕM_b (kNm)
300
200
100
80
60
40
20
10
380PFC
300PFC
250PFC
230PFC
200PFC
180PFC
150PFC
x-axis bending
without full lateral restraint
Values of ϕM_b based on $\alpha_m = 1$
0
1
2
3
4
5
6
7
8
Effective Length L_e (m)

TABLE 5.3-10

TAPER FLANGE CHANNELS
GRADE 250

DESIGN MOMENT CAPACITIES FOR MEMBERS WITHOUT FULL LATERAL RESTRAINT
bending about x-axis



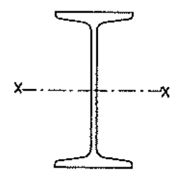
Designation	Mass per metre	ϕM_{sx}	ϕV_v	Design Member Moment Capacities, ϕM_b (kNm) Effective Length (L_e) in metres												
	kg/m	kNm	kN	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	7.0	8.0
125 TFC	13.4	18.6	105	16.8	15.1	13.6	12.3	11.2	10.2	9.39	8.66	8.03	7.48	6.99	6.16	5.50
100 TFC	9.34	10.4	70.2	8.96	7.94	7.08	6.35	5.74	5.22	4.77	4.39	4.05	3.76	3.51	3.08	2.74
75 TFC	6.65	5.39	52.7	4.54	4.03	3.60	3.24	2.93	2.66	2.44	2.24	2.07	1.92	1.79	1.57	1.40

Note: Values of ϕM_b based on $\alpha_m = 1$ (uniform moment over entire segment).
For other moment distributions use the appropriate value of α_m obtained from AS 4100 Table 5.6.1 or 5.6.2 and use the minimum of $\alpha_m \phi M_b$ & ϕM_s given above.

TABLE 5.3-11

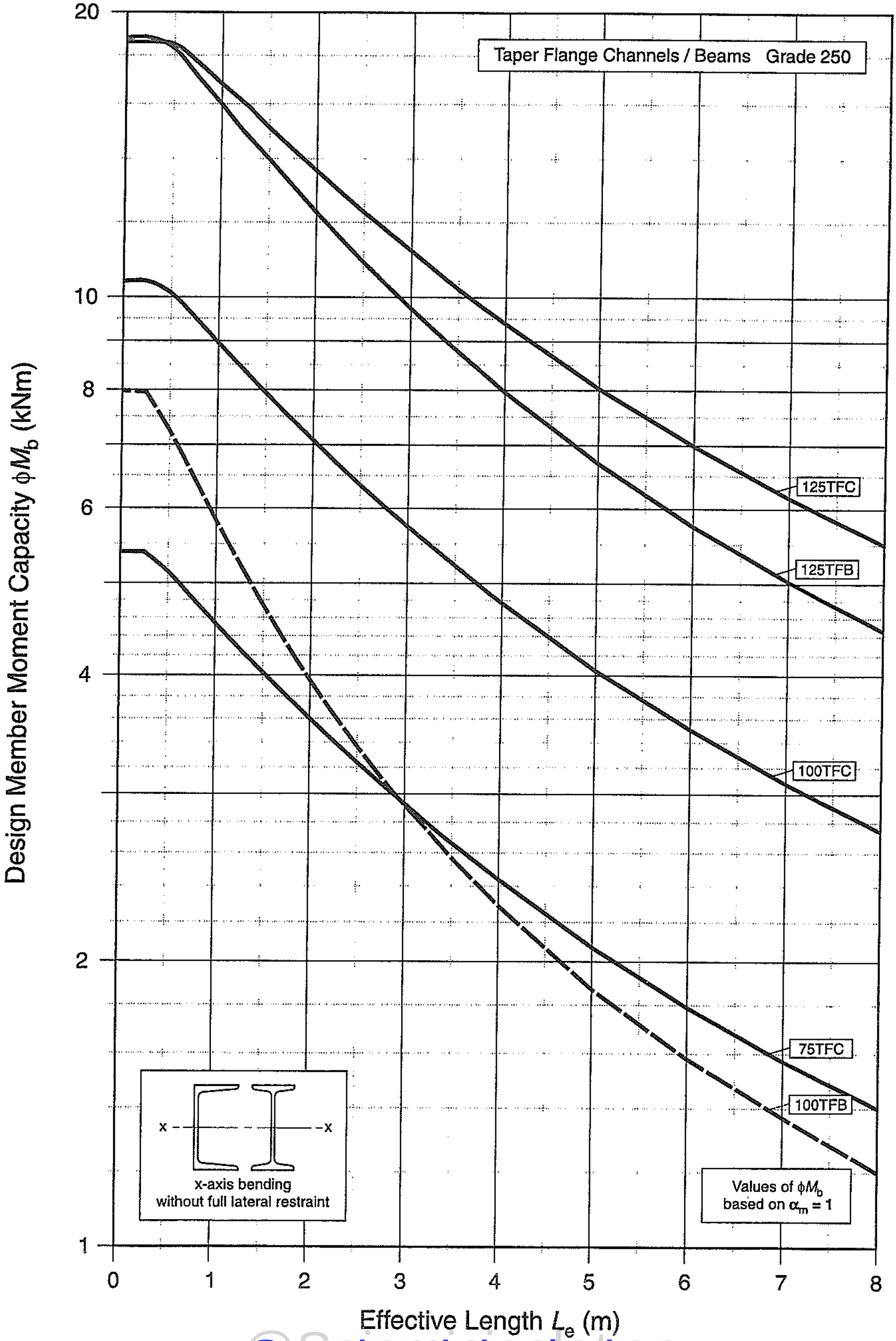
TAPER FLANGE BEAMS
GRADE 250

DESIGN MOMENT CAPACITIES FOR MEMBERS WITHOUT FULL LATERAL RESTRAINT
bending about x-axis



Designation	Mass per metre	ϕM_{sx}	ϕV_v	Design Member Moment Capacities, ϕM_b (kNm) Effective Length (L_e) in metres												
		kNm	kN	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0
125TFB	13.1	18.8	87.8	18.3	17.1	16.0	14.9	14.0	13.1	12.3	10.9	9.74	8.78	7.97	7.29	6.70
100TFB	7.20	7.98	56.2	7.25	6.50	5.82	5.24	4.74	4.32	3.95	3.37	2.92	2.57	2.29	2.06	1.87

Note: Values of ϕM_b based on $\alpha_m = 1$ (uniform moment over entire segment).
For other moment distributions use the appropriate value of α_m obtained from AS 4100 Table 5.6.1 or 5.6.2 and use the minimum of $\alpha_m \phi M_b$ & ϕM_s given above.


Taper Flange Channels / Beams Grade 250
Design Member Moment Capacity ϕM_b (kNm)
20
10
8
6
4
2
1
125TFC
125TFB
100TFC
75TFC
100TFB
x-axis bending
without full lateral restraint
x
x
Values of ϕM_b
based on $\alpha_m = 1$
0
1
2
3
4
5
6
7
8
Effective Length L_e (m)

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PART 6 MEMBERS SUBJECT TO AXIAL COMPRESSION

TABLES

PART 6 MEMBERS SUBJECT TO AXIAL COMPRESSION

6.1 General

Values of the design member capacity in compression (ϕN_c) for buckling about both principal axes, for a range of effective lengths (L_e) are given in Tables 6-1 to 6-13. The capacities are determined from Section 6 of AS 4100. Many tables are supplemented by graphs of ϕN_c versus L_e placed consecutively after the tables for each corresponding grade and section. All loads are assumed to be applied through the centroid of the section. The column capacity is associated with flexural or flexural-torsional buckling.

The tables in this section have been grouped into two series:

- the (A) series for the member buckling about the x-axis, and
- the (B) series for the member buckling about the y-axis.

The (A) series tables and graphs are immediately followed by the (B) series of tables and graphs.

6.2 Design Section Capacity in Axial Compression

The design section capacity in compression (ϕN_s) is obtained from Clause 6.2 of AS 4100 and is given by:

$$\phi N_s = \phi\, k_f\, A_n\, f_y$$

where ϕ = 0.9 (Table 3.4 of AS 4100)

k_f = form factor (see Section 3.2.2.3)

A_n = net area of the cross-section

= A_g assuming no penetrations or holes

f_y = yield stress (*for sections where the flange and web yield stresses (f_{yf} & f_{yw}) differ, the **lower** value applied to the entire cross-section in the above equation for* ϕN_s)

The design *section* capacity considers the behaviour of the cross-section only (as in a stub column test), and is affected by the element slenderness of each plate element in the cross-section. The form factor (k_f) represents the proportion of the section that is effective in axial compression due to local buckling. The design *member* capacity in compression (Section 6.3) accounts for (amongst other factors) overall member buckling considering the effective length of the member.

6.3 Design Member Capacity in Axial Compression

The design member capacity in compression (ϕN_c) is obtained from Clause 6.3 of AS 4100 and is given by:

$$\phi N_c = \phi\, \alpha_c\, N_s \qquad \leq \phi N_s$$

where ϕ = 0.9 (Table 3.4 of AS 4100)

α_c = member slenderness reduction factor

The member slenderness reduction factor (α_c) depends on the modified member slenderness (λ_n) and the member section constant (α_b). From Clause 6.3.3 of AS 4100

$$\alpha_c = \xi\left\{1-\sqrt{\left[1-\left(\frac{90}{\xi\lambda}\right)^2\right]}\right\}$$

where

$$\xi = \frac{\left(\frac{\lambda}{90}\right)^2 + 1 + \eta}{2\left(\frac{\lambda}{90}\right)^2}$$

$$\lambda_n = \left(\frac{L_e}{r}\right)\sqrt{(k_f)}\sqrt{\left(\frac{f_y}{250}\right)}$$

$$\lambda = \lambda_n + \alpha_a\,\alpha_b$$

$$\alpha_a = \frac{2100\,(\lambda_n - 13.5)}{\lambda_n^2 - 15.3\,\lambda_n + 2050}$$

$$\eta = 0.00326\,(\lambda - 13.5) \geq 0$$

L_e = effective length of a compression member

r = radius of gyration about the axis of buckling

For routine design the above equations need not be used. AS 4100 Table 6.3.3(3) should be consulted to obtain the value of α_c directly from λ_n and α_b.

Note that the design member capacity equals the design section capacity ($\phi N_c = \phi N_s$) when the effective length is zero ($L_e = 0$).

Table 6.1 below lists values α_b for the sections considered in this publication.

TABLE 6.1

Section	**Member section constant α_b**	
	$k_f = 1.0$	$k_f < 1.0$
WB, WC	0	0.5
UB, UC, TFB	0	0
Channels	0.5	1.0
Structural Tees	0.5	1.0
Angles	0.5	1.0

6.4 Effective Length

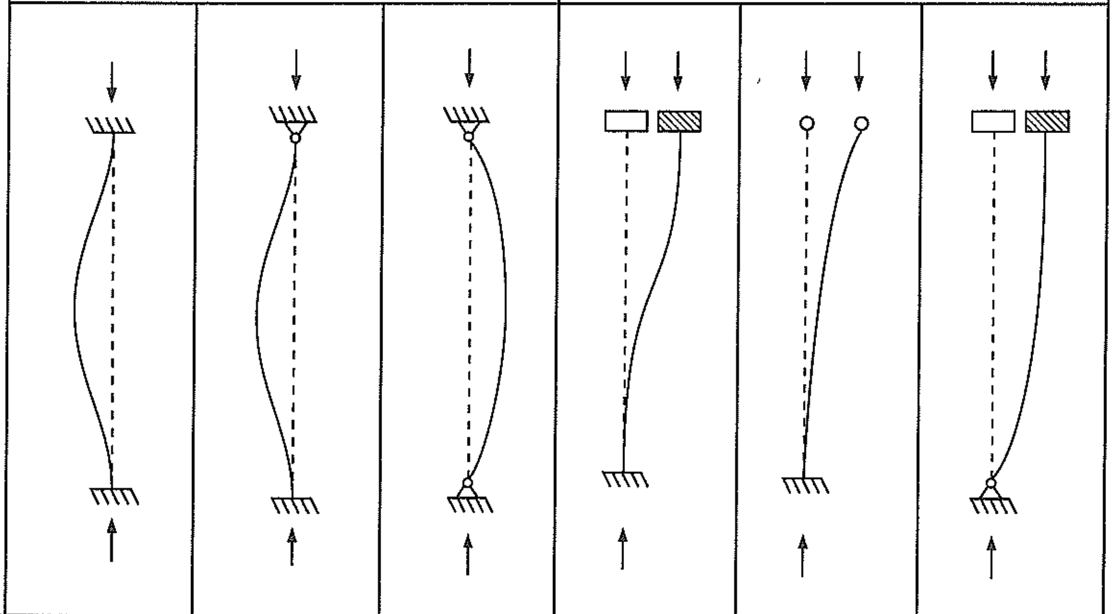
The values of ϕN_c depend on the *effective length* (L_e) of the member. The effective length depends on the rotational and translational restraints at the ends of the member and is determined using the following formula:

$$L_e = k_e L$$

The member effective length factor (k_e) (Clause 6.3.2 of AS 4100) can be determined using Clause 4.6.3 of AS 4100 or by a rational frame buckling analysis (Clause 4.7 of AS 4100).

k_e is given in Table 6.2 for members with idealised end restraints. For braced or sway members in frames, k_e depends on the ratio (γ) of the compression member stiffness to the end restraint stiffness, calculated at each end of the member. Example 2 of Section 4.3 provides a sample calculation of k_e for a simple unbraced plane frame.

TABLE 6.2: Effective Length Factors for Members for Idealised Conditions of End Restraint

	Braced Member			Sway Member		
Buckled Shape						
Effective length factor (k_e)	0.7	0.85	1.0	1.2	2.2	2.2
Symbols for end restraint conditions	= Rotation fixed, translation fixed = Rotation free, translation fixed			= Rotation fixed, translation free = Rotation free, translation free		

6.5 Example

Design a Universal Column, with a length of 5.8 m, in Grade 300 steel to resist a design axial force, $N^* = 850$ kN. Assume that for x-axis buckling both ends are pinned (rotation free, translation fixed), while for y-axis buckling one end is pinned and the other end is rotationally and translationally fixed.

<u>Design Data</u>

$N^* = 850$ kN

<u>Solution</u>

(i) Determine effective lengths

For x-axis buckling $k_e = 1.0$ (Table 6.2)

$\therefore \quad L_{ex} = k_e L = 1 \times 5.8 = 5.8 \text{ m} \approx 6.0 \text{ m}$

For y-axis buckling $k_e = 0.85$ (Table 6.2)

$\therefore \quad L_{ey} = k_e L = 0.85 \times 5.8 = 4.93 \text{ m} \approx 5.0 \text{ m}$

(ii) Select a member

For buckling about the x-axis, the smallest member is

200UC46.2 $\quad \phi N_{cx} = 1140$ kN $\quad (L_{ex} = 6.0 \text{ m})$ (Table 6-6(A))

$> N^*$

For buckling about the y-axis

200UC46.2 $\quad \phi N_{cy} = 786$ kN $\quad (L_{ey} = 5.0 \text{ m})$ (Table 6-6(B))

$< N^*$ which is inadequate

Select new section based on y-axis buckling

200UC52.2 $\quad \phi N_{cy} = 900$ kN $\quad (L_{ey} = 5.0 \text{ m})$ (Table 6-6(B))

$> N^*$

Check new section for buckling about x-axis

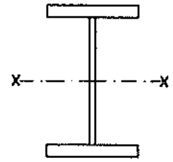
200UC52.2 $\quad \phi N_{cx} = 1300$ kN $\quad (L_{ex} = 6.0 \text{ m})$ (Table 6-6(A))

$> N^*$

$\therefore$ Adopt a 200UC52.2 Grade 300 steel member.

TABLE 6-1(A)

WELDED BEAMS
GRADE 300
DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION
buckling about x-axis



Designation	ϕN_s (kN)	Design Member Capacities in Axial Compression, ϕN_c (kN) Effective Length (L_e) in metres													
	(L_e=0)	2	4	6	8	10	12	15	18	21	24	27	30	33	36
1200WB455	12200	12200	12200	12200	12100	11900	11700	11300	11000	10600	10200	9810	9390	8950	8490
423	11200	11200	11200	11200	11100	10900	10700	10400	10000	9700	9350	8980	8590	8180	7760
392	10200	10200	10200	10200	10100	9910	9720	9430	9130	8820	8490	8150	7790	7420	7030
342	8580	8580	8580	8580	8500	8340	8180	7930	7670	7410	7130	6840	6540	6220	5890
317	7780	7780	7780	7780	7700	7550	7400	7170	6940	6700	6450	6180	5900	5610	5310
278	6540	6540	6540	6540	6470	6340	6220	6020	5830	5620	5400	5180	4940	4690	4430
249	5600	5600	5600	5600	5530	5420	5310	5140	4970	4800	4610	4410	4200	3990	3770
1000WB322	8580	8580	8580	8580	8390	8190	8000	7700	7390	7070	6720	6350	5970	5570	5180
296	7780	7780	7780	7770	7590	7420	7240	6960	6680	6380	6060	5720	5370	5010	4650
258	6540	6540	6540	6530	6380	6230	6070	5840	5600	5340	5070	4780	4470	4170	3860
215	5450	5450	5450	5420	5280	5150	5020	4810	4590	4360	4110	3850	3590	3320	3050
900WB282	7650	7650	7650	7610	7420	7230	7050	6760	6450	6130	5780	5420	5040	4670	4300
257	6840	6840	6840	6800	6630	6470	6300	6040	5760	5470	5160	4830	4490	4150	3810
218	5610	5610	5610	5570	5430	5290	5150	4940	4710	4470	4210	3930	3650	3370	3100
175	4480	4480	4480	4440	4320	4200	4080	3900	3710	3500	3280	3050	2810	2580	2350
800WB192	5070	5070	5070	4990	4850	4710	4570	4350	4110	3850	3580	3300	3020	2740	2490
168	4300	4300	4300	4230	4110	3990	3870	3680	3480	3260	3020	2780	2540	2310	2090
146	3830	3830	3830	3760	3650	3540	3420	3240	3050	2840	2620	2400	2180	1970	1770
122	3020	3020	3020	2960	2870	2780	2690	2550	2390	2230	2050	1870	1700	1530	1380
700WB173	4710	4710	4710	4580	4430	4280	4120	3870	3600	3300	3000	2700	2410	2150	1920
150	3980	3980	3980	3870	3740	3610	3470	3260	3020	2770	2510	2260	2010	1790	1600
130	3560	3560	3560	3440	3320	3200	3070	2870	2640	2410	2160	1930	1710	1510	1340
115	3020	3020	3020	2920	2810	2710	2600	2420	2230	2020	1810	1610	1430	1260	1120

@Seismicisolation

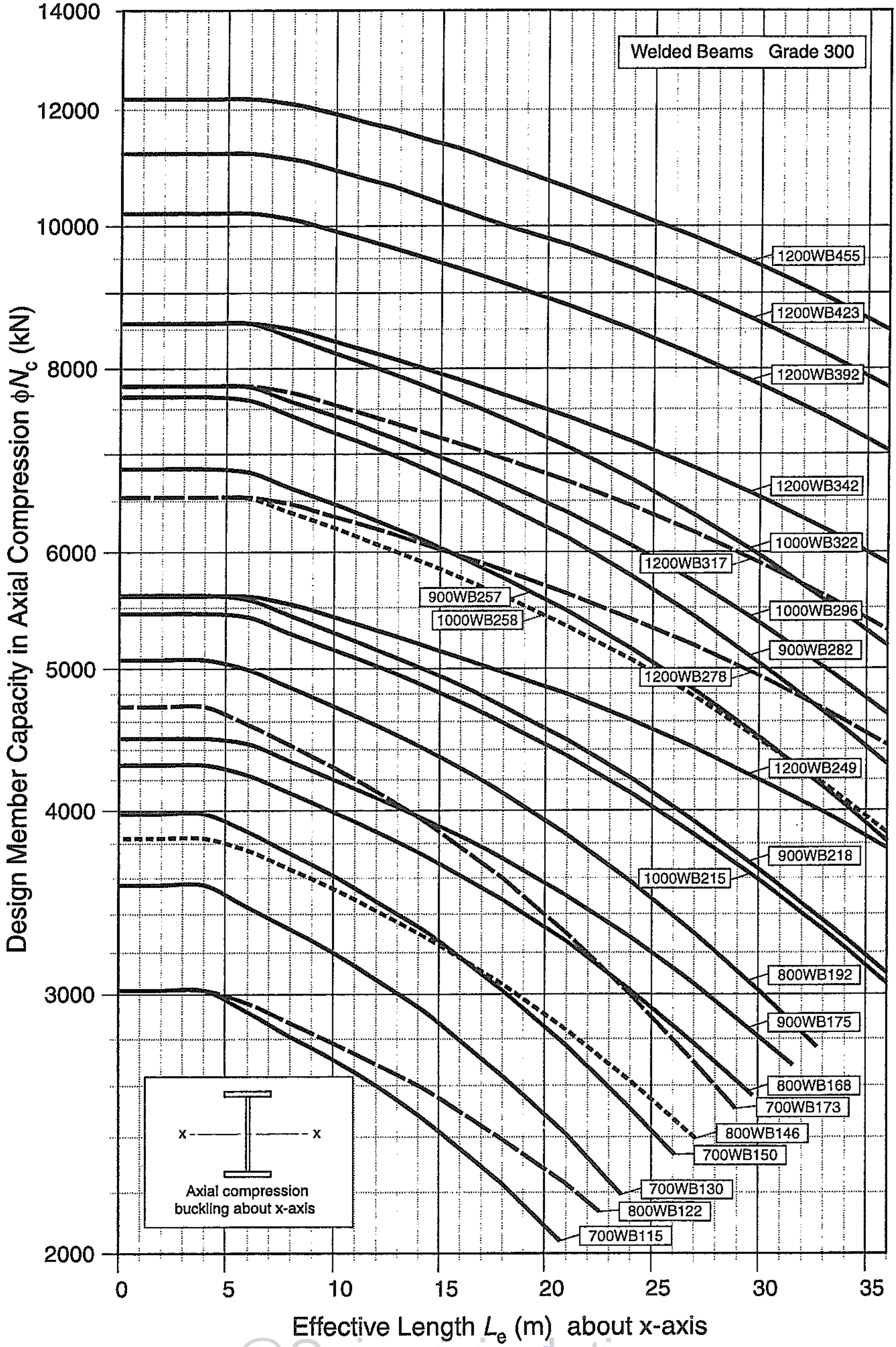

Welded Beams Grade 300
Design Member Capacity in Axial Compression ϕN_c (kN)
Effective Length L_e (m) about x-axis
14000
12000
10000
8000
6000
5000
4000
3000
2000
0
5
10
15
20
25
30
35
1200WB455
1200WB423
1200WB392
1200WB342
1000WB322
1200WB317
900WB257
1000WB258
1000WB296
900WB282
1200WB278
1200WB249
900WB218
1000WB215
800WB192
900WB175
800WB168
700WB173
800WB146
700WB150
700WB130
800WB122
700WB115
x
x
Axial compression buckling about x-axis

TABLE 6-1(B)

WELDED BEAMS
GRADE 300
DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION
buckling about y-axis

Designation	ϕN_s (kN)	Design Member Capacities in Axial Compression, ϕN_c (kN) Effective Length (L_e) in metres													
	(L_e=0)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	10.0
1200WB455	12200	12200	12200	12100	11800	11600	11300	11100	10800	10500	9980	9390	8750	8090	7420
423	11200	11200	11200	11000	10800	10600	10400	10100	9890	9640	9130	8570	7980	7370	6750
392	10200	10200	10200	10000	9830	9620	9410	9200	8980	8750	8270	7760	7210	6650	6080
342	8580	8580	8480	8260	8030	7800	7560	7320	7060	6790	6220	5610	5000	4420	3890
317	7780	7780	7680	7470	7260	7040	6820	6600	6360	6110	5580	5010	4450	3930	3450
278	6540	6540	6360	6150	5940	5720	5490	5250	4990	4720	4160	3610	3100	2660	2290
249	5600	5500	5270	5020	4770	4500	4210	3900	3580	3260	2670	2180	1800	1490	1260
1000WB322	8580	8580	8480	8260	8030	7800	7560	7320	7060	6790	6220	5610	5000	4420	3890
296	7780	7780	7680	7470	7260	7040	6820	6600	6360	6110	5570	5010	4450	3920	3450
258	6540	6540	6360	6150	5940	5720	5490	5250	4990	4720	4160	3610	3100	2660	2290
215	5450	5370	5150	4920	4680	4430	4160	3870	3570	3270	2700	2220	1830	1530	1290
900WB282	7650	7650	7590	7400	7210	7020	6820	6620	6410	6190	5720	5210	4690	4190	3720
257	6840	6840	6790	6620	6440	6270	6090	5900	5710	5510	5080	4630	4160	3710	3290
218	5610	5610	5490	5330	5160	4990	4810	4620	4430	4220	3780	3340	2910	2530	2190
175	4480	4450	4280	4120	3940	3760	3570	3360	3140	2920	2470	2070	1740	1460	1240
800WB192	5070	5070	4900	4730	4560	4380	4190	3990	3780	3550	3100	2660	2260	1930	1660
168	4300	4270	4110	3950	3780	3610	3420	3220	3020	2800	2380	1990	1670	1410	1190
146	3830	3790	3640	3490	3330	3160	2980	2790	2590	2390	2000	1660	1380	1150	975
122	3020	2960	2820	2680	2530	2370	2200	2020	1840	1660	1340	1080	885	732	614
700WB173	4710	4690	4510	4340	4160	3970	3770	3560	3330	3100	2630	2210	1860	1570	1330
150	3980	3920	3760	3590	3420	3230	3030	2820	2600	2370	1960	1610	1330	1110	933
130	3560	3490	3340	3180	3010	2830	2640	2430	2220	2010	1640	1330	1090	905	760
115	3020	2960	2820	2680	2530	2370	2200	2020	1840	1660	1340	1080	885	732	614

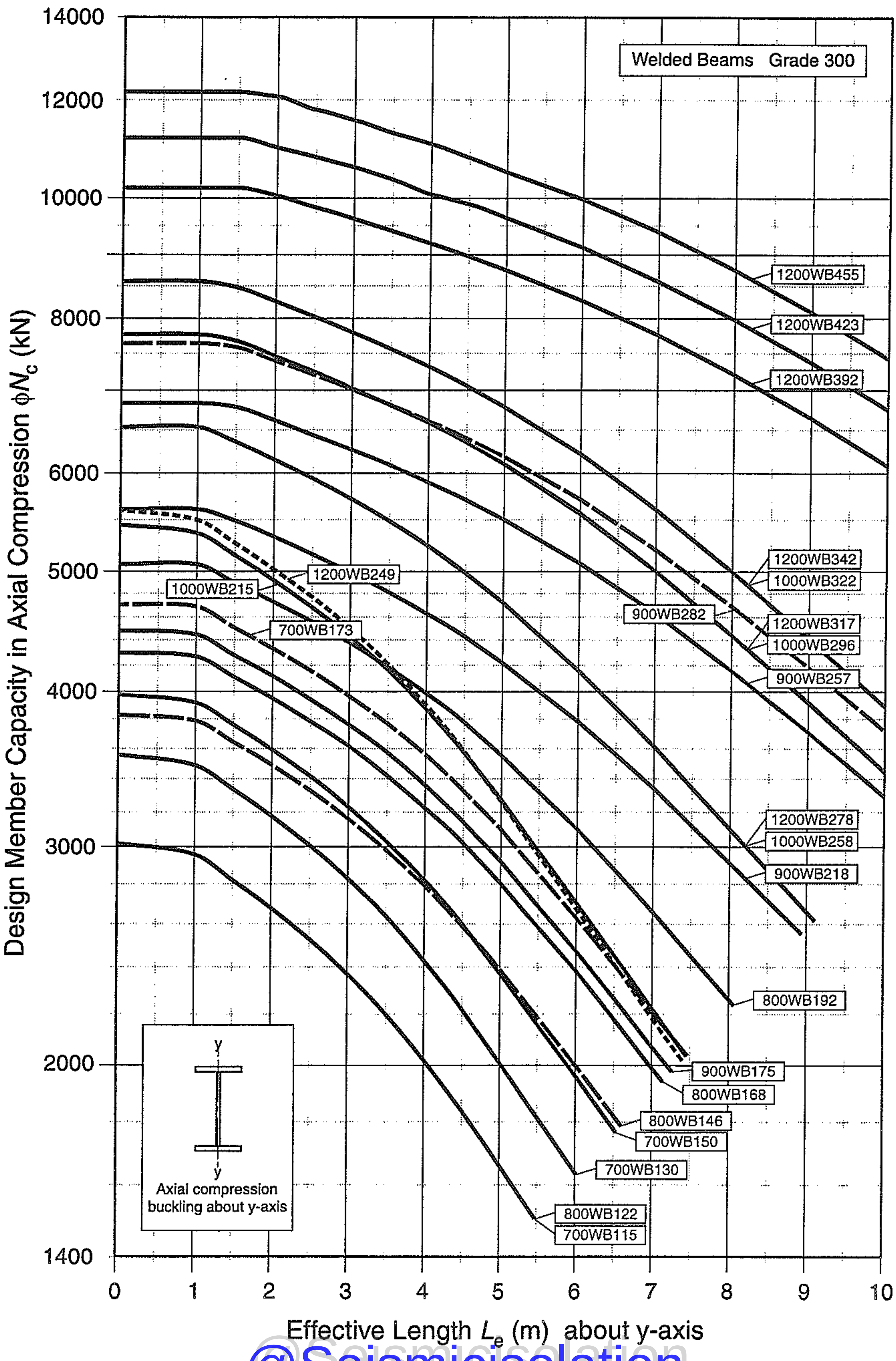
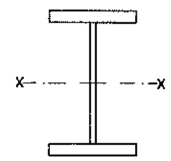

Welded Beams Grade 300
Design Member Capacity in Axial Compression ϕN_c (kN)
Effective Length L_e (m) about y-axis
14000
12000
10000
8000
6000
5000
4000
3000
2000
1400
0
1
2
3
4
5
6
7
8
9
10
1200WB455
1200WB423
1200WB392
1200WB342
1000WB322
900WB282
1200WB317
1000WB296
900WB257
1200WB249
1000WB215
700WB173
1200WB278
1000WB258
900WB218
800WB192
900WB175
800WB168
800WB146
700WB150
700WB130
800WB122
700WB115
y
y
Axial compression buckling about y-axis

TABLE 6-2(A)

WELDED BEAMS
GRADE 400
DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION
buckling about x-axis



Designation	ϕN_s (kN)	Design Member Capacities in Axial Compression, ϕN_c (kN) Effective Length (L_e) in metres													
	(L_e=0)	2	4	6	8	10	12	15	18	21	24	27	30	33	36
1200WB455	15400	15400	15400	15400	15100	14800	14500	14000	13500	12900	12400	11800	11100	10500	9830
423	14100	14100	14100	14100	13800	13500	13200	12800	12300	11800	11300	10800	10200	9580	8970
392	12800	12800	12800	12800	12600	12300	12000	11600	11200	10700	10200	9740	9210	8660	8110
342	10700	10700	10700	10700	10500	10300	10100	9710	9350	8970	8560	8140	7690	7230	6770
317	9680	9680	9680	9680	9490	9290	9080	8760	8430	8080	7720	7330	6930	6510	6080
278	8090	8090	8090	8090	7930	7760	7580	7310	7030	6740	6430	6100	5760	5410	5050
249	6870	6870	6870	6870	6740	6590	6430	6200	5970	5720	5450	5170	4880	4570	4270
1000WB322	10700	10700	10700	10600	10400	10100	9810	9390	8940	8460	7960	7420	6870	6330	5800
296	9680	9680	9680	9590	9340	9100	8850	8460	8060	7620	7160	6670	6170	5670	5190
258	8090	8090	8090	8010	7800	7590	7380	7050	6710	6340	5940	5530	5100	4690	4280
215	6590	6590	6590	6500	6330	6150	5970	5690	5390	5070	4730	4370	4010	3660	3330
900WB282	9660	9660	9660	9510	9250	8980	8710	8290	7840	7360	6850	6310	5780	5260	4770
257	8620	8620	8620	8490	8250	8010	7770	7390	6990	6550	6090	5610	5130	4660	4230
218	7030	7030	7030	6920	6720	6530	6330	6020	5680	5330	4940	4550	4160	3780	3420
175	5500	5500	5500	5400	5240	5080	4920	4660	4390	4090	3780	3460	3140	2840	2560
800WB192	6390	6390	6390	6230	6030	5830	5620	5300	4940	4560	4170	3770	3380	3030	2710
168	5400	5400	5400	5260	5090	4920	4750	4470	4170	3840	3500	3170	2840	2540	2270
146	4730	4730	4730	4600	4440	4290	4130	3870	3600	3300	2990	2690	2400	2140	1910
122	3710	3710	3710	3600	3480	3350	3230	3030	2810	2570	2330	2090	1860	1660	1480
700WB173	5930	5930	5910	5700	5480	5270	5040	4670	4260	3830	3400	3000	2640	2320	2050
150	5000	5000	4970	4790	4610	4420	4230	3910	3570	3200	2840	2500	2200	1930	1700
130	4390	4390	4360	4190	4030	3860	3680	3390	3070	2730	2410	2110	1840	1610	1420
115	3710	3710	3680	3540	3400	3250	3090	2840	2570	2290	2010	1760	1530	1340	1180

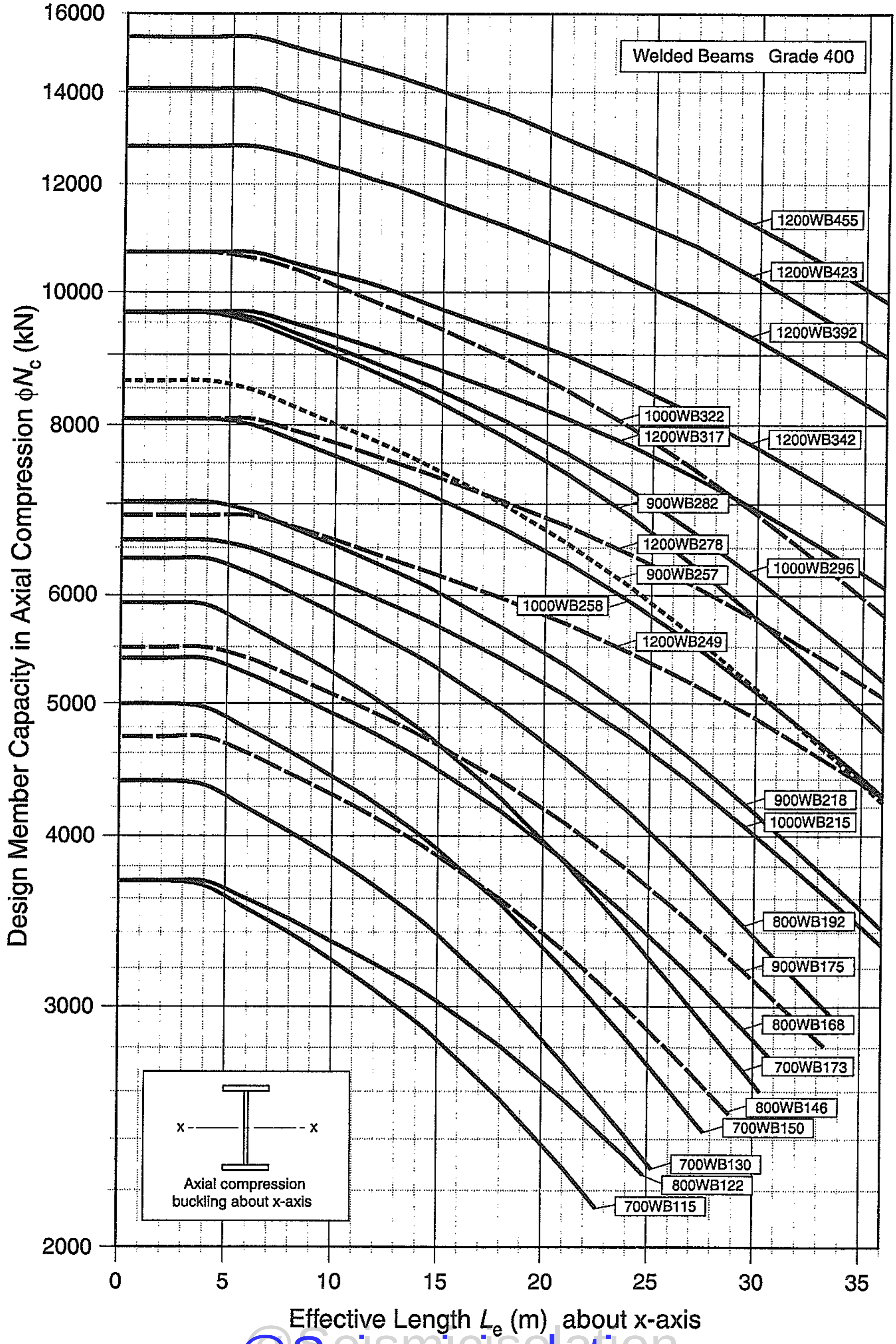
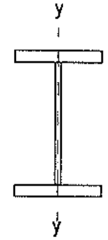
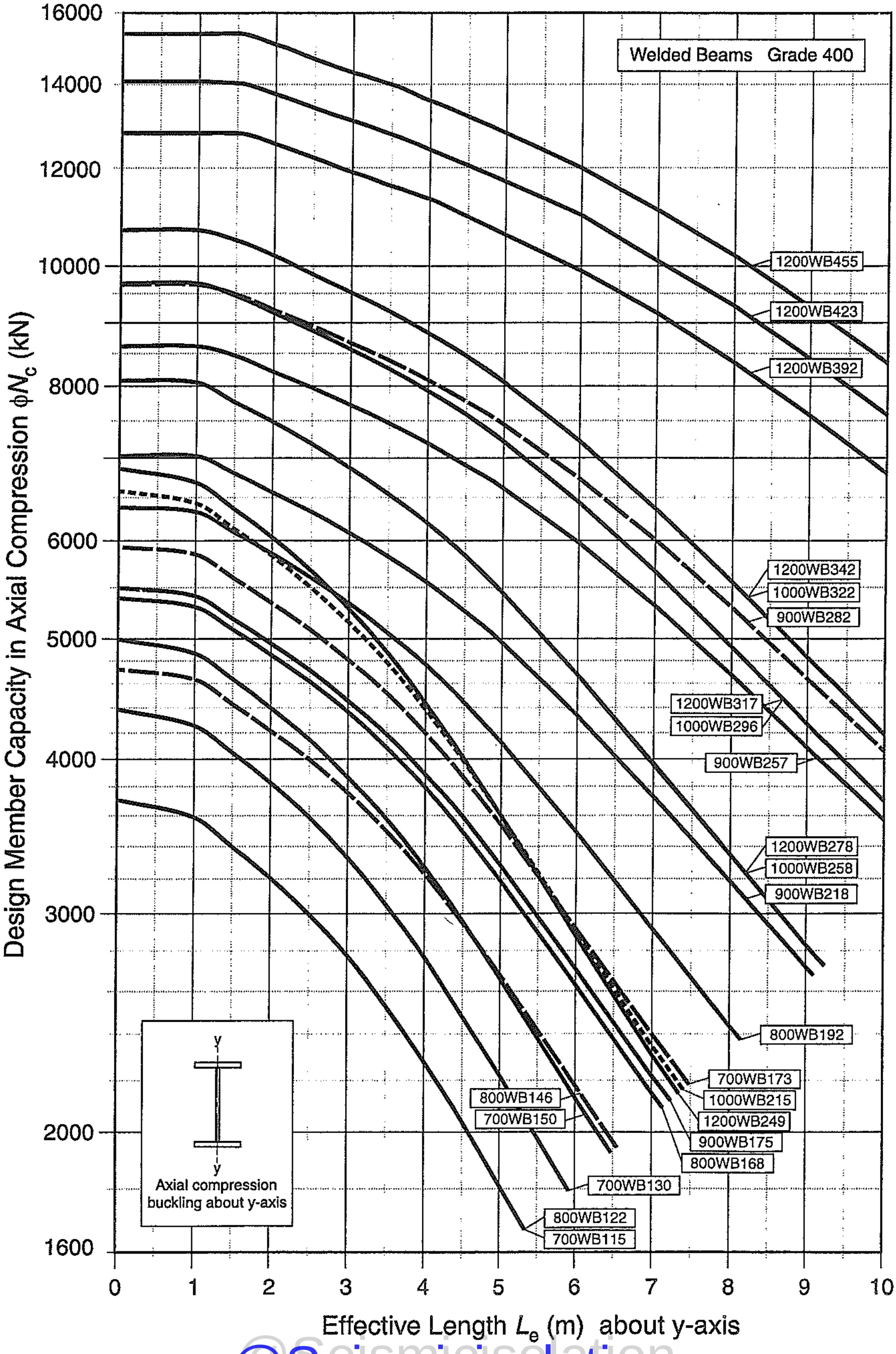

Welded Beams Grade 400
Design Member Capacity in Axial Compression ϕN_c (kN)
16000
14000
12000
10000
8000
6000
5000
4000
3000
2000
1200WB455
1200WB423
1200WB392
1000WB322
1200WB317
1200WB342
900WB282
1200WB278
900WB257
1000WB296
1000WB258
1200WB249
900WB218
1000WB215
800WB192
900WB175
800WB168
700WB173
800WB146
700WB150
700WB130
800WB122
700WB115
x
x
Axial compression buckling about x-axis
0
5
10
15
20
25
30
35
Effective Length L_e (m) about x-axis

TABLE 6-2(B)

WELDED BEAMS
GRADE 400
DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION
buckling about y-axis



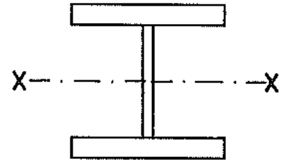
Designation	ϕN_s (kN)	Design Load Capacities for Axial Compression, ϕN_c (kN) Effective Length (L_e) in metres													
	(L_e=0)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	10.0
1200WB455	15400	15400	15400	15000	14700	14300	14000	13600	13200	12800	12000	11100	10200	9260	8350
423	14100	14100	14100	13700	13400	13100	12800	12400	12100	11700	11000	10100	9290	8420	7580
392	12800	12800	12800	12500	12200	11900	11600	11300	10900	10600	9910	9160	8360	7570	6800
342	10700	10700	10500	10200	9850	9520	9190	8830	8460	8060	7230	6370	5560	4830	4190
317	9680	9680	9460	9170	8880	8570	8260	7930	7590	7220	6450	5670	4930	4270	3700
278	8090	8060	7770	7490	7190	6880	6550	6210	5840	5450	4680	3970	3350	2830	2420
249	6870	6690	6370	6040	5680	5290	4880	4440	4010	3600	2880	2310	1880	1550	1300
100WB322	10700	10700	10500	10200	9850	9520	9190	8830	8460	8060	7230	6370	5560	4830	4190
296	9680	9680	9460	9170	8870	8570	8260	7930	7590	7220	6450	5670	4930	4270	3700
258	8090	8060	7770	7490	7190	6880	6550	6210	5840	5450	4680	3960	3350	2830	2420
215	6590	6440	6140	5840	5510	5160	4790	4390	3990	3600	2910	2350	1920	1590	1330
900WB282	9660	9660	9490	9220	8950	8670	8390	8090	7780	7450	6740	6010	5300	4640	4060
257	8620	8620	8470	8220	7980	7730	7470	7200	6910	6620	5980	5320	4680	4090	3570
218	7030	7030	6810	6570	6340	6090	5830	5560	5270	4970	4340	3730	3190	2720	2340
175	5500	5420	5190	4960	4720	4460	4190	3890	3590	3280	2710	2220	1840	1530	1290
800WB192	6390	6340	6100	5860	5610	5350	5060	4770	4450	4130	3490	2920	2440	2050	1740
168	5400	5310	5090	4860	4620	4370	4090	3800	3490	3190	2630	2150	1780	1480	1250
146	4730	4640	4430	4220	4000	3760	3500	3230	2950	2680	2180	1770	1450	1200	1010
122	3710	3590	3400	3210	3000	2780	2530	2280	2040	1810	1430	1140	922	757	631
700WB173	5930	5850	5600	5350	5090	4810	4520	4200	3870	3540	2920	2400	1980	1650	1390
150	5000	4870	4640	4400	4150	3870	3580	3270	2960	2660	2130	1720	1400	1150	966
130	4390	4260	4050	3830	3590	3330	3050	2770	2480	2220	1760	1410	1140	938	783
115	3710	3590	3400	3210	3000	2780	2530	2280	2040	1810	1430	1140	921	757	631



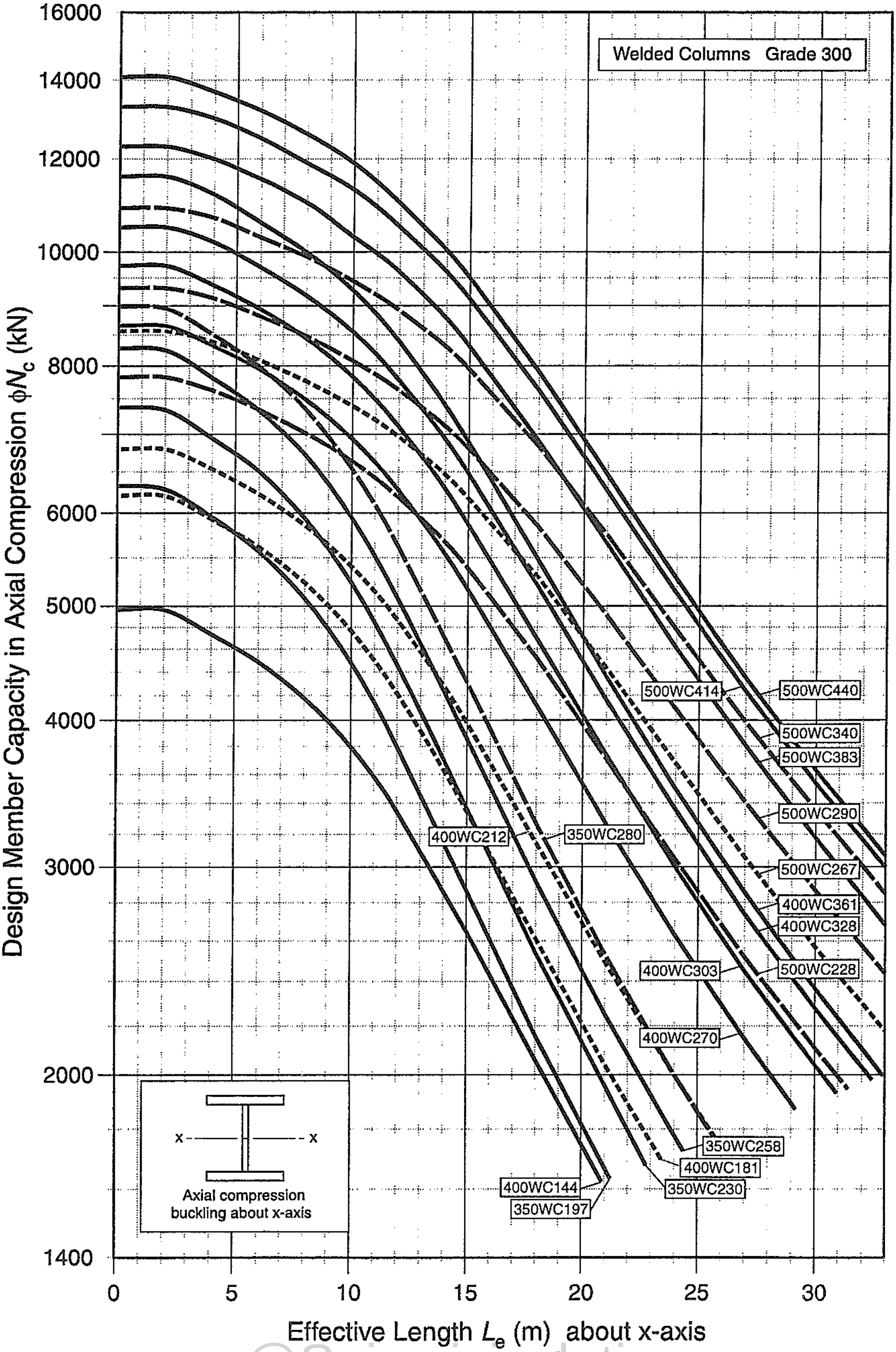
Welded Beams Grade 400
Design Member Capacity in Axial Compression ϕN_c (kN)
16000
14000
12000
10000
8000
6000
5000
4000
3000
2000
1600
1200WB455
1200WB423
1200WB392
1200WB342
1000WB322
900WB282
1200WB317
1000WB296
900WB257
1200WB278
1000WB258
900WB218
800WB192
700WB173
1000WB215
1200WB249
900WB175
800WB168
800WB146
700WB150
700WB130
800WB122
700WB115
Axial compression buckling about y-axis
0
1
2
3
4
5
6
7
8
9
10
Effective Length L_e (m) about y-axis

TABLE 6-3(A)

WELDED COLUMNS
GRADE 300
DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION
buckling about x-axis



Designation	ϕN_s (kN)	Design Member Capacities in Axial Compression, ϕN_c (kN) Effective Length (L_e) in metres												
	(L_e=0)	2	4	6	8	10	12	15	18	21	24	27	30	33
500WC440	14100	14100	13700	13200	12600	11900	11000	9510	7910	6460	5280	4350	3630	3070
414	13300	13300	13000	12500	11900	11300	10500	9120	7630	6260	5130	4240	3540	3000
383	12300	12300	12000	11500	11000	10300	9610	8310	6910	5650	4610	3810	3180	2680
340	10900	10900	10700	10300	9910	9450	8920	7950	6840	5750	4780	3990	3360	2850
290	9320	9320	9140	8820	8480	8080	7630	6800	5850	4910	4090	3410	2870	2440
267	8570	8570	8390	8090	7770	7400	6970	6180	5300	4430	3680	3060	2570	2180
228	7830	7830	7630	7340	7020	6640	6190	5390	4520	3710	3050	2520	2110	1780
400WC361	11600	11600	11200	10600	10000	9280	8390	6890	5490	4360	3500	2860	2370	1990
328	10500	10500	10200	9710	9180	8550	7780	6480	5210	4160	3360	2740	2280	1920
303	9730	9730	9370	8940	8440	7830	7100	5870	4690	3740	3000	2450	2040	1710
270	8660	8660	8330	7950	7490	6940	6280	5170	4120	3270	2630	2150	1780	1500
212	6800	6800	6540	6230	5860	5410	4870	3980	3150	2490	2000	1630	1350	1130
181	6210	6210	5930	5620	5240	4770	4220	3350	2610	2040	1630	1320	1090	916
144	4970	4970	4740	4490	4180	3800	3350	2650	2060	1610	1280	1040	858	720
350WC280	9000	8960	8510	7990	7350	6540	5630	4310	3270	2530	2000	1620	1340	1120
258	8290	8250	7820	7330	6720	5950	5080	3860	2920	2250	1780	1440	1180	991
230	7380	7340	6950	6510	5940	5240	4460	3370	2540	1960	1550	1250	1030	861
197	6330	6290	5960	5570	5080	4480	3800	2870	2160	1670	1310	1060	873	731


Welded Columns Grade 300
Design Member Capacity in Axial Compression ϕN_c (kN)
Effective Length L_e (m) about x-axis
16000
14000
12000
10000
8000
6000
5000
4000
3000
2000
1400
0
5
10
15
20
25
30
500WC414
500WC440
500WC340
500WC383
500WC290
500WC267
400WC361
400WC328
500WC228
400WC303
400WC270
400WC212
350WC280
350WC258
400WC181
350WC230
400WC144
350WC197
x
x
Axial compression buckling about x-axis

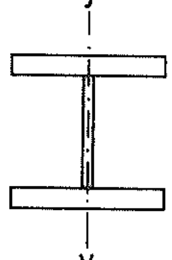
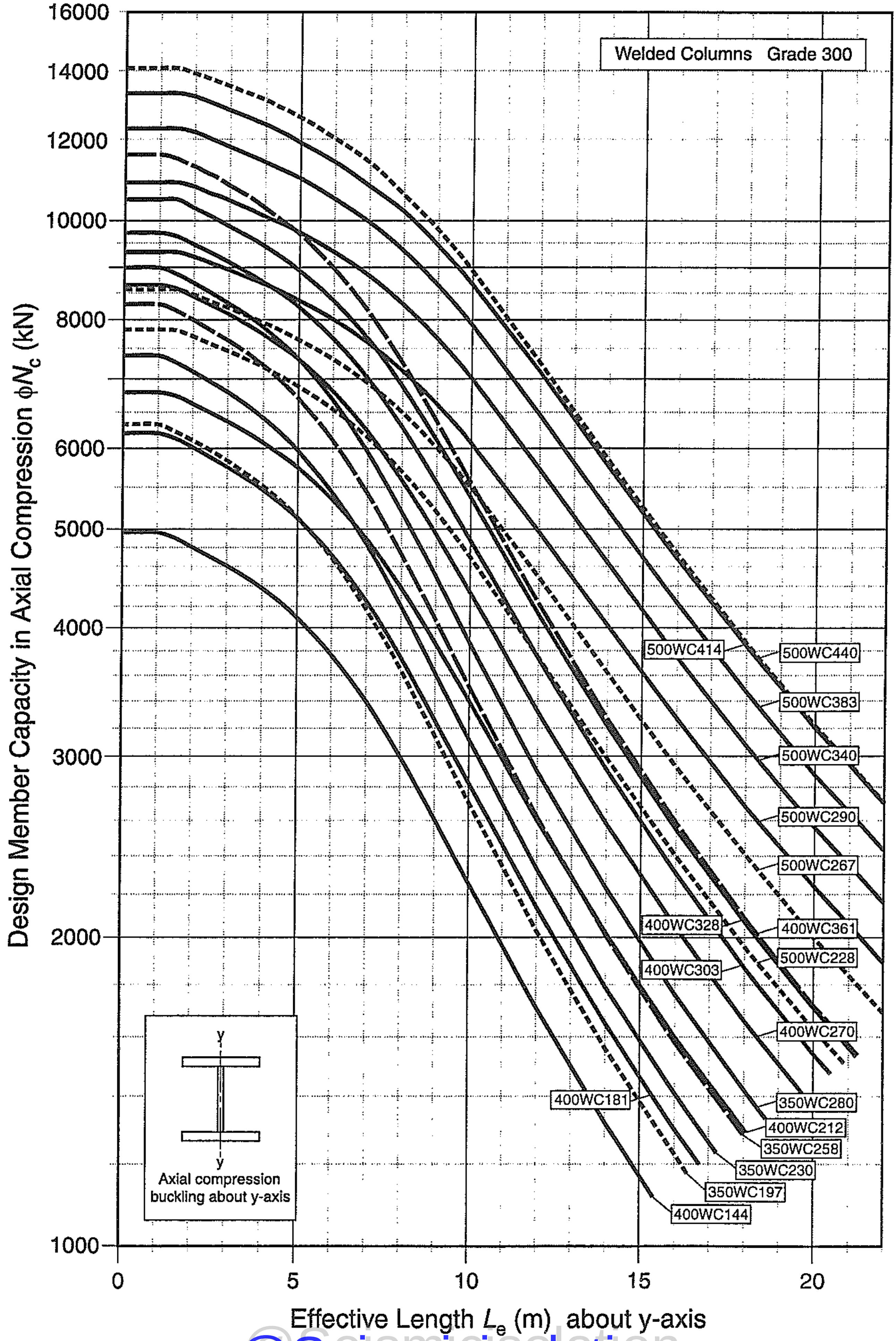


TABLE 6-3(B)

WELDED COLUMNS
GRADE 300

DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION
buckling about y-axis

Designation	ϕN_s (kN)	Design Member Capacities in Axial Compression, ϕN_c (kN) Effective Length (L_e) in metres														
	(L_e=0)	1	2	3	4	5	6	7	8	10	12	14	16	18	20	22
500WC440	14100	14100	13900	13500	13100	12600	12000	11400	10600	8940	7260	5840	4730	3870	3220	2710
414	13300	13300	13200	12800	12400	11900	11400	10800	10200	8660	7110	5750	4670	3840	3200	2700
383	12300	12300	12200	11800	11400	11000	10500	9960	9340	7910	6460	5210	4230	3470	2880	2430
340	10900	10900	10800	10500	10100	9740	9320	8840	8280	7020	5730	4630	3750	3080	2560	2160
290	9320	9320	9220	8950	8670	8350	8000	7590	7130	6070	4970	4020	3270	2680	2240	1890
267	8570	8570	8470	8220	7950	7650	7320	6940	6500	5500	4490	3620	2930	2410	2000	1690
228	7830	7830	7710	7460	7190	6890	6550	6150	5700	4700	3750	2990	2400	1960	1630	1370
400WC361	11600	11600	11300	10800	10300	9700	8980	8150	7260	5560	4230	3270	2590	2090	1720	1440
328	10500	10500	10300	9880	9450	8940	8350	7660	6890	5380	4130	3220	2550	2070	1710	1430
303	9730	9730	9480	9110	8700	8230	7660	7010	6290	4880	3740	2910	2310	1870	1540	1290
270	8660	8660	8430	8110	7740	7320	6820	6230	5590	4340	3320	2580	2050	1660	1370	1150
212	6800	6800	6630	6370	6080	5750	5350	4890	4380	3400	2600	2020	1600	1300	1070	895
181	6210	6210	6020	5760	5470	5130	4720	4250	3750	2830	2140	1650	1300	1050	863	723
144	4970	4970	4810	4610	4380	4100	3770	3400	3000	2260	1710	1320	1040	839	691	578
350WC280	9000	9000	8690	8300	7860	7320	6680	5950	5200	3870	2900	2230	1760	1420	1160	973
258	8290	8290	8000	7640	7220	6710	6110	5430	4730	3510	2620	2010	1580	1280	1050	877
230	7380	7380	7120	6800	6420	5970	5430	4830	4200	3120	2330	1790	1410	1130	932	779
197	6330	6330	6110	5840	5520	5140	4690	4170	3650	2710	2030	1560	1230	990	814	681

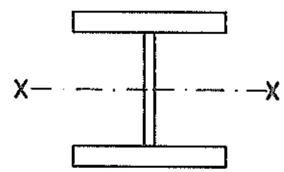

Welded Columns Grade 300
Design Member Capacity in Axial Compression ϕN_c (kN)
16000
14000
12000
10000
8000
6000
5000
4000
3000
2000
1000
0
5
10
15
20
Effective Length L_e (m) about y-axis
500WC414
500WC440
500WC383
500WC340
500WC290
500WC267
400WC328
400WC361
500WC228
400WC303
400WC270
350WC280
400WC181
400WC212
350WC258
350WC230
350WC197
400WC144
y
y
Axial compression buckling about y-axis

TENSION

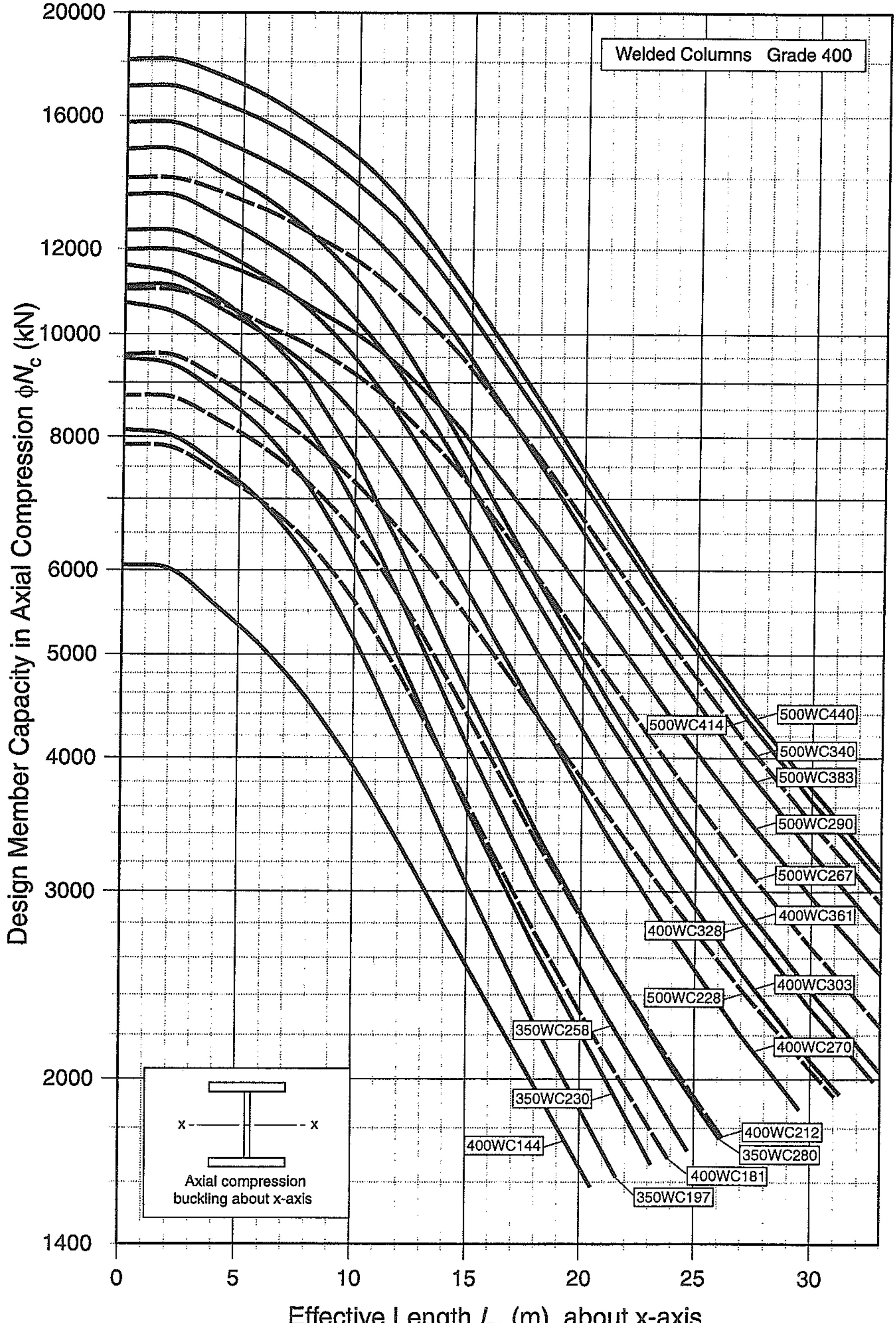
TABLE 6-4(A)

WELDED COLUMNS
GRADE 400

DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION
buckling about x-axis



Designation	ϕN_s (kN)	Design Member Capacities in Axial Compression, ϕN_c (kN) Effective Length (L_e) in metres												
	(L_e=0)	2	4	6	8	10	12	15	18	21	24	27	30	33
500WC440	18100	18100	17500	16700	15700	14600	13200	10800	8650	6870	5520	4510	3740	3140
414	17100	17100	16500	15800	14900	13800	12600	10400	8370	6680	5380	4400	3650	3070
383	15800	15800	15200	14500	13700	12700	11500	9470	7560	6010	4830	3940	3270	2750
340	14000	14000	13600	13100	12400	11700	10800	9280	7660	6220	5070	4170	3480	2930
290	12000	12000	11600	11200	10600	10000	9260	7930	6550	5320	4330	3560	2970	2510
267	11000	11000	10700	10200	9740	9150	8440	7190	5900	4780	3890	3190	2660	2240
228	9570	9570	9100	8530	7920	7250	6520	5400	4390	3570	2930	2430	2040	1730
400WC361	14900	14900	14200	13400	12400	11200	9760	7620	5860	4560	3620	2930	2420	2030
328	13500	13500	12900	12200	11400	10300	9120	7210	5590	4370	3480	2820	2330	1960
303	12500	12500	11900	11300	10500	9460	8290	6510	5020	3910	3110	2520	2080	1750
270	11100	11100	10600	9990	9270	8370	7310	5710	4400	3420	2720	2200	1820	1520
212	8750	8730	8310	7820	7230	6500	5650	4380	3350	2610	2070	1670	1380	1160
181	7870	7830	7420	6950	6360	5620	4790	3630	2740	2120	1670	1350	1110	931
144	6070	6020	5570	5090	4540	3940	3340	2560	1970	1550	1240	1010	839	707
350WC280	11600	11400	10800	9970	8920	7630	6290	4600	3420	2610	2050	1650	1360	1130
258	10700	10500	9900	9130	8130	6900	5650	4110	3040	2320	1820	1470	1200	1010
230	9490	9370	8800	8100	7180	6070	4950	3580	2650	2020	1590	1270	1050	874
197	8130	8030	7540	6930	6140	5180	4210	3050	2250	1710	1340	1080	887	741

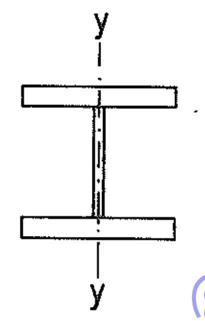


Welded Columns Grade 400
Design Member Capacity in Axial Compression ϕN_c (kN)
20000
16000
12000
10000
8000
6000
5000
4000
3000
2000
1400
Effective Length L_e (m) about x-axis
0
5
10
15
20
25
30
500WC440
500WC414
500WC340
500WC383
500WC290
500WC267
400WC361
400WC328
400WC303
500WC228
350WC258
400WC270
350WC230
400WC212
400WC144
350WC280
400WC181
350WC197
x
x
Axial compression buckling about x-axis

TABLE 6-4(B)

WELDED COLUMNS
GRADE 400

DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION
buckling about y-axis



Designation	ϕN_s (kN)	Design Member Capacities in Axial Compression, ϕN_c (kN) Effective Length (L_e) in metres														
	(L_e=0)	1	2	3	4	5	6	7	8	10	12	14	16	18	20	22
500WC440	18100	18100	17800	17200	16500	15700	14800	13700	12500	10000	7840	6160	4910	3990	3300	2770
414	17100	17100	16800	16200	15600	14900	14100	13100	12100	9780	7710	6080	4870	3960	3280	2760
383	15800	15800	15500	15000	14400	13700	13000	12100	11100	8900	6990	5500	4400	3580	2960	2490
340	14000	14000	13700	13300	12800	12200	11500	10700	9800	7900	6200	4890	3910	3180	2630	2210
290	12000	12000	11800	11400	10900	10400	9870	9210	8460	6850	5390	4260	3410	2770	2290	1930
267	11000	11000	10800	10400	10000	9560	9020	8390	7690	6190	4850	3820	3050	2480	2050	1730
228	9570	9570	9240	8760	8250	7700	7100	6460	5810	4590	3610	2870	2320	1900	1580	1340
400WC361	14900	14900	14300	13600	12800	11900	10700	9400	8120	5940	4410	3370	2650	2130	1750	1460
328	13500	13500	13100	12500	11800	11000	10000	8930	7790	5790	4340	3330	2620	2110	1740	1450
303	12500	12500	12100	11500	10900	10100	9180	8150	7090	5250	3920	3010	2370	1910	1570	1310
270	11100	11100	10700	10200	9680	8990	8170	7250	6300	4660	3480	2670	2100	1690	1390	1160
212	8750	8750	8430	8050	7600	7060	6410	5680	4940	3650	2720	2090	1640	1320	1090	909
181	7870	7870	7540	7170	6720	6180	5530	4820	4130	3000	2220	1690	1330	1070	877	732
144	6070	6070	5710	5320	4890	4420	3900	3400	2930	2170	1640	1270	1010	821	679	570
350WC280	11600	11600	11000	10500	9750	8870	7840	6750	5720	4100	3010	2290	1790	1440	1180	986
258	10700	10700	10200	9620	8950	8130	7160	6140	5190	3700	2720	2070	1620	1300	1060	889
230	9490	9480	9040	8550	7960	7230	6360	5460	4610	3290	2420	1840	1440	1150	946	790
197	8130	8130	7760	7350	6850	6230	5500	4730	4010	2870	2110	1600	1250	1010	827	690

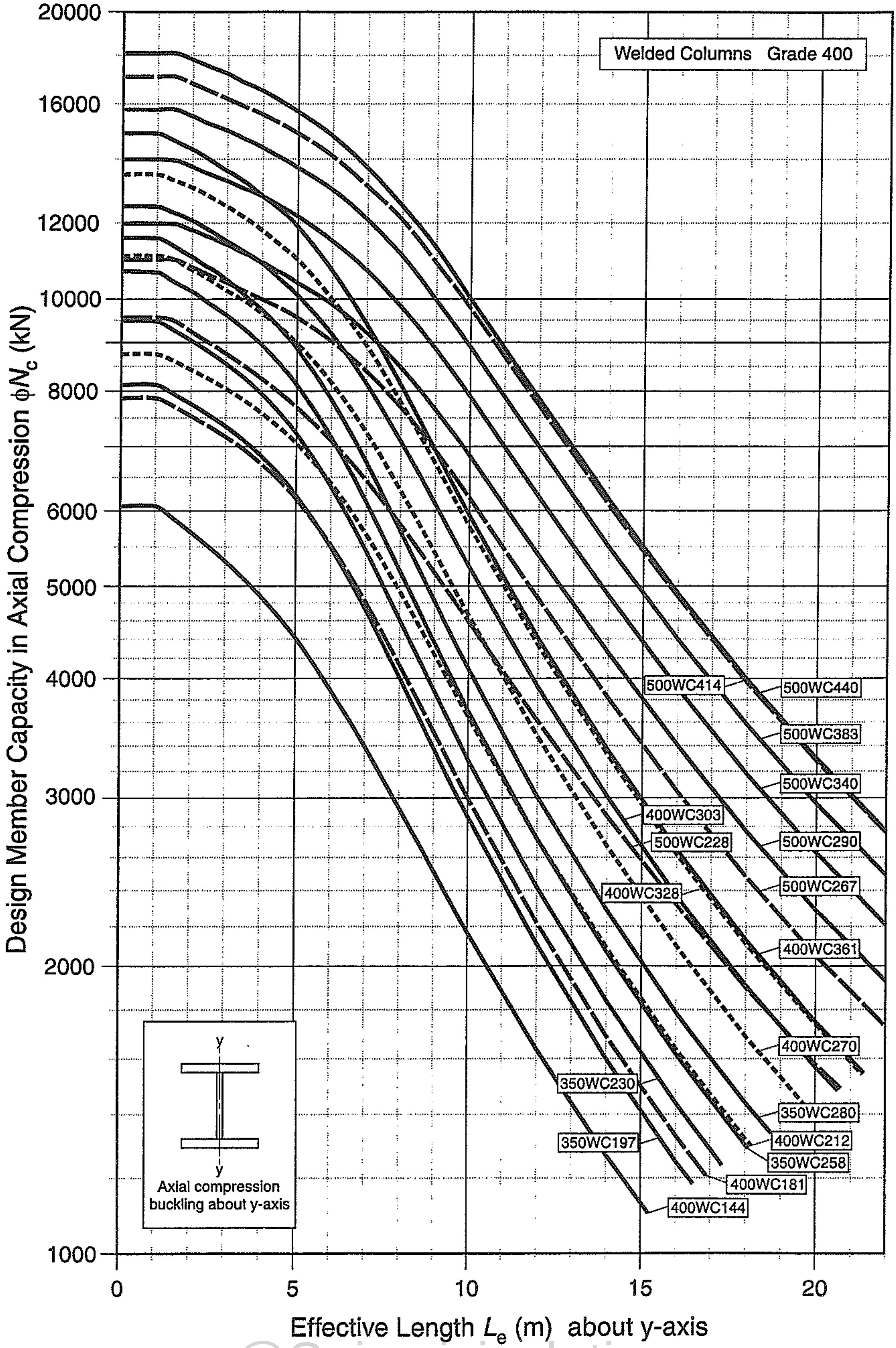
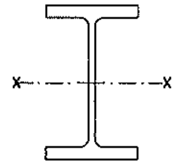

Welded Columns Grade 400
Design Member Capacity in Axial Compression ϕN_c (kN)
20000
16000
12000
10000
8000
6000
5000
4000
3000
2000
1000
Effective Length L_e (m) about y-axis
0
5
10
15
20
500WC414
500WC440
500WC383
500WC340
400WC303
500WC228
500WC290
400WC328
500WC267
400WC361
400WC270
350WC230
350WC280
350WC197
400WC212
350WC258
400WC181
400WC144
y
y
Axial compression buckling about y-axis

TABLE 6-5(A)

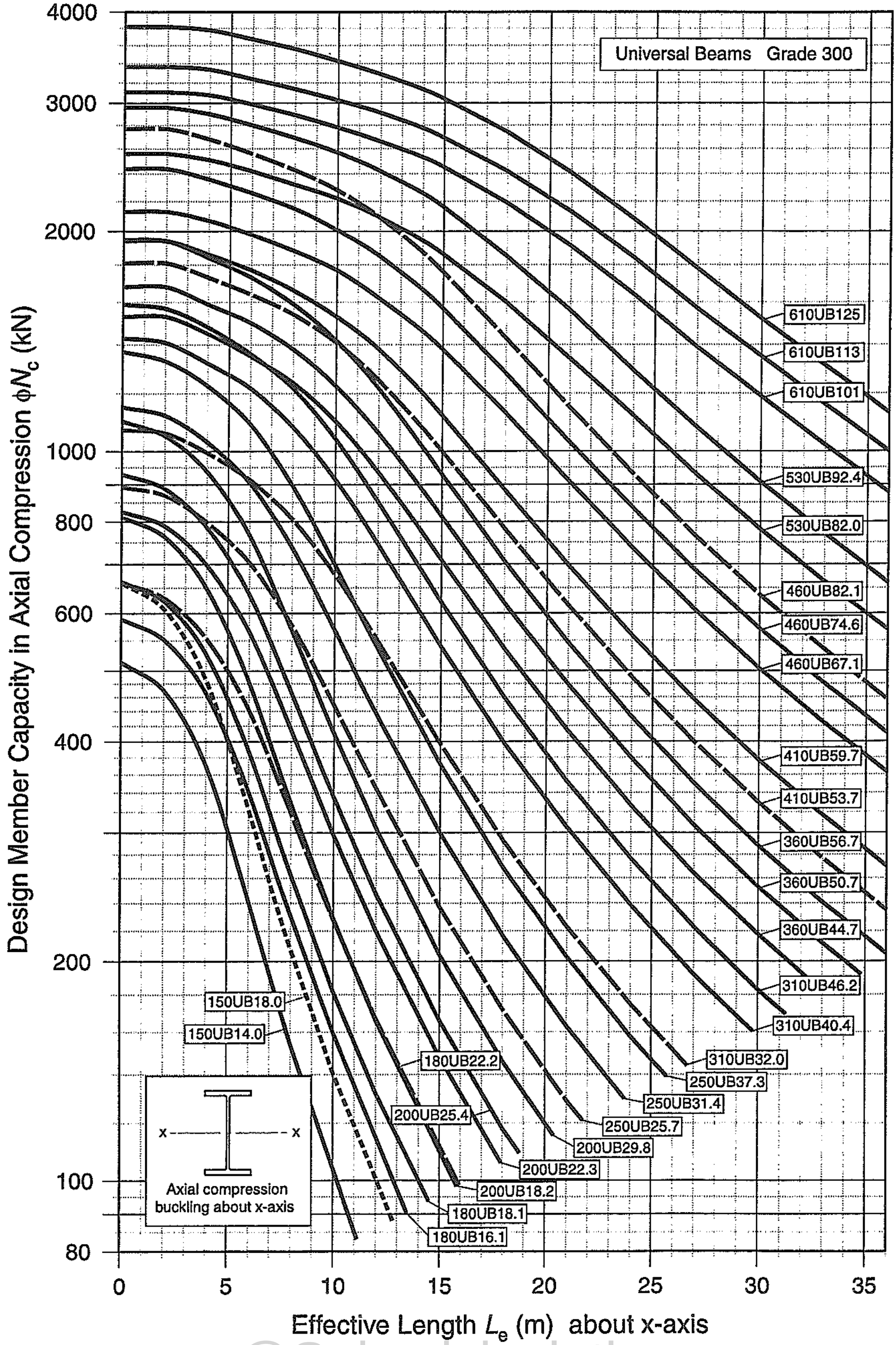
UNIVERSAL BEAMS
GRADE 300
DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION
buckling about x-axis



Designation	ϕN_s (kN)	Design Member Capacities in Axial Compression, ϕN_c (kN) Effective Length (L_e) in metres													
	(L_e=0)	2	4	6	8	10	12	15	18	21	24	27	30	33	36
610UB125	3820	3820	3780	3670	3560	3430	3290	3040	2740	2410	2080	1780	1520	1310	1130
113	3370	3370	3340	3240	3140	3030	2910	2690	2420	2130	1840	1570	1350	1160	1000
101	3110	3110	3080	2990	2890	2780	2660	2450	2190	1910	1640	1390	1190	1020	878
530UB 92.4	2960	2960	2900	2800	2690	2570	2420	2160	1850	1560	1290	1080	908	771	661
82.0	2560	2560	2510	2420	2320	2220	2090	1860	1600	1340	1120	930	782	664	570
460UB 82.1	2770	2770	2680	2560	2430	2280	2090	1760	1430	1150	933	765	636	536	457
74.6	2440	2440	2360	2260	2150	2010	1850	1570	1280	1030	837	687	572	482	411
67.1	2130	2130	2070	1980	1880	1770	1620	1380	1130	909	738	606	504	425	363
410UB 59.7	1940	1940	1860	1770	1660	1530	1380	1120	884	698	560	456	377	317	270
53.7	1810	1810	1730	1640	1540	1410	1250	1000	783	615	491	399	330	277	235
360UB 56.7	1950	1940	1840	1730	1590	1420	1220	930	707	547	433	350	288	241	205
50.7	1680	1680	1590	1500	1380	1230	1060	814	620	480	380	307	253	212	180
44.7	1530	1530	1450	1350	1240	1100	936	710	537	414	327	264	218	182	155
310UB 46.2	1590	1570	1480	1360	1220	1040	852	622	461	352	277	223	183	153	129
40.4	1430	1410	1320	1220	1080	915	746	540	399	305	239	192	158	132	112
32.0	1070	1060	995	914	807	679	551	397	293	223	175	141	116	96.4	81.7
250UB 37.3	1370	1330	1230	1090	897	700	538	372	269	203	158	127	104	86.4	73.1
31.4	1150	1120	1030	904	738	570	435	300	217	163	127	102	83.1	69.3	58.6
25.7	893	870	799	704	578	449	344	237	172	129	101	80.6	66.0	54.9	46.5
200UB 29.8	1100	1050	938	767	569	411	304	204	146	109	84.7	67.6	55.2	45.9	38.8
25.4	930	889	787	637	467	336	247	166	118	88.6	68.7	54.8	44.7	37.2	31.4
22.3	826	790	699	566	415	298	220	148	105	78.8	61.1	48.7	39.8	33.1	27.9
18.2	661	630	554	442	319	228	167	112	79.7	59.6	46.2	36.8	30.1	25.0	21.1
180UB 22.2	813	764	650	483	329	229	166	110	78.1	58.3	45.1	35.9	29.3	24.3	20.5
18.1	663	623	527	388	263	182	132	87.5	62.1	46.3	35.8	28.5	23.2	19.3	16.3
16.1	589	552	466	341	231	160	115	76.6	54.3	40.5	31.3	24.9	20.3	16.9	14.2
150UB 18.0	661	609	486	323	208	141	101	66.5	47.0	34.9	27.0	21.5	17.5	14.5	12.2
14.0	514	471	371	242	154	104	74.6	49.1	34.6	25.8	19.9	15.8	12.9	10.7	9.01

Note: Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

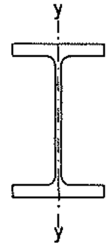
@Seismicisolation



Universal Beams Grade 300
Design Member Capacity in Axial Compression ϕN_c (kN)
Effective Length L_e (m) about x-axis
4000
3000
2000
1000
800
600
400
200
100
80
0
5
10
15
20
25
30
35
610UB125
610UB113
610UB101
530UB92.4
530UB82.0
460UB82.1
460UB74.6
460UB67.1
410UB59.7
410UB53.7
360UB56.7
360UB50.7
360UB44.7
310UB46.2
310UB40.4
310UB32.0
250UB37.3
250UB31.4
250UB25.7
200UB29.8
200UB22.3
200UB18.2
180UB18.1
180UB16.1
200UB25.4
180UB22.2
150UB18.0
150UB14.0
x
x
Axial compression buckling about x-axis

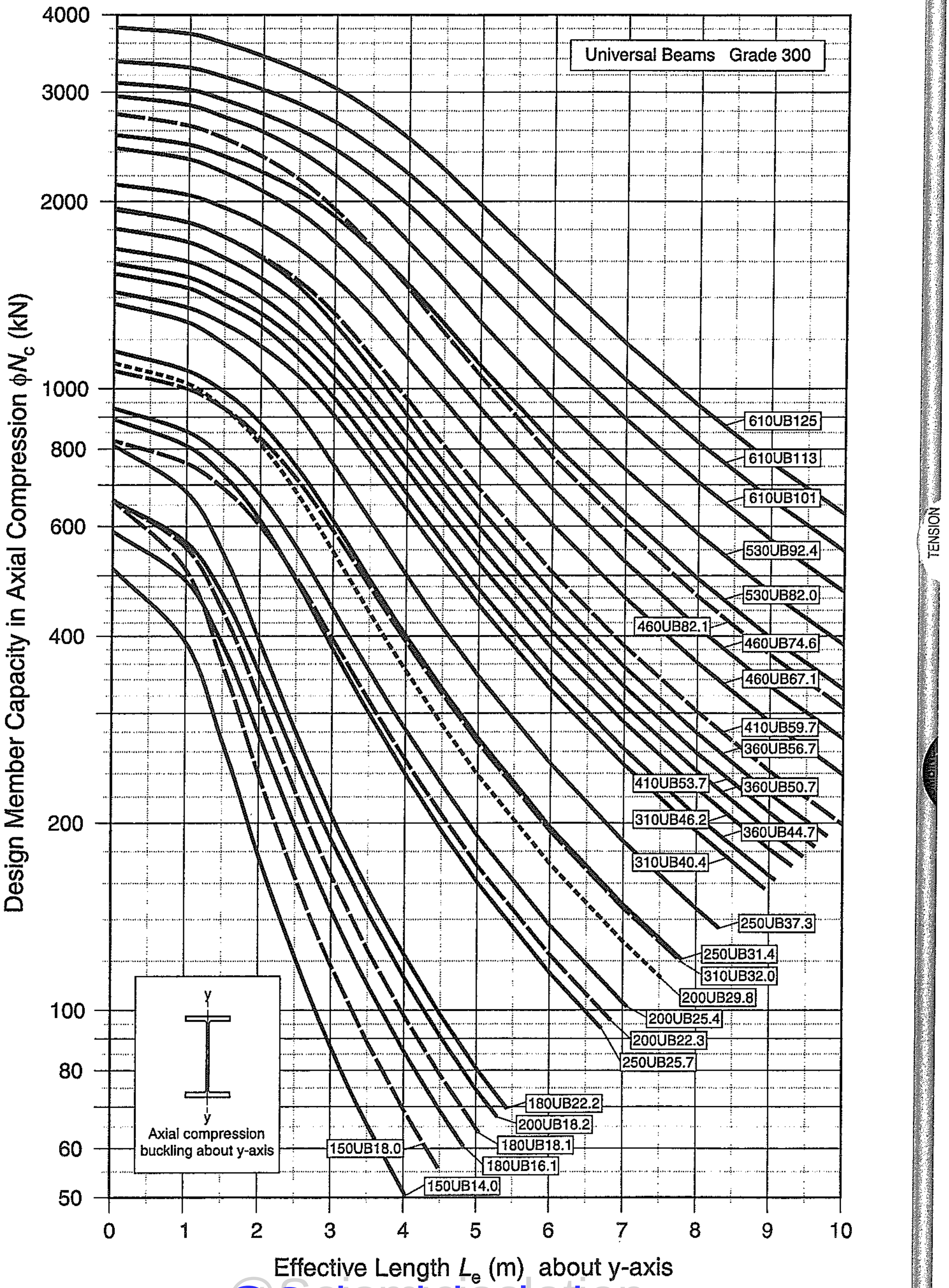
TABLE 6-5(B)

UNIVERSAL BEAMS
GRADE 300
DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION
buckling about y-axis



Designation	ϕN_s (kN)	Design Member Capacities in Axial Compression, ϕN_c (kN) Effective Length (L_e) in metres													
	(L_e=0)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	10.0
610UB125	3820	3730	3590	3430	3250	3040	2790	2520	2240	1970	1520	1180	938	760	628
113	3370	3290	3170	3030	2870	2680	2450	2210	1960	1720	1320	1030	819	663	547
101	3110	3030	2910	2770	2610	2420	2200	1970	1730	1510	1150	892	707	571	471
530UB 92.4	2960	2860	2730	2590	2410	2200	1970	1720	1490	1280	963	740	583	470	387
82.0	2560	2470	2360	2230	2080	1890	1680	1470	1270	1090	818	628	494	398	328
460UB 82.1	2770	2650	2520	2360	2170	1940	1690	1450	1230	1050	775	591	463	373	306
74.6	2440	2340	2220	2080	1920	1720	1500	1280	1090	932	690	526	413	332	273
67.1	2130	2050	1950	1830	1680	1500	1310	1120	957	816	604	461	362	291	239
410UB 59.7	1940	1850	1750	1630	1490	1320	1130	961	812	689	507	385	302	242	199
53.7	1810	1720	1620	1500	1360	1180	1000	843	707	597	437	331	259	208	170
360UB 56.7	1950	1850	1750	1620	1460	1270	1080	906	760	642	470	356	279	223	183
50.7	1680	1600	1510	1400	1260	1100	936	786	660	557	408	309	242	194	159
44.7	1530	1450	1360	1260	1120	967	814	678	566	476	347	263	205	165	135
310UB 46.2	1590	1510	1420	1320	1190	1040	880	739	620	523	383	290	227	182	149
40.4	1430	1350	1270	1170	1050	907	764	638	533	449	327	248	194	155	127
32.0	1070	1000	929	833	715	591	481	392	323	269	194	146	114	91.0	74.4
250UB 37.3	1370	1280	1180	1060	913	755	615	502	413	345	249	187	146	116	95.3
31.4	1150	1070	989	880	747	612	494	401	329	274	197	148	115	92.2	75.4
25.7	893	810	726	615	491	383	301	240	195	161	115	86.1	66.8	53.3	43.5
200UB 29.8	1100	1020	929	815	679	547	437	352	288	239	172	129	100	80.0	65.3
25.4	930	854	777	675	555	443	352	283	231	191	137	103	79.8	63.7	52.0
22.3	826	759	691	601	496	396	315	253	207	171	123	92.1	71.5	57.1	46.6
18.2	661	566	467	350	254	188	144	113	90.8	74.6	52.8	39.3	30.4	24.2	19.7
180UB 22.2	813	682	544	394	281	206	157	123	98.4	80.7	57.0	42.4	32.7	26.0	21.2
18.1	663	554	440	317	225	165	125	98.1	78.8	64.6	45.6	33.9	26.2	20.8	17.0
16.1	589	491	388	278	198	145	110	85.9	69.0	56.5	39.9	29.7	22.9	18.2	14.8
150UB 18.0	661	511	361	239	164	118	88.9	69.2	55.3	45.3	31.9	23.6	18.2	14.5	11.8
14.0	514	391	271	178	122	87.4	65.7	51.1	40.9	33.4	23.5	17.4	13.4	10.7	8.68

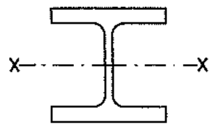
Note: Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.



Universal Beams Grade 300
Design Member Capacity in Axial Compression ϕN_c (kN)
4000
3000
2000
1000
800
600
400
200
100
80
60
50
610UB125
610UB113
610UB101
530UB92.4
530UB82.0
460UB82.1
460UB74.6
460UB67.1
410UB59.7
360UB56.7
410UB53.7
360UB50.7
310UB46.2
360UB44.7
310UB40.4
250UB37.3
250UB31.4
310UB32.0
200UB29.8
200UB25.4
200UB22.3
250UB25.7
180UB22.2
200UB18.2
180UB18.1
150UB18.0
180UB16.1
150UB14.0
y
y
Axial compression buckling about y-axis
0
1
2
3
4
5
6
7
8
9
10
Effective Length L_e (m) about y-axis
TENSION

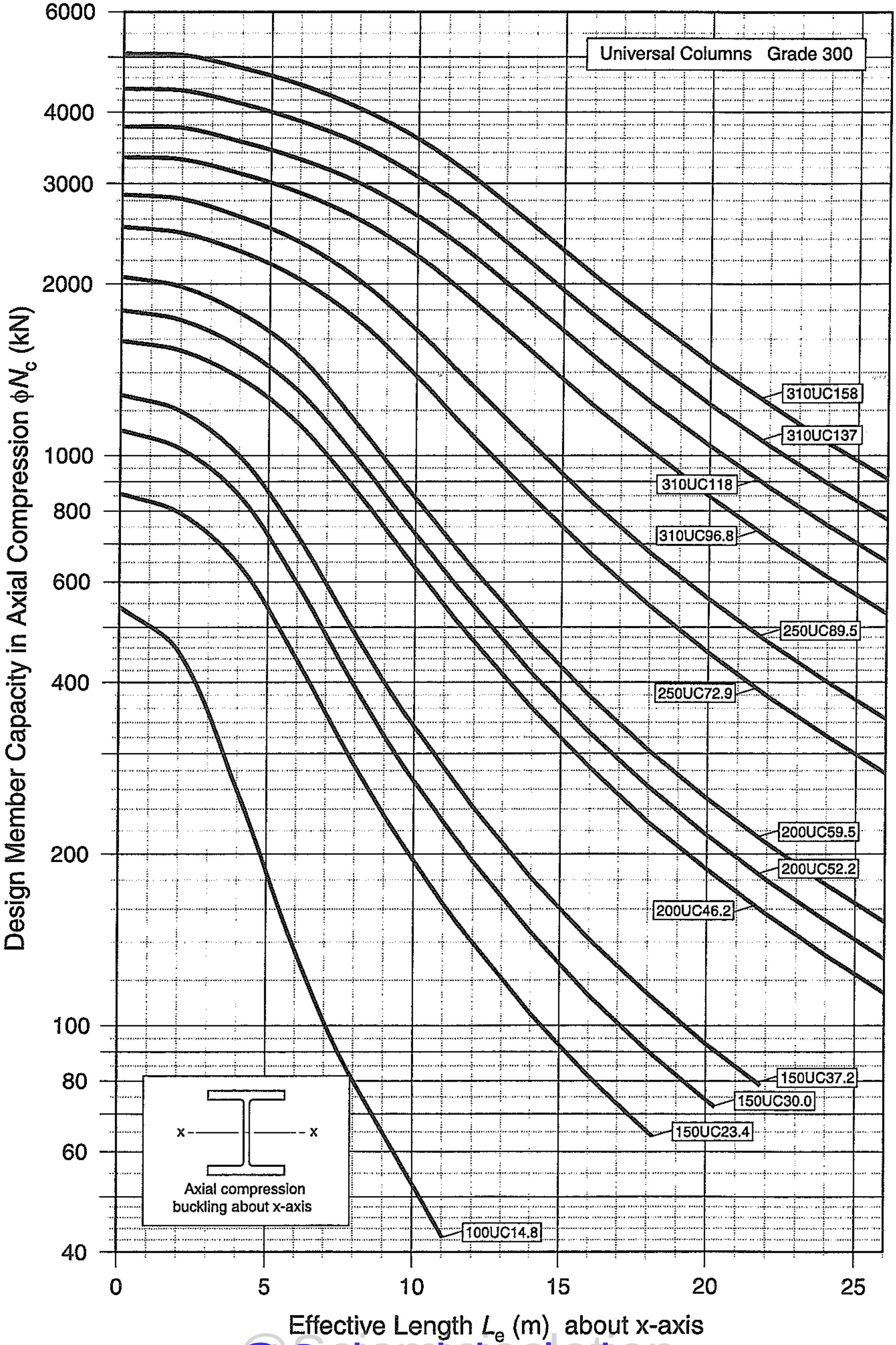
TABLE 6-6(A)

UNIVERSAL COLUMNS
GRADE 300
DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION
buckling about x-axis



Designation	ϕN_s (kN)	Design Member Capacities in Axial Compression, ϕN_c (kN) Effective Length (L_e) in metres												
	(L_e=0)	2	4	6	8	10	12	14	16	18	20	22	24	26
310UC158	5070	5040	4780	4470	4070	3590	3040	2520	2080	1730	1450	1230	1050	909
137	4400	4370	4140	3860	3520	3080	2610	2150	1770	1470	1230	1040	892	772
118	3780	3760	3550	3310	3010	2630	2220	1830	1500	1240	1040	880	753	651
96.8	3340	3310	3120	2890	2600	2240	1850	1510	1230	1020	848	716	612	528
250UC 89.5	2870	2820	2620	2370	2040	1660	1310	1040	830	676	560	471	401	345
72.9	2520	2460	2280	2040	1730	1380	1070	842	671	545	451	378	322	277
200UC 59.5	2060	1980	1780	1500	1140	842	628	481	378	304	250	209	177	152
52.2	1800	1730	1550	1300	992	729	543	415	326	263	216	180	153	141
46.2	1590	1530	1370	1140	868	636	472	361	284	228	188	157	133	114
150UC 37.2	1280	1200	1000	725	486	335	242	182	142	114	93.0	77.5	65.5	56.1
30.0	1110	1030	853	597	393	269	194	146	113	90.7	74.2	61.7	52.2	44.7
23.4	859	795	645	440	286	195	140	105	81.8	65.3	53.4	44.4	37.6	32.2
100UC 14.8	543	454	259	135	80.1	52.7	37.2	27.7	21.4	17.0	13.8	11.5	9.69	8.28

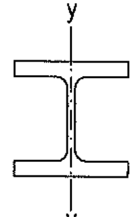
Note: Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.



Universal Columns Grade 300
Design Member Capacity in Axial Compression ϕN_c (kN)
6000
4000
3000
2000
1000
800
600
400
200
100
80
60
40
0
5
10
15
20
25
Effective Length L_e (m) about x-axis
310UC158
310UC137
310UC118
310UC96.8
250UC89.5
250UC72.9
200UC59.5
200UC52.2
200UC46.2
150UC37.2
150UC30.0
150UC23.4
100UC14.8
x
x
Axial compression
buckling about x-axis

TABLE 6-6(B)

UNIVERSAL COLUMNS
GRADE 300
DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION
buckling about y-axis



Designation	ϕN_s (kN)	Design Member Capacities in Axial Compression, ϕN_c (kN) Effective Length (L_e) in metres													
	(L_e=0)	1	2	3	4	5	6	7	8	9	10	11	12	13	14
310UC158	5070	5070	4840	4590	4280	3890	3440	2960	2510	2120	1790	1530	1320	1150	1000
137	4400	4400	4200	3970	3700	3360	2960	2540	2150	1810	1530	1310	1130	978	856
118	3780	3780	3610	3410	3170	2870	2520	2160	1820	1540	1300	1110	954	828	724
96.8	3340	3330	3170	2980	2750	2470	2140	1810	1510	1260	1070	906	778	674	589
250UC 89.5	2870	2840	2680	2490	2240	1930	1600	1310	1070	881	735	621	531	458	399
72.9	2520	2490	2340	2150	1920	1630	1330	1070	872	716	596	502	429	370	322
200UC 59.5	2060	2000	1840	1620	1330	1030	793	616	489	396	327	274	232	200	174
52.2	1800	1750	1610	1420	1160	900	689	535	425	344	283	237	202	173	151
46.2	1590	1550	1420	1250	1020	786	600	466	369	299	246	206	175	151	131
150UC 37.2	1280	1210	1060	821	581	410	299	227	177	142	116	97.1	82.2	70.5	61.1
30.0	1110	1050	903	686	476	333	242	183	143	114	93.7	78.1	66.1	56.6	49.1
23.4	859	807	685	507	345	239	173	131	102	81.5	66.7	55.6	47.0	40.3	34.9
100UC 14.8	543	477	323	183	111	73.6	52.2	38.9	30.1	24.0	19.6	16.2	13.7	11.7	10.1

Note: Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

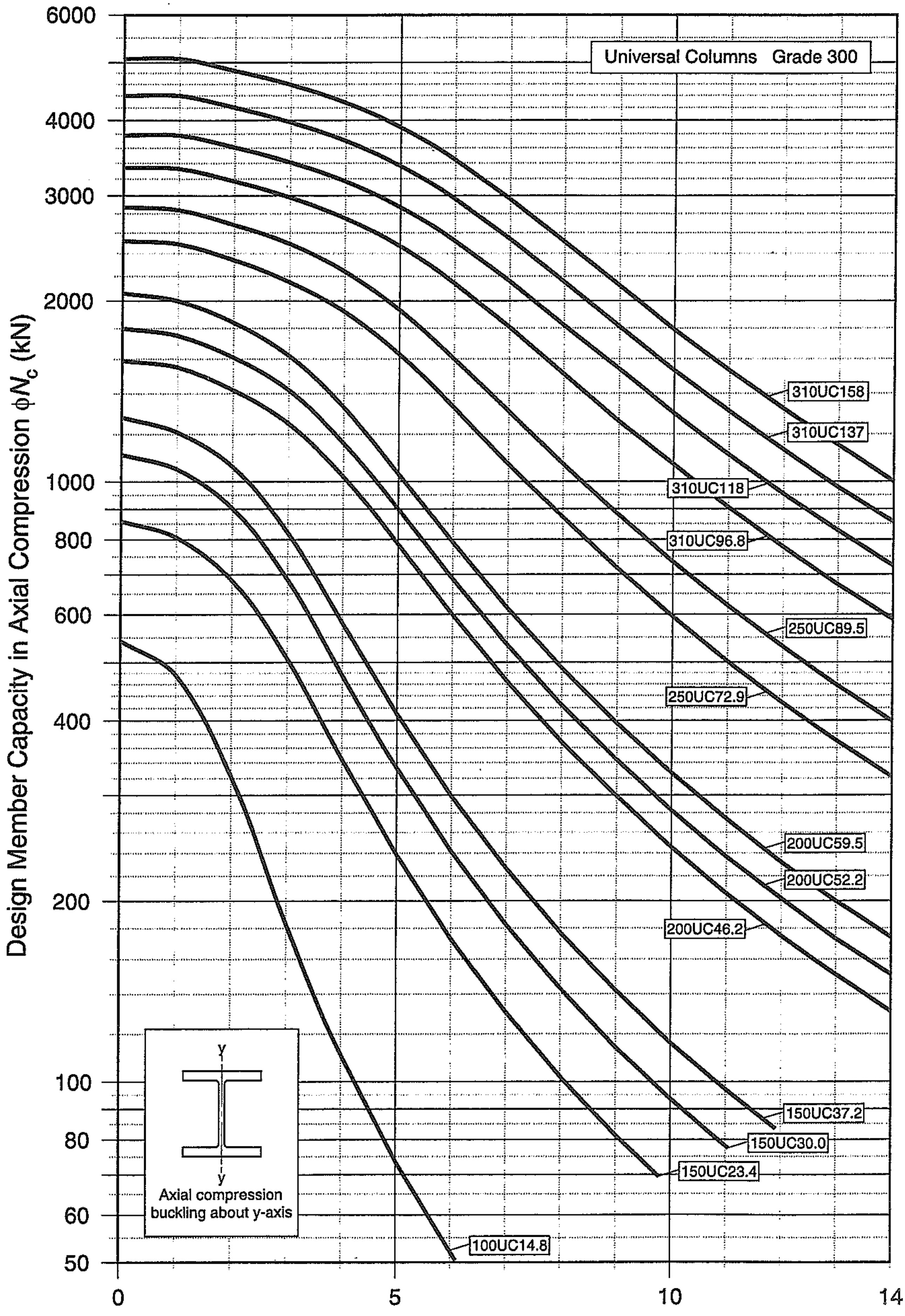
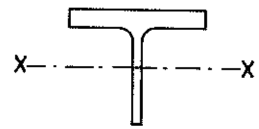

Universal Columns Grade 300
Design Member Capacity in Axial Compression ϕN_c (kN)
6000
4000
3000
2000
1000
800
600
400
200
100
80
60
50
0
5
10
14
Effective Length L_e (m) about y-axis
310UC158
310UC137
310UC118
310UC96.8
250UC89.5
250UC72.9
200UC59.5
200UC52.2
200UC46.2
150UC37.2
150UC30.0
150UC23.4
100UC14.8
y
y
Axial compression buckling about y-axis

TABLE 6-7(A)

TEES CUT FROM UNIVERSAL BEAMS GRADE 300

DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION buckling about x-axis



Designation	ϕN_s (kN)	Design Member Capacities in Axial Compression, ϕN_c (kN) Effective Length (L_e) in metres												
	(L_e=0)	1	2	3	4	5	6	7	8	9	10	12	14	16
305BT62.5	1690	1690	1610	1490	1360	1230	1110	992	883	784	697	553	444	362
56.5	1490	1490	1420	1320	1210	1100	990	887	792	705	627	499	402	328
50.5	1380	1380	1310	1210	1110	1010	909	814	726	645	574	456	367	300
265BT46.3	1310	1310	1220	1100	989	876	768	670	583	508	444	343	271	218
41.0	1130	1130	1050	957	861	765	674	590	516	450	394	306	242	195
230BT41.1	1230	1210	1090	962	833	711	602	508	431	367	315	237	184	146
37.3	1090	1080	968	855	742	635	539	456	387	330	284	214	166	132
33.6	951	945	852	755	657	564	481	408	347	297	255	193	150	119
205BT29.9	870	851	751	647	545	453	375	311	259	218	186	138	106	83.6
26.9	810	792	699	602	507	421	348	289	241	203	172	128	98.3	77.6
190BT28.4	871	833	713	589	475	379	304	245	201	167	140	103	78.0	61.1
25.4	756	725	622	516	418	335	269	218	178	148	125	91.3	69.5	54.5
22.4	688	659	565	468	379	304	243	197	162	134	113	82.7	62.9	49.3
155BT23.1	721	667	543	421	320	243	188	148	119	97.8	81.4	58.7	44.2	34.4
20.2	652	602	488	378	286	217	167	132	106	86.8	72.2	52.1	39.2	30.5
16.0	487	454	373	293	225	173	134	106	85.8	70.4	58.7	42.4	32.0	25.0
125BT18.7	635	559	419	298	210	153	114	88.2	69.9	56.6	46.8	33.3	24.9	19.3
15.7	523	464	353	255	182	133	100	77.4	61.5	49.9	41.2	29.4	22.0	17.1
12.9	405	361	275	199	143	104	78.6	60.9	48.3	39.2	32.4	23.2	17.3	13.5
100BT14.9 *	542	443	294	188	124	86.5	63.3	48.1	37.7	30.3	24.8	17.6	13.1	10.1
12.7 *	446	367	248	160	106	74.4	54.5	41.5	32.5	26.2	21.5	15.2	11.3	8.74
11.2 *	380	313	212	137	91.2	63.9	46.8	35.6	28.0	22.5	18.5	13.1	9.73	7.52
9.1	297	247	169	110	73.9	51.9	38.1	29.1	22.8	18.4	15.1	10.7	7.96	6.15
90BT11.1	406	337	217	127	79.3	53.6	38.4	28.8	22.4	17.9	14.6	10.3	7.62	5.87
9.1	319	248	154	93.1	59.9	41.2	29.8	22.5	17.6	14.1	11.5	8.14	6.04	4.66
8.1	274	214	133	81.2	52.4	36.1	26.2	19.8	15.4	12.4	10.1	7.15	5.31	4.09
75BT 9.0	329	261	151	83.4	51.1	34.1	24.3	18.2	14.1	11.3	9.18	6.44	4.77	3.67
7.0	256	202	116	64.2	39.3	26.3	18.7	14.0	10.8	8.65	7.06	4.95	3.66	2.82

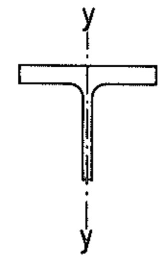
Notes: (1) * indicates buckling about y-axis for the axis shown in the diagram.
(2) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

TABLE 6-7(B)

TEES CUT FROM UNIVERSAL BEAMS GRADE 300

DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

buckling about y-axis



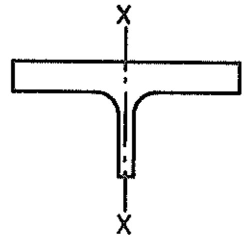
Designation	ϕN_s (kN)	Design Member Capacities in Axial Compression, ϕN_c (kN) Effective Length (L_e) in metres													
	(L_e=0)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	10.0
305BT62.5	1690	1620	1510	1390	1280	1160	1050	941	844	755	607	492	404	336	283
56.5	1490	1430	1330	1230	1120	1020	920	826	740	662	531	430	353	293	247
50.5	1380	1310	1220	1120	1020	919	824	737	656	585	466	376	307	255	214
265BT46.3	1310	1240	1140	1030	931	830	736	650	574	507	398	318	258	213	178
41.0	1130	1060	977	887	797	711	629	555	489	432	339	270	219	180	151
230BT41.1	1230	1140	1040	930	825	726	635	554	483	423	328	259	209	171	142
37.3	1090	1010	918	824	732	644	564	492	430	376	292	231	186	152	127
33.6	951	884	804	722	642	565	494	431	376	330	256	202	163	133	111
205BT29.9	870	801	724	646	568	496	431	373	324	282	217	171	137	112	93.1
26.9	810	739	664	588	513	445	383	330	285	247	189	148	118	96.5	80.1
190BT28.4	871	795	714	632	552	478	412	355	306	266	203	159	127	104	86.2
25.4	756	690	620	549	480	415	358	308	266	231	177	138	111	90.3	74.9
22.4	688	623	557	489	425	365	313	268	230	199	151	118	94.3	76.8	63.7
155BT23.1	721	657	590	521	455	393	338	291	251	218	166	130	104	84.9	70.4
20.2	652	591	528	464	402	346	296	253	218	188	143	112	89.1	72.6	60.2
16.0	487	429	374	321	271	227	191	160	136	116	87.1	67.2	53.2	43.1	35.6
125BT18.7	635	557	486	416	350	293	246	207	175	150	112	86.3	68.3	55.3	45.6
15.7	523	456	396	337	283	236	197	165	140	119	88.9	68.5	54.2	43.8	36.1
12.9	405	338	284	233	189	153	125	103	85.7	72.3	53.2	40.5	31.8	25.6	21.1
100BT14.9 *	542	461	393	327	269	220	181	151	126	107	79.0	60.5	47.6	38.4	31.6
12.7 *	446	377	320	266	217	178	146	121	101	85.5	63.1	48.2	38.0	30.6	25.2
11.2 *	380	324	277	231	190	156	129	107	89.6	75.9	56.2	43.0	33.9	27.4	22.5
9.1	297	226	176	135	103	79.8	63.1	50.8	41.7	34.7	25.1	18.9	14.7	11.8	9.64
90BT11.1	405	317	244	177	129	96.6	74.5	58.9	47.6	39.3	28.0	20.9	16.2	12.9	10.5
9.1	319	229	172	127	94.9	72.4	56.6	45.2	36.8	30.6	21.9	16.5	12.8	10.2	8.35
8.1	274	198	149	119	82.5	63.0	49.3	39.4	32.2	26.7	19.2	14.4	11.2	8.94	7.30
75BT 9.0	329	233	162	110	77.0	56.4	42.9	33.7	27.1	22.2	15.7	11.7	9.04	7.19	5.86
7.0	256	178	122	81.8	57.2	41.8	31.8	24.9	20.0	16.4	11.6	8.63	6.67	5.31	4.32

Notes: (1) * indicates buckling about x-axis for the axis shown in the diagram.
(2) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

TABLE 6-8(A)

TEES CUT FROM UNIVERSAL COLUMNS
GRADE 300

DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION
buckling about x-axis



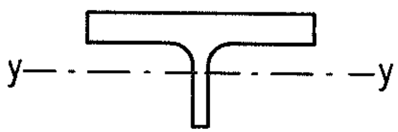
Designation	ϕN_s (kN)	Design Member Capacities in Axial Compression, ϕN_c (kN) Effective Length (L_e) in metres													
	(L_e=0)	1	2	3	4	5	6	7	8	9	10	11	12	13	14
155CT79.0	2530	2530	2360	2190	1990	1770	1550	1320	1130	962	825	711	618	541	477
68.5	2200	2200	2050	1890	1720	1530	1330	1140	967	824	705	608	528	462	407
59.0	1890	1890	1760	1620	1470	1310	1130	968	822	699	598	516	447	391	345
48.4	1670	1660	1540	1420	1280	1120	959	811	684	579	493	423	367	320	282
125CT44.8	1430	1410	1300	1170	1020	867	718	592	489	409	345	294	253	220	193
36.5	1260	1230	1130	1010	872	729	597	488	401	333	280	239	205	178	156
100CT29.8	1030	987	874	743	597	465	362	286	230	188	157	132	113	97.4	84.9
26.1	897	863	764	648	520	405	315	249	200	164	136	115	97.9	84.5	73.7
23.1	795	763	674	570	456	354	275	217	174	142	118	99.7	85.1	73.4	64.0
75CT18.6	637	589	488	368	263	189	141	108	85.4	69.0	56.8	47.6	40.4	34.7	30.1
15.0	554	509	416	307	216	155	114	87.6	69.0	55.7	45.8	38.3	32.5	27.9	24.2
11.7	428	390	314	227	157	111	82.2	62.7	49.3	39.7	32.7	27.3	23.2	19.9	17.3
50CT 7.4	270	225	144	84.1	52.6	35.5	25.4	19.1	14.8	11.9	9.69	8.06	6.81	5.83	5.04

Note: Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

TABLE 6-8(B)

TEES CUT FROM UNIVERSAL COLUMNS
GRADE 300

DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION
buckling about y-axis



Designation	ϕN_s (kN)	Design Member Capacities in Axial Compression, ϕN_c (kN) Effective Length (L_e) in metres													
	(L_e=0)	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0
155CT79.0	2530	2530	2360	2170	1970	1750	1510	1290	1100	932	797	686	596	521	459
68.5	2200	2190	2040	1880	1700	1500	1300	1100	934	793	677	582	505	441	388
59.0	1890	1880	1750	1610	1450	1280	1100	930	786	666	568	488	423	369	325
48.4	1670	1660	1530	1400	1250	1090	922	774	648	546	464	397	343	299	263
125CT44.8	1430	1400	1280	1140	974	805	654	532	435	361	303	257	221	192	168
36.5	1260	1220	1110	972	819	666	534	429	350	289	241	205	175	152	133
100CT29.8	1030	983	865	726	574	442	342	269	216	176	146	123	105	90.6	78.9
26.1	897	857	751	626	491	376	290	227	182	148	123	104	88.3	76.2	66.3
23.1	795	759	665	554	435	332	256	201	161	131	109	91.5	78.0	67.3	58.6
75CT18.6	637	591	492	374	269	195	145	112	88.3	71.4	58.8	49.3	41.8	36.0	31.2
15.0	554	509	417	308	217	155	115	88.1	69.4	56.0	46.1	38.6	32.7	28.1	24.4
11.7	428	396	328	247	176	127	94.6	72.6	57.3	46.3	38.1	31.9	27.1	23.3	20.2
50CT 7.4	270	218	131	73.3	45.1	30.3	21.6	16.2	12.6	10.0	8.18	6.80	5.74	4.91	4.25

Note: Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

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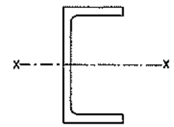
TABLE 6-9(A)

PARALLEL FLANGE CHANNELS
GRADE 300
DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION
buckling about x-axis



Designation	Mass per metre	ϕN_s (kN)	Design Member Capacities in Axial Compression, ϕN_c (kN) Effective Length (L_e) in metres												
	kg/m	(L_e=0)	1	2	3	4	5	6	7	8	9	10	12	14	16
380 PFC	55.2	1770	1770	1760	1700	1640	1570	1500	1430	1350	1270	1180	1010	851	717
300 PFC	40.1	1380	1380	1350	1280	1220	1150	1070	990	904	819	736	591	476	388
250 PFC	35.5	1220	1220	1170	1100	1030	951	865	774	685	602	528	408	321	258
230 PFC	25.1	864	864	819	766	709	645	577	507	441	382	331	252	197	157
200 PFC	22.9	788	788	734	678	617	548	476	407	346	295	252	189	146	115
180 PFC	20.9	718	713	658	601	535	463	392	328	274	230	195	145	111	87.0
150 PFC	17.7	649	632	571	502	422	343	274	221	180	148	124	90.0	68.0	53.2

Note: Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

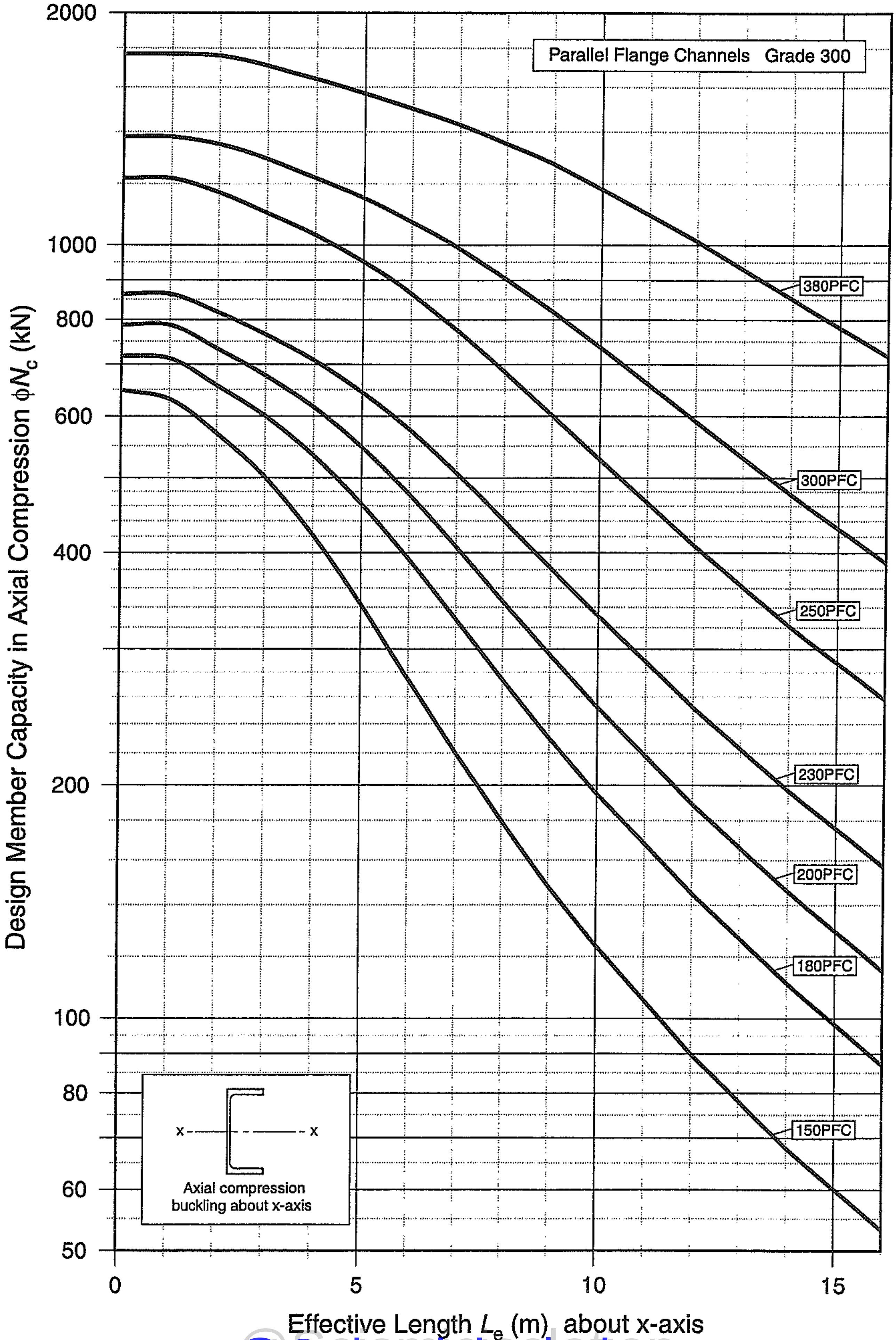
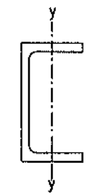

Parallel Flange Channels Grade 300
Design Member Capacity in Axial Compression ϕN_c (kN)
2000
1000
800
600
400
200
100
80
60
50
380PFC
300PFC
250PFC
230PFC
200PFC
180PFC
150PFC
x
x
Axial compression buckling about x-axis
0
5
10
15
Effective Length L_e (m) about x-axis

TABLE 6-9(B)

PARALLEL FLANGE CHANNELS
GRADE 300
DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION
buckling about y-axis



Designation	Mass per metre	ϕN_s (kN)	Design Member Capacities in Axial Compression, ϕN_c (kN) Effective Length (L_e) in metres													
		(L_e=0)	0.25	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.25	2.5	3.0	3.5	4.0	5.0
380 PFC	55.2	1770	1770	1740	1660	1580	1500	1410	1310	1210	1100	1000	815	662	543	378
300 PFC	40.1	1380	1380	1340	1270	1200	1130	1040	955	864	775	691	548	438	355	243
250 PFC	35.5	1220	1220	1190	1130	1060	999	927	851	771	692	618	491	393	318	219
230 PFC	25.1	864	864	822	770	715	654	587	519	454	395	343	263	205	164	110
200 PFC	22.9	788	788	750	704	655	600	541	480	421	367	320	245	192	153	103
180 PFC	20.9	718	718	684	642	597	547	493	437	384	334	292	224	175	140	103
150 PFC	17.7	649	649	616	577	534	488	437	385	336	291	253	193	151	120	80.9

Note: Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

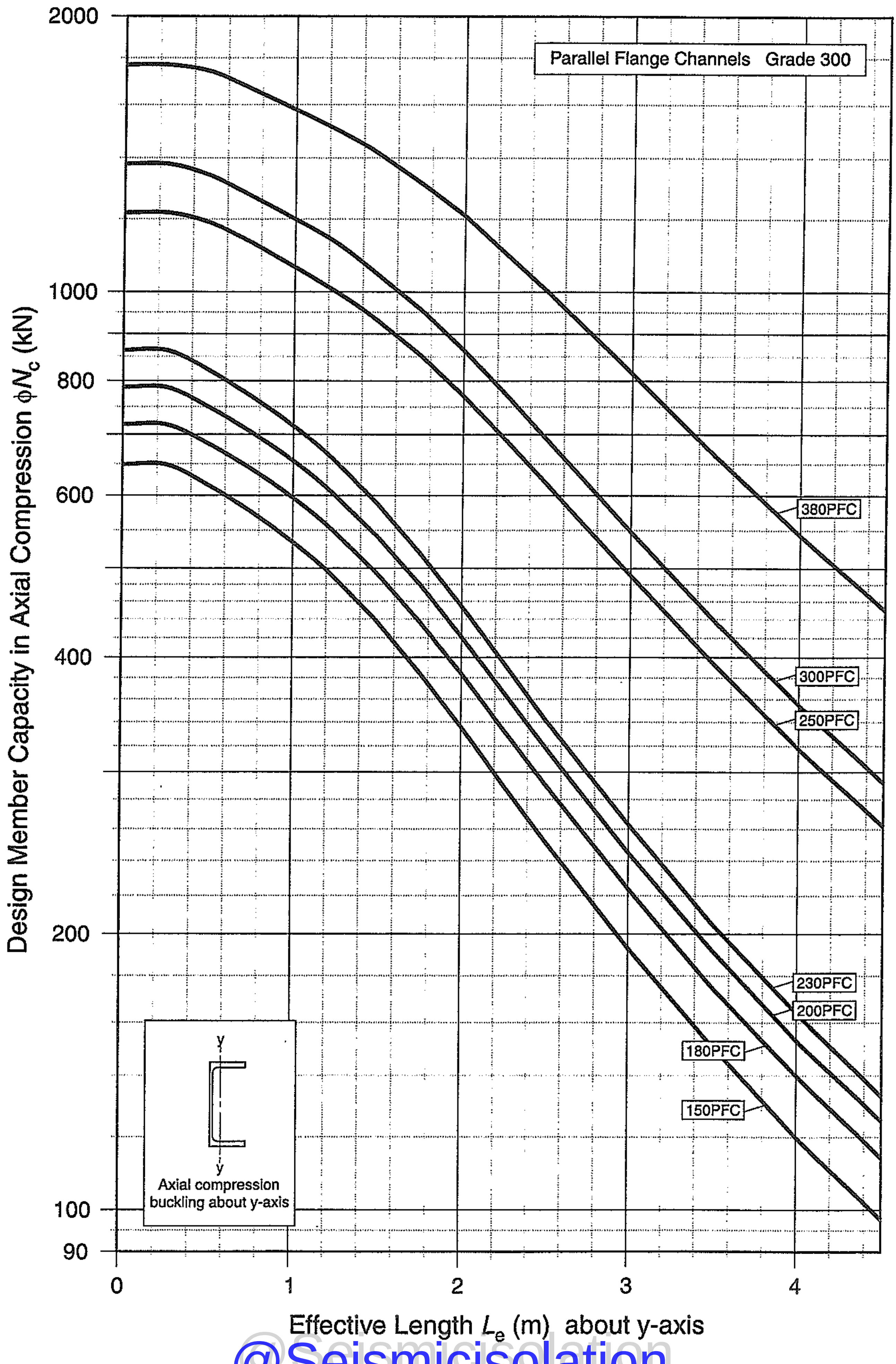
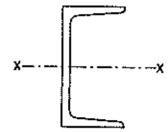

Parallel Flange Channels Grade 300
Design Member Capacity in Axial Compression ϕN_c (kN)
2000
1000
800
600
400
200
100
90
0
1
2
3
4
Effective Length L_e (m) about y-axis
380PFC
300PFC
250PFC
230PFC
200PFC
180PFC
150PFC
y
y
Axial compression buckling about y-axis

TABLE 6-10(A)

TAPER FLANGE CHANNELS
GRADE 250

DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION
buckling about x-axis

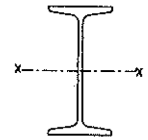


Designation	Mass per metre	ϕN_s (kN)	Design Member Capacities in Axial Compression ϕN_c (kN) Effective Length (L_e) in metres												
	kg/m	(L_e=0)	1	2	3	4	5	6	7	8	9	10	12	14	16
125 TFC	13.4	400	386	344	295	240	189	148	117	94.6	77.5	64.6	46.6	35.1	27.3
100 TFC	9.34	279	262	223	176	131	96.8	73.0	56.5	44.8	36.4	30.0	21.4	16.0	12.4
75 TFC	6.65	198	177	135	90.8	60.4	42.1	30.7	23.3	18.2	14.6	12.0	8.48	6.31	4.87

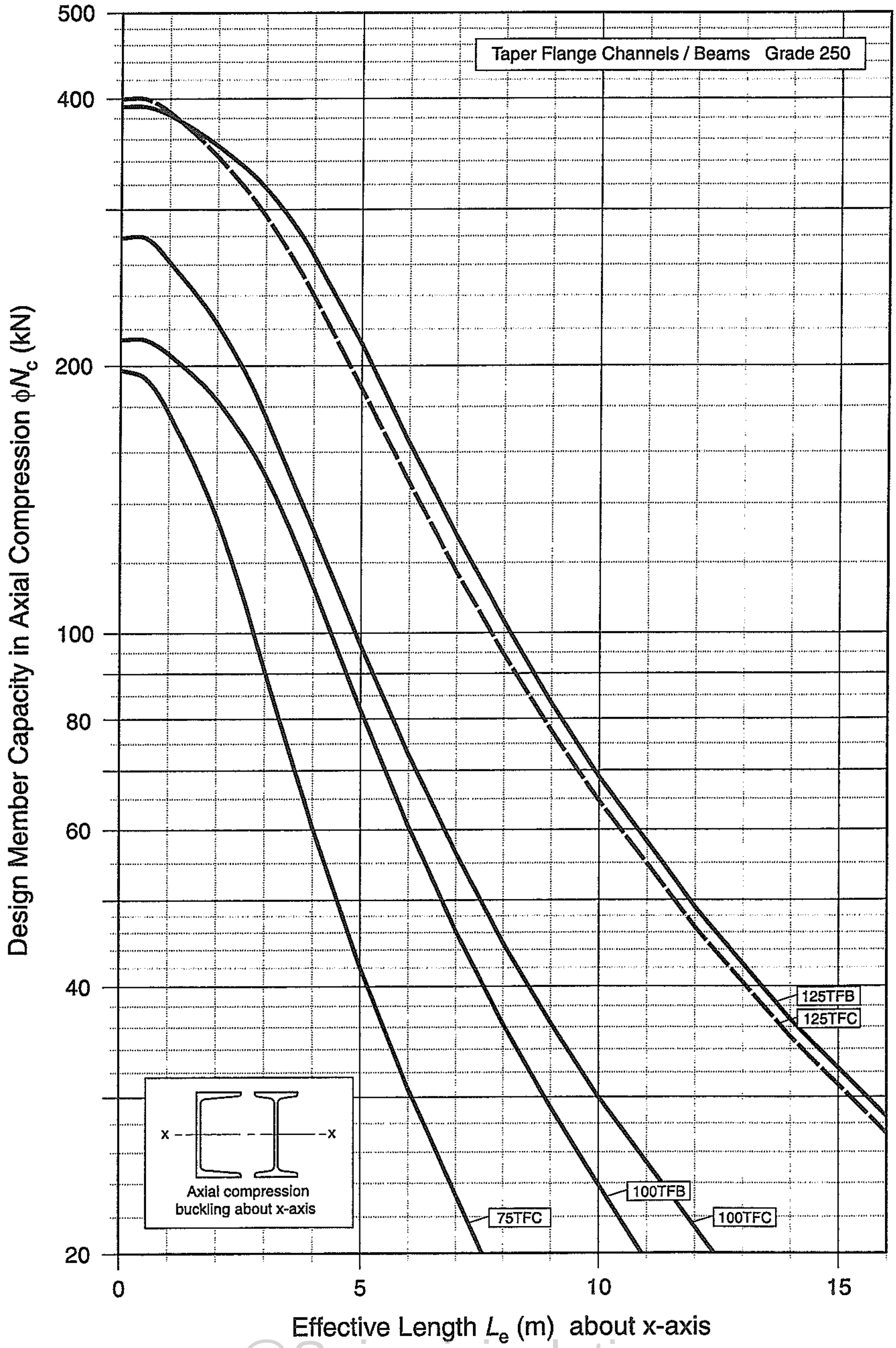
TABLE 6-11(A)

TAPER FLANGE BEAMS
GRADE 250

DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION
buckling about x-axis



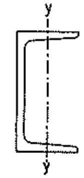
Designation	Mass per metre	ϕN_s (kN)	Design Member Capacities in Axial Compression ϕN_c (kN) Effective Length (L_e) in metres										
	kg/m	(L_e=0)	1	2	3	4	5	6	7	8	9	10	11	12
125 TFB	13.1	392	383	354	317	266	212	164	129	103	83.3	68.8	57.7	49.1
100 TFB	7.20	214	206	183	151	113	81.9	60.6	46.2	36.3	29.2	23.9	20.0	16.9



Taper Flange Channels / Beams Grade 250
Design Member Capacity in Axial Compression ϕN_c (kN)
500
400
200
100
80
60
40
20
0
5
10
15
Effective Length L_e (m) about x-axis
125TFB
125TFC
100TFB
100TFC
75TFC
x
x
Axial compression buckling about x-axis

TABLE 6-10(B)

TAPER FLANGE CHANNELS
GRADE 250
DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION
buckling about y-axis

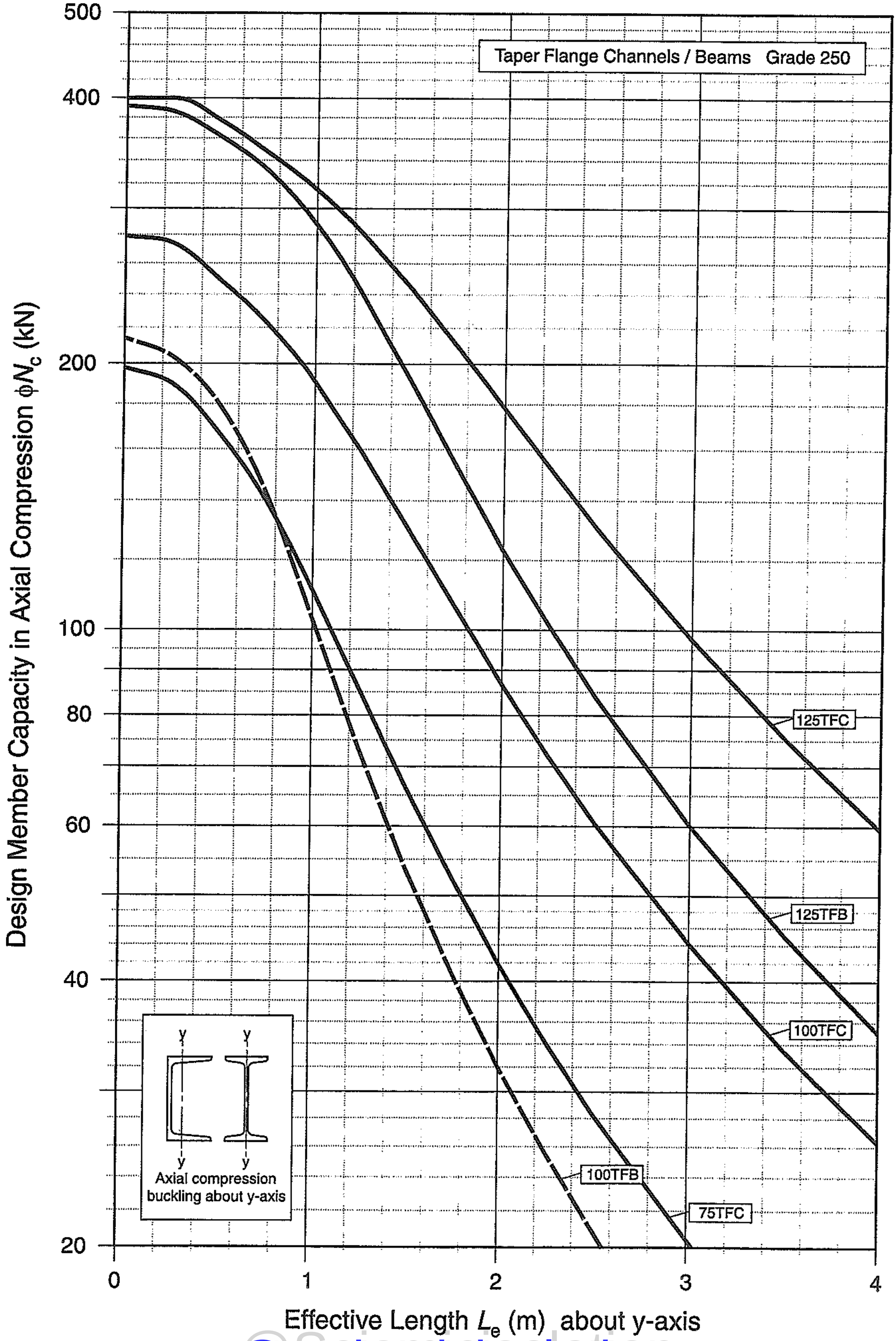


Designation	Mass per metre	ϕN_s (kN)	Design Member Capacities in Axial Compression ϕN_c (kN) Effective Length (L_e) in metres													
	kg/m	(L_e=0)	0.25	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.25	2.5	3.0	3.5	4.0	5.0
125 TFC	13.4	400	400	374	346	315	280	244	209	178	152	130	97.5	75.2	59.5	39.7
100 TFC	9.34	279	274	249	222	191	159	130	106	86.7	72.0	60.5	44.2	33.5	26.3	17.3
75 TFC	6.65	198	190	167	140	111	85.7	66.3	52.2	41.8	34.2	28.4	20.4	15.3	11.9	7.81

TABLE 6-11(B)

TAPER FLANGE BEAMS
GRADE 250
DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION
buckling about y-axis

Designation	Mass per metre	ϕN_s (kN)	Design Member Capacities in Axial Compression ϕN_c (kN) Effective Length (L_e) in metres													
	kg/m	(L_e=0)	0.25	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.25	2.5	2.75	3.0	3.25
125 TFB	13.1	392	386	361	330	288	239	192	153	123	101	83.8	70.5	60.1	51.8
100 TFB	7.20	214	204	180	143	103	73.4	53.8	40.9	32.0	25.7	21.0	17.6	14.9	12.8



Taper Flange Channels / Beams Grade 250
Design Member Capacity in Axial Compression ϕN_c (kN)
500
400
200
100
80
60
40
20
0
1
2
3
4
Effective Length L_e (m) about y-axis
125TFC
125TFB
100TFC
100TFB
75TFC
y
y
y
y
Axial compression buckling about y-axis

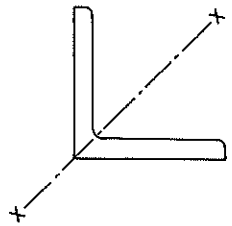


TABLE 6-12(A)-1

EQUAL ANGLES
GRADE 300

DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION
buckling about x-axis

Designation	ϕN_s (kN)	Design Member Capacities in Axial Compression, ϕN_c (kN) Effective Length (L_e) in metres									
	(L_e=0)	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	6.0	8.0
200×200×26EA	2820	2820	2800	2690	2590	2480	2360	2110	1830	1560	1090
20EA	2210	2210	2190	2110	2030	1950	1860	1670	1450	1240	872
18EA	2000	2000	1990	1910	1840	1760	1690	1510	1320	1120	794
16EA	1790	1790	1780	1710	1650	1580	1510	1350	1180	1010	715
13EA	1470	1470	1460	1410	1350	1300	1240	1110	975	833	591
150×150×19EA	1540	1540	1500	1420	1340	1250	1160	955	760	600	387
16EA	1300	1300	1260	1200	1130	1060	981	811	647	512	331
12EA	1000	1000	973	924	874	819	760	631	505	401	260
10EA	769	769	741	692	641	589	538	441	357	289	194
125×125×16EA	1070	1070	1010	949	879	802	718	551	415	317	197
12EA	826	826	785	735	682	624	560	432	327	250	156
10EA	661	661	629	590	548	501	451	349	265	203	126
8EA	516	516	485	445	404	363	323	252	196	154	99.2

Note: Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

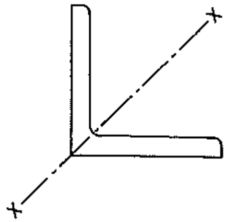


TABLE 6-12(A)-2

EQUAL ANGLES
GRADE 250

DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION
buckling about x-axis

Designation	ϕN_s (kN)	Design Member Capacities in Axial Compression, ϕN_c (kN) Effective Length (L_e) in metres									
	(L_e=0)	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	6.0	8.0
100×100×12EA	529	529	494	457	416	371	323	236	173	130	79.2
10EA	424	424	397	368	335	300	262	192	141	106	64.8
8EA	352	352	329	305	279	249	218	161	118	88.7	54.3
6EA	273	273	256	237	217	194	170	126	92.4	69.5	42.6
90× 90×10EA	380	377	349	319	286	248	211	148	106	78.7	47.5
8EA	315	313	290	265	238	207	176	124	89.1	66.1	39.9
6EA	245	244	226	207	185	162	138	97.5	70.0	51.9	31.4
75× 75×10EA	313	306	278	246	209	172	139	91.6	63.5	46.2	27.4
8EA	260	255	231	205	175	144	116	77.2	53.6	39.0	23.1
6EA	203	199	180	160	137	113	91.7	60.8	42.3	30.8	18.3
5EA	157	154	140	124	106	87.9	71.3	47.4	32.9	24.0	14.2
65× 65×10EA	269	259	230	196	159	124	97.3	62.0	42.3	30.5	17.9
8EA	224	213	181	149	119	94.5	75.3	49.5	34.4	25.1	14.9
6EA	175	169	151	130	106	83.4	65.5	41.9	28.7	20.7	12.1
5EA	136	131	117	101	82.6	65.3	51.4	33.0	22.6	16.3	9.57
55× 55× 6EA	147	139	120	97.2	73.9	55.4	42.1	26.1	17.5	12.5	7.29
5EA	114	106	86.9	68.0	52.0	39.8	30.9	19.7	13.4	9.70	5.70
50× 50× 8EA	169	158	132	102	73.7	53.7	40.1	24.5	16.3	11.6	6.72
6EA	133	124	104	80.9	59.0	43.1	32.3	19.7	13.2	9.38	5.43
5EA	104	94.5	75.0	56.6	42.0	31.4	24.0	15.0	10.2	7.31	4.27
3EA	69.0	64.5	54.6	42.6	31.3	23.0	17.2	10.5	7.05	5.02	2.91
45× 45× 6EA	118	108	88.3	64.6	45.2	32.3	23.9	14.4	9.54	6.77	3.90
5EA	92.3	84.8	69.3	51.0	35.9	25.7	19.0	11.5	7.61	5.40	3.12
3EA	61.4	56.5	46.3	34.3	24.2	17.3	12.8	7.75	5.15	3.66	2.11
40× 40× 6EA	104	93.4	72.2	49.3	33.1	23.1	16.9	10.0	6.62	4.68	2.69
5EA	81.5	73.2	56.9	39.1	26.4	18.5	13.5	8.04	5.31	3.75	2.16
3EA	54.4	49.0	38.2	26.4	17.9	12.5	9.17	5.47	3.61	2.55	1.47
30× 30× 6EA	76.2	63.0	40.0	23.1	14.4	9.72	6.97	4.06	2.65	1.86	1.06
5EA	60.0	46.5	28.6	17.3	11.1	7.62	5.52	3.25	2.13	1.50	0.861
3EA	40.4	33.7	21.9	12.8	8.04	5.44	3.90	2.28	1.49	1.05	0.597
25× 25× 6EA	62.1	47.4	25.3	13.6	8.20	5.45	3.88	2.24	1.45	1.02	0.580
5EA	49.2	37.9	20.6	11.1	6.74	4.49	3.19	1.84	1.20	0.840	0.478
3EA	33.3	25.9	14.2	7.72	4.69	3.13	2.22	1.29	0.836	0.586	0.334

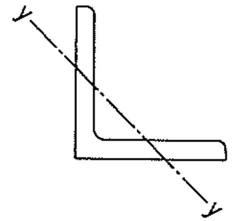


TABLE 6-12(B)-1

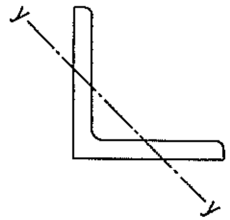
EQUAL ANGLES
GRADE 300

DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION
buckling about y-axis

Designation	ϕN_s (kN)	Design Member Capacities in Axial Compression, ϕN_c (kN) Effective Length (L_e) in metres									
	(L_e=0)	0.25	0.5	0.75	1.0	1.25	1.5	2.0	2.5	3.0	4.0
200×200×26EA	2820	2820	2800	2700	2600	2490	2380	2140	1870	1600	1130
20EA	2210	2210	2200	2120	2040	1950	1870	1680	1470	1260	874
18EA	2000	2000	1990	1920	1850	1770	1690	1520	1340	1140	813
16EA	1790	1790	1780	1720	1650	1590	1520	1370	1200	1030	731
13EA	1470	1470	1460	1410	1360	1300	1250	1120	987	847	605
150×150×19EA	1540	1540	1500	1420	1350	1260	1170	974	781	620	402
16EA	1300	1300	1260	1200	1140	1070	990	823	661	525	341
12EA	1000	1000	975	927	877	824	766	639	514	409	266
10EA	769	769	742	694	644	594	543	447	363	295	199
125×125×16EA	1070	1070	1020	954	886	811	729	565	428	328	205
12EA	826	826	786	738	686	628	566	440	334	256	160
10EA	661	661	630	591	550	505	455	354	270	207	129
8EA	516	516	486	447	406	366	326	256	199	157	101

Note: Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

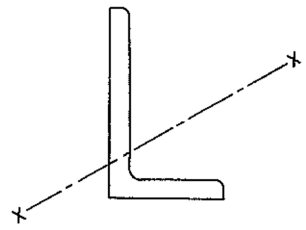
TABLE 6-12(B)-2



EQUAL ANGLES
GRADE 250
DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION
buckling about y-axis

Designation	ϕN_s (kN)	Design Member Capacities in Axial Compression, ϕN_c (kN) Effective Length (L_e) in metres									
	(L_e=0)	0.25	0.5	0.75	1.0	1.25	1.5	2.0	2.5	3.0	4.0
100×100×12EA	529	529	495	459	420	376	329	243	178	134	82.1
10EA	424	424	398	369	337	302	265	196	144	109	66.5
8EA	352	352	330	306	280	251	221	163	120	90.6	55.6
6EA	273	273	256	238	218	196	172	128	94.4	71.1	43.7
90× 90×10EA	380	378	350	321	288	252	215	152	109	81.1	49.0
8EA	315	313	291	267	239	209	179	127	91.3	67.8	41.0
6EA	245	244	226	208	187	164	140	99.6	71.7	53.3	32.3
75× 75×10EA	313	307	279	248	213	176	143	94.9	66.0	48.1	28.6
8EA	260	255	232	207	177	147	119	79.5	55.3	40.4	24.0
6EA	203	199	181	161	139	115	93.7	62.6	43.6	31.8	18.9
5EA	157	154	141	125	108	89.7	73.2	48.9	34.1	24.9	14.8
65× 65×10EA	269	260	232	199	163	129	101	65.0	44.5	32.1	18.9
8EA	224	214	183	151	122	96.9	77.4	51.2	35.7	26.1	15.5
6EA	175	169	151	131	107	85.1	67.0	43.1	29.5	21.3	12.5
5EA	136	132	118	102	83.8	66.6	52.6	33.9	23.2	16.8	9.87
55× 55× 6EA	147	139	121	98.6	75.7	57.0	43.5	27.0	18.2	13.0	7.59
5EA	114	107	87.7	69.0	53.1	40.8	31.7	20.3	13.9	10.0	5.90
50× 50× 8EA	169	158	134	105	76.9	56.4	42.4	25.9	17.3	12.3	7.15
6EA	133	124	105	82.5	60.8	44.7	33.6	20.5	13.7	9.79	5.68
5EA	104	94.8	75.8	57.7	43.0	32.3	24.8	15.6	10.6	7.59	4.44
3EA	69.0	64.8	55.1	43.5	32.3	23.8	18.0	11.0	7.38	5.27	3.06
45× 45× 6EA	118	109	89.4	66.3	46.8	33.6	24.9	15.0	9.99	7.10	4.10
5EA	92.3	85.0	69.9	52.1	36.8	26.5	19.6	11.9	7.88	5.60	3.23
3EA	61.4	56.7	46.8	35.0	24.9	17.9	13.3	8.05	5.35	3.80	2.20
40× 40× 6EA	104	93.9	73.6	51.1	34.6	24.3	17.8	10.6	7.00	4.96	2.85
5EA	81.5	73.5	57.7	40.2	27.2	19.1	14.0	8.37	5.53	3.91	2.25
3EA	54.4	49.2	38.8	27.1	18.5	13.0	9.53	5.70	3.76	2.66	1.53
30× 30× 6EA	76.2	63.9	42.1	24.9	15.6	10.6	7.61	4.44	2.90	2.04	1.17
5EA	60.0	47.1	29.5	18.1	11.7	8.04	5.83	3.45	2.26	1.60	0.915
3EA	40.4	34.0	22.5	13.3	8.40	5.69	4.09	2.39	1.56	1.10	0.627
25× 25× 6EA	62.1	48.8	27.6	15.1	9.24	6.17	4.39	2.54	1.66	1.16	0.661
5EA	49.2	38.6	21.7	11.9	7.23	4.82	3.44	1.99	1.29	0.907	0.517
3EA	33.3	26.2	14.8	8.07	4.92	3.29	2.34	1.36	0.881	0.618	0.352

TABLE 6-13(A)

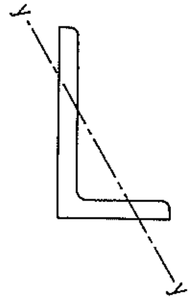


UNEQUAL ANGLES
GRADE 300 & 250
DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION
buckling about x-axis

Designation	ϕN_s (kN)	Design Member Capacities in Axial Compression, ϕN_c (kN) Effective Length (L_e) in metres									
	(L_e=0)	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	6.0	8.0
150×100×12UA	826	826	790	744	695	641	582	460	353	273	172
10UA	644	644	609	561	512	462	414	326	256	202	131
150× 90×16UA	1020	1020	976	917	854	784	708	553	422	324	203
12UA	791	791	755	710	662	609	552	433	331	255	160
10UA	617	617	582	535	487	439	392	308	240	189	122
8UA	453	453	431	400	367	333	301	240	190	152	99.6
125× 75×12UA	529	529	499	466	430	390	347	263	196	149	92.1
10UA	424	424	401	375	346	315	280	213	160	121	75.1
8UA	352	352	333	311	288	261	233	178	133	101	62.9
6UA	238	238	224	206	187	168	149	116	90.5	71.0	45.8
100× 75×10UA	369	366	339	310	278	242	205	145	104	76.7	46.3
8UA	306	304	282	258	231	201	172	121	86.9	64.4	38.9
6UA	238	237	219	201	180	157	134	95.0	68.2	50.6	30.6
75× 50× 8UA	215	206	176	145	116	92.7	74.1	48.9	34.1	24.9	14.8
6UA	169	163	146	126	103	81.9	64.5	41.5	28.4	20.5	12.1
5UA	131	127	114	98.2	80.8	64.2	50.7	32.6	22.4	16.2	9.50
65× 50× 8UA	197	184	153	122	94.6	73.2	57.3	36.9	25.3	18.4	10.8
6UA	154	147	129	107	84.1	64.3	49.5	31.1	21.0	15.1	8.81
5UA	120	113	94.0	75.3	58.8	45.8	35.9	23.2	16.0	11.6	6.85

Notes: (1) For 150×90 angles and above: Grade 300.
(2) For 125×75 angles and below: Grade 250.
(3) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

TABLE 6-13(B)



UNEQUAL ANGLES
GRADE 300 & 250
DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION
buckling about y-axis

Designation	ϕN_s (kN)	Design Member Capacities in Axial Compression, ϕN_c (kN) Effective Length (L_e) in metres									
	(L_e=0)	0.25	0.5	0.75	1.0	1.25	1.5	2.0	3.5	3.0	4.0
150×100×12UA	826	826	773	718	656	588	515	380	280	210	129
10UA	644	644	592	534	476	418	364	273	206	158	99.8
150× 90×16UA	1020	1020	942	862	774	673	573	404	290	215	130
12UA	791	787	729	668	600	524	447	316	227	169	102
10UA	617	614	555	493	431	371	317	230	170	129	79.7
8UA	453	453	413	371	328	286	247	183	137	105	65.6
125× 75×12UA	529	522	480	435	383	327	272	187	132	97.2	58.2
10UA	424	419	386	350	309	264	220	152	107	79.0	47.3
8UA	352	348	320	290	257	220	184	127	89.8	66.1	39.7
6UA	238	237	213	189	164	141	120	86.7	63.8	48.2	29.8
100× 75×10UA	369	364	334	302	266	226	188	129	90.0	66.8	40.0
8UA	306	302	278	251	221	188	157	108	76.1	56.0	33.5
6UA	238	235	216	196	173	148	123	84.6	59.9	44.1	26.4
75× 50× 8UA	215	201	165	129	99.2	76.0	59.1	37.7	25.8	18.6	11.0
6UA	169	160	139	114	87.6	66.1	50.5	31.4	21.2	15.2	8.84
5UA	131	125	108	89.1	68.8	52.1	39.8	24.8	16.7	12.0	6.99
65× 50× 8UA	197	182	149	117	88.9	67.9	52.7	33.5	22.9	16.5	9.71
6UA	154	146	126	103	78.5	59.0	44.9	27.9	18.8	13.4	7.81
5UA	120	111	91.5	71.8	55.1	42.2	32.8	20.9	14.3	10.3	6.08

Notes: (1) For 150x90 angles and above: Grade 300.
(2) For 125x75 angles and below: Grade 250.
(3) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

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PART 7 MEMBERS SUBJECT TO AXIAL TENSION

TABLES

TENSION

COMBINED

PART 7 MEMBERS SUBJECT TO AXIAL TENSION

7.1 General

Tables 7-1 to 7-24 give values of design section capacity in axial tension. Section 7 of AS 4100 is used to determine these values. The tables list the design section capacity in tension for a variety of standardised bolted and welded connections.

Note: **This chapter considers only connections with standardised detailing parameters summarised in Section 10 of this publication.**

7.2 Design Section Capacity in Axial Tension

The design section capacity in axial tension (ϕN_t) has been determined from Clause 7.2 of AS 4100 and taken as the *lesser* of:

$\phi N_t = \phi A_g f_y$ (Yielding of the gross section)

$\phi N_t = \phi (0.85) k_t A_n f_u$ (Fracture of the net section at a connection)

where ϕ = 0.9 (Table 3.4 of AS 4100)

f_y = yield stress used in design (*For sections where the flange and web yield stresses (f_{yf} & f_{yw}) differ, the* ***lower*** *of the two is applied to the entire cross-section.*)

f_u = ultimate tensile strength used in design

A_g = gross area of the cross-section

A_n = net area of the cross-section (accounting for any fastener holes in the section)

k_t = a correction factor to account for the distribution of forces at a connection (shown in Table 7.1)

Note: *For staggered bolt holes (not considered in these Tables) designers should consult Clause 9.1.10 of AS 4100 to determine the deduction to the gross area due to the holes.*

7.3 Example

1. Design an appropriate Equal Angle section for a design axial tensile force, N^* = 1300 kN, assuming an eccentrically bolted connection through one leg of the angle.

Solution:

Select a suitable member from Tables 7-22(1) and 7-22(2). The alternatives are:

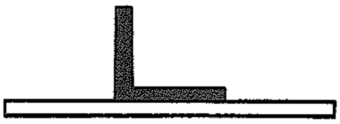
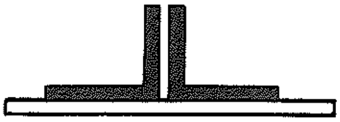
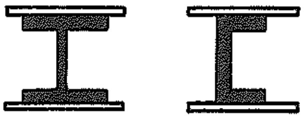
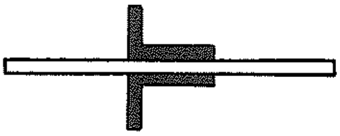
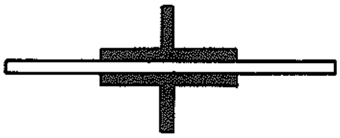
150 x 150 x 19 EA - Grade 300 (42.1 kg/m) $\phi N_t = 1350 > N^*$

200 x 200 x 13 EA - Grade 300 (40.0 kg/m) $\phi N_t = 1370 > N^*$

In each case there is a single line of 22 mm holes (20 mm bolts) in one leg of the angle.

Choose a 200 x 200 x 13 EA - Grade 300 section as it is more economical based on mass.

TABLE 7.1: Correction Factor (k_t)

Configuration Case	Correction Factor (k_t)
	0.75 for Unequal Angles connected by the Short Leg 0.85 Otherwise
	0.75 for Unequal Angles connected by the Short Leg 0.85 Otherwise
	0.85
	0.90
	0.75†
	0.85*
	1.0
	1.0
	1.0
Other end connection providing uniform force distribution	1.0#

Notes:
* Such connections for Channels and I- sections must satisfy Clause 7.3.2(b) of AS 4100.
# These connections must satisfy Clause 7.3.1 of AS 4100.
† This configuration not considered in Section 7 of AS 4100.

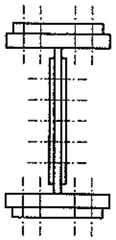
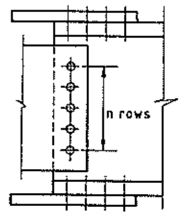


TABLE 7-1

WELDED BEAMS
GRADE 300

DESIGN SECTION CAPACITIES IN AXIAL TENSION
with end connections to FLANGE and to WEB



Designation	Design Section Capacity in Axial Tension, ϕN_t (kN)												
	Welded No Holes	Bolted - Two Holes in Each Flange, N in Web Bolted - Four Holes in Each Flange (for $b_f \geq 400$mm), N in Web											
		Hole Dia.	N =										
	N = 0	mm	5	6	7	8	9	10	11	12	13	14	15
1200WB455	14600	26			$N < N_{min}$			14600	14600	14600	14600	14600	14600
455 *	14600	26						14600	14600	14600	14500	14400	14300
423	13600	26						13600	13600	13600	13600	13600	13600
423 *	13600	26						13600	13600	13600	13500	13400	13200
392	12600	26						12600	12600	12600	12600	12600	12600
392 *	12600	26						12600	12600	12600	12500	12300	12200
342	11000	26						11000	11000	11000	11000	11000	11000
342 *	11000	26						10800	10600	10500	10300	10200	10100
317	10200	26						10200	10200	10200	10200	10200	10200
317 *	10200	26						9980	9840	9710	9570	9430	9290
278	8930	26						8930	8930	8930	8930	8880	8740
249	7980	26						7980	7980	7920	7780	7650	7510
1000WB322	10300	26				10300	10300	10300	10300	10300			
322 *	10300	26				10200	10100	9920	9780	9640			
296	9520	26				9520	9520	9520	9520	9520			
296 *	9520	26				9410	9270	9140	9000	8860			
258	8280	26				8280	8280	8280	8280	8280			
215	7390	26				7220	7080	6950	6810	6670			
900WB282	9050	26			9050	9050	9050	9050	9050				
282 *	9050	26			8910	8810	8700	8600	8500				
257	8250	26			8250	8250	8250	8250	8250				
257 *	8250	26			8130	8030	7920	7820	7720				
218	7010	26			7010	7010	7010	7010	7010				
175	6030	26			5940	5840	5730	5630	5530				
800WB192	6150	26		6150	6150	6150	6150				$N > N_{max}$		
168	5380	26		5380	5380	5380	5380						
146	5020	26		4920	4840	4750	4660						
122	4210	26		4070	3990	3900	3810						
700WB173	5540	26	5540	5540	5540	5540							
150	4810	26	4810	4810	4810	4740							
130	4480	26	4350	4260	4180	4090							
115	3940	26	3830	3740	3660	3570							

Notes: (1) * indicates four holes in each flange.
(2) $N > N_{max}$ denotes that this number of bolts usually cannot be used in the web.
(3) $N < N_{min}$ denotes that this number of bolts is not usually used in practical connections.

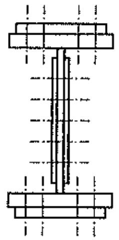
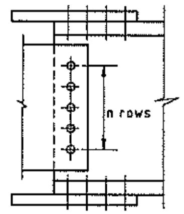


TABLE 7-2

WELDED BEAMS
GRADE 400

DESIGN SECTION CAPACITIES IN AXIAL TENSION
with end connections to FLANGE and to WEB



Designation	Welded No Holes	Bolted - Two Holes in Each Flange, N in Web / Bolted - Four Holes in Each Flange (for $b_f \geq 400$mm), N in Web											
	Design Section Capacity in Axial Tension, ϕN_t (kN)	Hole Dia.	N =										
	N = 0	mm	5	6	7	8	9	10	11	12	13	14	15
1200WB455	18800	26						18200	18100	17900	17800	17600	17400
455*	18800	26						16700	16500	16400	16200	16100	15900
423	17500	26						16900	16700	16600	16400	16300	16100
423*	17500	26						15500	15400	15200	15100	14900	14800
392	16200	26						15600	15400	15300	15100	15000	14800
392*	16200	26			$N < N_{min}$			14400	14200	14100	13900	13700	13600
342	14100	26						13200	13100	12900	12800	12600	12500
342*	14100	26						12000	11900	11700	11600	11400	11200
317	13100	26						12200	12100	11900	11800	11600	11400
317*	13100	26						11100	11000	10800	10700	10500	10400
278	11500	26						10500	10400	10200	10100	9910	9760
249	10300	26						9150	8990	8840	8690	8540	8380
1000WB322	13300	26				12600	12400	12300	12100	12000			
322*	13300	26				11400	11200	11100	10900	10800			
296	12200	26				11600	11400	11300	11100	11000			
296*	12200	26				10500	10400	10200	10000	9890			
258	10600	26				9890	9740	9580	9430	9280			
215	9360	26				8060	7910	7760	7600	7450			
900WB282	11600	26			11200	11100	10900	10800	10700				
282*	11600	26			9940	9830	9710	9600	9490				
257	10600	26			10100	10000	9910	9800	9690				
257*	10600	26			9070	8960	8850	8730	8620				
218	9010	26			8460	8340	8230	8120	8000				
175	7630	26			6630	6520	6400	6290	6170				
800WB192	7910	26		7320	7220	7130	7030						
168	6920	26		6310	6220	6120	6030				$N > N_{max}$		
146	6360	26		5490	5400	5300	5210						
122	5340	26		4640	4540	4450	4350						
700WB173	7130	26	6530	6440	6340	6250							
150	6190	26	5580	5490	5390	5300							
130	5680	26	4850	4760	4660	4570							
115	4990	26	4270	4180	4080	3990							

Notes: (1) * indicates Four Holes in Each Flange.
(2) $N > N_{max}$ denotes that this number of bolts usually cannot be used in the web.
(3) $N < N_{min}$ denotes that this number of bolts is not usually used in practical connections.

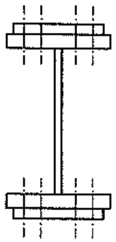


TABLE 7-3

WELDED BEAMS
GRADE 300

DESIGN SECTION CAPACITIES IN AXIAL TENSION with end connections to FLANGE only

Designation	Design Section Capacity in Axial Tension, ϕN_t (kN)			
	Welded No Holes	Bolted — N Holes/Flange		
		Hole Dia.	N =	
	N = 0	mm	2	4
1200WB455	14600	26	14600	13900
423	13600	26	13600	13000
392	12600	26	12600	12100
342	11000	26	11000	10300
317	10200	26	10200	9650
278	8930	26	8930	—
249	7980	26	7980	—
1000WB322	10300	26	10300	9590
296	9520	26	9520	8930
258	8280	26	8280	—
215	7390	26	7070	—
900WB282	9050	26	9050	8180
257	8250	26	8250	7520
218	7010	26	7010	—
175	6030	26	5660	—
800WB192	6150	26	6010	—
168	5380	26	5240	—
146	5020	26	4620	—
122	4210	26	3900	—
700WB173	5540	26	5340	—
150	4810	26	4610	—
130	4480	26	4060	—
115	3940	26	3620	—

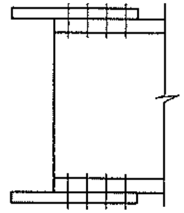


TABLE 7-4

WELDED BEAMS
GRADE 400

DESIGN SECTION CAPACITIES IN AXIAL TENSION with end connections to FLANGE only

Designation	Design Section Capacity in Axial Tension, ϕN_t (kN)			
	Welded No Holes	Bolted — N Holes/Flange		
		Hole Dia.	N =	
	N = 0	mm	2	4
1200WB455	18100	26	16800	15500
423	16800	26	15700	14500
392	15600	26	14500	13500
342	13600	26	12500	11500
317	12600	26	11700	10800
278	11100	26	10200	—
249	9880	26	9070	—
1000WB322	12800	26	11700	10700
296	11800	26	10900	9970
258	10300	26	9440	—
215	8540	26	7890	—
900WB282	11200	26	10200	9130
257	10200	26	9300	8390
218	8680	26	7870	—
175	6970	26	6320	—
800WB192	7620	26	6710	—
168	6660	26	5850	—
146	5810	26	5160	—
122	4870	26	4350	—
700WB173	6870	26	5960	—
150	5960	26	5150	—
130	5180	26	4530	—
115	4560	26	4040	—

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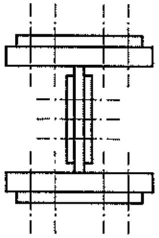


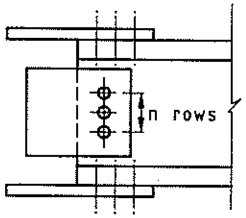


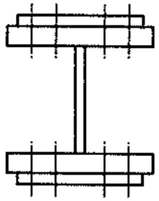
TABLE 7-5

WELDED COLUMNS GRADE 300

DESIGN SECTION CAPACITIES IN AXIAL TENSION with end connections to FLANGE and to WEB

Designation	Design Section Capacity in Axial Tension, ϕN_t (kN)						
	Welded No Holes	Bolted - Two Holes in Each Flange, N in Web; Bolted - Four Holes in Each Flange (for $b_f \geq 400$mm), N in Web					
		Hole Dia.	N =				
	N = 0	mm	1	2	3	4	5
500WC440	14100	26	$N < N_{min}$	14100	14100	14100	14100
440 *	14100	26		14100	14100	14100	14000
414	13300	26		13300	13300	13300	13300
414 *	13300	26		13300	13300	13300	13300
383	12300	26		12300	12300	12300	12300
383 *	12300	26		12300	12300	12300	12200
340	10900	26		10900	10900	10900	10900
340 *	10900	26		10900	10900	10900	10900
290	9320	26		9320	9320	9320	9320
290 *	9320	26		9320	9320	9320	9320
267	8570	26		8570	8570	8570	8570
267 *	8570	26		8570	8570	8570	8570
228	7830	26		7830	7830	7830	7830
228 *	7830	26		7830	7660	7490	7320
400WC361	11600	26	11600	11600	11600	11600	
361 *	11600	26	11600	11600	11400	11000	
328	10500	26	10500	10500	10500	10500	
328 *	10500	26	10500	10500	10300	10100	
303	9730	26	9730	9730	9730	9730	
303 *	9730	26	9730	9730	9520	9280	
270	8660	26	8660	8660	8660	8660	
270 *	8660	26	8660	8660	8470	8250	
212	6800	26	6800	6800	6800	6800	
212 *	6800	26	6800	6800	6660	6490	
181	6210	26	6210	6210	6210	6200	
181 *	6210	26	6030	5860	5680	5510	
144	4970	26	4970	4970	4970	4960	
144 *	4970	26	4820	4680	4550	4410	
350WC280	9000	26	9000	9000	9000	$N > N_{max}$	
258	8290	26	8290	8290	8290		
230	7380	26	7380	7380	7380		
197	6330	26	6330	6330	6330		

Notes: (1) * indicates four holes in each flange.
(2) $N > N_{max}$ denotes that this number of bolts usually cannot be used in the web.
(3) $N < N_{min}$ denotes that this number of bolts is not usually used in practical connections.



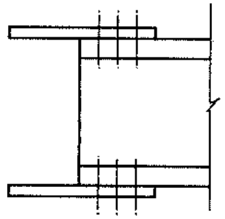
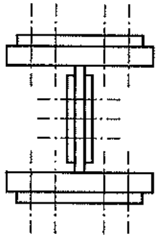


TABLE 7-6

WELDED COLUMNS GRADE 300

DESIGN SECTION CAPACITIES IN AXIAL TENSION with end connections to FLANGE only

Designation	Design Section Capacity in Axial Tension, ϕN_t (kN)			
	Welded No Holes	Bolted — N Holes/Flange		
		Hole Dia.	N =	
	N = 0	mm	2	4
500WC440	14100	26	14100	13300
414	13300	26	13300	12400
383	12300	26	12300	11600
340	10900	26	10900	10200
290	9320	26	9320	8720
267	8570	26	8570	8050
228	7830	26	7530	6950
400WC361	11600	26	11600	10500
328	10500	26	10500	9360
303	9730	26	9730	8700
270	8660	26	8660	7740
212	6800	26	6800	6100
181	6210	26	5850	5270
144	4970	26	4680	4210
350WC280	9000	26	8820	—
258	8290	26	8150	—
230	7380	26	7250	—
197	6330	26	6200	—



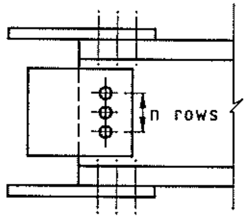


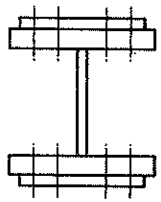
TABLE 7-7

WELDED COLUMNS GRADE 400

DESIGN SECTION CAPACITIES IN AXIAL TENSION with end connections to FLANGE and to WEB

Designation	Design Section Capacity in Axial Tension, ϕN_t (kN)						
	Welded No Holes	Bolted - Two Holes in Each Flange, N in Web; Bolted - Four Holes in Each Flange (for $b_f \geq 400$mm), N in Web					
		Hole Dia.	N =				
	N = 0	mm	1	2	3	4	5
500WC440	18100	26	$N > N_{min}$	18100	17900	17500	17100
440 *	18100	26		16700	16400	16000	15600
414	17100	26		17100	16900	16600	16300
414 *	17100	26		15700	15400	15100	14800
383	15800	26		15800	15600	15300	15000
383 *	15800	26		14600	14300	13900	13600
340	14000	26		14000	13900	13700	13500
340 *	14000	26		13000	12700	12500	12200
290	12000	26		12000	11900	11800	11600
290 *	12000	26		11100	10900	10700	10500
267	11000	26		11000	11000	10800	10600
267 *	11000	26		10200	10000	9810	9620
228	9920	26		9500	9310	9120	8930
228 *	9920	26		8740	8550	8360	8170
400WC361	14900	26	14900	14600	14200	13800	
361 *	14900	26	13500	13100	12700	12300	
328	13500	26	13500	13300	13000	12800	
328 *	13500	26	12000	11800	11500	11200	
303	12500	26	12500	12300	12000	11700	
303 *	12500	26	11200	10900	10600	10400	
270	11100	26	11100	10900	10700	10400	
270 *	11100	26	9930	9690	9450	9210	
212	8750	26	8750	8580	8390	8200	
212 *	8750	26	7810	7620	7430	7240	
181	7870	26	7490	7300	7110	6920	
181 *	7870	26	6730	6540	6350	6150	
144	6290	26	5990	5840	5690	5530	
144 *	6290	26	5380	5230	5080	4920	
350WC280	11600	26	11300	11000	10800	$N > N_{max}$	
258	10700	26	10400	10200	9900		
230	9490	26	9290	9050	8810		
197	8130	26	7960	7770	7570		

Notes: (1) * indicates four holes in each flange.
(2) $N > N_{max}$ denotes that this number of bolts usually cannot be used in the web.
(3) $N < N_{min}$ denotes that this number of bolts is not usually used in practical connections.



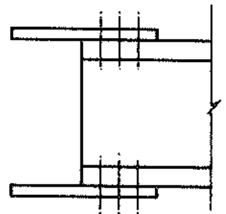


TABLE 7-8

WELDED COLUMNS GRADE 400

DESIGN SECTION CAPACITIES IN AXIAL TENSION with end connections to FLANGE only

Designation	Design Section Capacity in Axial Tension, ϕN_t (kN)			
	Welded No Holes	Bolted — N Holes/Flange		
		Hole Dia.	N =	
	N = 0	mm	2	4
500WC440	17500	26	16200	14900
414	16500	26	15200	13900
383	15200	26	14100	12900
340	13500	26	12500	11400
290	11500	26	10600	9730
267	10600	26	9800	8990
228	9050	26	8400	7750
400WC361	14400	26	13100	11800
328	13000	26	11700	10400
303	12000	26	10900	9710
270	10700	26	9680	8640
212	8430	26	7620	6800
181	7180	26	6530	5880
144	5740	26	5220	4700
350WC280	11100	26	9840	—
258	10300	26	9100	—
230	9140	26	8100	—
197	7830	26	6930	—

COMBINED

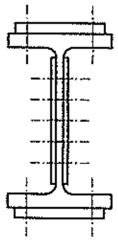
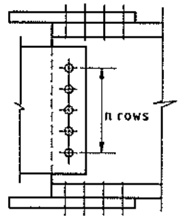


TABLE 7-9

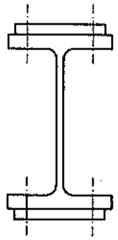
UNIVERSAL BEAMS GRADE 300

DESIGN SECTION CAPACITIES IN AXIAL TENSION with end connections to FLANGE and to WEB



Designation	Design Section Capacity in Axial Tension, ϕN_t (kN)								
	Welded No Holes	Bolted - Two Holes in Each Flange, N in Web							
		Hole Dia.	N =						
	N = 0	mm	1	2	3	4	5	6	7
610UB125	4020	22	N < N_{min}			4020	4020	4020	4020
113	3650	22				3650	3650	3650	3650
101	3510	22				3510	3510	3460	3380
530UB 92.4	3190	22			3190	3190	3130	3060	
82.0	2840	22			2840	2840	2790	2720	
460UB 82.1	2830	22		2830	2830	2760	2680		
74.6	2570	22		2570	2570	2510	2440		
67.1	2320	22		2320	2320	2260	2200		
410UB 59.7	2060	22	2060	2060	2020	1960			
53.7	1980	22	1940	1880	1830	1770			
360UB 56.7	1960	22	1960	1930	1880				
50.7	1750	22	1750	1730	1680				
44.7	1650	22	1590	1540	1490				
310UB 46.2	1600	22	1600	1550	1500				
40.4	1500	22	1410	1360	1320				
32.0	1180	22	1100	1050	1010				
250UB 37.3	1370	22	1230	1180					
31.4	1150	22	1050	1000					
25.7	941	18	845	815					
200UB 29.8	1100	22	956	909					
25.4	930	22	814	771		N > N_{max}			
22.3	826	22	721	684					
18.2	668	†							
180UB 22.2	813	†							
18.1	663	†							
16.1	589	†							
150UB 18.0	661	†							
14.0	514	†							

Notes: (1) N > N_{max} denotes that this number of bolts usually cannot be used in the web.
(2) N < N_{min} denotes that this number of bolts is not usually used in practical connections.
(3) † indicates flange too small for high strength structural bolts.
(4) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.



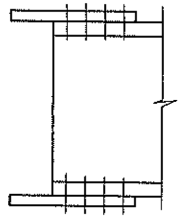


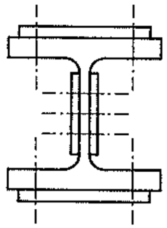
TABLE 7-10

UNIVERSAL BEAMS GRADE 300

DESIGN SECTION CAPACITIES IN AXIAL TENSION with end connections to FLANGE only

Designation	Design Section Capacity in Axial Tension, ϕN_t (kN)		
	Welded No Holes	Bolted — N Holes/Flange	
		Hole Dia.	N =
	N = 0	mm	2
610UB125	4020	22	4020
113	3650	22	3650
101	3510	22	3340
530UB 92.4	3190	22	2990
82.0	2840	22	2670
460UB 82.1	2830	22	2590
74.6	2570	22	2360
67.1	2320	22	2130
410UB 59.7	2060	22	1860
53.7	1970	22	1700
360UB 56.7	1960	22	1750
50.7	1750	22	1560
44.7	1640	22	1390
310UB 46.2	1600	22	1400
40.4	1490	22	1230
32.0	1170	22	966
250UB 37.3	1360	22	1080
31.4	1150	22	930
25.7	935	18	770
200UB 29.8	1090	22	852
25.4	924	22	728
22.3	821	22	644
18.2	663	†	†
180UB 22.2	807	†	†
18.1	659	†	†
16.1	585	†	†
150UB 18.0	657	†	†
14.0	511	†	†

Notes: (1) † indicates flange too small for high strength structural bolts.
(2) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.



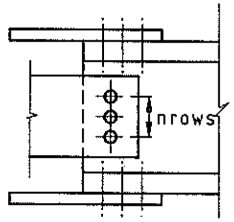


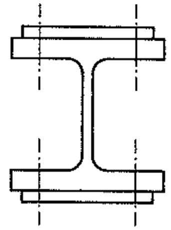
TABLE 7-11

UNIVERSAL COLUMNS GRADE 300

DESIGN SECTION CAPACITIES IN AXIAL TENSION with end connections to FLANGE and to WEB

Designation	Design Section Capacity in Axial Tension, ϕN_t (kN)				
	Welded No Holes	Bolted — Two Holes in Each Flange, N in Web			
		Hole Dia.	N =		
	N = 0	mm	1	2	3
310UC158	5070	26	5070	5070	5070
137	4400	26	4400	4400	4400
118	3780	26	3780	3780	3780
96.8	3340	26	3340	3340	3340
250UC 89.5	2870	22	2870	2870	2870
72.9	2520	22	2520	2520	2520
200UC 59.5	2060	22	2060	2010	1940
52.2	1800	22	1800	1750	1690
46.2	1590	22	1590	1550	1500
150UC 37.2	1280	22	1190	1130	—
30.0	1110	22	972	923	—
23.4	859	22	757	712	—
100UC 14.8	543	22	391	—	—

Notes: (1) — indicates that $N > N_{max}$, i.e. this number of bolts usually cannot be used in the web.
(2) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.



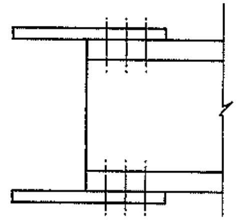


TABLE 7-12

UNIVERSAL COLUMNS GRADE 300

DESIGN SECTION CAPACITIES IN AXIAL TENSION with end connections to FLANGE only

Designation	Design Section Capacity in Axial Tension, ϕN_t (kN)		
	Welded No Holes	Bolted — N Holes/Flange	
		Hole Dia.	N =
	N = 0	mm	2
310UC158	5070	26	5020
137	4400	26	4350
118	3780	26	3740
96.8	3340	26	3080
250UC 89.5	2870	22	2820
72.9	2520	22	2310
200UC 59.5	2060	22	1820
52.2	1800	22	1590
46.2	1590	22	1410
150UC 37.2	1280	22	1060
30.0	1100	22	868
23.4	853	22	682
100UC 14.8	540	22	364

Note: Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

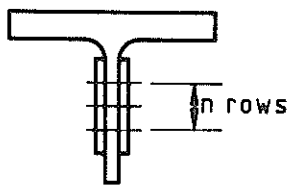


TABLE 7-13

TEES CUT FROM UNIVERSAL BEAMS GRADE 300

DESIGN SECTION CAPACITIES IN AXIAL TENSION with end connections to WEB only

Designation	Design Section Capacity in Axial Tension, ϕN_t (kN)				
	Welded No Holes	Bolted — N Holes in Web			
		Hole Dia.	N =		
	N = 0	mm	1	2	3
305BT62.5	2010	22	1950	1880	1810
56.5	1820	22	1760	1700	1640
50.5	1640	22	1580	1520	1460
265BT46.3	1490	22	1430	1380	1320
41.0	1320	22	1270	1220	1160
230BT41.1	1320	22	1260	1210	—
37.3	1200	22	1150	1100	—
33.6	1080	22	1030	986	—
205BT29.9	962	22	919	876	—
26.9	867	22	825	783	—
180BT28.4	912	22	868	—	—
25.4	815	22	775	—	—
22.4	721	22	682	—	—
155BT23.1	747	22	710	—	—
20.2	656	22	622	—	—
16.0	514	22	483	—	—
125BT18.7	598	22	563	—	—
15.7	505	22	471	—	—
12.9	411	22	383	—	—
100BT14.9	481	22	446	—	—
12.7	406	22	374	—	—
11.2	361	22	333	—	—
9.1	291	22	266	—	—
90BT11.1	355	18	327	—	—
9.1	289	18	267	—	—
8.1	257	18	236	—	—
75BT 9.0	288	18	261	—	—
7.0	224	18	201	—	—

Notes: (1) — indicates that $N > N_{max}$, i.e. this number of bolts usually cannot be used in the web.
(2) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

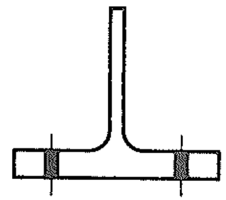


TABLE 7-14

TEES CUT FROM UNIVERSAL BEAMS GRADE 300

DESIGN SECTION CAPACITIES IN AXIAL TENSION with end connections to FLANGE only

Designation	Design Section Capacity in Axial Tension, ϕN_t (kN)		
	Welded No Holes	Bolted — N Holes/Flange	
		Hole Dia.	N =
	N = 0	mm	2
305BT62.5	2010	22	1890
56.5	1820	22	1730
50.5	1750	22	1570
265BT46.3	1590	22	1370
41.0	1420	22	1240
230BT41.1	1410	22	1160
37.3	1280	22	1050
33.6	1160	22	958
205BT29.9	1030	22	813
26.9	990	22	750
180BT28.4	977	22	748
25.4	872	22	672
22.4	822	22	606
155BT23.1	799	22	582
20.2	748	22	515
16.0	586	22	403
125BT18.7	682	22	427
15.7	576	22	376
12.9	469	18	319
100BT14.9	549	22	321
12.7	464	22	280
11.2	412	22	246
9.1	332	†	†
90BT11.1	405	†	†
9.1	330	†	†
8.1	293	†	†
75BT 9.0	329	†	†
7.0	256	†	†

Notes: (1) † indicates flange too small for high strength structural bolts.
(2) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

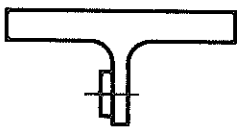


TABLE 7-15

TEES CUT FROM UNIVERSAL COLUMNS GRADE 300

DESIGN SECTION CAPACITIES IN AXIAL TENSION with end connections to WEB only

Designation	Design Section Capacity in Axial Tension, ϕN_t (kN)		
	Welded No Holes	Bolted — N Holes in Web	
		Hole Dia.	N =
	N = 0	mm	1
155CT79.0	2530	26	2430
68.5	2200	26	2110
59.0	1890	26	1810
48.4	1560	26	1490
125CT44.8	1430	22	1380
36.5	1170	22	1130
100CT29.8	960	22	908
26.1	839	22	795
23.1	744	22	703
75CT18.6	596	22	551
15.0	486	22	449
11.7	375	22	341
50CT 7.4	237	22	209

Note: Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

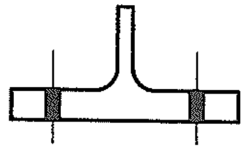


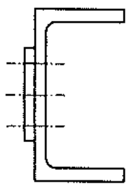
TABLE 7-16

TEES CUT FROM UNIVERSAL COLUMNS GRADE 300

DESIGN SECTION CAPACITIES IN AXIAL TENSION with end connections to FLANGE only

Designation	Design Section Capacity in Axial Tension, ϕN_t (kN)		
	Welded No Holes	Bolted — N Holes/Flange	
		Hole Dia.	N =
	N = 0	mm	2
155CT79.0	2530	26	2260
68.5	2200	26	1960
59.0	1890	26	1680
48.4	1670	26	1390
125CT44.8	1430	22	1260
36.5	1260	22	1030
100CT29.8	1030	22	773
26.1	897	22	674
23.1	795	22	598
75CT18.6	637	22	408
15.0	554	22	332
11.7	428	22	269
50CT 7.4	270	22	97.5

Note: Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.



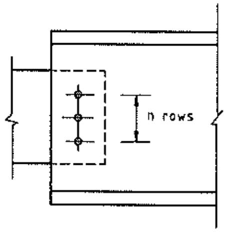


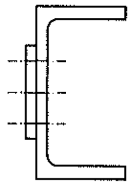
TABLE 7-17

PARALLEL FLANGE CHANNELS GRADE 300

DESIGN SECTION CAPACITIES IN AXIAL TENSION with end connections to WEB only

Designation	Mass per metre	Design Section Capacity in Axial Tension, ϕN_t (kN)					
		Welded No Holes	Bolted - N Holes in Web				
			Hole Dia.	N =			
	kg/m	N = 0	mm	1	2	3	4
380 PFC	55.2	1770	22	1770	1770	1770	1760
300 PFC	40.1	1380	22	1380	1360	1310	—
250 PFC	35.5	1220	22	1220	1190	—	—
230 PFC	25.1	864	22	864	834	—	—
200 PFC	22.9	788	22	788	759	—	—
180 PFC	20.9	718	22	718	—	—	—
150 PFC	17.7	645	18	614	—	—	—

Notes: (1) — indicates that $N > N_{max}$ i.e. this number of bolts usually cannot be used in the web.
(2) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.



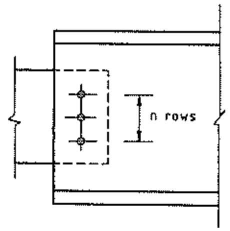


TABLE 7-19

TAPER FLANGE CHANNELS GRADE 250

DESIGN SECTION CAPACITIES IN AXIAL TENSION with End Connections to WEB only

Designation	Mass per metre	Design Section Capacity in Axial Tension, ϕN_t (kN)				
		Welded No Holes	Bolted - N Holes in Web			
			Hole Dia.	N =		
	kg/m	N = 0	mm	1	2	3
125 TFC	13.4	400	18	400	—	—
100 TFC	9.34	279	18	279	—	—
75 TFC	6.65	198	18	198	—	—

Note: — indicates that $N > N_{max}$ i.e. this number of bolts usually cannot be used in the web.

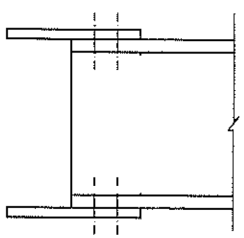


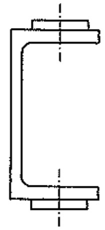
TABLE 7-18

PARALLEL FLANGE CHANNELS GRADE 300

DESIGN SECTION CAPACITIES IN AXIAL TENSION with end connections to FLANGE only

Designation	Mass per metre	Design Section Capacity in Axial Tension, ϕN_t (kN)		
		Welded No Holes	Bolted — N Holes/Flange	
			Hole Dia.	N =
	kg/m	N = 0	mm	1
380 PFC	55.2	1770	22	1770
300 PFC	40.1	1380	22	1260
250 PFC	35.5	1220	22	1100
230 PFC	25.1	864	22	765
200 PFC	22.9	788	22	684
180 PFC	20.9	718	22	623
150 PFC	17.7	645	18	547

Note: Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.



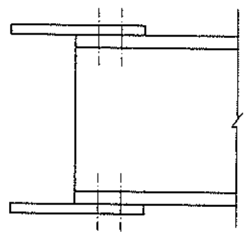


TABLE 7-20

TAPER FLANGE CHANNELS GRADE 250

DESIGN SECTION CAPACITIES IN AXIAL TENSION with end connections to FLANGE only

Designation	Mass per metre	Design Section Capacity in Axial Tension, ϕN_t (kN)		
		Welded No Holes	Bolted — N Holes/Flange	
			Hole Dia.	N =
	kg/m	N = 0	mm	1
125 TFC	13.4	400	18	379
100 TFC	9.34	279	†	†
75 TFC	6.65	198	†	†

Note: † Flange too small for high strength bolts.

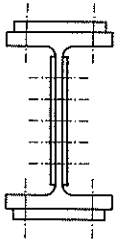
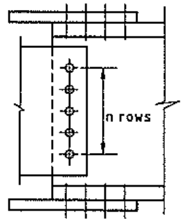


TABLE 7-21

TAPER FLANGE BEAMS GRADE 250

DESIGN SECTION CAPACITIES IN AXIAL TENSION with end connections to FLANGES and to WEB

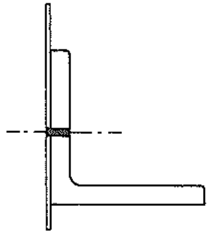


Designation	Mass per metre	Design Section Capacity in Axial Tension, ϕN_t (kN)				
		Welded No Holes	Bolted - Two Holes in Each Flange, N in Web			
			Hole Dia.	N =		
	kg/m	N = 0	mm	1	2	3
125 TFB	13.1	392	†	—	—	—
100 TFB	7.20	215	†	—	—	—

Notes: (1) — indicates that N > N_{max} i.e. this number of bolts usually cannot be used in the web.
(2) † Flange too small for high strength structural bolts.

TABLE 7-22(1)

EQUAL ANGLES GRADE 300



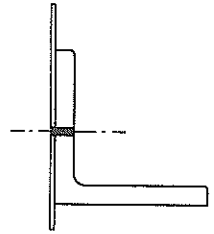
DESIGN SECTION CAPACITIES IN AXIAL TENSION one leg attached

Designation	Design Section Capacity in Axial Tension, ϕN_t (kN)			
	Welded No Holes	Bolted - N Holes in Leg		
		Hole Dia.	N =	
	N = 0	mm	1	2
200 x 200 x 26EA	2470	22	2470	2470
20EA	1930	22	1930	1930
18EA	1750	22	1750	1750
16EA	1670	22	1670	1570
13EA	1370	22	1370	1290
150 x 150 x 19EA	1350	22	1350	1300
16EA	1220	22	1190	1090
12EA	940	22	921	845
10EA	797	22	737	677
125 x 125 x 16EA	1000	18	980	899
12EA	774	18	758	697
10EA	657	18	608	559
8EA	544	18	503	463

Note: Grade 300 refers to BHP Grade 300 PLUS™. See Note (1) on page 2-2.

TABLE 7-22(2)

EQUAL ANGLES GRADE 250



DESIGN SECTION CAPACITIES IN AXIAL TENSION one leg attached

Designation	Design Section Capacity in Axial Tension, ϕN_t (kN)			
	Welded No Holes	Bolted - N Holes in Leg		
		Hole Dia.	N =	
	N = 0	mm	1	2
100 x 100 x 12EA	529	18	529	—
10EA	424	18	424	—
8EA	352	18	352	—
6EA	273	18	273	—
90 x 90 x 10EA	380	18	380	—
8EA	315	18	315	—
6EA	245	18	245	—
75 x 75 x 10EA	313	18	311	—
8EA	260	18	259	—
6EA	203	18	202	—
5EA	157	18	157	—
65 x 65 x 10EA	269	18	261	—
8EA	224	18	218	—
6EA	175	18	171	—
5EA	136	18	133	—
55 x 55 x 6EA	147	18	139	—
5EA	114	18	108	—
50 x 50 x 8EA	169	18	155	—
6EA	133	18	123	—
5EA	104	18	96.0	—
3EA	69.0	18	64.2	—
45 x 45 x 6EA	118	—	—	—
5EA	92.3	—	—	—
3EA	61.4	—	—	—
40 x 40 x 6EA	104	—	—	—
5EA	81.5	—	—	—
3EA	54.4	—	—	—
30 x 30 x 6EA	76.2	—	—	—
5EA	60.0	—	—	—
3EA	40.4	—	—	—
25 x 25 x 6EA	62.1	—	—	—
5EA	49.2	—	—	—
3EA	33.3	—	—	—

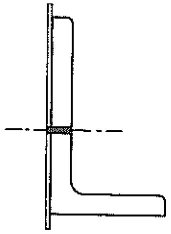


TABLE 7-23

UNEQUAL ANGLES
GRADE 300 & 250

DESIGN SECTION CAPACITIES IN AXIAL TENSION
long leg attached

Designation	Design Section Capacity in Axial Tension, ϕN_t (kN)			
	Welded No Holes	Bolted - N Holes in Leg		
		Hole Dia.	N =	
	N = 0	mm	1	2
150 x 100 x 12UA	774	22	745	669
10UA	657	22	597	537
150 x 90 x 16UA	959	18	935	854
12UA	742	18	724	662
10UA	630	18	581	532
8UA	519	18	479	439
125 x 75 x 12UA	529	18	529	487
10UA	424	18	424	392
8UA	352	18	352	326
6UA	273	18	273	254
100 x 75 x 10UA	369	18	369	—
8UA	306	18	306	—
6UA	238	18	238	—
75 x 50 x 8UA	215	18	208	—
6UA	169	18	163	—
5UA	131	18	127	—
65 x 50 x 8UA	197	18	187	—
6UA	154	18	147	—
5UA	120	18	114	—

Notes: (1) For 150 x 90 angles and above: Grade 300.
(2) For 125 x 75 angles and below: Grade 250.
(3) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

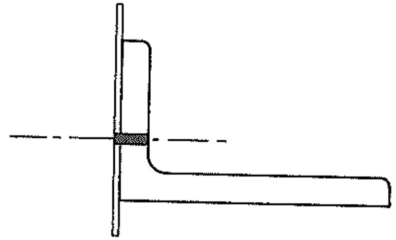


TABLE 7-24

UNEQUAL ANGLES
GRADE 300 & 250

DESIGN SECTION CAPACITIES IN AXIAL TENSION
short leg attached

Designation	Design Section Capacity in Axial Tension, ϕN_t (kN)		
	Welded No Holes	Bolted - N Holes in Leg	
		Hole Dia.	N =
	N = 0	mm	1
150 x 100 x 12UA	724	18	669
10UA	579	18	536
150 x 90 x 16UA	897	18	825
12UA	693	18	639
10UA	556	18	512
8UA	458	18	423
125 x 75 x 12UA	529	18	481
10UA	424	18	386
8UA	352	18	320
6UA	273	18	249
100 x 75 x 10UA	369	18	330
8UA	306	18	274
6UA	238	18	214
75 x 50 x 8UA	215	18	184
6UA	169	18	144
5UA	131	18	112
65 x 50 x 8UA	197	18	165
6UA	154	18	129
5UA	120	18	101

Notes: (1) For 150 x 90 angles and above: Grade 300.
(2) For 125 x 75 angles and below: Grade 250.
(3) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

PART 8 MEMBERS SUBJECT TO COMBINED ACTIONS

COMBINED

TABLES

Tables 8.1-1 to 8.1-13 provide the information required to design members for combined actions. All relevant section capacities in bending, compression, tension and shear are given as well as reduced section moment capacities. These tables also provide reference to the appropriate tables in Sections 5 and 6 to determine design member capacities in bending and axial compression.

PART 8 MEMBERS SUBJECT TO COMBINED ACTIONS

8.1 Scope

This part of the Tables contains the interaction formulae which are used to design members subject to combined actions in accordance with Section 8 of AS 4100. Tables 8.1-1 to 8.1-11 list design section capacities, including the effects of combined actions.

Sections 8.6, 8.7 and 8.8 present methods for calculating maximum design loads for angles as beams and as struts eccentrically loaded in trusses. Tables 8.2-1 to 8.2-12 and 8.3-1 to 8.3-6 list these maximum design loads.

8.2 Design for Combined Actions

Sections 8.3 and 8.4 give the formulae for combined bending and axial compression and combined bending and axial tension respectively. Each section describes the method for uniaxial bending about the major principal x-axis, for uniaxial bending about the minor principal y-axis, and for biaxial bending. Section 8.5 gives the interaction formulae for biaxial bending without axial forces. In every case both the section capacity and the member capacity must be checked.

Note: The equations for section capacities listed in this section include the changes in Amendment 2 of AS 4100.

For all cases of combined bending and axial force the designer should first ensure that the appropriate design axial capacity is greater than the design axial force (i.e. $\phi N \geq N^*$).

8.3 Combined Bending and Axial Compression

In this section:

ϕ = 0.9 (Table 3.4 of AS 4100)
ϕM_{sx} = design section moment capacity for bending about the major principal x-axis
ϕM_{sy} = design section moment capacity for bending about the minor principal y-axis
N^* = design axial compressive force
ϕN_s = design section capacity in compression
ϕN_{cx} = design member capacity in compression, buckling about the x-axis
ϕN_{cy} = design member capacity in compression, buckling about the y-axis

8.3.1 Compression and Uniaxial Bending - about the major principal x-axis

For a member subject to uniaxial bending about the major principal x-axis and axial compression, the following condition must be satisfied:

$$M_x^* \leq \min\ [\phi M_{rx}\ ;\ \phi M_{ix}\ ;\ \phi M_{ox}\ ]$$

where M_x^* = design bending moment about the major principal x-axis
ϕM_{rx} = design section moment capacity (ϕM_s) for bending about the major principal x-axis reduced by axial force (see Section 8.3.1.1)
ϕM_{ix} = design in-plane member moment capacity (ϕM_i) for bending about the major principal x-axis (see Section 8.3.1.2(a))
ϕM_{ox} = design out-of-plane member moment capacity (ϕM_o) for bending about the major principal x-axis (see Section 8.3.1.2(b))

8.3.1.1 Section Capacity

The value of ϕM_{rx} must be determined at all points along the member and the minimum value used to satisfy Section 8.3.1.

$$\phi M_{rx} = \phi M_{sx}\left(1 - \frac{N^*}{\phi N_s}\right) \qquad \text{(Clause 8.3.2 of AS 4100)}$$

Alternatively, for doubly symmetric I- sections *compact about the x-axis* with k_f = 1.0 subject to bending and compression

$$\phi M_{rx} = 1.18\phi M_{sx}\left(1 - \frac{N^*}{\phi N_s}\right) \leq \phi M_{sx} \qquad \text{(Clause 8.3.2 of AS 4100)}$$

For doubly symmetric I- sections *compact about the x-axis* with k_f < 1.0 subject to bending and compression

$$\phi M_{rx} = \phi M_{sx}\left(1 - \frac{N^*}{\phi N_s}\right)\left[1 + 0.18\left(\frac{82 - \lambda_w}{82 - \lambda_{wy}}\right)\right] \leq \phi M_{sx} \qquad \text{(Clause 8.3.2 of AS 4100)}$$

where λ_w = the element slenderness of the web (Clause 6.2.3 of AS 4100)

$= \dfrac{d_1}{t_w}\sqrt{\dfrac{f_y}{250}}$ (where $f_y = \min [\, f_{yf} \,;\, f_{yw} \,]$)

λ_{wy} = the web yield slenderness limit (Table 6.2.4 of AS 4100)

= 45 for the hot-rolled I- sections considered in this publication.

= 35 for the welded I- sections considered in this publication.

*For doubly symmetric I- sections, Tables 8.1-1 to 8.1-6, list ϕM_{sx}, ϕM_{rx} (comp), and ϕM_{rx} (tens). Designers should calculate $n = N^*/\phi N_s$, and use it to calculate the value of ϕM_{rx}, and ensure that it is **less** than the design section capacity ϕM_{sx}. For other sections (tees and channels) the reduced section moment capacity is calculated by using the first of the equations given above.*

8.3.1.2 Member Capacity

This section only applies to members analysed using an elastic method of analysis. Where there is sufficient restraint to prevent lateral buckling, only the in-plane requirements of Sections 8.3.1.1 and 8.3.1.2 need to be satisfied. If there is insufficient restraint to prevent lateral buckling, then both the in-plane and out-of-plane requirements of Sections 8.3.1.1 and 8.3.1.2 need to be satisfied.

(a) In-plane capacity

$$\phi M_{ix} = \phi M_{sx}\left(1 - \frac{N^*}{\phi N_{cx}}\right) \qquad \text{(Clause 8.4.2.2 of AS 4100)}$$

For braced and sway members, the above value of ϕN_{cx} is to be calculated using an effective length factor (k_{ex}) equal to 1.0 (i.e. $L_{ex} = L$), unless a lower value of k_{ex} has been calculated for a braced member, provided that $N^* \leq \phi N_{cx}$ where the value of ϕN_{cx} in this inequality is calculated using the correct value of k_{ex}.

(b) Out-of-plane capacity

$$\phi M_{ox} = \phi M_{bx}\left(1 - \frac{N^*}{\phi N_{cy}}\right) \qquad \text{(Clause 8.4.4.1 of AS 4100)}$$

where ϕM_{bx} = design member moment capacity for bending about the major principal x-axis

For doubly symmetric compact I- sections with k_f = 1.0, alternatives for calculating ϕM_{ix} and ϕM_{ox} are presented in AS 4100 Clauses 8.4.2.2 and 8.4.4.1. This is beyond the scope of this publication.

8.3.2 Compression and Uniaxial Bending - about the minor principal *y*-axis

For a member subject to uniaxial bending about the minor principal y-axis and axial compression, the following condition must be satisfied:

$$M_y^* \leq \min\,[\phi M_{ry}\,;\,\phi M_{iy}]$$

where ϕ = 0.9 (Table 3.4 of AS 4100)

M_y^* = design bending moment about the minor principal y-axis

ϕM_{ry} = design section moment capacity (ϕM_s) about the minor principal y-axis reduced by axial force (see Section 8.3.2.1)

ϕM_{iy} = nominal in-plane member moment capacity (ϕM_i) about the minor principal y-axis (see Section 8.3.2.2)

8.3.2.1 Section Capacity

The value of ϕM_{ry} must be determined at all points along the member and the minimum value is used to satisfy Section 8.3.2.

$$\phi M_{ry} = \phi M_{sy}\left(1 - \frac{N^*}{\phi N_s}\right) \qquad \text{(Clause 8.3.3 of AS 4100)}$$

Alternatively, for doubly symmetric I- sections *compact about the y-axis* subject to bending and compression

$$\phi M_{ry} = 1.19\,\phi M_{sy}\left[1 - \left(\frac{N^*}{\phi N_s}\right)^2\right] \leq \phi M_{sy} \qquad \text{(Clause 8.3.3 of AS 4100)}$$

For doubly symmetric I- sections, Tables 8.1-1 to 8.1-6, list ϕM_{sy} and ϕM_{ry}. Designers should calculate $n = N^*/\phi N_s$, and use it to calculate the value of ϕM_{ry}, and ensure that it is ***less*** *than the design section capacity ϕM_{sy}. For other sections (tees and channels) the reduced section moment capacity is calculated by using the first of the equations given above.*

8.3.2.2 Member Capacity

This section applies only to members analysed using an elastic method of analysis. For bending about the minor principal y-axis only the in-plane requirements need to be satisfied.

In-plane capacity

$$\phi M_{iy} = \phi M_{sy}\left(1 - \frac{N^*}{\phi N_{cy}}\right) \qquad \text{(Clause 8.4.2.2 of AS 4100)}$$

For braced and sway members, the above value of ϕN_{cy} is to be calculated using an effective length factor (k_{ey}) equal to 1.0 (i.e. $L_{ey} = L$), unless a lower value of k_{ey} has been calculated for a braced member, provided that $N^* \leq \phi N_{cy}$ where the value of ϕN_{cy} in this inequality is calculated using the correct value of k_{ey}.

8.3.3 Compression and Biaxial Bending

For a member subject to biaxial bending and axial compression, both the conditions defined in Sections 8.3.3.1 and 8.3.3.2 must be satisfied.

8.3.3.1 Section Capacity

$$\frac{N^*}{\phi N_s} + \frac{M_x^*}{\phi M_{sx}} + \frac{M_y^*}{\phi M_{sy}} \leq 1 \qquad \text{(Clause 8.3.4 of AS 4100)}$$

Alternatively for doubly symmetric I- sections *compact about both x- and y-axes*

$$\left(\frac{M_x^*}{\phi M_{rx}}\right)^{\gamma} + \left(\frac{M_y^*}{\phi M_{ry}}\right)^{\gamma} \leq 1 \qquad \text{(Clause 8.3.4 of AS 4100)}$$

where $\gamma = 1.4 + \left(\dfrac{N^*}{\phi N_s}\right) \leq 2.0$

and ϕM_{rx} and ϕM_{ry} are calculated using the alternatives presented in Sections 8.3.1.1 & 8.3.2.1.

8.3.3.2 Member Capacity

$$\left(\frac{M_x^*}{\phi M_{cx}}\right)^{1.4} + \left(\frac{M_y^*}{\phi M_{iy}}\right)^{1.4} \leq 1 \qquad \text{(Clause 8.4.5.1 of AS 4100)}$$

where ϕM_{cx} = *lesser* of ϕM_{ix} and ϕM_{ox} (see Section 8.3.1.2)

8.4 Combined Bending and Axial Tension

In this section:

ϕ = 0.9 (Table 3.4 of AS 4100)
N^* = design axial tensile force
ϕN_t = design section capacity in axial tension

8.4.1 Tension & Uniaxial Bending - about the major principal *x*-axis

For a member subject to uniaxial bending about the major principal *x*-axis and axial tension, the following condition must be satisfied:

$$M_x^* \leq \min\,[\phi M_{rx}\,;\,\phi M_{ox}]$$

8.4.1.1 Section Capacity

The value of ϕM_{rx} must be determined at all points along the member and the minimum value is used to satisfy Section 8.4.1.

$$\phi M_{rx} = \phi M_{sx}\left(1 - \frac{N^*}{\phi N_t}\right) \qquad \text{(Clause 8.3.2 of AS 4100)}$$

Alternatively, for doubly symmetric I- sections *compact about the x-axis* subject to bending and tension

$$\phi M_{rx} = 1.18\phi M_{sx}\left(1 - \frac{N^*}{\phi N_t}\right) \le \phi M_{sx} \qquad \text{(Clause 8.3.2 of AS 4100)}$$

For doubly symmetric I- sections, Tables 8.1-1 to 8.1-6, list ϕM_{sx} and ϕM_{rx} (tens). *Designers should calculate* $n = N^*/\phi N_t$ *, and use it to calculate the value of* ϕM_{rx} *, and ensure that it is* ***less*** *than the design section capacity* ϕM_{sx} *. For other sections (tees and channels) the reduced section moment capacity is calculated by using the first of the equations given above.*

8.4.1.2 Member Capacity

This section only applies to members analysed using an elastic method of analysis. Only the out-of-plane capacity needs to be considered.

Out-of-plane capacity

$$\phi M_{ox} = \phi M_{bx}\left(1 + \frac{N^*}{\phi N_t}\right) \le \phi M_{rx} \qquad \text{(Clause 8.4.4.2 of AS 4100)}$$

8.4.2 Tension and Uniaxial Bending – about the minor principal *y*-axis

For a member subject to uniaxial bending about the minor principal *y*-axis and axial tension, the following condition must be satisfied:

$$M_y^* \le \phi M_{ry}$$

8.4.2.1 Section Capacity

The value of ϕM_{ry} must be determined at all points along the member and the minimum value is used to satisfy Section 8.4.2.

$$\phi M_{ry} = \phi M_{sy}\left(1 - \frac{N^*}{\phi N_s}\right) \qquad \text{(Clause 8.3.3 of AS 4100)}$$

Alternatively for doubly symmetric I- sections *compact about the y-axis* subject to bending and tension

$$\phi M_{ry} = 1.19\,\phi M_{sy}\left[1 - \left(\frac{N^*}{\phi N_t}\right)^2\right] \le \phi M_{sy} \qquad \text{(Clause 8.3.3 of AS 4100)}$$

For doubly symmetric I- sections, Tables 8.1-1 to 8.1-6, list ϕM_{sy} and ϕM_{ry} . *Designers should calculate* $n = N^*/\phi N_t$ *, and use it to calculate the value of* ϕM_{ry} *, and ensure that it is* ***less*** *than the design section capacity* ϕM_{sy} *. For other sections (tees and channels) the reduced section moment capacity is calculated by using the first of the equations given above.*

8.4.3 Tension and Biaxial Bending

For a member subject to biaxial bending and axial tension, both the conditions defined in Sections 8.4.3.1 and 8.4.3.2 must be satisfied.

8.4.3.1 Section Capacity

$$\frac{N^*}{\phi N_t} + \frac{M_x^*}{\phi M_{sx}} + \frac{M_y^*}{\phi M_{sy}} \leq 1 \qquad \text{(Clause 8.3.4 of AS 4100)}$$

Alternatively, for doubly symmetric I- sections *compact about both x- and y-axes*

$$\left(\frac{M_x^*}{\phi M_{rx}}\right)^{\gamma} + \left(\frac{M_y^*}{\phi M_{ry}}\right)^{\gamma} \leq 1 \qquad \text{(Clause 8.3.4 of AS 4100)}$$

where $\gamma = 1.4 + \left(\frac{N^*}{\phi N_t}\right) \leq 2.0$

and ϕM_{rx} and ϕM_{ry} are calculated using the alternatives presented in Sections 8.4.1.1 & 8.4.2.1.

8.4.3.2 Member Capacity

$$\left(\frac{M_x^*}{\phi M_{tx}}\right)^{1.4} + \left(\frac{M_y^*}{\phi M_{sy}}\right)^{1.4} \leq 1 \qquad \text{(Clause 8.4.5.2 of AS 4100)}$$

where $\phi M_{tx} = \min[\phi M_{rx}, \phi M_{ox}]$ (see Sections 8.4.1.1 and 8.4.1.2).

8.5 Biaxial Bending

For a member subject to biaxial bending without any axial force, both the conditions defined in Sections 8.5.1 and 8.5.2 must be satisfied.

8.5.1 Section Capacity

$$\frac{M_x^*}{\phi M_{sx}} + \frac{M_y^*}{\phi M_{sy}} \leq 1 \qquad \text{(Clause 8.3.4 of AS 4100)}$$

Alternatively, for doubly symmetric I- sections *compact about both x- and y-axes*

$$\left(\frac{M_x^*}{\phi M_{sx}}\right)^{1.4} + \left(\frac{M_y^*}{\phi M_{sy}}\right)^{1.4} \leq 1 \qquad \text{(Clause 8.3.4 of AS 4100)}$$

8.5.2 Member Capacity

$$\left(\frac{M_x^*}{\phi M_{bx}}\right)^{1.4} + \left(\frac{M_y^*}{\phi M_{sy}}\right)^{1.4} \leq 1 \qquad \text{(Clause 8.4.5 of AS 4100)}$$

8.6 Example

Considering further Example 1 of Section 4.3, the adequacy of the member under the calculated design action effects is now checked as required by Clauses 8.3 and 8.4 of AS 4100.

Design Data:

Section:	200UB29.8 Grade 300 steel	
Effective lengths:	Flexural buckling (x-axis)	= 4.0 m
	Flexural buckling (y-axis)	= 4.0 m
	Lateral buckling	= 4.0 m
Design action effects:	N^*	= 105 kN
	M_x^*	= 45 kNm
	M_y^*	= 6.40 kNm

Solution: The example involves biaxial bending and axial compression as described in Section 8.3.3 of these Tables.

(i) Section Capacity Check (Section 8.3.3.1)

From Table 8.1-5 obtain:

ϕN_s = 1100 kN > N^*

ϕM_{sx} = 90.9 kNm

ϕM_{sy} = 24.9 kNm

$$\text{Now} \quad \frac{N^*}{\phi N_s} = \frac{105}{1100} = 0.0955$$

Using Table 8.1-5

ϕM_{rx} (comp) = 107 (1-0.0955) = 96.8 kNm $> \phi M_{sx}$

$\therefore$ ϕM_{rx} = ϕM_{sx} = 90.9 kNm

ϕM_{ry} = 29.6 (1-0.0955^2) = 29.3 kNm $> \phi M_{sy}$

$\therefore$ ϕM_{ry} = ϕM_{sy} = 24.9 kNm

$$\text{Now} \quad \gamma = 1.4 + \left(\frac{N^*}{\phi N_s}\right) = 1.496 \quad < 2.0$$

$$\text{Then} \quad \left(\frac{M_x^*}{\phi M_{rx}}\right)^{\gamma} + \left(\frac{M_y^*}{\phi M_{ry}}\right)^{\gamma} = \left(\frac{45.0}{90.9}\right)^{1.496} + \left(\frac{6.40}{24.9}\right)^{1.496} = 0.480 \quad (< 1.0)$$

The above interaction equation was used as the section is *compact about both x- and y-axes.*

(ii) Member Capacity Check (Section 8.3.3.2)

$$\left(\frac{M_x^*}{\phi M_{cx}}\right)^{1.4} + \left(\frac{M_y^*}{\phi M_{iy}}\right)^{1.4} \leq 1$$

From the Tables obtain:

ϕN_{cx} = 938 kN (Table 6-5(A))

ϕN_{cy} = 352 kN (Table 6-5(B))

ϕM_{bx} = 47.6 kNm (Table 5.3-5) (based on α_m = 1.0)

ϕM_{sy} = 24.9 kNm (Table 8.1-5)

The moment distribution for x-axis bending is not uniform, but the above value of ϕM_{bx} is based on the uniform moment case. From Table 5.6.1 of AS 4100, $\alpha_m = 1.75$.

$$\therefore \quad \phi M_{bx} = \min[\alpha_m(\phi M_{bx}), \phi M_{sx}]$$
$$= \min[1.75 \times 47.6, 90.9] \quad = \min[83.3, 90.9]$$
$$= 83.3 \text{ kNm}$$

Calculate in-plane and out-of-plane capacities:

a) $$\phi M_{ix} = \phi M_{sx}\left(1 - \frac{N^*}{\phi N_{cx}}\right)$$
$$= 90.9\left(1 - \frac{105}{938}\right)$$
$$= 80.7 \text{ kNm}$$

b) $$\phi M_{ox} = \phi M_{bx}\left(1 - \frac{N^*}{\phi N_{cy}}\right)$$
$$= 83.3\left(1 - \frac{105}{352}\right)$$
$$= 58.4 \text{ kNm}$$

$$\therefore \quad \phi M_{cx} = \min[\phi M_{ix}, \phi M_{ox}]$$
$$= 58.4 \text{ kNm}$$

$$\phi M_{iy} = \phi M_{sy}\left(1 - \frac{N^*}{\phi N_{cy}}\right)$$
$$= 24.9\left(1 - \frac{105}{352}\right)$$
$$= 17.5 \text{ kNm}$$

Thus, $$\left(\frac{M_x^*}{\phi M_{cx}}\right)^{1.4} + \left(\frac{M_y^*}{\phi M_{iy}}\right)^{1.4} = \left(\frac{45}{58.4}\right)^{1.4} + \left(\frac{6.40}{17.5}\right)^{1.4}$$
$$= 0.939 \qquad (< 1.0 \;\therefore\; \text{O.K.})$$

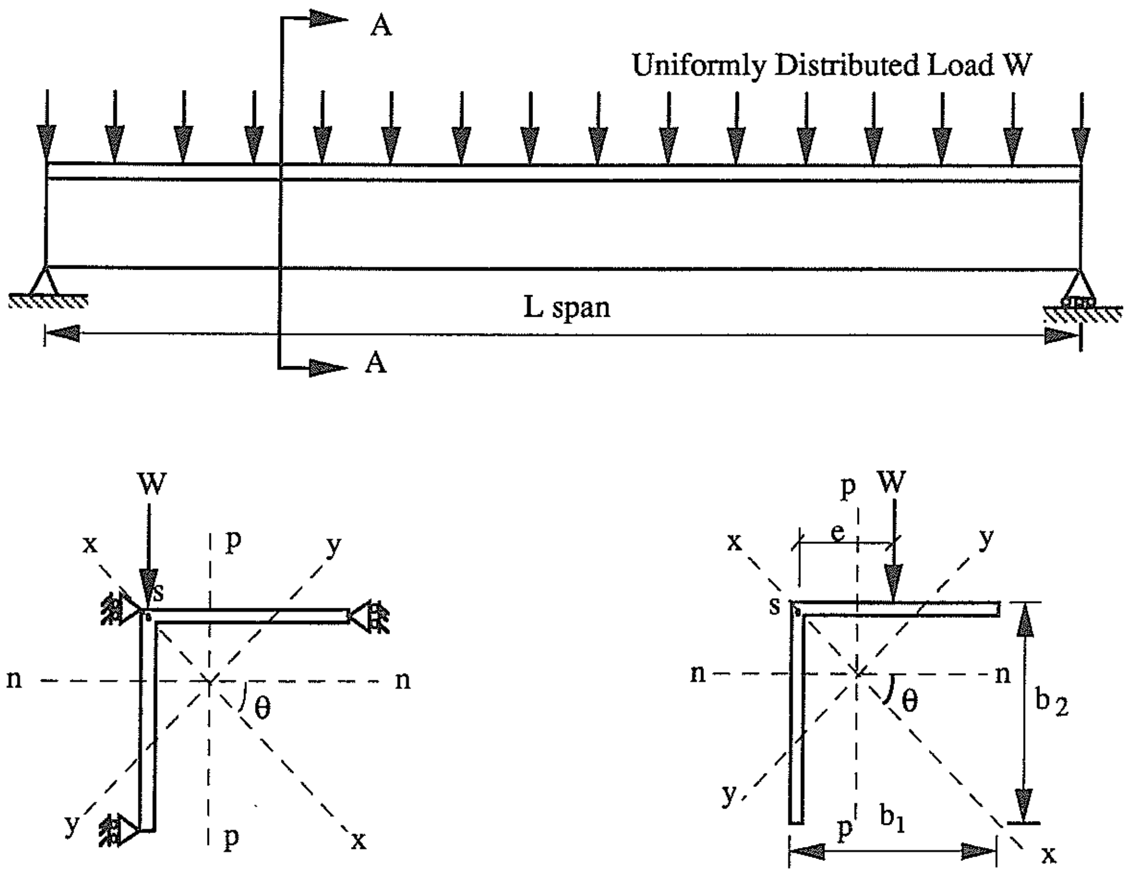
8.7 Maximum Design Loads for Angles Subject to Bending

8.7.1 General

Tables 8.2-1 to 8.2-12 give maximum design loads for strength (W_L^*) and serviceability (W_{S1}^*, W_{S2}^*) for simply supported angles subject to uniformly distributed transverse loads. **Designers should assess the maximum design loads for strength and serviceability separately as different load factors apply to these cases as specified in AS 1170.**

Two situations are considered as shown below. Case (a) refers to angles which are *continuously restrained against twisting and constrained to deflect in the loading plane.* Case (b) is for angles *unrestrained against twisting and deflection in any plane.* These cases are considered, in principle only, in Clause 5.7 of AS 4100.

For case (a) a first-order elastic analysis is suitable for determining the design action effects. However for the unrestrained case, case (b), the design action effects are dependent on the deformed shape of the member and a second-order analysis is required.



(a) Angle with Lateral Restraint
(Section A-A)

(b) Angle with No Lateral Restraint
(Section A-A)

Notes: (1) s - shear centre
(2) eccentricity $e = b_1/2$
(3) The angle is torsionally restrained at the support in both cases

Figure 8.1: Schematic Representation of Angle Configurations

8.7.2 Angles with Continuous Lateral Restraint

Tables 8.2-1 to 8.2-6 give maximum design loads for angles with full lateral restraint. The maximum design load for strength (W_L^*) is the *lesser* of the maximum design loads associated with either biaxial bending or biaxial shear. The serviceability load (W_{S1}^*) is the lesser of the load required to reach the deflection limit (L/250) and the yield load. Similarly the serviceability load (W_{S2}^*) is the lesser of the load required to reach the deflection limit (L/500) and the yield load.

It is assumed that the beams are simply supported with a uniformly distributed load applied along the horizontal leg of the angle. This loading ensures there are no torsional effects. Note that the direction of loading is important.

To constrain the member to bend in the loading plane (a non-principal plane), the restraint must apply a significant force (W_{rest}) at right angles to the external load (W). These two forces result in bending about both principal axes of the angle. The maximum design load for strength is determined by considering the biaxial bending section capacity of the angle, or the biaxial shear capacity. Similarly the maximum design serviceability load is calculated by considering the deflection caused by biaxial bending (though this deflection is constrained to be in the loading plane).

8.7.3 Angles without Continuous Lateral Restraint

Tables 8.2-7 to 8.2-12 give maximum design loads for angles without continuous lateral and torsional restraint. The maximum design load for strength (W_{S1}^*) is the lesser of the maximum design loads concerned with either biaxial bending, or combined biaxial shear and torsion. The serviceability load (W_{S1}^*) is the lesser of the load required to reach the deflection limit (L/250) and the yield load (either axial or shear yielding). Similarly the serviceability load (W_{S2}^*) is the lesser of the load required to reach the deflection limit (L/500) and the yield load.

It is assumed that the beams are simply supported with a uniformly distributed load applied eccentric to the shear centre through the horizontal leg of the angle (Figure 8.1). The angle is torsionally restrained at the supports only.

A second-order analysis is required to determine the design action effects and deflection.

More details on both cases can be found in the article *Design of Angles to AS 4100 - 1990* in the AISC technical journal, "Steel Construction", Vol 25, No 2, May 1991.

8.8 Eccentrically Loaded Single Angles in Trusses

Maximum design axial loads for single angles eccentrically loaded in trusses are given in Tables 8.3-1 to 8.3-6. These tables apply only to angles subject to axial force where there is eccentricity of the applied load due to the nature of the connection of the angle to the gusset plate in the truss.

Two cases are considered and are illustrated in Figure 8.2.

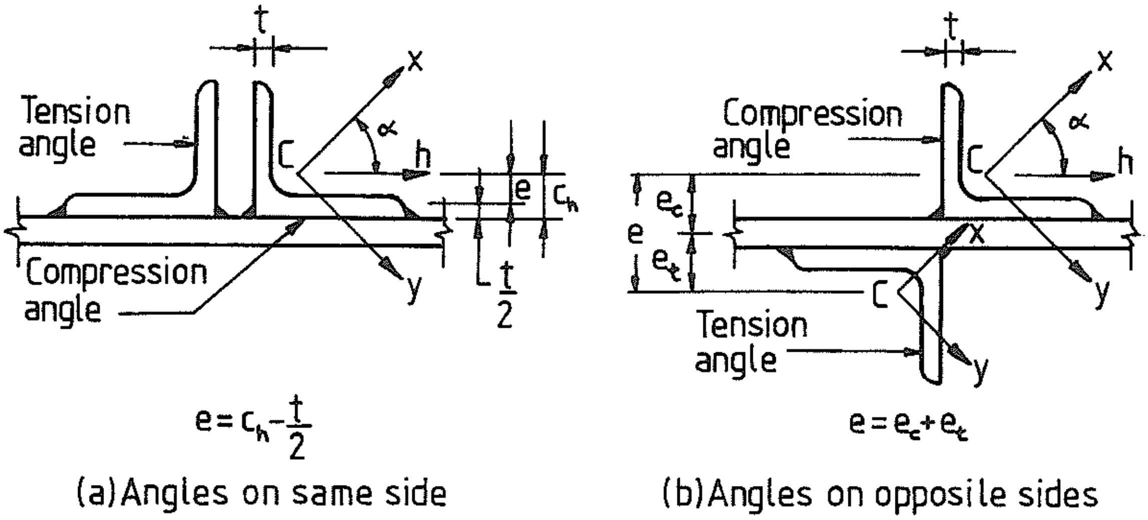


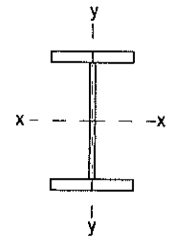
Figure 8.2: Single Angles Loaded Through One Leg

(Reproduced by courtesy of Standards Australia)

The maximum design loads are calculated using Clause 8.4.6 of AS 4100. It is assumed that the thickness of the gusset plate is 20 mm if the angle leg thickness is greater than or equal to 16 mm, and 10 mm if the angle thickness is less than 16 mm.

TABLE 8.1-1

WELDED BEAMS
GRADE 300
DESIGN SECTION CAPACITIES

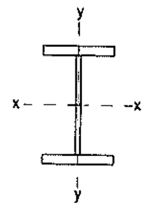


Designation	Design Section Axial Capacities		Design Section Moment Capacities					Design Shear Capacity
			About x-axis			About y-axis		
	ϕN_s	ϕN_t	ϕM_{sx}	ϕM_{rx} (comp)	ϕM_{rx} (tens)	ϕM_{sy}	ϕM_{ry}	ϕV_v
	kN	kN	kNm	kNm	kNm	kNm	kNm	kN
1200WB455	12200	14600	7110	7330 (1−n)	8390 (1−n)	1260	1500 $(1-n^2)$	2900
423	11200	13600	6510	6710 (1−n)	7680 (1−n)	1130	1350 $(1-n^2)$	2900
392	10200	12600	5910	6090 (1−n)	6970 (1−n)	1010	1010 (1−n)	2900
342	8580	11000	4980	5130 (1−n)	5880 (1−n)	646	769 $(1-n^2)$	2900
317	7780	10200	4500	4640 (1−n)	5320 (1−n)	565	673 $(1-n^2)$	2900
278	6540	8930	3790	3900 (1−n)	4470 (1−n)	387	460 $(1-n^2)$	2900
249	5600	7980	3250	3350 (1−n)	3830 (1−n)	239	285 $(1-n^2)$	2900
1000WB322	8580	10300	4130	4420 (1−n)	4870 (1−n)	646	768 $(1-n^2)$	2490
296	7780	9520	3720	3980 (1−n)	4390 (1−n)	565	672 $(1-n^2)$	2490
258	6540	8280	3100	3320 (1−n)	3660 (1−n)	387	460 $(1-n^2)$	2490
215	5450	7390	2580	2740 (1−n)	3050 (1−n)	244	290 $(1-n^2)$	2490
900WB282	7650	9050	3440	3520 (1−n)	4050 (1−n)	645	768 $(1-n^2)$	1730
257	6840	8250	3070	3140 (1−n)	3620 (1−n)	565	672 $(1-n^2)$	1730
218	5610	7010	2510	2570 (1−n)	2960 (1−n)	386	460 $(1-n^2)$	1730
175	4480	6030	2020	2050 (1−n)	2390 (1−n)	243	290 $(1-n^2)$	1730
800WB192	5070	6150	2030	2040 (1−n)	2400 (1−n)	318	378 $(1-n^2)$	1190
168	4300	5380	1720	1730 (1−n)	2030 (1−n)	238	284 $(1-n^2)$	1190
146	3830	5020	1540	1540 (1−n)	1540 (1−n)	204	243 $(1-n^2)$	1190
122	3020	4210	1220	1220 (1−n)	1220 (1−n)	135	135 (1−n)	1190
700WB173	4710	5540	1610	1680 (1−n)	1900 (1−n)	267	318 $(1-n^2)$	1100
150	3980	4810	1350	1420 (1−n)	1600 (1−n)	197	234 $(1-n^2)$	1100
130	3560	4480	1210	1260 (1−n)	1430 (1−n)	169	201 $(1-n^2)$	1100
115	3020	3940	1020	1060 (1−n)	1210 (1−n)	134	134 (1−n)	1100

Notes: (1) ϕM_{rx} (comp) refers to the design section moment capacity reduced by compression (where $n = N^*/\phi N_s$) and must be less than or equal to ϕM_{sx}.
(2) ϕM_{rx} (tens) refers to the design section moment capacity reduced by tension (where $n = N^*/\phi N_t$) and must be less than or equal to ϕM_{sx}.
(3) ϕM_{ry} refers to the design section moment capacity reduced by axial force (where $n = N^*/\phi N_t$ or $N^*/\phi N_s$) and must be less than or equal to ϕM_{sy}.
(4) The above values of ϕN_t are based on sections with no holes and $k_t = 1$. For other values of ϕN_t see pages 7-4 and 7-6.
(5) For the design member moment capacity ϕM_b see page 5-40.
(6) For the design member capacity in compression (x-axis) ϕN_{cx} see page 6-6.
(7) For the design member capacity in compression (y-axis) ϕN_{cy} see page 6-8.

TABLE 8.1-2

WELDED BEAMS
GRADE 400
DESIGN SECTION CAPACITIES

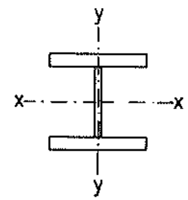


Designation	Design Section Axial Capacities		Design Section Moment Capacities					Design Shear Capacity
			About x-axis			About y-axis		
	ϕN_s	ϕN_t	ϕM_{sx}	ϕM_{rx} (comp)	ϕM_{rx} (tens)	ϕM_{sy}	ϕM_{ry}	ϕV_v
	kN	kN	kNm	kNm	kNm	kNm	kNm	kN
1200WB455	15400	18800	9090	9090 (1−n)	9090 (1−n)	1620	1930 $(1-n^2)$	3320
423	14100	17500	8320	8320 (1−n)	8320 (1−n)	1460	1460 (1−n)	3320
392	12800	16200	7550	7550 (1−n)	7550 (1−n)	1260	1260 (1−n)	3320
342	10700	14100	6360	6360 (1−n)	6360 (1−n)	830	988 $(1-n^2)$	3320
317	9680	13100	5750	5750 (1−n)	5750 (1−n)	723	723 (1−n)	3320
278	8090	11500	4830	4830 (1−n)	4830 (1−n)	497	497 (1−n)	3320
249	6870	10300	4140	4140 (1−n)	4140 (1−n)	308	366 $(1-n^2)$	3320
1000WB322	10700	13300	5310	5510 (1−n)	6260 (1−n)	830	988 $(1-n^2)$	3150
296	9680	12200	4780	4960 (1−n)	5640 (1−n)	723	723 (1−n)	3150
258	8090	10600	3990	4140 (1−n)	4700 (1−n)	497	497 (1−n)	3150
215	6590	9360	3270	3370 (1−n)	3860 (1−n)	303	303 (1−n)	3150
900WB282	9660	11600	4370	4370 (1−n)	4370 (1−n)	830	987 $(1-n^2)$	1820
257	8620	10600	3900	3900 (1−n)	3900 (1−n)	721	721 (1−n)	1820
218	7030	9010	3190	3190 (1−n)	3190 (1−n)	495	495 (1−n)	1820
175	5500	7630	2500	2500 (1−n)	2500 (1−n)	302	302 (1−n)	1820
800WB192	6390	7910	2540	2540 (1−n)	2540 (1−n)	408	486 $(1-n^2)$	1190
168	5400	6920	2150	2150 (1−n)	2150 (1−n)	307	365 $(1-n^2)$	1190
146	4730	6360	1880	1880 (1−n)	1880 (1−n)	258	258 (1−n)	1190
122	3710	5340	1480	1480 (1−n)	1480 (1−n)	166	166 (1−n)	1190
700WB173	5930	7130	2070	2090 (1−n)	2440 (1−n)	343	408 $(1-n^2)$	1380
150	5000	6190	1740	1760 (1−n)	2050 (1−n)	253	301 $(1-n^2)$	1380
130	4390	5680	1540	1540 (1−n)	1810 (1−n)	214	255 $(1-n^2)$	1380
115	3710	4990	1300	1300 (1−n)	1530 (1−n)	166	166 (1−n)	1380

Notes: (1) ϕM_{rx} (comp) refers to the design section moment capacity reduced by compression (where $n = N^*/\phi N_s$) and must be less than or equal to ϕM_{sx}.
(2) ϕM_{rx} (tens) refers to the design section moment capacity reduced by tension (where $n = N^*/\phi N_t$) and must be less than or equal to ϕM_{sx}.
(3) ϕM_{ry} refers to the design section moment capacity reduced by axial force (where $n = N^*/\phi N_t$ or $N^*/\phi N_s$) and must be less than or equal to ϕM_{sy}.
(4) The above values of ϕN_t are based on sections with no holes and $k_t = 1$. For other values of ϕN_t see pages 7-5 and 7-6.
(5) For the design member moment capacity ϕM_b see page 5-42.
(6) For the design member capacity in compression (x-axis) ϕN_{cx} see page 6-10.
(7) For the design member capacity in compression (y-axis) ϕN_{cy} see page 6-12.

TABLE 8.1-3

WELDED COLUMNS
GRADE 300
DESIGN SECTION CAPACITIES

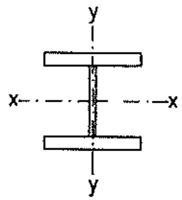


Designation	Design Section Axial Capacities		Design Section Moment Capacities					Design Shear Capacity
			About x-axis			About y-axis		
	ϕN_s	ϕN_t	ϕM_{sx}	ϕM_{rx} (comp)	ϕM_{rx} (tens)	ϕM_{sy}	ϕM_{ry}	ϕV_v
	kN	kN	kNm	kNm	kNm	kNm	kNm	kN
500WC440	14100	14100	2620	3090 $(1-n)$	3090 $(1-n)$	1260	1500 $(1-n^2)$	2420
414	13300	13300	2540	3000 $(1-n)$	3000 $(1-n)$	1260	1500 $(1-n^2)$	1940
383	12300	12300	2300	2710 $(1-n)$	2710 $(1-n)$	1140	1350 $(1-n^2)$	1940
340	10900	10900	2260	2670 $(1-n)$	2670 $(1-n)$	1010	1200 $(1-n^2)$	1700
290	9320	9320	1910	1910 $(1-n)$	1910 $(1-n)$	860	860 $(1-n)$	1460
267	8570	8570	1690	1690 $(1-n)$	1690 $(1-n)$	747	747 $(1-n)$	1460
228	7830	7830	1410	1410 $(1-n)$	1410 $(1-n)$	593	593 $(1-n)$	1460
400WC361	11600	11600	1880	2220 $(1-n)$	2220 $(1-n)$	810	964 $(1-n^2)$	2120
328	10500	10500	1790	2110 $(1-n)$	2110 $(1-n)$	808	961 $(1-n^2)$	1480
303	9730	9730	1620	1910 $(1-n)$	1910 $(1-n)$	727	865 $(1-n^2)$	1480
270	8660	8660	1430	1680 $(1-n)$	1680 $(1-n)$	646	769 $(1-n^2)$	1320
212	6800	6800	1100	1100 $(1-n)$	1100 $(1-n)$	504	504 $(1-n)$	1130
181	6210	6210	922	922 $(1-n)$	922 $(1-n)$	408	408 $(1-n)$	1130
144	4970	4970	698	698 $(1-n)$	698 $(1-n)$	303	303 $(1-n)$	907
350WC280	9000	9000	1240	1470 $(1-n)$	1470 $(1-n)$	618	736 $(1-n^2)$	1160
258	8290	8290	1120	1320 $(1-n)$	1320 $(1-n)$	557	663 $(1-n^2)$	1160
230	7380	7380	986	1160 $(1-n)$	1160 $(1-n)$	495	589 $(1-n^2)$	1040
197	6330	6330	844	995 $(1-n)$	995 $(1-n)$	433	515 $(1-n^2)$	891

Notes: (1) ϕM_{rx} (comp) refers to the design section moment capacity reduced by compression (where $n = N^*/\phi N_s$) and must be less than or equal to ϕM_{sx}.
(2) ϕM_{rx} (tens) refers to the design section moment capacity reduced by tension (where $n = N^*/\phi N_t$) and must be less than or equal to ϕM_{sx}.
(3) ϕM_{ry} refers to the design section moment capacity reduced by axial force (where $n = N^*/\phi N_t$ or $N^*/\phi N_s$) and must be less than or equal to ϕM_{sy}.
(4) The above values of ϕN_t are based on sections with no holes and $k_t = 1$. For other values of ϕN_t see page 7-8.
(5) For the design member moment capacity ϕM_b see page 5-44.
(6) For the design member capacity in compression (x-axis) ϕN_{cx} see page 6-14.
(7) For the design member capacity in compression (y-axis) ϕN_{cy} see page 6-16.

TABLE 8.1-4

WELDED COLUMNS
GRADE 400
DESIGN SECTION CAPACITIES

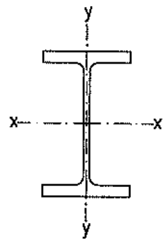


Designation	Design Section Axial Capacities		Design Section Moment Capacities					Design Shear Capacity
			About x-axis			About y-axis		
	ϕN_s	ϕN_t	ϕM_{sx}	ϕM_{rx} (comp)	ϕM_{rx} (tens)	ϕM_{sy}	ϕM_{ry}	ϕV_v
	kN	kN	kNm	kNm	kNm	kNm	kNm	kN
500WC440	18100	18100	3370	3980 (1−n)	3980 (1−n)	1620	1930 $(1-n^2)$	3010*
414	17100	17100	3270	3850 (1−n)	3850 (1−n)	1620	1930 $(1-n^2)$	2490
383	15800	15800	2960	3490 (1−n)	3490 (1−n)	1460	1740 $(1-n^2)$	2490
340	14000	14000	2860	2860 (1−n)	2860 (1−n)	1270	1270 (1−n)	2190
290	12000	12000	2400	2400 (1−n)	2400 (1−n)	1070	1070 (1−n)	1850
267	11000	11000	2120	2120 (1−n)	2120 (1−n)	928	928 (1−n)	1850
228	9570	9920	1660	1660 (1−n)	1660 (1−n)	717	717 (1−n)	1850
400WC361	14900	14900	2420	2850 (1−n)	2850 (1−n)	1040	1240 $(1-n^2)$	2690*
328	13500	13500	2300	2710 (1−n)	2710 (1−n)	1040	1240 $(1-n^2)$	1910
303	12500	12500	2080	2450 (1−n)	2450 (1−n)	935	1110 $(1-n^2)$	1910
270	11100	11100	1830	2160 (1−n)	2160 (1−n)	831	988 $(1-n^2)$	1700
212	8750	8750	1380	1380 (1−n)	1380 (1−n)	631	631 (1−n)	1440
181	7870	7870	1140	1140 (1−n)	1140 (1−n)	499	499 (1−n)	1440
144	6070	6290	824	824 (1−n)	824 (1−n)	367	367 (1−n)	1150
350WC280	11600	11600	1600	1890 (1−n)	1890 (1−n)	795	946 $(1-n^2)$	1500
258	10700	10700	1440	1700 (1−n)	1700 (1−n)	716	852 $(1-n^2)$	1500
230	9490	9490	1270	1500 (1−n)	1500 (1−n)	636	757 $(1-n^2)$	1340
197	8130	8130	1080	1280 (1−n)	1280 (1−n)	556	662 $(1-n^2)$	1130

Notes: (1) ϕM_{rx} (comp) refers to the design section moment capacity reduced by compression (where $n = N^*/\phi N_s$) and must be less than or equal to ϕM_{sx}.
(2) ϕM_{rx} (tens) refers to the design section moment capacity reduced by tension (where $n = N^*/\phi N_t$) and must be less than or equal to ϕM_{sx}.
(3) ϕM_{ry} refers to the design section moment capacity reduced by axial force (where $n = N^*/\phi N_t$ or $N^*/\phi N_s$) and must be less than or equal to ϕM_{sy}.
(4) The above values of ϕN_t are based on sections with no holes and $k_t = 1$. For other values of ϕN_t see page 7-9.
(5) For the design member moment capacity ϕM_b see page 5-46.
(6) For the design member capacity in compression (x-axis) ϕN_{cx} see page 6-18.
(7) For the design member capacity in compression (y-axis) ϕN_{cy} see page 6-20.
(8) * indicates shear capacity governed by the shear capacity of the weld.

TABLE 8.1-5

UNIVERSAL BEAMS GRADE 300
DESIGN SECTION CAPACITIES

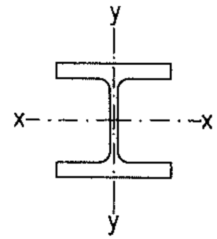


Designation	Design Section Axial Capacities		Design Section Moment Capacities					Design Shear Capacity
			About x-axis			About y-axis		
	ϕN_s	ϕN_t	ϕM_{sx}	ϕM_{rx} (comp)	ϕM_{rx} (tens)	ϕM_{sy}	ϕM_{ry}	ϕV_v
	kN	kN	kNm	kNm	kNm	kNm	kNm	kN
610UB125	3820	4020	927	1070 (1−n)	1090 (1−n)	130	154 $(1-n^2)$	1180
113	3370	3650	829	942 (1−n)	979 (1−n)	114	135 $(1-n^2)$	1100
101	3110	3510	782	869 (1−n)	923 (1−n)	104	124 $(1-n^2)$	1100
530UB 92.4	2960	3190	640	728 (1−n)	755 (1−n)	92.2	110 $(1-n^2)$	939
82.0	2560	2840	558	625 (1−n)	658 (1−n)	78.0	92.9 $(1-n^2)$	876
460UB 82.1	2770	2830	496	579 (1−n)	585 (1−n)	79.0	94.0 $(1-n^2)$	788
74.6	2440	2570	449	515 (1−n)	529 (1−n)	70.8	84.3 $(1-n^2)$	719
67.1	2130	2320	399	451 (1−n)	471 (1−n)	62.0	73.8 $(1-n^2)$	667
410UB 59.7	1940	2060	324	369 (1−n)	382 (1−n)	54.8	65.3 $(1-n^2)$	548
53.7	1810	1980	304	342 (1−n)	359 (1−n)	49.8	59.3 $(1-n^2)$	529
360UB 56.7	1950	1960	273	322 (1−n)	323 (1−n)	52.0	61.9 $(1-n^2)$	496
50.7	1680	1750	242	280 (1−n)	286 (1−n)	45.5	54.1 $(1-n^2)$	449
44.7	1530	1650	222	222 (1−n)	222 (1−n)	40.4	40.4 (1−n)	420
310UB 46.2	1590	1600	197	231 (1−n)	232 (1−n)	44.0	52.3 $(1-n^2)$	356
40.4	1430	1500	182	208 (1−n)	215 (1−n)	40.0	47.6 $(1-n^2)$	320
32.0	1070	1180	134	134 (1−n)	134 (1−n)	25.0	25.0 (1−n)	283
250UB 37.3	1370	1370	140	165 (1−n)	165 (1−n)	33.5	39.9 $(1-n^2)$	283
31.4	1150	1150	114	114 (1−n)	114 (1−n)	26.3	26.3 (1−n)	265
25.7	893	941	92.0	105 (1−n)	109 (1−n)	17.8	21.1 $(1-n^2)$	214
200UB 29.8	1100	1100	90.0	107 (1−n)	107 (1−n)	24.9	29.6 $(1-n^2)$	225
25.4	930	930	74.6	74.6 (1−n)	74.6 (1−n)	19.8	19.8 (1−n)	204
22.3	826	826	65.3	65.3 (1−n)	65.3 (1−n)	17.4	17.4 (1−n)	174
18.2	661	668	51.8	60.8 (1−n)	61.1 (1−n)	9.92	11.8 $(1-n^2)$	154
180UB 22.2	813	813	56.2	66.4 (1−n)	66.4 (1−n)	11.7	13.9 $(1-n^2)$	186
18.1	663	663	45.2	53.4 (1−n)	53.4 (1−n)	9.36	11.1 $(1-n^2)$	151
16.1	589	589	39.8	47.0 (1−n)	47.0 (1−n)	8.19	9.75 $(1-n^2)$	135
150UB 18.0	661	661	38.9	45.9 (1−n)	45.9 (1−n)	7.74	9.21 $(1-n^2)$	161
14.0	514	514	29.3	34.6 (1−n)	34.6 (1−n)	5.70	6.78 $(1-n^2)$	130

Notes: (1) ϕM_{rx} (comp) refers to the design section moment capacity reduced by compression (where $n = N^*/\phi N_s$) and must be less than or equal to ϕM_{sx}.
(2) ϕM_{rx} (tens) refers to the design section moment capacity reduced by tension (where $n = N^*/\phi N_t$) and must be less than or equal to ϕM_{sx}.
(3) ϕM_{ry} refers to the design section moment capacity reduced by axial force (where $n = N^*/\phi N_t$ or $N^*/\phi N_s$) and must be less than or equal to ϕM_{sy}.
(4) The above values of ϕN_t are based on sections with no holes and $k_t = 1$. For other values of ϕN_t see page 7-10.
(5) For the design member moment capacity ϕM_b see page 5-48
(6) For the design member capacity in compression (x-axis) ϕN_{cx} see page 6-22.
(7) For the design member capacity in compression (y-axis) ϕN_{cy} see page 6-24.
(8) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

TABLE 8.1-6

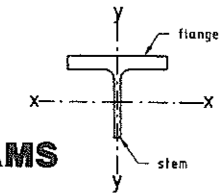
UNIVERSAL COLUMNS
GRADE 300
DESIGN SECTION CAPACITIES



Designation	Design Section Axial Capacities		Design Section Moment Capacities					Design Shear Capacity
			About x-axis			About y-axis		
	ϕN_s	ϕN_t	ϕM_{sx}	ϕM_{rx} (comp)	ϕM_{rx} (tens)	ϕM_{sy}	ϕM_{ry}	ϕV_v
	kN	kN	kNm	kNm	kNm	kNm	kNm	kN
310UC158	5070	5070	676	798 (1−n)	798 (1−n)	305	363 $(1-n^2)$	832
137	4400	4400	580	684 (1−n)	684 (1−n)	261	311 $(1-n^2)$	717
118	3780	3780	494	582 (1−n)	582 (1−n)	222	264 $(1-n^2)$	606
96.8	3340	3340	422	422 (1−n)	422 (1−n)	187	187 (1−n)	527
250UC 89.5	2870	2870	309	365 (1−n)	365 (1−n)	143	170 $(1-n^2)$	472
72.9	2520	2520	266	266 (1−n)	266 (1−n)	123	123 (1−n)	377
200UC 59.5	2060	2060	177	209 (1−n)	209 (1−n)	80.6	96.0 $(1-n^2)$	337
52.2	1800	1800	154	182 (1−n)	182 (1−n)	70.3	83.6 $(1-n^2)$	285
46.2	1590	1590	133	133 (1−n)	133 (1−n)	60.3	60.3 (1−n)	257
150UC 37.2	1280	1280	83.6	98.7 (1−n)	98.7 (1−n)	36.9	43.9 $(1-n^2)$	226
30.0	1110	1110	71.9	84.8 (1−n)	84.8 (1−n)	31.7	37.7 $(1-n^2)$	180
23.4	859	859	50.7	50.7 (1−n)	50.7 (1−n)	21.2	21.2 (1−n)	161
100UC 14.8	543	543	21.4	25.3 (1−n)	25.3 (1−n)	9.91	11.8 $(1-n^2)$	83.8

Notes: (1) ϕM_{rx} (comp) refers to the design section moment capacity reduced by compression (where $n = N^*/\phi N_s$) and must be less than or equal to ϕM_{sx}.
(2) ϕM_{rx} (tens) refers to the design section moment capacity reduced by tension (where $n = N^*/\phi N_t$) and must be less than or equal to ϕM_{sx}.
(3) ϕM_{ry} refers to the design section moment capacity reduced by axial force (where $n = N^*/\phi N_t$ or $N^*/\phi N_s$) and must be less than or equal to ϕM_{sy}.
(4) The above values of ϕN_t are based on sections with no holes and $k_t = 1$. For other values of ϕN_t see page 7-11.
(5) For the design member moment capacity ϕM_b see page 5-50.
(6) For the design member capacity in compression (x-axis) ϕN_{cx} see page 6-26.
(7) For the design member capacity in compression (y-axis) ϕN_{cy} see page 6-28.
(8) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

TABLE 8.1-7



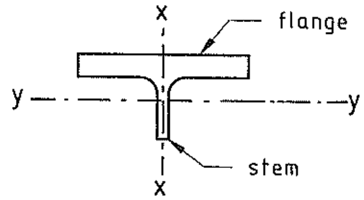
TEES CUT FROM UNIVERSAL BEAMS GRADE 300

DESIGN SECTION CAPACITIES

Designation	Design Section Axial Capacities		Design Section Moment Capacities			Design Shear Capacity
			About x-axis		About y-axis	
			stem down	stem up		
	ϕN_s	ϕN_t	ϕM_{sxf}	ϕM_{sxs}	ϕM_{sy}	ϕV_v
	kN	kN	kNm	kNm	kNm	kN
305BT62.5	1690	2010	112	72.7	64.9	520
56.5	1490	1820	104	59.6	56.8	486
50.5	1380	1750	103	49.5	52.1	488
265BT46.3	1310	1590	78.3	45.3	46.1	414
41.0	1130	1420	72.1	37.0	39.0	387
230BT41.1	1230	1410	56.8	39.5	39.5	346
37.3	1090	1280	51.8	32.7	35.4	316
33.6	951	1160	47.6	26.3	31.0	293
205BT29.9	870	1030	35.3	20.8	27.4	240
26.9	810	989	35.8	18.8	24.9	232
180BT28.4	870	976	28.2	20.2	26.0	217
25.4	756	872	25.4	17.0	22.7	196
22.4	688	822	24.4	14.2	20.2	184
155BT23.1	721	799	17.6	12.4	22.0	154
20.2	652	748	16.8	10.2	20.0	139
16.0	487	586	13.6	7.23	12.5	123
125BT18.7	632	682	12.3	9.38	16.7	123
15.7	523	576	11.2	8.37	13.2	115
12.9	405	469	9.03	5.56	8.88	92.5
100BT14.9 *	549	549	7.86	6.60	12.4	97.4
12.7 *	446	464	6.92	5.67	9.90	88.2
11.2 *	380	412	5.62	4.50	8.68	75.2
9.1	297	332	5.11	3.64	4.96	66.3
90BT11.1	405	405	5.40	4.75	5.85	80.4
9.1	319	330	4.37	3.57	4.68	65.3
8.1	274	293	3.87	3.01	4.09	58.0
75BT 9.0	329	329	4.96	3.66	3.87	69.7
7.0	256	256	3.14	2.73	2.85	56.2

Notes: (1) * indicates x- and y-axes are interchanged from that shown on the diagram.
(2) ϕM_{sxf} refers to bending about the x-axis that causes compression in the flange.
(3) ϕM_{sxs} refers to bending about the x-axis that causes compression in the stem.
(4) For all sections $\phi M_{rx} = \phi M_{sx}$ (1-n) where n = $N^*/\phi N_s$ or $N^*/\phi N_t$.
(5) For all sections $\phi M_{ry} = \phi M_{sy}$ (1-n) where n = $N^*/\phi N_s$ or $N^*/\phi N_t$.
(6) The above values of ϕN_t are based on sections with no holes and k_t = 1. For other values of ϕN_t see page 7-12.
(7) For the design member moment capacity ϕM_b see pages 5-52 and 5-53.
(8) For the design member capacity in compression (x-axis) ϕN_{cx} see page 6-30.
(9) For the design member capacity in compression (y-axis) ϕN_{cy} see page 6-31.
(10) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

TABLE 8.1-8



TEES CUT FROM UNIVERSAL COLUMNS GRADE 300

DESIGN SECTION CAPACITIES

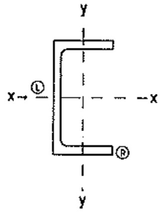
Designation	Design Section Axial Capacities		Design Section Moment Capacities			Design Shear Capacity
			About y-axis		About x-axis	
			stem down	stem up		
	ϕN_s	ϕN_t	ϕM_{syf}	ϕM_{sys}	ϕM_{sx}	ϕV_v
	kN	kN	kNm	kNm	kNm	kNm
155CT79.0	2530	2530	42.7	42.5	152	357
68.5	2200	2200	36.5	35.3	131	308
59.0	1890	1890	30.7	28.6	111	260
48.4	1670	1670	24.7	23.1	93.7	226
125CT44.8	1430	1430	18.3	17.5	71.5	202
36.5	1260	1260	15.2	13.9	61.3	161
100CT29.8	1030	1030	11.2	10.8	40.3	144
26.1	897	897	9.44	8.79	35.1	122
23.1	795	795	8.13	7.66	30.1	110
75CT18.6	637	637	5.69	5.66	18.4	96.9
15.0	554	554	4.78	4.51	15.9	76.8
11.7	428	428	3.53	3.84	10.6	68.9
50CT 7.4	270	270	1.33	1.32	4.95	35.4

Notes: (1) ϕM_{syf} refers to bending about the y-axis that causes compression in the flange.
(2) ϕM_{sys} refers to bending about the y-axis that causes compression in the stem.
(3) For all sections $\phi M_{rx} = \phi M_{sx}$ (1-n) where n = $N^*/\phi N_s$ or $N^*/\phi N_t$.
(4) For all sections $\phi M_{ry} = \phi M_{sy}$ (1-n) where n = $N^*/\phi N_s$ or $N^*/\phi N_t$.
(5) The above values of ϕN_t are based on sections with no holes and k_t = 1. For other values of ϕN_t see page 7-13.
(6) For tees bending about the y-axis the design member moment capacity ϕM_b equals the design section moment capacity, ϕM_{sy}.
(7) For the design member capacity in compression (x-axis) ϕN_{cx} see page 6-32.
(8) For the design member capacity in compression (y-axis) ϕN_{cy} see page 6-33.
(9) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

TABLE 8.1-9

PARALLEL FLANGE CHANNELS GRADE 300

DESIGN SECTION CAPACITIES



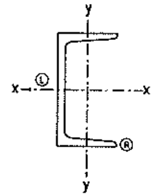
Designation	Mass per metre	Design Section Axial Capacities		Design Section Moment Capacities			Design Shear Capacity
				About x-axis	About y-axis		
		ϕN_s	ϕN_t	ϕM_{sx}	ϕM_{syL}	ϕM_{syR}	ϕV_v
	kg/m	kN	kN	kNm	kNm	kNm	kN
380 PFC	55.2	1770	1770	238	28.9	33.8	657
300 PFC	40.1	1380	1380	152	22.2	26.1	415
250 PFC	35.5	1220	1220	114	24.0	24.0	346
230 PFC	25.1	864	864	73.3	12.2	13.6	258
200 PFC	22.9	788	788	59.7	12.6	13.2	207
180 PFC	20.9	718	718	49.0	12.1	12.1	187
150 PFC	17.7	649	649	37.0	11.1	11.1	156

Notes: (1) ϕM_{syL} refers to bending about the y-axis that causes compression in the web marked L.
(2) ϕM_{syR} refers to bending about the y-axis that causes compression in the flange marked R.
(3) For all sections $\phi M_{rx} = \phi M_{sx}$ (1-n) where $n = N^*/\phi N_s$ or $N^*/\phi N_t$.
(4) For all sections $\phi M_{ry} = \phi M_{sy}$ (1-n) where $n = N^*/\phi N_s$ or $N^*/\phi N_t$.
(5) The above values of ϕN_t are based on sections with no holes and k_t = 1. For other values of ϕN_t see page 7-14.
(6) For the design member moment capacity ϕM_b see page 5-54.
(7) For the design member capacity in compression (x-axis) ϕN_{cx} see page 6-34.
(8) For the design member capacity in compression (y-axis) ϕN_{cy} see page 6-36.
(9) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

TABLE 8.1-10

TAPER FLANGE CHANNELS GRADE 250

DESIGN SECTION CAPACITIES



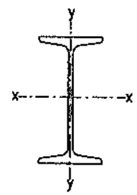
Designation	Mass per metre	Design Section Axial Capacities		Design Section Moment Capacities			Design Shear Capacity
				About x-axis	About y-axis		
		ϕN_s	ϕN_t	ϕM_{sx}	ϕM_{syL}	ϕM_{syR}	ϕV_v
	kg/m	kN	kN	kNm	kNm	kNm	kN
125 TFC	13.4	400	400	18.6	4.72	4.72	105
100 TFC	9.34	279	279	10.4	2.64	2.64	70.2
75 TFC	6.65	198	198	5.39	1.46	1.46	52.7

Notes: (1) ϕM_{syL} refers to bending about the y-axis that causes compression in the web marked L.
(2) ϕM_{syR} refers to bending about the y-axis that causes compression in the flange marked R.
(3) For all sections $\phi M_{rx} = \phi M_{sx}$ (1-n) where $n = N^*/\phi N_s$ or $N^*/\phi N_t$.
(4) For all sections $\phi M_{ry} = \phi M_{sy}$ (1-n) where $n = N^*/\phi N_s$ or $N^*/\phi N_t$.
(5) The above values of ϕN_t are based on sections with no holes and k_t = 1. For other values of ϕN_t see page 7-14.
(6) For the design member moment capacity ϕM_b see page 5-56.
(7) For the design member capacity in compression (x-axis) ϕN_{cx} see page 6-38.
(8) For the design member capacity in compression (y-axis) ϕN_{cy} see page 6-40.

TABLE 8.1-11

TAPER FLANGE BEAMS GRADE 250

DESIGN SECTION CAPACITIES

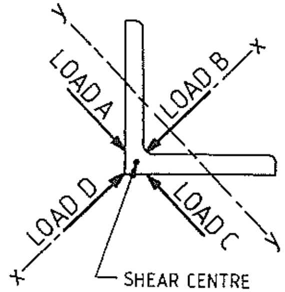


Designation	Mass per metre	Design Section Axial Capacities		Design Section Moment Capacities					Design Shear Capacity
				About x-axis			About y-axis		
		ϕN_s	ϕN_t	ϕM_{sx}	ϕM_{rx} (comp)	ϕM_{rx} (tens)	ϕM_{sy}	ϕM_{ry}	ϕV_v
	kg/m	kN	kN	kNm	kNm	kNm	kNm	kNm	kN
125 TFB	13.1	392	392	18.8	22.2 (1−n)	22.2 (1−n)	3.64	4.33 (1−n²)	87.8
100 TFB	7.20	214	214	7.98	9.41 (1−n)	9.41 (1−n)	1.24	1.48 (1−n²)	56.2

Notes: (1) ϕM_{rx} (comp) refers to the design section moment capacity reduced by compression (where $n = N^*/\phi N_s$) and must be less than or equal to ϕM_{sx}.
(2) ϕM_{rx} (tens) refers to the design section moment capacity reduced by tension (where $n = N^*/\phi N_t$) and must be less than or equal to ϕM_{sx}.
(3) ϕM_{ry} refers to the design section moment capacity reduced by axial force (where $n = N^*/\phi N_t$ or $N^*/\phi N_s$) and must be less than or equal to ϕM_{sy}.
(4) The above values of ϕN_t are based on sections with no holes and k_t = 1. For other values of ϕN_t see page 7-15.
(5) For the design member moment capacity ϕM_b see page 5-56.
(6) For the design member capacity in compression (x-axis) ϕN_{cx} see page 6-38
(7) For the design member capacity in compression (y-axis) ϕN_{cy} see page 6-40.

TABLE 8.1-12(1)

EQUAL ANGLES
GRADE 300
DESIGN SECTION CAPACITIES

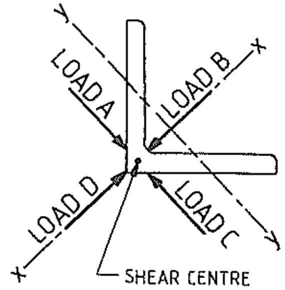


Designation	Design Section Axial Capacities		Design Section Moment Capacities		
			About x-axis	About y-axis	
			Load A	Load B	Load D
	ϕN_s	ϕN_t	ϕM_{sx}	ϕM_{sy}	ϕM_{sy}
	kN	kN	kNm	kNm	kNm
200 x 200 x 26EA	2470	2470	152	67.3	74.8
20EA	1930	1930	121	55.0	61.7
18EA	1750	1750	108	49.5	57.0
16EA	1670	1670	99.7	46.5	55.8
13EA	1370	1370	76.9	36.7	47.5
150 x 150 x 19EA	1350	1350	62.6	27.8	30.9
16EA	1220	1220	57.1	25.8	28.9
12EA	940	940	41.9	19.5	23.4
10EA	769	797	32.8	15.7	20.8
125 x 125 x 16EA	1000	1000	38.6	17.1	19.0
12EA	774	774	29.8	13.6	15.5
10EA	661	657	24.0	11.2	13.8
8EA	516	544	18.5	8.84	11.8

Notes: (1) The values of ϕM_{sx} and ϕM_{sy} depend on the direction of the bending moment. The appropriate value is based on the direction of the load (A, B or D) as shown in the diagram.
(2) For all sections $\phi M_{rx} = \phi M_{sx}$ (1-n) where n = $N^*/\phi N_s$ or $N^*/\phi N_t$.
(3) For all sections $\phi M_{ry} = \phi M_{sy}$ (1-n) where n = $N^*/\phi N_s$ or $N^*/\phi N_t$.
(4) The above values of ϕN_t are based on sections with no holes and $k_t = 0.85$ (one leg attached). For other values of ϕN_t see page 7-15.
(5) For the design member capacity in compression (x-axis) ϕN_{cx} see page 6-42.
(6) For the design member capacity in compression (y-axis) ϕN_{cy} see page 6-44.
(7) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

TABLE 8.1-12(2)

EQUAL ANGLES
GRADE 250
DESIGN SECTION CAPACITIES

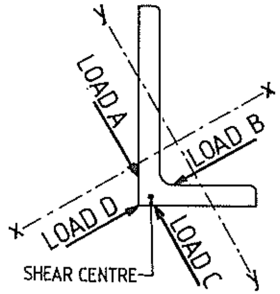


Designation	Design Section Axial Capacities		Design Section Moment Capacities		
			About x-axis	About y-axis	
			Load A	Load B	Load D
	ϕN_s	ϕN_t	ϕM_{sx}	ϕM_{sy}	ϕM_{sy}
	kN	kN	kNm	kNm	kNm
100 x 100 x 12EA	529	529	16.4	7.29	8.10
10EA	424	424	13.2	6.03	6.80
8EA	352	352	10.5	4.91	5.83
6EA	273	273	7.55	3.63	4.71
90 x 90 x 10EA	380	380	10.7	4.83	5.37
8EA	315	315	8.64	4.00	4.62
6EA	245	245	6.29	3.01	3.75
75 x 75 x 10EA	313	313	7.15	3.19	3.55
8EA	260	260	6.04	2.76	3.07
6EA	203	203	4.51	2.13	2.51
5EA	157	157	3.21	1.58	2.04
65 x 65 x 10EA	269	269	5.28	2.32	2.57
8EA	224	224	4.50	2.01	2.23
6EA	175	175	3.52	1.62	1.84
5EA	136	136	2.58	1.22	1.50
55 x 55 x 6EA	147	147	2.50	1.44	1.26
5EA	114	114	1.89	0.891	1.04
50 x 50 x 8EA	169	169	2.51	1.10	1.22
6EA	133	133	2.03	0.917	1.02
5EA	104	104	1.58	0.738	0.839
3EA	69.0	69.0	0.933	0.464	0.604
45 x 45 x 6EA	118	118	1.61	0.716	0.796
5EA	92.3	92.3	1.29	0.590	0.656
3EA	61.4	61.4	0.776	0.378	0.472
40 x 40 x 6EA	104	104	1.24	0.545	0.606
5EA	81.5	81.5	0.993	0.452	0.502
3EA	54.4	54.4	0.626	0.303	0.364
30 x 30 x 6EA	76.2	76.2	0.641	0.277	0.308
5EA	60.0	60.0	0.522	0.232	0.257
3EA	40.4	40.4	0.359	0.171	0.190
25 x 25 x 6EA	62.1	62.1	0.417	0.180	0.200
5EA	49.2	49.2	0.344	0.150	0.167
3EA	33.3	33.3	0.240	0.112	0.125

Notes: (1) The values of ϕM_{sx} and ϕM_{sy} depend on the direction of the bending moment. The appropriate value is based on the direction of the load (A, B or D) as shown in the diagram.
(2) For all sections $\phi M_{rx} = \phi M_{sx}$ (1-n) where n = $N^*/\phi N_s$ or $N^*/\phi N_t$.
(3) For all sections $\phi M_{ry} = \phi M_{sy}$ (1-n) where n = $N^*/\phi N_s$ or $N^*/\phi N_t$.
(4) The above values of ϕN_t are based on sections with no holes and $k_t = 0.85$ (one leg attached). For other values of ϕN_t see page 7-15.
(5) For the design member capacity in compression (x-axis) ϕN_{cx} see page 6-43.
(6) For the design member capacity in compression (y-axis) ϕN_{cy} see page 6-45.

TABLE 8.1-13

UNEQUAL ANGLES
GRADE 300 & 250
DESIGN SECTION CAPACITIES



Designation	Design Section Axial Capacities		Design Section Moment Capacities			
			About x-axis		About y-axis	
			Load A	Load C	Load B	Load D
	ϕN_s	ϕN_t	ϕM_{sx}	ϕM_{sx}	ϕM_{sy}	ϕM_{sy}
	kN	kN	kNm	kNm	kNm	kNm
150 x 100 x 12UA	774	724	27.6	29.8	9.54	11.5
10UA	644	579	21.6	23.5	7.48	9.91
150 x 90 x 16UA	959	897	35.6	35.8	10.7	11.9
12UA	742	693	26.0	28.1	7.78	9.35
10UA	617	556	20.3	23.6	6.10	8.07
8UA	451	458	15.3	17.4	4.58	6.72
125 x 75 x 12UA	529	529	16.3	16.5	4.89	5.51
10UA	424	424	12.4	13.4	3.73	4.46
8UA	352	352	9.70	11.2	2.91	3.73
6UA	238	273	6.68	7.59	2.01	2.91
100 x 75 x 10UA	369	369	9.43	9.57	3.82	4.31
8UA	306	306	7.51	8.02	3.04	3.61
6UA	238	238	5.38	5.47	2.18	2.84
75 x 50 x 8UA	215	215	4.05	4.05	1.41	1.57
6UA	169	169	3.03	3.21	1.05	1.24
5UA	131	131	2.17	2.39	0.758	0.977
65 x 50 x 8UA	197	197	3.29	3.29	1.37	1.52
6UA	154	154	2.57	2.62	1.07	1.21
5UA	120	120	1.88	1.96	0.784	0.958

Notes: (1) For 150 x 90 angles and above: Grade 300.
(2) For 125 x 75 angles and below: Grade 250.
(3) The values of ϕM_{sx} and ϕM_{sy} depend on the direction of the bending moment. The appropriate value is based on the direction of the load (A, B, C or D) as shown in the diagram.
(4) For all sections $\phi M_{rx} = \phi M_{sx}(1-n)$ where $n = N^*/\phi N_s$ or $N^*/\phi N_t$.
(5) For all sections $\phi M_{ry} = \phi M_{sy}(1-n)$ where $n = N^*/\phi N_s$ or $N^*/\phi N_t$.
(6) The above values of ϕN_t are based on sections with no holes and $k_t = 0.75$ (short leg attached). For other values of ϕN_t see page 7-16.
(7) For the design member capacity in compression (x-axis) ϕN_{cx} see page 6-46.
(8) For the design member capacity in compression (y-axis) ϕN_{cy} see page 6-47.
(9) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

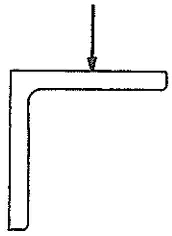


TABLE 8.2-1(1)

EQUAL ANGLES
GRADE 300

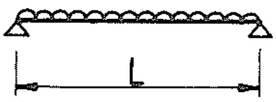
MAXIMUM DESIGN LOADS FOR BEAMS WITH FULL LATERAL RESTRAINT
vertical leg down

W_L^* Maximum Design Load based on Moment or Shear
W_{S1}^* Serviceability Load based on Deflection Limit of Span/250 or First Yield
W_{S2}^* Serviceability Load based on Deflection Limit of Span/500 or First Yield

Designation	Mass Per m	W_L^* (kN)/W_{S1}^*(kN)/W_{S2}^*(kN) Span in metres									
	kg/m	1	2	3	4	5	6	7	8	9	10
200 x 200 x 26EA	76.8	**681**	**340**	**227**	**170**	**136**	**113**	**97.2**	**85.1**	**75.6**	**68.1**
		571	285	190	138	88.1	61.2	45.0	34.4	27.2	22.0
		571	*275*	*122*	*68.8*	*44.1*	*30.6*	*22.5*	*17.2*	*13.6*	*11.0*
20EA	60.1	**548**	**274**	**183**	**137**	**110**	**91.3**	**78.3**	**68.5**	**60.9**	**54.8**
		451	225	150	110	70.7	49.1	36.1	27.6	21.8	17.7
		451	*221*	*98.2*	*55.2*	*35.3*	*24.5*	*18.0*	*13.8*	*10.9*	*8.84*
18EA	54.4	**490**	**245**	**163**	**123**	**98.1**	**81.7**	**70.0**	**61.3**	**54.5**	**49.0**
		409	205	136	101	64.5	44.8	32.9	25.2	19.9	16.1
		409	*202*	*89.6*	*50.4*	*32.3*	*22.4*	*16.5*	*12.6*	*9.96*	*8.07*
16EA	48.7	**457**	**228**	**152**	**114**	**91.3**	**76.1**	**65.2**	**57.1**	**50.7**	**45.7**
		393	197	131	90.9	58.2	40.4	29.7	22.7	18.0	14.5
		393	*182*	*80.8*	*45.5*	*29.1*	*20.2*	*14.8*	*11.4*	*8.98*	*7.27*
13EA	40.0	**355**	**177**	**118**	**88.7**	**71.0**	**59.2**	**50.7**	**44.4**	**39.4**	**35.5**
		324	162	108	75.5	48.3	33.6	24.7	18.9	14.9	12.1
		324	*151*	*67.1*	*37.7*	*24.2*	*16.8*	*12.3*	*9.44*	*7.46*	*6.04*
150 x 150 x 19EA	42.1	**281**	**140**	**93.6**	**70.2**	**56.2**	**46.8**	**40.1**	**35.1**	**31.2**	**28.1**
		235	117	75.6	42.5	27.2	18.9	13.9	10.6	8.40	6.80
		235	*85.1*	*37.8*	*21.3*	*13.6*	*9.45*	*6.94*	*5.32*	*4.20*	*3.40*
16EA	35.4	**259**	**129**	**86.2**	**64.7**	**51.7**	**43.1**	**37.0**	**32.3**	**28.7**	**25.9**
		213	106	64.7	36.4	23.3	16.2	11.9	9.1	7.19	5.83
		213	*72.8*	*32.4*	*18.2*	*11.7*	*8.09*	*5.95*	*4.55*	*3.60*	*2.91*
12EA	27.3	**192**	**95.9**	**64.0**	**48.0**	**38.4**	**32.0**	**27.4**	**24.0**	**21.3**	**19.2**
		165	82.5	50.9	28.6	18.3	12.7	9.36	7.16	5.66	4.58
		165	*57.3*	*25.5*	*14.3*	*9.17*	*6.37*	*4.68*	*3.58*	*2.83*	*2.29*
10EA	21.9	**152**	**75.9**	**50.6**	**37.9**	**30.3**	**25.3**	**21.7**	**19.0**	**16.9**	**15.2**
		141	70.7	41.3	23.2	14.9	10.3	7.58	5.8	4.58	3.71
		141	*46.4*	*20.6*	*11.6*	*7.43*	*5.16*	*3.79*	*2.9*	*2.29*	*1.86*
125 x 125 x 16EA	29.1	**173**	**86.7**	**57.8**	**43.4**	**34.7**	**28.9**	**24.8**	**21.7**	**19.3**	
		145	72.4	36.3	20.4	13.1	9.07	6.67	5.1	4.03	
		145	*40.8*	*18.1*	*10.2*	*6.53*	*4.54*	*3.33*	*2.55*	*2.02*	
12EA	22.5	**135**	**67.7**	**45.1**	**33.9**	**27.1**	**22.6**	**19.3**	**16.9**	**15.0**	
		113	56.3	28.7	16.2	10.3	7.18	5.28	4.04	3.19	
		113	*32.3*	*14.4*	*8.08*	*5.17*	*3.59*	*2.64*	*2.02*	*1.60*	
10EA	18.0	**110**	**55.0**	**36.6**	**27.5**	**22.0**	**18.3**	**15.7**	**13.7**	**12.2**	
		96.7	48.3	23.4	13.1	8.41	5.84	4.29	3.28	2.60	
		96.7	*26.3*	*11.7*	*6.57*	*4.20*	*2.92*	*2.14*	*1.64*	*1.30*	
8EA	14.9	**85.6**	**42.8**	**28.5**	**21.4**	**17.1**	**14.3**	**12.2**	**10.7**	**9.51**	
		80.2	40.1	19.5	11.0	7.03	4.88	3.59	2.74	2.17	
		80.2	*22.0*	*9.76*	*5.49*	*3.51*	*2.44*	*1.79*	*1.37*	*1.08*	

Notes: (1) Shading indicates serviceability load governed by yielding.
(2) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

FULL LATERAL RESTRAINT



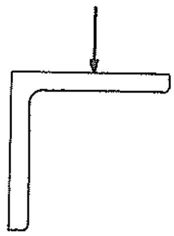


TABLE 8.2-1(2)

EQUAL ANGLES
GRADE 250

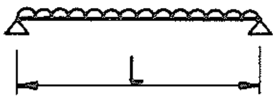
MAXIMUM DESIGN LOADS FOR BEAMS WITH FULL LATERAL RESTRAINT
vertical leg down

W_L^* Maximum Design Load based on Moment or Shear
W_{S1}^* Serviceability Load based on Deflection Limit of Span/250 or First Yield
W_{S2}^* Serviceability Load based on Deflection Limit of Span/500 or First Yield

Designation	Mass Per m	W_L^* (kN)/W_{S1}^*(kN)/W_{S2}^*(kN) Span in metres									
	kg/m	1	2	3	4	5	6	7	8	9	10
100 x 100 x 12EA	17.7	**73.6**	**36.8**	**24.5**	**18.4**	**14.7**	**12.3**	**10.5**			
		61.0	30.5	14.2	7.97	5.10	3.54	2.60			
		61.0	*15.9*	*7.08*	*3.99*	*2.55*	*1.77*	*1.30*			
10EA	14.2	**60.0**	**30.0**	**20.0**	**15.0**	**12.0**	**10.0**	**8.57**			
		49.2	24.6	11.6	6.52	4.17	2.90	2.13			
		49.2	*13.0*	*5.79*	*3.26*	*2.09*	*1.45*	*1.06*			
8EA	11.8	**48.3**	**24.1**	**16.1**	**12.1**	**9.66**	**8.05**				
		40.9	20.4	9.72	5.47	3.50	2.43				
		40.9	*10.9*	*4.86*	*2.73*	*1.75*	*1.21*				
6EA	9.16	**35.0**	**17.5**	**11.7**	**8.74**	**6.99**	**5.83**				
		31.8	15.9	7.64	4.30	2.75	1.91				
		31.8	*8.59*	*3.82*	*2.15*	*1.37*	*0.950*				
90 x 90 x 10EA	12.7	**48.3**	**24.2**	**16.1**	**12.1**	**9.66**					
		39.4	18.7	8.31	4.67	2.99					
		37.4	*9.35*	*4.15*	*2.34*	*1.50*					
8EA	10.6	**39.5**	**19.8**	**13.2**	**9.88**	**7.90**					
		32.8	15.7	6.98	3.93	2.51					
		31.4	*7.86*	*3.49*	*1.96*	*1.26*					
6EA	8.22	**29.1**	**14.5**	**9.69**	**7.26**	**5.81**					
		25.5	12.4	5.50	3.09	1.98					
		24.7	*6.19*	*2.75*	*1.55*	*0.990*					
75 x 75 x 10EA	10.5	**32.2**	**16.1**	**10.7**	**8.04**						
		26.7	10.5	4.65	2.62						
		20.9	*5.23*	*2.33*	*1.31*						
8EA	8.73	**27.5**	**13.7**	**9.15**	**6.87**						
		22.3	8.83	3.93	2.21						
		17.7	*4.42*	*1.96*	*1.10*						
6EA	6.81	**20.7**	**10.4**	**6.92**	**5.19**						
		17.4	6.98	3.10	1.75						
		14.0	*3.49*	*1.55*	*0.873*						
5EA	5.27	**15.0**	**7.49**	**4.99**	**3.74**						
		13.4	5.45	2.42	1.36						
		10.9	*2.73*	*1.21*	*0.681*						
65 x 65 x 10EA	9.02	**23.5**	**11.8**	**7.85**							
		20.0	6.71	2.98							
		13.4	*3.36*	*1.49*							
8EA	7.51	**20.3**	**10.1**	**6.75**							
		16.8	5.70	2.54							
		11.4	*2.85*	*1.27*							
6EA	5.87	**16.0**	**8.02**	**5.35**							
		13.2	4.55	2.02							
		9.11	*2.28*	*1.01*							
5EA	4.56	**11.9**	**5.94**	**3.96**							
		10.3	3.59	1.60							
		7.18	*1.79*	*0.798*							
55 x 55 x 6EA	4.93	**11.4**	**5.68**	**3.78**							
		9.27	2.69	1.19							
		5.37	*1.34*	*0.597*							
5EA	3.84	**8.70**	**4.35**	**2.90**							
		7.24	2.13	0.946							
		4.26	*1.06*	*0.473*							
50 x 50 x 8EA	5.68	**11.2**	**5.60**								
		9.58	2.46								
		4.93	*1.23*								
6EA	4.46	**9.18**	**4.59**								
		7.57	1.98								
		3.97	*0.992*								
5EA	3.48	**7.23**	**3.62**								
		5.92	1.58								
		3.15	*0.788*								
3EA	2.31	**4.36**	**2.18**								
		3.92	1.07								
		2.13	*0.533*								

FULL LATERAL RESTRAINT

Notes: (1) Shading indicates serviceability load governed by yielding.
(2) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.



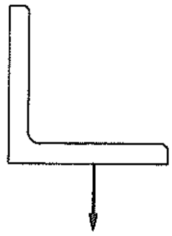


TABLE 8.2-2(1)

EQUAL ANGLES
GRADE 300

MAXIMUM DESIGN LOADS FOR BEAMS WITH FULL LATERAL RESTRAINT
vertical leg up

W_L^* Maximum Design Load based on Moment or Shear
W_{S1}^* Serviceability Load based on Deflection Limit of Span/250 or First Yield
W_{S2}^* Serviceability Load based on Deflection Limit of Span/500 or First Yield

Designation	Mass Per m	W_L^* (kN)/W_{S1}^*(kN)/W_{S2}^*(kN) Span in metres									
mm mm	kg/m	1	2	3	4	5	6	7	8	9	10
200 x 200 x 26EA	76.8	681	340	227	170	136	113	97.2	85.1	75.6	68.1
		571	285	190	138	88.1	61.2	45.0	34.4	27.2	22.0
		571	275	122	68.8	44.1	30.6	22.5	17.2	13.6	11.0
20EA	60.1	550	275	183	138	110	91.7	78.6	68.8	61.1	55.0
		451	225	150	110	70.7	49.1	36.1	27.6	21.8	17.7
		451	221	98.2	55.2	35.3	24.5	18.0	13.8	10.9	8.84
18EA	54.4	497	248	166	124	99.3	82.8	70.9	62.1	55.2	49.7
		409	205	136	101	64.5	44.8	32.9	25.2	19.9	16.1
		409	202	89.6	50.4	32.3	22.4	16.5	12.6	9.96	8.07
16EA	48.7	469	235	156	117	93.8	78.2	67.0	58.6	52.1	46.9
		393	197	131	90.9	58.2	40.4	29.7	22.7	18.0	14.5
		393	182	80.8	45.5	29.1	20.2	14.8	11.4	8.98	7.27
13EA	40.0	373	187	124	93.4	74.7	62.2	53.3	46.7	41.5	37.3
		324	162	108	75.5	48.3	33.6	24.7	18.9	14.9	12.1
		324	151	67.1	37.7	24.2	16.8	12.3	9.44	7.46	6.04
150 x 150 x 19EA	42.1	281	140	93.6	70.2	56.2	46.8	40.1	35.1	31.2	28.1
		235	117	75.6	42.5	27.2	18.9	13.9	10.6	8.40	6.80
		235	85.1	37.8	21.3	13.6	9.45	6.94	5.32	4.20	3.40
16EA	35.4	259	130	86.4	64.8	51.9	43.2	37.0	32.4	28.8	25.9
		213	106	64.7	36.4	23.3	16.2	11.9	9.10	7.19	5.83
		213	72.8	32.4	18.2	11.7	8.09	5.95	4.55	3.60	2.91
12EA	27.3	197	98.6	65.7	49.3	39.4	32.9	28.2	24.6	21.9	19.7
		165	82.5	50.9	28.6	18.3	12.7	9.36	7.16	5.66	4.58
		165	57.3	25.5	14.3	9.17	6.37	4.68	3.58	2.83	2.29
10EA	21.9	161	80.4	53.6	40.2	32.2	26.8	23.0	20.1	17.9	16.1
		141	70.7	41.3	23.2	14.9	10.3	7.58	5.80	4.58	3.71
		141	46.4	20.6	11.6	7.43	5.16	3.79	2.90	2.29	1.86
125 x 125 x 16EA	29.1	173	86.7	57.8	43.4	34.7	28.9	24.8	21.7	19.3	17.3
		145	72.4	36.3	20.4	13.1	9.07	6.67	5.10	4.03	3.27
		145	40.8	18.1	10.2	6.53	4.54	3.33	2.55	2.02	1.63
12EA	22.5	137	68.4	45.6	34.2	27.4	22.8	19.5	17.1	15.2	13.7
		113	56.3	28.7	16.2	10.3	7.18	5.28	4.04	3.19	2.59
		113	32.3	14.4	8.08	5.17	3.59	2.64	2.02	1.60	1.29
10EA	18.0	114	57.0	38.0	28.5	22.8	19.0	16.3	14.2	12.7	11.4
		96.7	48.3	23.4	13.1	8.41	5.84	4.29	3.28	2.60	2.10
		96.7	26.3	11.7	6.57	4.20	2.92	2.14	1.64	1.30	1.05
8EA	14.9	90.9	45.5	30.3	22.7	18.2	15.2	13.0	11.4	10.1	9.09
		80.2	40.1	19.5	11.0	7.03	4.88	3.59	2.74	2.17	1.76
		80.2	22.0	9.76	5.49	3.51	2.44	1.79	1.37	1.08	0.878

Notes: (1) Shading indicates serviceability load governed by yielding.
(2) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

FULL LATERAL RESTRAINT

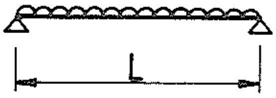
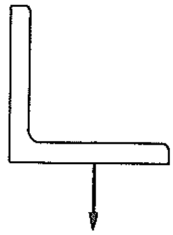


TABLE 8.2-2(2)



EQUAL ANGLES
GRADE 250

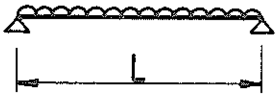
MAXIMUM DESIGN LOADS FOR BEAMS WITH FULL LATERAL RESTRAINT
vertical leg up

W_L^* Maximum Design Load based on Moment or Shear
W_{S1}^* Serviceability Load based on Deflection Limit of Span/250 or First Yield
W_{S2}^* Serviceability Load based on Deflection Limit of Span/500 or First Yield

Designation	Mass Per m	W_L^* (kN)/W_{S1}^*(kN)/W_{S2}^*(kN) Span in metres								
	kg/m	1	2	3	4	5	6	7	8	9
100 x 100 x 12EA	17.7	**73.6**	**36.8**	**24.5**	**18.4**	**14.7**	**12.3**	**10.5**	**9.20**	
		61.0	30.5	14.2	7.97	5.10	3.54	2.60	1.99	
		61.0	*15.9*	*7.08*	*3.99*	*2.55*	*1.77*	*1.30*	*1.00*	
10EA	14.2	**60.3**	**30.2**	**20.1**	**15.1**	**12.1**	**10.1**	**8.62**	**7.54**	
		49.2	24.6	11.6	6.52	4.17	2.90	2.13	1.63	
		49.2	*13.0*	*5.79*	*3.26*	*2.09*	*1.45*	*1.06*	*0.818*	
8EA	11.8	**49.4**	**24.7**	**16.5**	**12.3**	**9.88**	**8.23**			
		40.9	20.4	9.72	5.47	3.50	2.43			
		40.9	*10.9*	*4.86*	*2.73*	*1.75*	*1.21*			
6EA	9.16	**36.8**	**18.4**	**12.3**	**9.21**	**7.37**				
		31.8	15.9	7.64	4.30	2.75				
		31.8	*8.59*	*3.82*	*2.15*	*1.37*				
90 x 90 x 10EA	12.7	**48.3**	**24.2**	**16.1**	**12.1**	**9.66**	**8.05**			
		39.4	18.7	8.31	4.67	2.99	2.08			
		37.4	*9.35*	*4.15*	*2.34*	*1.50*	*1.04*			
8EA	10.6	**40.0**	**20.0**	**13.3**	**10.0**	**8.01**	**6.67**			
		32.8	15.7	6.98	3.93	2.51	1.75			
		31.4	*7.86*	*3.49*	*1.96*	*1.26*	*0.870*			
6EA	8.22	**30.2**	**15.1**	**10.1**	**7.56**	**6.04**				
		25.5	12.4	5.50	3.09	1.98				
		24.7	*6.19*	*2.75*	*1.55*	*0.990*				
75 x 75 x 10EA	10.5	**32.2**	**16.1**	**10.7**	**8.04**	**6.43**				
		26.7	10.5	4.65	2.62	1.67				
		20.9	*5.23*	*2.33*	*1.31*	*0.84*				
8EA	8.73	**27.5**	**13.7**	**9.15**	**6.87**	**5.49**				
		22.3	8.83	3.93	2.21	1.41				
		17.7	*4.42*	*1.96*	*1.10*	*0.710*				
6EA	6.81	**21.2**	**10.6**	**7.06**	**5.29**					
		17.4	6.98	3.10	1.75					
		14.0	*3.49*	*1.55*	*0.873*					
5EA	5.27	**15.7**	**7.86**	**5.24**	**3.93**					
		13.4	5.45	2.42	1.36					
		10.9	*2.73*	*1.21*	*0.681*					
65 x 65 x 10EA	9.02	**23.5**	**11.8**	**7.85**						
		20.0	6.71	2.98						
		13.4	*3.36*	*1.49*						
8EA	7.51	**20.3**	**10.1**	**6.75**						
		16.8	5.70	2.54						
		11.4	*2.85*	*1.27*						
6EA	5.87	**16.2**	**8.08**	**5.39**						
		13.2	4.55	2.02						
		9.11	*2.28*	*1.01*						
5EA	4.56	**12.3**	**6.14**	**4.09**						
		10.3	3.59	1.60						
		7.18	*1.79*	*0.798*						
55 x 55 x 6EA	4.93	**11.4**	**5.68**	**3.78**						
		9.27	2.69	1.19						
		5.37	*1.34*	*0.897*						
5EA	3.84	**8.84**	**4.42**	**2.95**						
		7.24	2.13	0.946						
		4.26	*1.06*	*0.473*						
50 x 50 x 8EA	5.68	**11.2**	**5.60**							
		9.58	2.46							
		4.93	*1.23*							
6EA	4.46	**9.18**	**4.59**							
		7.57	1.98							
		3.97	*0.992*							
5EA	3.48	**7.29**	**3.65**							
		5.92	1.58							
		3.15	*0.788*							
3EA	2.31	**4.59**	**2.29**							
		3.92	1.07							
		2.13	*0.533*							

FULL LATERAL RESTRAINT

Note: Shading indicates serviceability load governed by yielding.



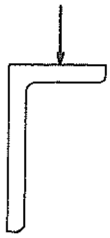


TABLE 8.2-3

UNEQUAL ANGLES GRADE 300 & 250

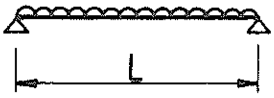
MAXIMUM DESIGN LOADS FOR BEAMS WITH FULL LATERAL RESTRAINT

long leg down

W_L^* Maximum Design Load based on Moment or Shear
W_{S1}^* Serviceability Load based on Deflection Limit of Span/250 or First Yield
W_{S2}^* Serviceability Load based on Deflection Limit of Span/500 or First Yield

Designation	Mass Per m	W_L^* (kN)/W_{S1}^*(kN)/ W_{S2}^*(kN) Span in metres							
	kg/m	1	2	3	4	5	6	7	8
150 x 100 x 12UA	22.5	**184**	**92.0**	**61.4**	**46.0**	**36.8**	**30.7**	**26.3**	**23.0**
		155	77.6	44.5	25.0	16.0	11.1	8.18	6.26
		155	*50.1*	*22.3*	*12.5*	*8.01*	*5.57*	*4.09*	*3.13*
10UA	18.0	**147**	**73.7**	**49.1**	**36.9**	**29.5**	**24.6**	**21.1**	**18.4**
		133	66.4	36.1	20.3	13.0	9.03	6.63	5.08
		133	*40.6*	*18.1*	*10.2*	*6.50*	*4.51*	*3.32*	*2.54*
150 x 90 x 16UA	27.9	**234**	**117**	**77.9**	**58.4**	**46.8**	**39.0**	**33.4**	**29.2**
		196	98.1	54.4	30.6	19.6	13.6	9.99	7.65
		196	*61.2*	*27.2*	*15.3*	*9.79*	*6.80*	*5.00*	*3.82*
12UA	21.6	**183**	**91.4**	**61.0**	**45.7**	**36.6**	**30.5**	**26.1**	**22.9**
		152	76.2	42.9	24.1	15.5	10.7	7.88	6.04
		152	*48.3*	*21.5*	*12.1*	*7.73*	*5.37*	*3.94*	*3.02*
10UA	17.3	**154**	**76.8**	**51.2**	**38.4**	**30.7**	**25.6**	**21.9**	**19.2**
		131	65.3	34.8	19.6	12.5	8.71	6.40	4.90
		131	*39.2*	*17.4*	*9.80*	*6.27*	*4.36*	*3.20*	*2.45*
8UA	14.3	**115**	**57.5**	**38.3**	**28.8**	**23.0**	**19.2**	**16.4**	**14.4**
		108	54.1	29.1	16.4	10.5	7.27	5.34	4.09
		108	*32.7*	*14.5*	*8.18*	*5.24*	*3.64*	*2.67*	*2.05*
125 x 75 x 12UA	17.7	**108**	**53.9**	**35.9**	**26.9**	**21.5**	**18.0**		
		90.1	45.0	24.2	13.6	8.70	6.04		
		90.1	*27.2*	*12.1*	*6.79*	*4.35*	*3.02*		
10UA	14.2	**87.2**	**43.6**	**29.1**	**21.8**	**17.4**	**14.5**		
		72.5	36.3	19.7	11.1	7.90	4.92		
		72.5	*22.2*	*9.84*	*5.54*	*3.54*	*2.46*		
8UA	11.8	**72.6**	**36.3**	**24.2**	**18.1**	**14.5**	**12.1**		
		60.2	30.1	16.5	9.27	5.93	4.12		
		60.2	*18.5*	*8.24*	*4.64*	*2.97*	*2.06*		
6UA	9.16	**50.2**	**25.1**	**16.7**	**12.6**	**10.0**	**8.37**		
		46.7	23.4	12.9	7.27	4.65	3.23		
		46.7	*14.5*	*6.46*	*3.64*	*2.33*	*1.62*		
100 x 75 x 10UA	12.4	**55.5**	**27.8**	**18.5**	**13.9**	**11.1**			
		47.1	23.5	10.5	5.93	3.80			
		47.1	*11.9*	*5.27*	*2.97*	*1.90*			
8UA	10.3	**46.5**	**23.2**	**15.5**	**11.6**	**9.30**			
		39.2	19.6	8.86	4.98	3.19			
		39.2	*9.97*	*4.43*	*2.49*	*1.59*			
6UA	7.98	**32.6**	**16.3**	**10.9**	**8.16**	**6.53**			
		30.5	15.2	6.97	3.92	2.51			
		30.5	*7.84*	*3.48*	*1.96*	*1.25*			
75 x 50 x 8UA	7.23	**25.1**	**12.6**	**8.37**					
		21.3	7.85	3.49					
		15.7	*3.93*	*1.74*					
6UA	5.66	**19.9**	**9.94**	**6.63**					
		16.7	6.26	2.78					
		12.5	*3.13*	*1.39*					
5UA	4.40	**14.9**	**7.46**	**4.97**					
		13.0	4.93	2.19					
		9.86	*2.47*	*1.10*					
65 x 50 x 8UA	6.59	**18.8**	**9.40**	**6.26**	FULL LATERAL RESTRAINT				
		16.1	5.23	2.32					
		10.5	*2.62*	*1.16*					
6UA	5.16	**15.0**	**7.49**	**4.99**					
		12.7	4.18	1.86					
		8.36	*2.09*	*0.929*					
5UA	4.02	**11.3**	**5.66**	**3.77**					
		9.89	3.30	1.47					
		6.60	*1.65*	*0.734*					

Notes: (1) Shading indicates serviceability load governed by yielding.
(2) For 150 x 90 angles and above: Grade 300.
(3) For 125 x 75 angles and below: Grade 250.
(4) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.



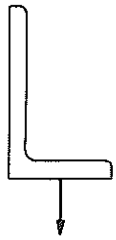


TABLE 8.2-4

UNEQUAL ANGLES
GRADE 300 & 250

MAXIMUM DESIGN LOADS FOR BEAMS WITH FULL LATERAL RESTRAINT
long leg up

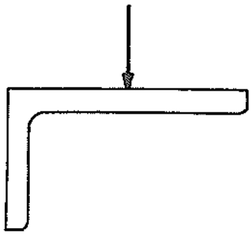
W_L^* Maximum Design Load based on Moment or Shear
W_{S1}^* Serviceability Load based on Deflection Limit of Span/250 or First Yield
W_{S2}^* Serviceability Load based on Deflection Limit of Span/500 or First Yield

Designation	Mass Per m	W_L^* (kN)/W_{S1}^*(kN)/W_{S2}^*(kN) Span in metres							
	kg/m	1	2	3	4	5	6	7	8
150 x 100 x 12UA	22.5	**170**	**85.1**	**56.8**	**42.6**	**34.1**	**28.4**	**24.3**	**21.3**
		155	77.6	44.5	25.0	16.0	11.1	8.18	6.26
		155	*50.1*	*22.3*	*12.5*	*8.01*	*5.57*	*4.09*	*3.13*
10UA	18.0	**133**	**66.5**	**44.3**	**33.2**	**26.6**	**22.2**	**19.0**	**16.6**
		133	66.4	36.1	20.3	13.0	9.03	6.63	5.08
		133	*40.6*	*18.1*	*10.2*	*6.50*	*4.51*	*3.32*	*2.54*
150 x 90 x 16UA	27.9	**232**	**116**	**77.4**	**58.1**	**46.5**	**38.7**	33.2	**29.0**
		196	98.1	54.4	30.6	19.6	13.6	9.99	7.65
		196	*61.2*	*27.2*	*15.3*	*9.79*	*6.80*	*5.00*	*3.82*
12UA	21.6	**169**	**84.6**	**56.4**	**42.3**	**33.8**	**28.2**	**24.2**	**21.1**
		152	76.2	42.9	24.1	15.5	10.7	7.88	6.04
		152	*48.3*	*21.5*	*12.1*	*7.73*	*5.37*	*3.94*	*3.02*
10UA	17.3	**132**	**66.0**	**44.0**	**33.0**	**26.4**	**22.0**	**18.9**	**16.5**
		131	65.3	34.8	19.6	12.5	8.71	6.40	4.90
		131	*39.2*	*17.4*	*9.80*	*6.27*	*4.36*	*3.20*	*2.45*
8UA	14.3	**99.1**	**49.6**	**33.0**	**24.8**	**19.8**	**16.5**	**14.2**	**12.4**
		108	54.1	29.1	16.4	10.5	7.27	5.34	4.09
		108	*32.7*	*14.5*	*8.18*	*5.24*	*3.64*	*2.67*	*2.05*
125 x 75 x 12UA	17.7	**106**	**53.2**	**35.4**	**26.6**	**21.3**	**17.7**		
		90.1	45.0	24.2	13.6	8.70	6.04		
		90.1	*27.2*	*12.1*	*6.79*	*4.35*	*3.02*		
10UA	14.2	**81.0**	**40.5**	**27.0**	**20.2**	**16.2**	**13.5**		
		72.5	36.3	19.7	11.1	7.09	4.92		
		72.5	*22.2*	*9.84*	*5.54*	*3.54*	*2.46*		
8UA	11.8	**63.0**	**31.5**	**21.0**	**15.8**	**12.6**	**10.5**		
		60.2	30.1	16.5	9.27	5.93	4.12		
		60.2	*18.5*	*8.24*	*4.64*	*2.97*	*2.06*		
6UA	9.16	**43.3**	**21.7**	**14.4**	**10.8**	**8.67**	**7.22**		
		46.7	23.4	12.9	7.27	4.65	3.23		
		46.7	*14.5*	*6.46*	*3.64*	*2.33*	*1.62*		
100 x 75 x 10UA	12.4	**54.9**	**27.3**	**18.2**	**13.7**	**10.9**			
		47.1	23.5	10.5	5.93	3.80			
		47.1	*11.9*	*5.27*	*2.97*	*1.90*			
8UA	10.3	**43.5**	**21.8**	**14.5**	**10.9**	**8.71**			
		39.2	19.6	8.86	4.98	3.19			
		39.2	*9.97*	*4.43*	*2.49*	*1.59*			
6UA	7.98	**31.1**	**15.6**	**10.4**	**7.78**	**6.23**			
		30.5	15.2	6.97	3.92	2.51			
		30.5	*7.84*	*3.48*	*1.96*	*1.25*			
75 x 50 x 8UA	7.23	**25.1**	**12.6**	**8.37**					
		21.3	7.85	3.49					
		15.7	*3.93*	*1.74*					
6UA	5.66	**18.8**	**9.38**	**6.25**					
		16.7	6.26	2.78					
		12.5	*3.13*	*1.39*					
5UA	4.40	**13.4**	**6.71**	**4.48**					
		13.0	4.93	2.19					
		9.86	*2.47*	*1.10*					
65 x 50 x 8UA	6.59	**18.8**	**9.40**	**6.26**					
		16.1	5.23	2.32					
		10.5	*2.62*	*1.16*					
6UA	5.16	**14.7**	**7.33**	**4.89**					
		12.7	4.18	1.86					
		8.36	*2.09*	*0.929*					
5UA	4.02	**10.7**	**5.35**	**3.57**					
		9.89	3.30	1.47					
		6.60	*1.65*	*0.734*					

FULL LATERAL RESTRAINT

Notes: (1) Shading indicates serviceability load governed by yielding.
(2) For 150 x 90 angles and above: Grade 300.
(3) For 125 x 75 angles and below: Grade 250.
(4) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

TABLE 8.2-5



UNEQUAL ANGLES
GRADE 300 & 250

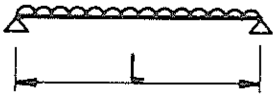
MAXIMUM DESIGN LOADS FOR BEAMS WITH FULL LATERAL RESTRAINT
short leg down

W_L^* Maximum Design Load based on Moment or Shear
W_{S1}^* Serviceability Load based on Deflection Limit of Span/250 or First Yield
W_{S2}^* Serviceability Load based on Deflection Limit of Span/500 or First Yield

Designation	Mass Per m	W_L^* (kN)/W_{S1}^* (kN)/ W_{S2}^* (kN) Span in metres							
	kg/m	1	2	3	4	5	6	7	8
150 x 100 x 12UA	22.5	**81.7**	**40.9**	**27.2**	**20.4**	**16.3**	**13.6**	**11.7**	**10.2**
		74.1	35.9	16.0	8.98	5.75	3.99	2.93	2.24
		71.8	*18.0*	*7.98*	*4.49*	*2.87*	*2.00*	*1.47*	*1.12*
10UA	18.0	**67.4**	**33.7**	**22.5**	**16.9**	**13.5**	**11.2**	**9.63**	**8.43**
		63.7	29.3	13.0	7.33	4.69	3.26	2.39	1.83
		58.7	*14.7*	*6.52*	*3.67*	*2.35*	*1.63*	*1.20*	*0.916*
150 x 90 x 16UA	27.9	**86.8**	**43.4**	**28.9**	**21.7**	**17.4**	**14.5**	**12.4**	**10.8**
		76.7	33.1	14.7	8.26	5.29	3.67	2.70	2.07
		66.1	*16.5*	*7.35*	*4.13*	*2.64*	*1.84*	*1.35*	*1.03*
12UA	21.6	**66.4**	**33.2**	**22.1**	**16.6**	**13.3**	**11.1**	**9.49**	**8.30**
		60.0	26.4	11.7	6.60	4.23	2.93	2.16	1.65
		52.8	*13.2*	*5.87*	*3.30*	*2.11*	*1.47*	*1.08*	*0.825*
10UA	17.3	**55.0**	**27.5**	**18.3**	**13.8**	**11.0**	**9.17**		
		51.6	21.6	9.61	5.40	3.46	2.40		
		43.2	*10.8*	*4.80*	*2.70*	*1.73*	*1.20*		
8UA	14.3	**43.7**	**21.9**	**14.6**	**10.9**	**8.74**	**7.29**		
		42.9	18.1	8.06	4.54	2.90	2.02		
		36.3	*9.07*	*4.03*	*2.27*	*1.45*	*1.01*		
125 x 75 x 12UA	17.7	**40.0**	**20.0**	**13.3**	**10.0**	**8.00**			
		35.2	14.7	6.54	3.68	2.36			
		29.4	*7.36*	*3.27*	*1.84*	*1.18*			
10UA	14.2	**31.8**	**15.9**	**10.6**	**7.94**	**6.35**			
		28.5	12.1	5.38	3.03	1.94			
		24.2	*6.06*	*2.69*	*1.51*	*0.969*			
8UA	11.8	**25.8**	**12.9**	**8.59**	**6.44**	**5.16**			
		23.7	10.2	4.54	2.55	1.63			
		20.4	*5.10*	*2.27*	*1.28*	*0.816*			
6UA	9.16	**19.0**	**9.51**	**6.34**	**4.75**	**3.80**			
		18.5	8.05	3.58	2.01	1.29			
		16.1	*4.02*	*1.79*	*1.01*	*0.644*			
100 x 75 x 10UA	12.4	**31.8**	**15.9**	**10.6**	**7.95**	**6.36**			
		27.8	11.4	5.07	2.85	1.83			
		22.8	*5.70*	*2.54*	*1.43*	*0.913*			
8UA	10.3	**26.0**	**13.0**	**8.68**	**6.51**	**5.21**			
		23.1	9.62	4.27	2.40	1.54			
		19.2	*4.81*	*2.14*	*1.20*	*0.769*			
6UA	7.98	**19.5**	**9.73**	**6.49**	**4.87**	**3.89**			
		18.0	7.59	3.38	1.90	1.22			
		15.2	*3.80*	*1.69*	*0.949*	*0.608*			
75 x 50 x 8UA	7.23	**11.5**	**5.73**	**3.82**					
		10.1	2.78	1.24					
		5.56	*1.39*	*0.618*					
6UA	5.66	**8.89**	**4.45**	**2.96**					
		7.98	2.23	0.993					
		4.47	*1.12*	*0.496*					
5UA	4.40	**6.70**	**3.35**	**2.23**					
		6.23	1.77	0.787					
		3.54	*0.885*	*0.393*					
65 x 50 x 8UA	6.59	**11.3**	**5.67**	**3.78**					
		9.94	2.67	1.19					
		5.34	*1.33*	*0.593*					
6UA	5.16	**8.98**	**4.49**	**2.99**					
		7.84	2.15	0.954					
		4.29	*1.07*	*0.477*					
5UA	4.02	**6.81**	**3.41**	**2.27**					
		6.13	1.70	0.757					
		3.40	*0.851*	*0.378*					

FULL LATERAL RESTRAINT

Notes: (1) Shading indicates serviceability load governed by yielding.
(2) For 150 x 90 angles and above: Grade 300.
(3) For 125 x 75 angles and below: Grade 250.
(4) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.



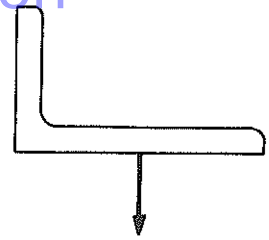


TABLE 8.2-6

UNEQUAL ANGLES GRADE 300 & 250

MAXIMUM DESIGN LOADS FOR BEAMS WITH FULL LATERAL RESTRAINT short leg up

W_L^* Maximum Design Load based on Moment or Shear
W_{S1}^* Serviceability Load based on Deflection Limit of Span/250 or First Yield
W_{S2}^* Serviceability Load based on Deflection Limit of Span/500 or First Yield

Designation	Mass Per m	W_L^* (kN)/W_{S1}^*(kN)/W_{S2}^*(kN) Span in metres						
	kg/m	1	2	3	4	5	6	7
150 x 100 x 12UA	22.5	**81.2**	**40.6**	**27.1**	**20.3**	**16.2**	**13.5**	**11.6**
		74.1	35.9	16.0	8.98	5.75	3.99	2.93
		71.8	*18.0*	*7.98*	*4.49*	*2.87*	*2.00*	*1.47*
10UA	18.0	**64.0**	**32.0**	**21.3**	**16.0**	**12.8**	**10.7**	**9.15**
		63.7	29.3	13.0	7.33	4.69	3.26	2.39
		58.7	*14.7*	*6.52*	*3.67*	*2.35*	*1.63*	*1.20*
150 x 90 x 16UA	27.9	**86.7**	**43.3**	**28.9**	**21.7**	**17.3**	**14.4**	**12.4**
		76.7	33.1	14.7	8.26	5.29	3.67	2.70
		66.1	*16.5*	*7.35*	*4.13*	*2.64*	*1.84*	*1.35*
12UA	21.6	**65.6**	**32.8**	**21.9**	**16.4**	**13.1**	**10.9**	**9.37**
		60.0	26.4	11.7	6.60	4.23	2.93	2.16
		52.8	*13.2*	*5.87*	*3.30*	*2.11*	*1.47*	*1.08*
10UA	17.3	**52.9**	**26.5**	**17.6**	**13.2**	**10.6**	**8.82**	**7.56**
		51.6	21.6	9.61	5.40	3.46	2.40	1.76
		43.2	*10.8*	*4.80*	*2.70*	*1.73*	*1.20*	*0.882*
8UA	14.3	**39.6**	**19.8**	**13.2**	**9.90**	**7.92**	**6.60**	**5.66**
		42.9	18.1	8.06	4.54	2.90	2.02	1.48
		36.3	*9.07*	*4.03*	*2.27*	*1.45*	*1.01*	*0.741*
125 x 75 x 12UA	17.7	**39.9**	**20.0**	**13.3**	**9.98**	**7.99**		
		35.2	14.7	6.54	3.68	2.36		
		29.4	*7.36*	*3.27*	*1.84*	*1.18*		
10UA	14.2	**31.4**	**15.7**	**10.5**	**7.85**	**6.28**		
		28.5	12.1	5.38	3.03	1.94		
		24.2	*6.06*	*2.69*	*1.51*	*0.969*		
8UA	11.8	**25.2**	**12.6**	**8.41**	**6.30**	**5.04**		
		23.7	10.2	4.54	2.55	1.63		
		20.4	*5.10*	*2.27*	*1.28*	*0.816*		
6UA	9.16	**17.3**	**8.66**	**5.77**	**4.33**	**3.46**		
		18.5	8.05	3.58	2.01	1.29		
		16.1	*4.02*	*1.79*	*1.01*	*0.644*		
100 x 75 x 10UA	12.4	**31.8**	**16.9**	**10.6**	**7.95**			
		27.8	11.4	5.07	2.85			
		22.8	*5.70*	*2.54*	*1.43*			
8UA	10.3	**26.1**	**13.0**	**8.69**	**6.52**			
		23.1	9.62	4.27	2.40			
		19.2	*4.81*	*2.14*	*1.20*			
6UA	7.98	**18.3**	**9.13**	**6.09**	**4.56**			
		18.0	7.59	3.38	1.90			
		15.2	*3.80*	*1.69*	*0.949*			
75 x 50 x 8UA	7.23	**11.5**	**5.73**	**3.82**				
		10.1	2.78	1.24				
		5.56	*1.39*	*0.618*				
6UA	5.66	**8.85**	**4.42**	**2.95**				
		7.98	2.23	0.993				
		4.47	*1.12*	*0.496*				
5UA	4.40	**6.47**	**3.23**	**2.16**				
		6.23	1.77	0.787				
		3.54	*0.885*	*0.393*				
65 x 50 x 8UA	6.59	**11.3**	**5.67**	**3.78**				
		9.94	2.67	1.19				
		5.34	*1.33*	*0.593*				
6UA	5.16	**8.99**	**4.49**	**3.00**				
		7.84	2.15	0.954				
		4.29	*1.07*	*0.477*				
5UA	4.02	**6.67**	**3.33**	**2.22**				
		6.13	1.70	0.757				
		3.40	*0.851*	*0.378*				

FULL LATERAL RESTRAINT

Notes: (1) Shading indicates serviceability load governed by yielding.
(2) For 150 x 90 angles and above: Grade 300.
(3) For 125 x 75 angles and below: Grade 250.
(4) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

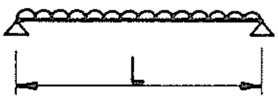
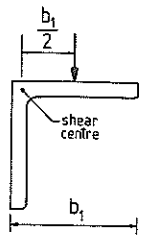


TABLE 8.2-7(1)

EQUAL ANGLES
GRADE 300



MAXIMUM DESIGN LOADS FOR BEAMS WITHOUT FULL LATERAL RESTRAINT
leg down

W_L^* Maximum Design Load based on Moment or Shear/Torsion
W_{S1}^* Serviceability Load based on Deflection Limit of Span/250 or First Yield
W_{S2}^* Serviceability Load based on Deflection Limit of Span/500 or First Yield

Designation	Mass per metre	W_L^* (kN)/W_{S1}^* (kN)/W_{S2}^* (kN) Span in metres									
	kg/m	1	2	3	4	5	6	7	8	9	10
200 x 200 x 26EA	76.8	212	209	173	130	104	86.3	73.9	64.6	57.3	51.5
		212	208	139	87.3	56.3	39.3	29.0	22.2	17.6	14.3
		212	173	78.2	44.3	28.5	19.9	14.6	11.2	8.87	7.19
20EA	60.1	133	131	128	105	83.9	69.8	59.7	52.2	46.3	41.6
		133	131	109	68.2	44.0	30.8	22.7	17.5	13.9	11.2
		133	131	61.5	35.0	22.5	15.7	11.6	8.88	7.03	5.70
18EA	54.4	109	108	106	95.6	76.3	63.5	54.4	47.5	42.2	37.9
		109	108	99.2	61.4	39.8	27.8	20.6	15.8	12.6	10.2
		109	108	55.6	31.7	20.4	14.3	10.5	8.07	6.39	5.18
16EA	48.7	94.2	93.5	91.6	88.4	73.1	60.8	52.0	45.5	40.4	36.2
		94.2	93.5	91.6	54.5	35.4	24.8	18.4	14.1	11.2	9.12
		94.2	93.5	49.5	28.3	18.3	12.8	9.43	7.24	5.73	4.65
13EA	40.0	64.0	63.6	62.5	60.8	58.5	49.9	42.7	37.4	33.2	29.9
		64.0	63.6	62.5	43.8	28.6	20.1	14.9	11.5	9.14	7.44
		64.0	63.6	40.2	23.1	14.9	10.5	7.75	5.96	4.72	3.83
150 x 150 x 19EA	42.1	114	107	71.3	53.4	42.7	35.5	30.4	26.5	23.5	21.1
		114	85.9	47.8	27.1	17.5	12.2	8.97	6.88	5.44	4.42
		114	54.0	24.3	13.7	8.83	6.14	4.52	3.46	2.74	2.22
16EA	35.4	87.6	85.5	65.8	49.2	39.3	32.7	28.0	24.4	21.6	19.4
		87.6	77.8	40.2	22.9	14.7	10.3	7.58	5.82	4.60	3.74
		87.6	45.5	20.5	11.6	7.48	5.21	3.84	2.94	2.33	1.89
12EA	27.3	52.9	51.9	49.7	38.4	30.6	25.5	21.8	19.0	16.8	14.8
		52.9	51.9	30.5	17.5	11.3	7.91	5.84	4.49	3.56	2.89
		52.9	34.8	15.9	9.02	5.81	4.05	2.99	2.29	1.81	1.47
10EA	21.9	36.5	35.9	34.7	32.5	26.0	21.7	18.6	16.0	13.9	12.2
		36.5	35.9	23.8	13.7	8.92	6.26	4.64	3.57	2.84	2.31
		36.5	27.4	12.6	7.18	4.65	3.25	2.40	1.84	1.46	1.18
125 x 125 x 16EA	29.1	83.9	65.9	43.9	32.9	26.2	21.8	18.6	16.2	14.4	12.9
		83.9	51.1	23.1	13.1	8.41	5.86	4.31	3.31	2.62	2.12
		83.9	26.0	11.7	6.61	4.24	2.95	2.17	1.66	1.32	1.07
12EA	22.5	51.2	49.3	34.9	26.1	20.8	17.3	14.8	12.9	11.3	9.91
		51.2	39.0	17.7	10.1	6.51	4.54	3.35	2.57	2.04	1.65
		51.2	20.2	9.10	5.15	3.31	2.31	1.70	1.30	1.03	0.834
10EA	18.0	35.5	34.4	29.8	22.3	17.8	14.8	12.6	10.7	9.25	8.14
		35.5	30.6	14.0	8.03	5.19	3.63	2.68	2.06	1.63	1.33
		35.5	16.0	7.29	4.14	2.66	1.86	1.37	1.05	0.831	0.674
8EA	14.9	24.6	24.0	22.8	18.4	14.7	12.3	10.3	8.73	7.56	6.63
		24.6	24.0	11.4	6.54	4.25	2.98	2.20	1.70	1.35	1.09
		24.6	13.1	5.98	3.42	2.21	1.54	1.14	0.872	0.690	0.560

Notes: (1) Shading indicates serviceability load governed by yielding.
(2) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

WITHOUT
FULL LATERAL RESTRAINT

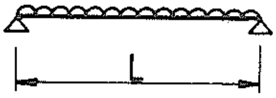
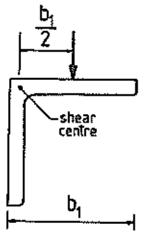


TABLE 8.2-7(2)

EQUAL ANGLES
GRADE 250



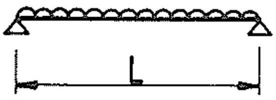
MAXIMUM DESIGN LOADS FOR BEAMS WITHOUT FULL LATERAL RESTRAINT
leg down

W_L^* Maximum Design Load based on Moment or Shear/Torsion
W_{S1}^* Serviceability Load based on Deflection Limit of Span/250 or First Yield
W_{S2}^* Serviceability Load based on Deflection Limit of Span/500 or First Yield

Designation	Mass per metre	W_L^* (kN)/W_{S1}^* (kN)/W_{S2}^* (kN) Span in metres							
	kg/m	1	2	3	4	5	6	7	8
100 x 100 x 12EA	17.7	42.3	28.0	18.7	14.0	11.1	9.25	7.90	6.88
		42.3	20.0	9.02	5.11	3.28	2.28	1.68	1.29
		39.6	10.2	4.57	2.58	1.65	1.15	0.846	0.648
10EA	14.2	27.7	23.1	15.4	11.5	9.15	7.59	6.48	5.59
		27.7	16.0	7.22	4.10	2.64	1.84	1.36	1.04
		27.7	8.21	3.69	2.09	1.34	0.932	0.686	0.526
8EA	11.8	19.3	18.4	12.8	9.56	7.63	6.33	5.34	4.53
		19.3	13.0	5.94	3.38	2.18	1.52	1.12	0.863
		19.3	6.79	3.06	1.73	1.12	0.777	0.572	0.439
6EA	9.16	11.8	11.4	9.90	7.41	5.93	4.88	4.05	3.44
		11.8	9.79	4.51	2.59	1.68	1.17	0.867	0.667
		11.8	5.19	2.36	1.35	0.867	0.605	0.446	0.342
90 x 90 x 10EA	12.7	27.1	18.4	12.2	9.15	7.30	6.05	5.16	4.45
		27.1	11.7	5.26	2.98	1.92	1.33	0.980	0.751
		23.1	5.95	2.67	1.51	0.966	0.672	0.494	0.379
8EA	10.6	18.9	15.5	10.3	7.68	6.11	5.07	4.26	3.62
		18.9	9.58	4.34	2.47	1.59	1.11	0.816	0.626
		18.9	4.94	2.22	1.26	0.807	0.562	0.413	0.317
6EA	8.22	11.7	11.0	8.01	5.99	4.78	3.89	3.22	2.73
		11.7	7.28	3.33	1.90	1.23	0.858	0.634	0.487
		11.7	3.81	1.73	0.980	0.630	0.439	0.323	0.248
75 x 75 x 10EA	10.5	24.6	12.3	8.17	6.11	4.87	4.03	3.44	
		20.1	6.69	3.00	1.69	1.09	0.756	0.556	
		13.3	3.39	1.51	0.853	0.547	0.380	0.279	
8EA	8.73	18.1	10.5	6.98	5.21	4.14	3.43		
		16.8	5.56	2.50	1.42	0.908	0.632		
		11.1	2.83	1.27	0.715	0.458	0.319		
6EA	6.81	11.2	8.29	5.51	4.12	3.27	2.63		
		11.2	4.29	1.94	1.10	0.709	0.494		
		8.54	2.21	0.993	0.561	0.360	0.251		
5EA	5.27	6.88	6.35	4.26	3.19	2.48			
		6.88	3.25	1.48	0.846	0.546			
		6.49	1.70	0.769	0.436	0.280			
65 x 65 x 10EA	9.02	18.0	8.98	5.97	4.46				
		14.8	4.35	1.95	1.10				
		8.66	2.19	0.979	0.552				
8EA	7.51	15.5	7.72	5.12	3.83				
		12.4	3.64	1.63	0.922				
		7.25	1.84	0.823	0.464				
6EA	5.87	10.9	6.20	4.11	3.06				
		9.76	2.84	1.28	0.724				
		5.67	1.45	0.650	0.367				
5EA	4.56	6.69	4.84	3.21	2.40				
		6.69	2.18	0.988	0.562				
		4.36	1.13	0.507	0.287				
55 x 55 x 6EA	4.93	8.69	4.33	2.87					
		6.68	1.71	0.768					
		3.42	0.868	0.387					
5EA	3.84	6.39	3.43	2.28					
		5.14	1.33	0.599					
		2.66	0.681	0.305					
50 x 50 x 8EA	5.68	8.58	4.28	2.84					
		6.37	1.61	0.720					
		3.22	0.812	0.362					
6EA	4.46	7.04	3.50	2.32					
		5.01	1.28	0.572					
		2.55	0.645	0.288					
5EA	3.48	5.65	2.81						
		3.88	0.998						
		2.00	0.508						
3EA	2.31	2.85	1.88						
		2.49	0.655						
		1.31	0.340						

WITHOUT FULL LATERAL RESTRAINT

Note: Shading indicates serviceability load governed by yielding.



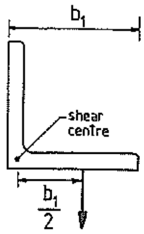


TABLE 8.2-8(1)

EQUAL ANGLES GRADE 300

MAXIMUM DESIGN LOADS FOR BEAMS WITHOUT FULL LATERAL RESTRAINT leg up

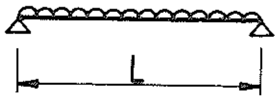
W^*_L Maximum Design Load based on Moment or Shear/Torsion
W^*_{S1} Serviceability Load based on Deflection Limit of Span/250 or First Yield
W^*_{S2} Serviceability Load based on Deflection Limit of Span/500 or First Yield

Designation	Mass per metre	W^*_L (kN)/W^*_{S1} (kN)/W^*_{S2} (kN) Span in metres									
	kg/m	1	2	3	4	5	6	7	8	9	10
200 x 200 x 26EA	76.8	207	204	178	134	107	89.0	76.2	66.7	59.2	53.3
		207	204	141	93.1	59.3	41.0	30.1	23.0	18.1	14.7
		207	*184*	*81.5*	*45.8*	*29.3*	*20.3*	*14.9*	*11.4*	*8.99*	*7.28*
20EA	60.1	130	129	126	109	87.5	72.9	62.4	54.6	48.5	43.6
		130	129	113	76.1	48.2	33.2	24.3	18.5	14.6	11.8
		130	*129*	*66.0*	*36.9*	*23.5*	*16.3*	*11.9*	*9.12*	*7.20*	*5.83*
18EA	54.4	108	107	104	98.8	79.0	65.8	56.4	49.3	43.7	39.3
		108	107	103	70.3	44.4	30.5	22.3	17.0	13.4	10.8
		108	*107*	*60.7*	*33.9*	*21.6*	*14.9*	*10.9*	*8.35*	*6.58*	*5.33*
16EA	48.7	93.0	92.3	90.3	86.7	74.8	62.2	53.3	46.5	41.2	36.9
		93.0	92.3	90.3	64.8	40.7	27.9	20.3	15.4	12.1	9.80
		93.0	*92.3*	*55.4*	*30.8*	*19.6*	*13.5*	*9.90*	*7.56*	*5.96*	*4.82*
13EA	40.0	63.5	63.0	61.9	59.8	56.6	49.8	42.6	37.2	32.1	28.0
		63.5	63.0	61.9	57.2	35.3	24.0	17.4	13.2	10.3	8.30
		63.5	*63.0*	*47.7*	*26.2*	*16.6*	*11.4*	*8.34*	*6.36*	*5.00*	*4.04*
150 x 150 x 19EA	42.1	111	108	73.5	55.1	44.1	36.7	31.4	27.5	24.4	21.9
		111	87.6	51.1	28.6	18.2	12.6	9.24	7.06	5.57	4.51
		111	*56.7*	*25.1*	*14.1*	*9.01*	*6.25*	*4.69*	*3.51*	*2.77*	*2.24*
16EA	35.4	85.9	83.7	68.7	51.5	41.2	34.3	29.3	25.6	22.7	20.2
		85.9	80.1	44.3	24.7	15.7	10.8	7.93	6.05	4.77	3.86
		85.9	*48.9*	*21.6*	*12.1*	*7.71*	*5.34*	*3.92*	*3.00*	*2.37*	*1.92*
12EA	27.3	52.3	51.2	48.7	39.3	31.3	26.1	22.2	19.0	16.3	14.2
		52.3	51.2	36.2	19.9	12.6	8.65	6.31	4.81	3.79	3.06
		52.3	*39.5*	*17.2*	*9.62*	*6.12*	*4.23*	*3.10*	*2.37*	*1.87*	*1.51*
10EA	21.9	36.2	35.6	34.1	31.5	25.7	21.0	17.1	14.3	12.1	10.4
		36.2	35.6	31.6	16.9	10.6	7.22	5.24	3.98	3.12	2.52
		36.2	*33.6*	*14.4*	*7.95*	*5.05*	*3.48*	*2.54*	*1.94*	*1.53*	*1.23*
125 x 125 x 16EA	29.1	81.9	68.2	45.4	34.1	27.2	22.7	19.4	16.9	15.0	13.4
		81.9	54.8	24.4	13.7	8.71	6.03	4.42	3.38	2.67	2.16
		81.9	*27.2*	*12.0*	*6.75*	*4.32*	*2.99*	*2.20*	*1.68*	*1.33*	*1.08*
12EA	22.5	50.4	48.4	36.2	27.1	21.7	18.0	15.4	13.1	11.3	9.78
		50.4	42.8	19.6	10.9	6.94	4.79	3.51	2.68	2.11	1.71
		50.4	*21.7*	*9.56*	*5.35*	*3.41*	*2.36*	*1.73*	*1.33*	*1.05*	*0.847*
10EA	18.0	35.2	33.9	30.3	22.7	18.0	14.6	12.0	9.97	8.44	7.26
		35.2	33.9	16.5	9.07	5.73	3.95	2.88	2.20	1.73	1.40
		35.2	*18.0*	*7.89*	*4.39*	*2.80*	*1.93*	*1.42*	*1.08*	*0.854*	*0.691*
8EA	14.9	24.4	23.7	22.0	18.2	14.2	11.1	8.99	7.42	6.25	5.34
		24.4	23.7	14.5	7.86	4.92	3.37	2.45	1.86	1.47	1.18
		24.4	*15.6*	*6.73*	*3.73*	*2.37*	*1.63*	*1.20*	*0.912*	*0.719*	*0.581*

Notes: (1) Shading indicates serviceability load governed by yielding.
(2) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

WITHOUT
FULL LATERAL RESTRAINT

@Seismicisolation



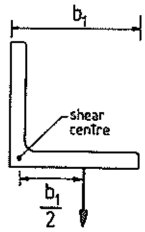


TABLE 8.2-8(2)

EQUAL ANGLES GRADE 250

MAXIMUM DESIGN LOADS FOR BEAMS WITHOUT FULL LATERAL RESTRAINT leg up

W^*_L Maximum Design Load based on Moment or Shear/Torsion
W^*_{S1} Serviceability Load based on Deflection Limit of Span/250 or First Yield
W^*_{S2} Serviceability Load based on Deflection Limit of Span/500 or First Yield

Designation	Mass per metre	W^*_L (kN)/W^*_{S1} (kN)/W^*_{S2} (kN) Span in metres							
	kg/m	1	2	3	4	5	6	7	8
100 x 100 x 12EA	17.7	41.2 41.2 *41.2*	29.0 21.6 *10.6*	19.3 9.49 *4.68*	14.5 5.31 *2.63*	11.6 3.39 *1.68*	9.62 2.35 *1.17*	8.23 1.72 *0.856*	7.18 1.32 *0.655*
10EA	14.2	27.3 27.3 *27.3*	24.0 18.0 *8.71*	16.0 7.85 *3.84*	12.0 4.37 *2.15*	9.57 2.78 *1.37*	7.95 1.92 *0.952*	6.69 1.41 *0.698*	5.64 1.08 *0.534*
8EA	11.8	19.1 19.1 *19.1*	18.1 15.6 *7.41*	13.1 6.71 *3.25*	9.82 3.72 *1.82*	7.82 2.36 *1.16*	6.34 1.63 *0.801*	5.19 1.19 *0.587*	4.33 0.908 *0.449*
6EA	9.16	11.8 11.8 *11.8*	11.2 11.2 *6.04*	9.87 5.56 *2.61*	7.36 3.03 *1.45*	5.63 1.90 *0.922*	4.41 1.31 *0.637*	3.56 0.952 *0.466*	2.93 0.725 *0.356*
90 x 90 x 10EA	12.7	26.6 26.6 *25.1*	19.2 12.7 *6.21*	12.8 5.58 *2.75*	9.57 3.12 *1.54*	7.64 1.99 *0.984*	6.35 1.37 *0.682*	5.36 1.01 *0.501*	4.52 0.770 *0.383*
8EA	10.6	18.7 18.7 *18.7*	16.0 10.9 *5.27*	10.6 4.74 *2.32*	7.96 2.64 *1.30*	6.34 1.68 *0.829*	5.14 1.16 *0.574*	4.21 0.850 *0.421*	3.52 0.650 *0.322*
6EA	8.22	11.5 11.5 *11.5*	10.8 9.10 *4.25*	8.08 3.87 *1.86*	6.02 2.13 *1.04*	4.62 1.35 *0.659*	3.61 0.928 *0.456*	2.91 0.678 *0.334*	2.40 0.518 *0.255*
75 x 75 x 10EA	10.5	25.0 20.4 *13.9*	12.6 7.03 *3.47*	8.43 3.10 *1.54*	6.31 1.74 *0.864*	5.04 1.11 *0.552*	4.19 0.769 *0.383*	3.57 0.565 *0.281*	
8EA	8.73	17.8 17.2 *11.9*	11.0 5.98 *2.93*	7.29 2.63 *1.30*	5.46 1.47 *0.728*	4.35 0.937 *0.465*	3.54 0.649 *0.323*		
6EA	6.81	11.1 11.1 *9.63*	8.50 4.86 *2.35*	5.65 2.11 *1.03*	4.22 1.18 *0.579*	3.23 0.749 *0.370*	2.54 0.518 *0.256*		
5EA	5.27	6.82 6.82 *6.82*	6.15 4.01 *1.88*	4.22 1.71 *0.823*	3.02 0.942 *0.459*	2.24 0.596 *0.292*			
65 x 65 x 10EA	9.02	18.4 15.0 *8.94*	9.18 4.50 *2.23*	6.12 1.99 *0.990*	4.59 1.12 *0.556*				
8EA	7.51	16.0 12.7 *7.60*	7.98 3.82 *1.89*	5.31 1.69 *0.837*	3.97 0.945 *0.470*				
6EA	5.87	10.7 10.1 *6.15*	6.44 3.09 *1.51*	4.28 1.36 *0.668*	3.20 0.757 *0.375*				
5EA	4.56	6.62 6.62 *5.00*	4.91 2.52 *1.21*	3.25 1.09 *0.532*	2.30 0.605 *0.297*				
55 x 55 x 6EA	4.93	9.02 7.07 *3.59*	4.50 1.80 *0.889*	3.00 0.794 *0.394*					
5EA	3.84	6.28 5.60 *2.89*	3.53 1.45 *0.709*	2.34 0.636 *0.313*					
50 x 50 x 8EA	5.68	8.74 6.65 *3.29*	4.36 1.65 *0.821*	2.91 0.731 *0.364*					
6EA	4.46	7.26 5.39 *2.64*	3.62 1.33 *0.657*	2.41 0.586 *0.291*					
5EA	3.48	5.85 4.39 *2.12*	2.92 1.06 *0.524*						
3EA	2.31	2.81 2.81 *1.51*	1.85 0.756 *0.364*						

WITHOUT FULL LATERAL RESTRAINT

Note: Shading indicates serviceability load governed by yielding.

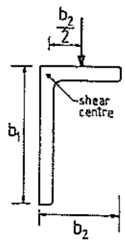


TABLE 8.2-9

UNEQUAL ANGLES
GRADE 300 & 250

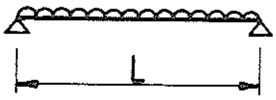
MAXIMUM DESIGN LOADS FOR BEAMS WITHOUT FULL LATERAL RESTRAINT
long leg down

W^*_L Maximum Design Load based on Moment or Shear/Torsion
W^*_{S1} Serviceability Load based on Deflection Limit of Span/250 or First Yield
W^*_{S2} Serviceability Load based on Deflection Limit of Span/500 or First Yield

Designation	Mass per metre	W^*_L (kN)/W^*_{S1} (kN)/W^*_{S2} (kN) Span in metres							
	kg/m	1	2	3	4	5	6	7	8
150 x 100 x 12UA	22.5	59.7	53.5	35.4	26.3	20.8	17.0	13.9	11.6
		59.7	48.0	26.3	15.1	9.81	6.87	5.08	3.91
		59.7	30.4	13.9	7.92	5.12	3.57	2.63	2.02
10UA	18.0	42.3	40.0	28.4	21.0	16.4	12.9	10.4	8.64
		42.3	40.0	20.2	11.7	7.64	5.38	3.99	3.08
		42.3	23.6	10.9	6.26	4.05	2.84	2.09	1.61
150 x 90 x 16UA	27.9	96.2	66.3	43.9	32.6	25.8	21.2	17.8	14.9
		96.2	58.7	34.1	19.5	12.6	8.80	6.49	4.99
		96.2	39.1	17.7	10.1	6.48	4.51	3.32	2.55
12UA	21.6	61.4	50.1	33.1	24.4	19.2	15.3	12.4	10.3
		61.4	45.4	25.4	14.6	9.49	6.65	4.92	3.79
		61.4	29.5	13.5	7.70	4.97	3.48	2.56	1.97
10UA	17.3	43.8	40.5	26.8	19.7	14.9	11.5	9.24	7.60
		43.8	38.8	19.4	11.3	7.37	5.18	3.85	2.97
		43.8	22.9	10.6	6.07	3.93	2.75	2.03	1.56
8UA	14.3	30.8	28.8	20.5	15.0	11.1	8.60	6.86	5.63
		30.8	28.8	15.2	8.90	5.85	4.13	3.08	2.38
		30.8	18.2	8.52	4.91	3.20	2.25	1.66	1.28
125 x 75 x 12UA	17.7	49.6	30.4	20.1	14.9	11.7	9.60	7.81	6.50
		49.6	27.0	15.0	8.58	5.54	3.87	2.86	2.19
		49.6	17.3	7.83	4.44	2.86	1.99	1.47	1.12
10UA	14.2	33.7	23.9	15.7	11.6	9.04	7.08	5.71	4.70
		33.7	21.7	11.7	6.71	4.35	3.04	2.25	1.73
		33.7	13.6	6.20	3.53	2.28	1.59	1.17	0.900
8UA	11.8	23.9	19.3	12.7	9.27	6.95	5.38	4.31	3.54
		23.9	17.9	9.33	5.39	3.51	2.47	1.83	1.41
		23.9	11.0	5.05	2.89	1.87	1.31	0.964	0.741
6UA	9.16	15.0	13.6	8.90	6.38	4.72	3.64	2.90	2.37
		15.0	13.6	6.73	3.93	2.58	1.82	1.36	1.05
		15.0	8.12	3.78	2.18	1.42	0.994	0.736	0.567
100 x 75 x 10UA	12.4	29.5	17.8	11.8	8.73	6.90	5.69	4.66	3.88
		29.5	14.5	6.56	3.73	2.40	1.68	1.24	0.948
		28.7	7.50	3.37	1.91	1.23	0.854	0.628	0.482
8UA	10.3	21.0	14.6	9.65	7.14	5.64	4.46	3.61	3.00
		21.0	11.7	5.36	3.06	1.98	1.38	1.02	0.783
		21.0	6.16	2.79	1.58	1.02	0.710	0.523	0.401
6UA	7.98	13.1	10.6	6.98	5.17	3.96	3.10	2.50	2.07
		13.1	8.70	4.04	2.32	1.51	1.06	0.781	0.600
		13.1	4.69	2.14	1.22	0.789	0.551	0.406	0.312
75 x 50 x 8UA	7.20	15.2	7.51	4.93	3.63	2.76	2.15	1.73	1.42
		13.4	4.97	2.24	1.27	0.816	0.568	0.418	0.321
		9.93	2.56	1.15	0.647	0.415	0.289	0.212	0.163
6UA	5.63	11.7	5.77	3.77	2.68	1.96	1.51	1.21	
		10.5	3.81	1.73	0.983	0.634	0.442	0.326	
		7.64	1.99	0.897	0.507	0.326	0.227	0.167	
5UA	4.37	7.77	4.28	2.75	1.87	1.36	1.04		
		7.77	2.86	1.31	0.750	0.485	0.339		
		5.76	1.53	0.692	0.393	0.253	0.177		
65 x 50 x 8UA	6.59	12.5	6.20	4.09	3.02	2.39			
		10.7	3.36	1.51	0.850	0.546			
		6.70	1.71	0.762	0.430	0.275			
6UA	5.16	9.77	4.83	3.17	2.34				
		8.44	2.60	1.17	0.665				
		5.21	1.34	0.600	0.339				
5UA	4.02	7.13	3.64	2.38	1.66				
		6.57	1.98	0.901	0.513				
		3.98	1.04	0.467	0.264				

WITHOUT FULL LATERAL RESTRAINT

Notes: (1) For 150 x 90 angles and above: Grade 300.
(2) For 125 x 75 angles and below: Grade 250.
(3) Shading indicates serviceability load governed by yielding.
(4) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.



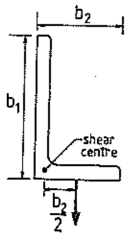


TABLE 8.2-10

UNEQUAL ANGLES GRADE 300 & 250

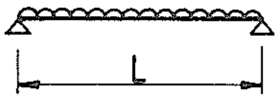
MAXIMUM DESIGN LOADS FOR BEAMS WITHOUT FULL LATERAL RESTRAINT long leg up

W^*_L Maximum Design Load based on Moment or Shear/Torsion
W^*_{S1} Serviceability Load based on Deflection Limit of Span/250 or First Yield
W^*_{S2} Serviceability Load based on Deflection Limit of Span/500 or First Yield

Designation	Mass per metre	W^*_L (kN)/W^*_{S1} (kN)/W^*_{S2} (kN) Span in metres							
	kg/m	1	2	3	4	5	6	7	8
150 x 100 x 12UA	22.5	60.1	56.8	37.8	28.2	22.5	18.1	14.7	12.1
		60.1	50.8	32.6	17.8	11.2	7.72	5.64	4.29
		60.1	35.4	15.4	8.58	5.45	3.77	2.76	2.11
10UA	18.0	42.3	40.4	30.9	23.0	17.4	13.4	10.7	8.76
		42.3	40.4	28.4	15.2	9.44	6.44	4.67	3.54
		42.3	30.2	12.9	7.10	4.49	3.09	2.26	1.72
150 x 90 x 16UA	27.9	99.4	72.5	48.3	36.0	28.7	23.8	19.5	16.2
		99.4	60.0	38.9	21.6	13.7	9.46	6.92	5.28
		99.4	42.8	18.9	10.6	6.73	4.66	3.42	2.61
12UA	21.6	62.3	54.2	36.0	26.9	21.2	16.5	13.3	10.9
		62.3	48.2	31.9	17.4	11.0	7.53	5.50	4.18
		62.3	34.6	15.0	8.38	5.32	3.68	2.69	2.05
10UA	17.3	44.1	41.7	29.5	21.6	15.8	12.1	9.63	7.81
		44.1	41.7	27.8	14.8	9.21	6.28	4.55	3.45
		44.1	29.5	12.6	6.93	4.38	3.02	2.20	1.68
8UA	14.3	30.9	29.5	23.5	16.2	11.6	8.83	6.94	5.59
		30.9	29.5	23.5	13.3	8.10	5.45	3.92	2.95
		30.9	26.5	10.9	5.95	3.73	2.55	1.86	1.41
125 x 75 x 12UA	17.7	50.9	33.2	22.0	16.5	13.1	10.5	8.49	7.02
		50.9	28.1	17.2	9.53	6.05	4.17	3.05	2.33
		50.9	19.0	8.34	4.66	2.97	2.06	1.51	1.15
10UA	14.2	34.1	25.8	17.1	12.8	9.77	7.59	6.07	4.97
		34.1	23.0	14.5	7.91	4.98	3.43	2.50	1.91
		34.1	15.8	6.86	3.82	2.43	1.68	1.23	0.938
8UA	11.8	24.1	20.7	13.7	10.1	7.39	5.68	4.50	3.65
		24.1	19.4	12.7	6.85	4.28	2.92	2.12	1.62
		24.1	13.7	5.87	3.24	2.05	1.42	1.03	0.789
6UA	9.16	15.0	14.2	10.1	6.85	4.94	3.74	2.93	2.36
		15.0	14.2	10.1	5.86	3.57	2.41	1.73	1.31
		15.0	11.8	4.85	2.64	1.66	1.13	0.826	0.629
100 x 75 x 10UA	12.4	29.6	18.9	12.6	9.40	7.50	6.04	4.89	4.05
		29.6	16.0	7.24	4.02	2.56	1.77	1.29	0.989
		29.6	8.03	3.53	1.98	1.26	0.875	0.642	0.491
8UA	10.3	20.9	15.3	10.2	7.59	5.88	4.59	3.69	3.04
		20.9	13.8	6.19	3.42	2.17	1.50	1.09	0.833
		20.9	6.82	2.99	1.67	1.06	0.735	0.539	0.412
6UA	7.98	13.1	11.3	7.50	5.49	4.04	3.10	2.47	2.01
		13.1	10.7	5.12	2.79	1.75	1.20	0.874	0.666
		13.1	5.57	2.40	1.34	0.847	0.584	0.427	0.326
75 x 50 x 8UA	7.20	16.3	8.13	5.38	4.01	2.97	2.29	1.83	1.49
		13.8	5.46	2.40	1.34	0.853	0.590	0.433	0.331
		10.9	2.67	1.18	0.662	0.423	0.293	0.215	0.165
6UA	5.63	12.4	6.18	4.09	2.83	2.06	1.57	1.24	
		11.0	4.47	1.94	1.07	0.682	0.471	0.345	
		8.85	2.15	0.944	0.528	0.337	0.233	0.171	
5UA	4.37	7.82	4.58	2.89	1.93	1.38	1.04		
		7.82	3.71	1.57	0.865	0.547	0.377		
		7.38	1.73	0.756	0.421	0.267	0.185		
65 x 50 x 8UA	6.59	13.0	6.51	4.33	3.23	2.51			
		11.0	3.55	1.57	0.877	0.560			
		7.07	1.75	0.776	0.436	0.279			
6UA	5.16	10.3	5.14	3.40	2.45				
		8.73	2.87	1.26	0.702				
		5.70	1.40	0.619	0.347				
5UA	4.02	7.11	3.84	2.51	1.69				
		6.92	2.34	1.01	0.561				
		4.65	1.12	0.493	0.275				

WITHOUT FULL LATERAL RESTRAINT

Notes: (1) For 150 x 90 angles and above: Grade 300.
(2) For 125 x 75 angles and below: Grade 250.
(3) Shading indicates serviceability load governed by yielding.
(4) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.



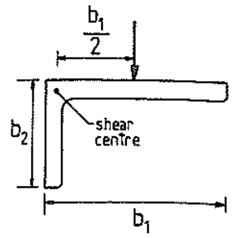


TABLE 8.2-11

UNEQUAL ANGLES
GRADE 300 & 250

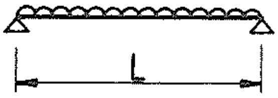
MAXIMUM DESIGN LOADS FOR BEAMS WITHOUT FULL LATERAL RESTRAINT
short leg down

W_L^* Maximum Design Load based on Moment or Shear/Torsion
W_{S1}^* Serviceability Load based on Deflection Limit of Span/250 or First Yield
W_{S2}^* Serviceability Load based on Deflection Limit of Span/500 or First Yield

Designation	Mass per metre	W_L^* (kN)/W_{S1}^* (kN)/W_{S2}^* *(kN)* Span in metres							
	kg/m	1	2	3	4	5	6	7	8
150 x 100 x 12UA	22.5	**40.6**	**38.5**	**25.6**	**19.2**	**15.4**	**12.8**	**11.0**	**9.63**
		40.6	23.0	10.3	5.84	3.75	2.61	1.92	1.47
		40.6	*11.6*	*5.21*	*2.94*	*1.88*	*1.31*	*0.963*	*0.738*
10UA	18.0	**28.5**	**28.0**	**22.0**	**16.5**	**13.2**	**11.0**	**9.45**	**8.28**
		28.5	18.4	8.31	4.71	3.03	2.11	1.55	1.19
		28.5	*9.39*	*4.21*	*2.38*	*1.53*	*1.06*	*0.781*	*0.599*
150 x 90 x 16UA	27.9	**64.9**	**41.0**	**27.3**	**20.5**	**16.4**	**13.7**	**11.7**	**10.3**
		63.3	22.0	9.85	5.55	3.56	2.47	1.82	1.39
		43.6	*11.1*	*4.94*	*2.78*	*1.78*	*1.24*	*0.909*	*0.696*
12UA	21.6	**39.9**	**31.9**	**21.3**	**15.9**	**12.8**	**10.6**	**9.12**	**7.98**
		39.9	17.2	7.73	4.36	2.80	1.95	1.43	1.10
		34.1	*8.70*	*3.89*	*2.19*	*1.40*	*0.976*	*0.717*	*0.550*
10UA	17.3	**27.9**	**27.3**	**18.2**	**13.7**	**11.0**	**9.14**	**7.84**	**6.88**
		27.9	13.9	6.25	3.53	2.27	1.58	1.16	0.890
		27.5	*7.04*	*3.15*	*1.78*	*1.14*	*0.793*	*0.583*	*0.447*
8UA	14.3	**19.4**	**19.2**	**15.1**	**11.4**	**9.11**	**7.60**	**6.52**	**5.72**
		19.4	11.5	5.19	2.94	1.89	1.32	0.969	0.743
		19.4	*5.86*	*2.63*	*1.48*			*0.487*	*0.374*
125 x 75 x 12UA	17.7	**33.1**	**18.9**	**12.6**	**9.44**	**7.55**	**6.29**	**5.40**	**4.72**
		29.1	9.75	4.36	2.46	1.57	1.09	0.804	0.616
		19.4	*4.90*	*2.19*	*1.23*	*0.789*	*0.547*	*0.402*	*0.308*
10UA	14.2	**21.8**	**15.2**	**10.1**	**7.61**	**6.09**	**5.07**	**4.35**	**3.81**
		21.8	7.90	3.54	2.00	1.28	0.890	0.654	0.501
		15.7	*3.98*	*1.78*	*1.00*	*0.642*	*0.446*	*0.328*	*0.251*
8UA	11.8	**15.3**	**12.6**	**8.42**	**6.32**	**5.06**	**4.22**	**3.62**	
		15.3	6.58	2.95	1.67	1.07	0.744	0.547	
		13.0	*3.33*	*1.49*	*0.838*	*0.537*	*0.374*	*0.275*	
6UA	9.16	**9.41**	**9.27**	**6.54**	**4.91**	**3.93**	**3.28**		
		9.41	5.10	2.30	1.30	0.836	0.582		
		9.41	*2.60*	*1.16*	*0.657*	*0.421*	*0.293*		
100 x 75 x 10UA	12.4	**21.3**	**14.3**	**9.51**	**7.13**	**5.70**			
		21.3	7.30	3.27	1.85	1.18			
		14.5	*3.69*	*1.65*	*0.928*	*0.595*			
8UA	10.3	**15.2**	**11.8**	**7.89**	**5.92**	**4.73**			
		15.2	6.07	2.73	1.54	0.990			
		12.1	*3.08*	*1.38*	*0.777*	*0.498*			
6UA	7.98	**9.52**	**9.16**	**6.11**	**4.59**	**3.68**			
		9.52	4.70	2.12	1.20	0.772			
		9.34	*2.40*	*1.08*	*0.608*	*0.390*			
75 x 50 x 8UA	7.20	**10.6**	**5.30**	**3.53**	**2.65**	**2.12**			
		7.27	1.84	0.820	0.462	0.296			
		3.67	*0.923*	*0.411*	*0.231*	*0.148*			
6UA	5.63	**8.34**	**4.17**	**2.78**	**2.09**				
		5.74	1.46	0.651	0.367				
		2.91	*0.734*	*0.327*	*0.184*				
5UA	4.37	**5.37**	**3.25**	**2.17**					
		4.47	1.14	0.512					
		2.28	*0.578*	*0.258*					
65 x 50 x 8UA	6.59	**10.1**	**5.06**						
		6.91	1.75						
		3.49	*0.878*						
6UA	5.16	**8.01**	**4.00**						
		5.44	1.38						
		2.76	*0.697*						
5UA	4.02	**5.34**	**3.11**						
		4.22	1.08						

WITHOUT
FULL LATERAL RESTRAINT

Notes: (1) For 150 x 90 angles and above: Grade 300.
(2) For 125 x 75 angles and below: Grade 250.
(3) Shading indicates serviceability load governed by yielding.
(4) Grade 300 refers to BHP Grade 300 PLUA™. See Note (1) on page 2-2.



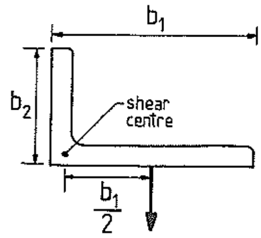


TABLE 8.2-12

UNEQUAL ANGLES
GRADE 300 & 250

MAXIMUM DESIGN LOADS FOR BEAMS WITHOUT FULL LATERAL RESTRAINT
short leg up

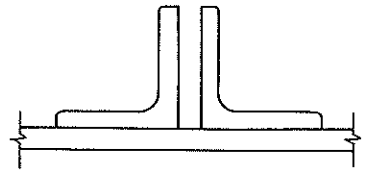
W^*_L Maximum Design Load based on Moment or Shear/Torsion
W^*_{S1} Serviceability Load based on Deflection Limit of Span/250 or First Yield
W^*_{S2} Serviceability Load based on Deflection Limit of Span/500 or First Yield

Designation	Mass per metre	W^*_L (kN)/W^*_{S1} (kN)/W^*_{S2} (kN) Span in metres							
	kg/m	1	2	3	4	5	6	7	8
150 x 100 x 12UA	22.5	40.4	36.7	24.5	18.3	14.5	12.2	10.5	9.15
		40.4	24.4	10.7	6.01	3.75	2.66	1.95	1.49
		40.4	12.0	5.31	2.98	1.88	1.32	0.971	0.743
10UA	18.0	28.4	27.6	19.3	14.5	11.3	9.64	8.25	7.19
		28.4	20.3	8.86	4.94	3.03	2.18	1.60	1.22
		28.4	9.84	4.35	2.44	1.53	1.08	0.792	0.606
150 x 90 x 16UA	27.9	64.3	40.9	27.3	20.5	16.3	13.6	11.7	10.2
		63.8	22.5	9.99	5.62	3.56	2.49	1.83	1.40
		44.5	11.2	4.98	2.80	1.78	1.25	0.915	0.700
12UA	21.6	39.7	30.1	20.1	15.1	11.9	10.0	8.60	7.52
		39.7	17.9	7.93	4.45	2.80	1.97	1.45	1.11
		35.4	8.87	3.94	2.21	1.40	0.982	0.722	0.552
10UA	17.3	27.8	23.9	15.9	11.9	9.39	7.94	6.80	5.93
		27.8	14.8	6.52	3.65	2.27	1.61	1.18	0.905
		27.8	7.27	3.22	1.81	1.14	0.802	0.589	0.450
8UA	14.3	19.3	18.0	12.0	8.99	7.06	5.98	5.12	4.40
		19.3	12.6	5.51	3.07	1.89	1.35	0.992	0.758
		19.3	6.12	2.70	1.51	0.953	0.670	0.492	0.376
125 x 75 x 12UA	17.7	32.8	18.8	12.5	9.38	7.47	6.25	5.36	4.69
		29.3	9.98	4.42	2.48	1.57	1.10	0.810	0.620
		19.8	4.96	2.20	1.24	0.789	0.551	0.405	0.310
10UA	14.2	21.7	14.4	9.61	7.21	5.72	4.80	4.11	3.60
		21.7	8.19	3.62	2.03	1.28	0.901	0.661	0.506
		16.2	4.06	1.80	1.01	0.642	0.449	0.330	0.252
8UA	11.8	15.2	11.4	7.57	5.68	4.48	3.78	3.23	
		15.2	6.94	3.06	1.71	1.07	0.758	0.556	
		13.8	3.42	1.51	0.850	0.537	0.377	0.277	
6UA	9.16	9.36	7.85	5.24	3.93	3.08	2.61		
		9.36	5.60	2.44	1.36	0.835	0.600		
		9.36	2.72	1.20	0.672	0.421	0.298		
100 x 75 x 10UA	12.4	21.3	14.3	9.53	7.15	5.64			
		21.3	7.62	3.36	1.89	1.18			
		15.1	3.77	1.67	0.938	0.595			
8UA	10.3	15.1	11.6	7.70	5.77	4.52			
		15.1	6.46	2.84	1.59	0.990			
		12.8	3.18	1.41	0.789	0.498			
6UA	7.98	9.51	8.24	5.49	4.12	3.21			
		9.51	5.21	2.27	1.27	0.773			
		9.51	2.53	1.11	0.624	0.390			
75 x 50 x 8UA	7.20	10.7	5.33	3.55	2.66	2.12			
		7.52	1.87	0.829	0.466	0.296			
		3.73	0.931	0.413	0.232	0.148			
6UA	5.63	8.06	4.03	2.68	2.01				
		6.07	1.50	0.664	0.372				
		2.99	0.744	0.330	0.186				
5UA	4.37	5.32	2.92	1.95					
		4.91	1.20	0.529					
		2.39	0.591	0.262					
65 x 50 x 8UA	6.59	10.2	5.10						
		7.17	1.78						
		3.55	0.886						
6UA	5.16	8.02	4.01						
		5.79	1.43						
		2.84	0.708						
5UA	4.02	5.30	2.96						
		4.69	1.14						
		2.27	0.562						

WITHOUT
FULL LATERAL RESTRAINT

Notes: (1) For 150 x 90 angles and above: Grade 300.
(2) For 125 x 75 angles and below: Grade 250.
(3) Shading indicates serviceability load governed by yielding.
(4) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

TABLE 8.3-1(1)



EQUAL ANGLES
GRADE 300

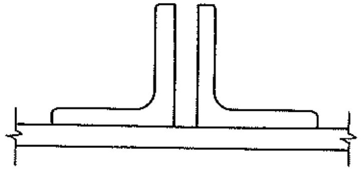
MAXIMUM DESIGN LOADS FOR ECCENTRICALLY LOADED SINGLE ANGLES IN TRUSSES

angles on the same side of the truss chord

Designation	Maximum Design Loads (kN) Length in metres																	
	0.25	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	7.0	8.0	9.0	10	11
200 x 200 x 26EA	903	903	891	863	835	806	776	743	709	672	635	598	562	494	433	381	336	297
20EA	717	717	701	677	652	627	601	574	546	517	487	458	430	377	331	291	256	227
18EA	646	646	629	606	583	559	535	510	485	459	432	406	381	334	293	257	227	201
16EA	610	609	588	564	539	515	490	465	440	414	388	364	340	296	259	227	200	177
13EA	482	479	460	438	416	396	375	354	334	313	293	274	256	223	195	171	151	134
150 x 150 x 19EA	496	496	479	458	436	413	388	361	334	307	282	259	237	200	169	145	125	108
16EA	452	451	431	409	387	364	340	314	289	264	241	220	201	169	143	122	105	90.8
12EA	342	338	321	302	284	266	247	227	208	190	174	159	145	122	103	88.1	76.0	66.1
10EA	269	263	245	226	208	191	174	159	145	132	121	110	101	85.2	72.6	62.4	54.2	47.4
125 x 125 x 16EA	367	366	347	327	306	282	257	232	209	187	168	151	136	112	92.7	77.8	66.2	56.8
12EA	285	282	265	248	231	212	193	174	156	140	125	113	101	83.3	69.2	58.3	49.6	42.7
10EA	237	231	215	198	182	166	149	133	119	106	95.2	85.4	76.9	63.1	52.5	44.3	37.8	32.6
8EA	180	175	159	144	130	117	105	93.7	83.9	75.3	67.7	61.1	55.4	45.9	38.5	32.8	28.2	24.5

Note: Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

TABLE 8.3-1(2)



EQUAL ANGLES
GRADE 250

MAXIMUM DESIGN LOADS FOR ECCENTRICALLY LOADED SINGLE ANGLES IN TRUSSES

angles on the same side of the truss chord

Designation	Maximum Design Loads (kN) Length in metres																	
	0.25	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	7.0	8.0	9.0	10	11
100 x 100 x 12EA	194	192	180	168	154	139	124	109	96.2	84.9	75.1	66.7	59.5	47.9	39.2	32.6	27.5	23.5
10EA	157	154	144	133	121	109	96.8	85.3	75.2	66.3	58.6	52.1	46.5	37.5	30.7	25.6	21.6	18.5
8EA	129	125	116	106	96.5	86.4	76.5	67.3	59.3	52.3	46.3	41.2	36.8	29.7	24.5	20.4	17.3	14.8
6EA	94.9	91.5	83.5	75.7	68.1	60.5	53.4	46.9	41.3	36.5	32.3	28.8	25.8	21.0	17.3	14.6	12.4	10.7
90 x 90 x 10EA	141	138	128	117	105	92.8	80.9	70.3	61.1	53.3	46.7	41.1	36.5	29.1	23.6	19.5	16.4	14.0
8EA	116	113	104	94.5	84.6	74.4	64.8	56.2	48.8	42.6	37.4	33.0	29.2	23.4	19.0	15.8	13.3	11.3
6EA	87.3	84.0	76.2	68.6	60.9	53.3	46.3	40.1	34.9	30.5	26.8	23.7	21.0	16.9	13.8	11.5	9.74	8.33
75 x 75 x 10EA	115	111	102	91.3	79.3	67.4	57.0	48.2	41.0	35.1	30.3	26.4	23.1	18.1	14.5	11.9	9.92	8.38
8EA	96.8	93.1	84.7	75.4	65.2	55.3	46.6	39.4	33.5	28.7	24.8	21.6	19.0	14.9	12.0	9.80	8.17	6.92
6EA	74.2	70.9	63.6	56.1	48.2	40.8	34.4	29.1	24.7	21.2	18.4	16.0	14.1	11.1	8.96	7.37	6.16	5.23
5EA	54.7	51.7	45.6	39.7	33.8	28.5	24.0	20.3	17.3	14.9	13.0	11.3	9.99	7.93	6.43	5.32	4.47	3.81
65 x 65 x 10EA	97.6	94.0	85.0	74.1	62.2	51.4	43.4	35.2	29.5	25.0	21.3	18.4	16.0	12.4	9.88	8.03	6.65	5.60
8EA	82.4	78.1	68.4	58.3	48.7	40.4	33.6	28.1	23.7	20.1	17.3	15.0	13.1	10.2	8.13	6.63	5.51	4.64
6EA	64.6	61.3	54.4	46.8	39.0	32.1	26.4	22.0	18.4	15.6	13.4	11.6	10.1	7.87	6.29	5.14	4.27	3.61
5EA	48.5	45.6	39.9	33.9	28.1	23.1	19.1	15.9	13.3	11.4	9.76	8.46	7.41	5.80	4.66	3.82	3.19	2.70
55 x 55 x 6EA	54.0	50.9	44.2	36.5	29.1	23.1	18.6	15.1	12.5	10.4	8.83	7.57	6.55	5.04	3.99	3.23	2.67	2.25
5EA	41.5	38.3	31.9	25.8	20.6	16.5	13.3	10.9	9.09	7.65	6.52	5.61	4.88	3.78	3.01	2.45	2.03	1.71
50 x 50 x 8EA	60.8	57.4	49.5	39.9	31.1	24.2	19.2	15.4	12.6	10.4	8.79	7.49	6.45	4.92	3.87	3.12	2.57	2.15
6EA	48.4	45.4	38.8	31.0	24.1	18.8	14.9	12.0	9.80	8.15	6.86	5.86	5.05	3.86	3.04	2.46	2.03	1.70
5EA	37.7	34.6	28.3	22.3	17.4	13.7	10.9	8.84	7.28	6.08	5.15	4.41	3.82	2.94	2.32	1.88	1.56	1.31
3EA	23.3	21.3	17.3	13.5	10.4	8.16	6.50	5.28	4.36	3.66	3.11	2.68	2.33	1.80	1.44	1.17	0.976	0.825
45 x 45 x 6EA	42.5	39.7	33.1	25.5	19.3	14.7	11.5	9.15	7.42	6.13	5.14	4.36	3.75	2.85	2.24	1.80	1.48	1.24
5EA	33.5	31.1	25.5	19.6	14.7	11.3	8.79	7.00	5.69	4.71	3.95	3.36	2.89	2.21	1.74	1.40	1.15	0.966
3EA	21.1	19.2	15.3	11.6	8.72	6.68	5.24	4.21	3.44	2.87	2.42	2.07	1.79	1.38	1.09	0.887	0.734	0.618
40 x 40 x 6EA	37.0	34.3	27.5	20.3	14.9	11.1	8.52	6.70	5.39	4.42	3.68	3.12	2.67	2.02	1.58	1.26	1.04	0.865
5EA	29.3	26.9	21.3	15.7	11.4	8.56	6.58	5.18	4.17	3.43	2.86	2.42	2.08	1.57	1.23	0.992	0.814	0.681
3EA	19.0	17.1	13.2	9.61	7.02	5.26	4.06	3.22	2.61	2.15	1.81	1.54	1.32	1.01	0.795	0.642	0.530	0.444
30 x 30 x 6EA	26.1	23.5	16.4	10.8	7.32	5.21	3.87	2.97	2.35	1.90	1.57	1.32	1.12	0.836	0.649	0.517	0.422	0.351
5EA	20.5	17.8	12.2	8.15	5.61	4.03	3.01	2.33	1.85	1.50	1.24	1.04	0.886	0.665	0.517	0.413	0.337	0.281
3EA	14.1	12.4	8.45	5.51	3.75	2.68	2.00	1.54	1.23	0.997	0.826	0.695	0.593	0.446	0.347	0.278	0.228	0.190
25 x 25 x 6EA	20.8	18.0	11.2	6.84	4.46	3.10	2.26	1.72	1.35	1.08	0.889	0.743	0.630	0.469	0.362	0.288	0.235	0.195
5EA	16.5	14.3	8.86	5.43	3.55	2.47	1.81	1.38	1.08	0.870	0.715	0.598	0.507	0.378	0.292	0.233	0.190	0.158
3EA	11.4	9.63	5.90	3.60	2.36	1.65	1.21	0.923	0.726	0.586	0.483	0.405	0.344	0.257	0.199	0.159	0.130	0.108

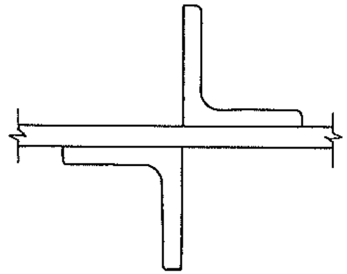


TABLE 8.3-2(1)

EQUAL ANGLES
GRADE 300

MAXIMUM DESIGN LOADS FOR ECCENTRICALLY LOADED SINGLE ANGLES IN TRUSSES

angles on opposite sides of the truss chord

Designation	Maximum Design Loads (kN) Length in metres																	
	0.25	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	7.0	8.0	9.0	10	11
200 x 200 x 26EA	399	399	395	384	374	363	352	341	329	317	305	293	281	257	235	214	196	179
20EA	331	331	324	313	303	293	282	272	261	251	240	229	219	199	181	164	149	136
18EA	302	302	294	283	273	263	253	243	233	223	213	204	194	176	159	144	131	120
16EA	288	287	277	265	254	243	233	222	212	202	192	182	173	155	140	126	114	104
13EA	246	243	233	221	211	200	190	180	171	162	153	145	137	122	109	98.0	88.4	80.0
150 x 150 x 19EA	212	212	205	198	190	182	174	166	157	149	140	132	124	110	98.1	87.3	78.0	69.9
16EA	216	215	206	197	188	178	169	159	149	140	131	122	114	100	88.0	77.6	68.8	61.3
12EA	168	166	157	149	140	132	124	116	108	101	93.8	87.4	81.4	70.9	62.1	54.7	48.4	43.2
10EA	134	131	121	112	104	96.2	88.8	82.0	75.8	70.1	64.9	60.2	55.9	48.5	42.4	37.3	33.1	29.6
125 x 125 x 16EA	167	167	159	151	143	135	126	118	109	101	93.9	86.9	80.5	69.3	60.0	52.3	45.8	40.4
12EA	136	134	126	119	112	104	96.7	89.4	82.5	76.0	70.0	64.6	59.6	51.1	44.1	38.3	33.6	29.6
10EA	115	111	103	95.9	88.7	81.7	74.9	68.5	62.6	57.2	52.4	48.1	44.2	37.7	32.4	28.1	24.6	21.8
8EA	88.3	85.0	77.6	70.7	64.3	58.5	53.1	48.3	44.0	40.2	36.8	33.8	31.1	26.6	22.9	20.0	17.6	15.6

Note: Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

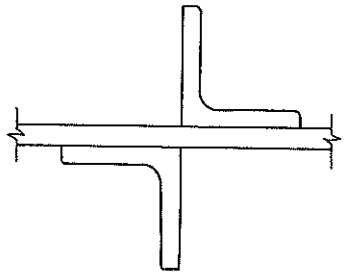


TABLE 8.3-2(2)

EQUAL ANGLES
GRADE 250

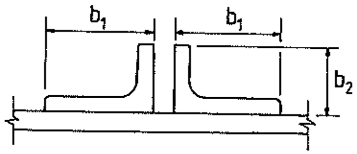
MAXIMUM DESIGN LOADS FOR ECCENTRICALLY LOADED SINGLE ANGLES IN TRUSSES

angles on opposite sides of the truss chord

Designation	Maximum Design Loads (kN) Length in metres																
	0.25	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	7.0	8.0	9.0	10	11
100 x 100 x 12EA	87.1	86.2	81.6	77.0	72.1	67.0	61.8	56.7	52.0	47.5	43.5	39.9	36.6	31.0	26.4	22.8	19.8	17.3
10EA	73.2	71.7	67.1	62.7	58.2	53.7	49.1	44.8	40.8	37.2	33.9	31.0	28.3	23.9	20.4	17.5	15.2	13.3
8EA	61.0	59.1	54.8	50.6	46.6	42.6	38.7	35.1	31.9	28.9	26.3	24.0	21.9	18.5	15.8	13.6	11.8	10.3
6EA	45.4	43.5	39.6	36.0	32.7	29.5	26.6	23.9	21.6	19.5	17.7	16.1	14.7	12.4	10.6	9.15	7.99	7.03
90 x 90 x 10EA	63.7	62.3	58.2	54.2	50.0	45.6	41.4	37.4	33.8	30.6	27.7	25.2	22.9	19.1	16.2	13.8	11.9	10.4
8EA	53.9	52.1	48.2	44.4	40.6	36.8	33.2	29.8	26.9	24.2	21.9	19.8	18.0	15.1	12.7	10.9	9.40	8.20
6EA	41.1	39.3	35.7	32.4	29.2	26.1	23.3	20.9	18.7	16.8	15.1	13.7	12.5	10.4	8.81	7.56	6.55	5.73
75 x 75 x 10EA	48.8	47.6	44.3	40.8	37.1	33.3	29.7	26.5	23.6	21.1	18.9	17.0	15.3	12.6	10.5	8.85	7.56	6.53
8EA	42.6	41.1	37.8	34.5	31.0	27.6	24.5	21.7	19.3	17.2	15.3	13.8	12.4	10.2	8.48	7.16	6.12	5.29
6EA	33.6	32.0	29.0	26.0	23.1	20.3	17.9	15.7	13.9	12.4	11.0	9.87	8.89	7.31	6.10	5.17	4.44	3.85
5EA	24.9	23.5	20.8	18.3	16.0	13.9	12.1	10.6	9.34	8.28	7.38	6.62	5.97	4.92	4.13	3.52	3.03	2.64
65 x 65 x 10EA	39.5	38.4	35.5	32.4	29.0	25.6	22.6	19.9	17.5	15.5	13.8	12.3	11.0	8.95	7.38	6.19	5.25	4.50
8EA	34.7	33.2	30.1	26.9	23.8	20.9	18.4	16.1	14.2	12.6	11.2	9.95	8.92	7.25	6.00	5.03	4.28	3.68
6EA	28.2	26.8	24.1	21.4	18.8	16.3	14.1	12.3	10.8	9.49	8.39	7.47	6.68	5.43	4.49	3.77	3.21	2.77
5EA	21.5	20.3	17.8	15.5	13.4	11.5	9.92	8.60	7.50	6.60	5.84	5.20	4.66	3.80	3.16	2.66	2.28	1.97
55 x 55 x 6EA	22.4	21.2	18.9	16.5	14.1	12.1	10.3	8.85	7.65	6.65	5.83	5.14	4.56	3.66	2.99	2.29	2.10	1.80
5EA	17.7	16.5	14.2	12.1	10.2	8.65	7.36	6.31	5.45	4.75	4.16	3.68	3.27	2.64	2.17	1.81	1.54	1.32
50 x 50 x 8EA	23.1	22.1	20.0	17.5	15.0	12.8	10.9	9.32	8.03	6.96	6.07	5.33	4.71	3.75	3.04	2.52	2.11	1.80
6EA	19.3	18.3	16.2	14.0	11.8	9.99	8.45	7.20	6.18	5.34	4.65	4.09	3.61	2.87	2.34	1.94	1.63	1.39
5EA	15.6	14.5	12.4	10.5	8.74	7.32	6.17	5.25	4.50	3.89	3.40	2.99	2.65	2.11	1.73	1.44	1.21	1.04
3EA	9.77	8.90	7.34	5.99	4.88	4.02	3.36	2.84	2.44	2.11	1.85	1.63	1.45	1.17	0.968	0.813	0.693	0.598
45 x 45 x 6EA	16.3	15.4	13.5	11.5	9.60	8.00	6.70	5.66	4.82	4.14	3.59	3.13	2.76	2.18	1.76	1.45	1.22	1.03
5EA	13.4	12.5	10.7	8.95	7.36	6.08	5.06	4.25	3.61	3.10	2.68	2.35	2.07	1.64	1.33	1.10	0.922	0.785
3EA	8.63	7.85	6.42	5.16	4.16	3.39	2.81	2.36	2.00	1.73	1.50	1.32	1.17	0.935	0.766	0.640	0.542	0.466
40 x 40 x 6EA	13.5	12.7	11.0	9.18	7.54	6.20	5.13	4.29	3.62	3.09	2.66	2.31	2.02	1.58	1.27	1.04	0.872	0.738
5EA	11.2	10.4	8.81	7.20	5.83	4.75	3.91	3.25	2.74	2.34	2.01	1.75	1.53	1.20	0.970	0.798	0.668	0.567
3EA	7.50	6.80	5.49	4.34	3.44	2.77	2.27	1.88	1.59	1.36	1.18	1.03	0.904	0.717	0.583	0.483	0.407	0.348
30 x 30 x 6EA	8.24	7.71	6.39	5.06	3.98	3.15	2.53	2.06	1.71	1.43	1.22	1.04	0.905	0.698	0.553	0.449	0.3722	0.313
5EA	6.90	6.31	5.07	3.96	3.09	2.44	1.95	1.59	1.32	1.11	0.940	0.808	0.702	0.543	0.432	0.351	0.292	0.246
3EA	5.04	4.52	3.48	2.62	1.99	1.55	1.24	1.00	0.830	0.698	0.594	0.512	0.446	0.347	0.277	0.227	0.189	0.160
25 x 25 x 6EA	5.92	5.49	4.38	3.35	2.56	1.98	1.56	1.25	1.03	0.852	0.718	0.612	0.528	0.403	0.318	0.257	0.212	0.177
5EA	5.01	4.59	3.57	2.69	2.03	1.56	1.23	0.987	0.807	0.670	0.565	0.482	0.416	0.319	0.252	0.204	0.168	0.141
3EA	3.71	3.29	2.44	1.78	1.32	1.01	0.789	0.633	0.518	0.432	0.365	0.312	0.270	0.208	0.165	0.134	0.111	0.094

TABLE 8.3-3

UNEQUAL ANGLES
GRADE 300 & 250



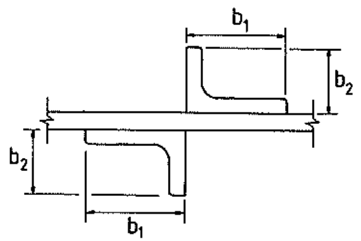
MAXIMUM DESIGN LOADS FOR ECCENTRICALLY LOADED SINGLE ANGLES IN TRUSSES

angles on same side of the truss chord — long leg attached

Designation	Maximum Design Loads (kN) Length in metres																
	0.25	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5
150 x 100 x 12UA	314	308	297	286	275	262	249	235	205	177	152	131	114	99.0	86.7	76.4	67.7
10UA	263	255	243	231	218	206	193	181	157	135	117	101	87.8	76.8	67.5	59.6	53.0
150 x 90 x 16UA	404	394	379	363	346	326	305	282	239	200	168	142	121	104	89.9	78.5	69.0
12UA	308	299	287	274	261	246	230	214	181	152	128	109	92.8	79.9	69.3	60.6	53.4
10UA	257	247	234	220	206	191	177	164	138	117	99.0	84.3	72.3	62.5	54.4	47.7	42.1
8UA	201	192	182	172	161	150	139	129	110	93.3	79.4	67.8	58.4	50.6	44.2	38.8	34.3
125 x 75 x 12UA	222	215	205	195	184	171	158	144	119	97.7	80.8	67.5	57.0	48.6	41.8	36.3	31.8
10UA	176	170	162	154	145	135	124	114	93.9	77.4	64.2	53.8	45.5	38.8	33.5	29.1	25.5
8UA	145	139	132	125	118	110	101	92.6	76.7	63.3	52.6	44.1	37.4	31.9	27.6	24.0	21.1
6UA	105	99.8	94.0	87.9	81.9	75.8	69.8	64.1	53.7	45.0	37.8	32.1	27.4	23.6	20.5	17.9	15.8
100 x 75 x 10UA	148	143	137	131	124	116	108	99.6	83.5	69.6	58.2	49.0	41.7	35.7	30.9	26.9	23.7
8UA	122	118	113	107	101	94.9	88.2	81.3	68.2	56.9	47.6	40.2	34.2	29.4	25.4	22.2	19.5
6UA	93.7	90.0	85.8	81.5	76.9	72.0	66.8	61.6	51.7	43.2	36.2	30.6	26.1	22.4	19.4	17.0	15.0
75 x 50 x 8UA	87.3	80.7	73.3	65.5	57.8	50.6	44.2	38.5	29.6	23.2	18.5	15.0	12.4	10.4	8.80	7.56	6.56
6UA	67.7	63.4	58.6	53.2	47.2	41.3	35.9	31.2	23.8	18.5	14.7	11.9	9.84	8.24	6.99	6.00	5.20
5UA	51.9	48.4	44.7	40.5	35.9	31.5	27.4	23.8	18.2	14.2	11.3	9.20	7.60	6.37	5.41	4.65	4.04
65 x 50 x 8UA	77.7	72.4	66.1	59.5	52.9	46.6	40.9	35.8	27.8	21.8	17.5	14.2	11.8	9.88	8.40	7.22	6.26
6UA	60.7	57.0	52.9	48.3	43.2	38.0	33.2	29.0	22.3	17.4	13.9	11.3	9.34	7.83	6.65	5.72	4.96
5UA	46.5	42.8	38.9	34.9	31.0	27.3	24.0	21.1	16.4	13.0	10.4	8.52	7.08	5.96	5.08	4.38	3.81

Notes: (1) For 150x 90 angles and above: Grade 300.
(2) For 125x 75 angles and below: Grade 250.
(3) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

TABLE 8.3-4



UNEQUAL ANGLES
GRADE 300 & 250

MAXIMUM DESIGN LOADS FOR ECCENTRICALLY LOADED SINGLE ANGLES IN TRUSSES

angles on opposite sides of the truss chord - long leg attached

Designation	Maximum Design Loads (kN) Length in metres																
	0.25	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5
150 x 100 x 12UA	136	134	130	126	122	118	114	109	99.7	90.4	81.7	73.7	66.5	60.1	54.4	49.4	67.7
10UA	119	116	111	107	102	98.0	93.5	89.1	80.6	72.5	65.2	58.6	52.8	47.6	43.0	39.0	35.5
150 x 90 x 16UA	156	154	149	145	140	135	129	124	112	100	89.8	80.3	71.8	64.4	57.9	52.2	47.3
12UA	127	124	120	116	111	107	102	97.4	87.6	78.3	69.7	62.1	55.5	49.7	44.6	40.2	36.3
10UA	111	107	103	98.2	93.6	88.9	84.3	79.7	71.0	63.0	55.9	49.7	44.2	39.5	35.5	31.9	28.9
8UA	91.6	88.1	84.2	80.3	76.4	72.6	68.7	65.0	57.8	51.3	45.5	40.4	36.0	32.1	28.8	26.0	23.5
125 x 75 x 12UA	85.0	83.3	80.6	77.7	74.7	71.5	68.0	64.5	57.4	50.7	44.8	39.6	35.1	31.2	27.8	24.9	22.4
10UA	70.9	68.9	66.4	63.8	61.1	58.3	55.3	52.2	46.3	40.8	35.9	31.6	28.0	24.9	22.2	19.8	17.8
8UA	60.3	58.2	55.9	53.6	51.1	48.6	46.0	43.4	38.3	33.6	29.5	26.0	22.9	20.4	18.1	16.2	14.6
6UA	46.7	44.6	42.5	40.4	38.3	36.2	34.1	32.0	28.2	24.8	21.8	19.3	17.1	15.2	12.5	12.1	10.9
100 x 75 x 10UA	61.6	60.3	58.3	56.3	54.1	51.8	49.4	46.9	41.9	37.2	32.9	29.2	25.9	23.1	20.7	18.5	16.7
8UA	52.4	50.9	49.0	47.2	45.2	43.2	41.1	38.9	34.6	30.6	27.0	23.9	21.2	18.9	16.9	15.1	13.6
6UA	41.6	40.0	38.4	36.8	35.1	33.4	31.6	29.9	26.4	23.3	20.5	18.1	16.0	14.3	12.7	11.4	10.3
70 x 50 x 8UA	31.8	30.2	28.5	26.7	24.8	22.9	21.1	19.4	16.4	13.8	11.7	10.0	8.61	7.47	6.52	5.74	5.08
6UA	25.8	24.5	23.1	21.7	20.1	18.5	17.0	15.5	13.0	10.9	9.18	7.81	6.71	5.81	5.07	4.46	3.95
5UA	20.5	19.3	18.1	16.9	15.6	14.3	13.1	11.9	9.90	8.28	6.98	5.94	5.10	4.42	3.86	2.40	3.01
65 x 50 x 8UA	29.0	27.8	26.3	24.7	23.1	21.4	19.8	18.2	15.5	13.1	11.2	9.56	8.25	7.16	6.26	5.52	4.89
6UA	23.7	22.6	21.4	20.1	18.7	17.3	15.9	14.6	12.2	10.3	8.71	7.43	6.39	5.54	4.85	4.26	3.78
5UA	18.8	17.6	16.5	15.3	14.1	12.9	11.9	10.9	9.10	7.66	6.49	5.55	4.78	4.15	3.64	3.21	2.85

Notes: (1) For 150 x 90 angles and above: Grade 300.
(2) For 125 x 75 angles and below: Grade 250.
(3) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

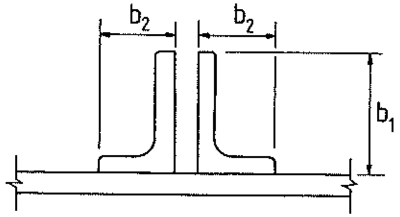


TABLE 8.3-5

UNEQUAL ANGLES
GRADE 300 & 250

MAXIMUM DESIGN LOADS FOR ECCENTRICALLY LOADED SINGLE ANGLES IN TRUSSES

angles on the same side of the truss chord — short leg attached

Designation	Maximum Design Loads (kN) Length in metres																
	0.25	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5
150 x 100 x 12UA	233	230	225	218	212	206	200	194	182	170	158	146	135	124	114	105	96.9
10UA	192	188	183	176	170	164	158	152	140	129	119	109	100	91.8	84.5	77.8	71.8
150 x 90 x 16UA	278	276	270	264	257	251	244	238	224	210	196	182	169	156	144	133	123
12UA	214	211	206	199	194	188	182	176	165	154	143	132	121	112	103	94.8	87.5
10UA	180	175	169	163	156	150	144	138	127	116	106	97.4	89.2	81.8	75.2	69.2	63.8
8UA	138	134	130	124	119	115	110	105	96.7	88.6	81.2	74.4	68.3	62.7	57.7	53.2	49.1
125 x 75 x 12UA	153	151	147	143	139	135	131	127	119	110	101	92.9	85.0	77.7	71.1	65.1	59.7
10UA	123	120	116	113	109	105	102	98.1	91.0	83.8	76.8	70.2	64.0	58.4	53.3	48.8	44.7
8UA	102	98.7	95.1	91.6	88.1	84.8	81.5	78.3	72.0	65.9	60.1	54.7	49.7	45.2	41.3	37.7	34.6
6UA	72.2	69.9	67.2	64.3	61.6	58.9	56.3	53.8	49.0	44.6	40.6	37.0	33.7	30.8	28.2	25.9	23.8
100 x 75 x 10UA	117	115	112	108	104	101	96.9	92.8	84.4	75.9	67.7	60.4	53.8	48.0	43.0	38.6	34.8
8UA	97.5	95.2	91.8	88.5	85.2	81.9	78.5	75.0	67.9	60.8	54.1	48.1	42.9	38.3	34.3	30.8	27.8
6UA	72.9	70.8	68.1	65.5	62.9	60.3	57.7	55.1	49.7	44.5	39.6	35.3	31.5	28.1	25.2	22.7	20.5
75 x 50 x 8UA	64.8	62.3	59.2	56.1	53.0	49.8	46.7	43.6	37.8	32.7	28.3	24.6	21.4	18.8	16.6	14.7	13.1
6UA	50.5	48.3	46.0	43.6	41.3	38.9	36.5	34.0	29.3	25.2	21.7	18.7	16.3	14.2	12.5	11.1	9.91
5UA	38.5	36.5	34.5	32.6	30.6	28.7	26.8	24.9	21.4	18.3	15.7	13.6	11.8	10.4	9.13	8.11	7.24
65 x 50 x 8UA	63.2	60.4	57.2	53.7	50.2	46.6	43.0	39.6	33.4	28.2	23.8	20.3	17.4	15.0	13.1	11.5	10.1
6UA	49.5	47.2	44.8	42.4	39.8	37.1	34.2	31.5	26.4	22.0	18.5	15.7	13.4	11.6	10.1	8.84	7.80
5UA	37.8	35.6	33.3	31.0	28.7	26.4	24.3	22.3	18.7	15.7	13.3	11.3	9.74	8.44	7.38	6.49	5.75

Notes: (1) For 150 x 90 angles and above: Grade 300.
(2) For 125 x 75 angles and below: Grade 250.
(3) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

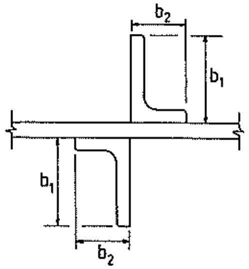


TABLE 8.3-6

UNEQUAL ANGLES
GRADE 300 & 250

MAXIMUM DESIGN LOADS FOR ECCENTRICALLY LOADED SINGLE ANGLES IN TRUSSES

angles on opposite sides of the truss chord — short leg attached

Designation	Maximum Design Loads (kN) Length in metres																
	0.25	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5
150 x 100 x 12UA	113	112	109	106	103	100	97.3	94.6	89.2	83.9	78.8	73.9	69.2	64.7	60.6	56.7	53.2
10UA	95.4	93.0	90.0	87.0	84.0	81.1	78.3	75.5	70.2	65.3	60.7	56.4	52.5	48.8	45.5	42.5	39.7
150 x 90 x 16UA	131	130	127	124	121	118	116	113	107	102	96.0	90.5	85.2	80.2	75.4	70.9	66.7
12UA	104	102	99.4	96.4	93.6	90.8	88.1	85.4	80.3	75.3	70.5	65.9	61.6	57.6	53.8	50.4	47.2
10UA	89.5	86.6	83.4	80.2	77.1	74.1	71.2	68.4	63.2	58.4	53.9	49.9	46.2	42.8	39.8	37.1	34.6
8UA	70.2	67.8	65.2	62.6	60.1	57.6	55.3	53.1	48.9	45.1	41.6	38.4	35.5	32.9	30.6	28.5	26.6
125 x 75 x 12UA	71.8	70.9	69.1	67.2	65.4	63.6	61.9	60.1	56.7	53.2	49.9	46.6	43.5	40.6	37.9	35.4	33.1
10UA	58.9	57.5	55.7	53.9	52.2	50.4	48.8	47.2	44.0	41.0	38.0	35.3	32.7	30.4	28.2	26.3	24.5
8UA	49.6	47.9	46.1	44.3	42.7	41.0	39.5	37.9	35.1	32.3	29.8	27.5	25.3	23.4	21.7	20.1	18.7
6UA	36.2	34.9	33.4	32.0	30.6	29.3	28.0	26.8	24.6	22.5	20.7	19.0	17.5	16.2	14.9	13.9	12.9
100 x 75 x 10UA	53.9	53.0	51.5	50.0	48.5	47.0	45.5	43.9	40.8	37.7	34.7	31.9	29.3	26.9	24.8	22.8	21.1
8UA	45.8	44.6	43.1	41.6	40.2	38.7	37.3	35.9	33.1	30.4	27.8	25.4	23.2	21.3	19.5	18.0	16.5
6UA	34.7	33.6	32.3	31.1	29.9	28.8	27.6	26.5	24.3	22.2	20.3	18.5	16.9	15.5	14.2	13.0	12.0
70 x 50 x 8UA	28.4	27.4	26.2	25.1	24.0	22.9	21.8	20.7	18.7	16.8	15.1	13.6	12.2	11.1	10.0	9.12	8.32
6UA	22.7	21.7	20.7	19.7	18.7	17.8	16.9	16.0	14.2	12.6	11.3	10.1	9.01	8.11	7.33	6.65	6.05
5UA	17.6	16.7	15.8	14.9	14.0	13.2	12.5	11.7	10.3	9.11	8.06	7.17	6.41	5.75	5.19	4.71	4.29
65 x 50 x 8UA	26.5	25.6	24.6	23.5	22.4	21.3	20.2	19.1	17.0	15.1	13.4	11.9	10.6	9.48	8.51	7.67	6.93
6UA	21.5	20.5	19.6	18.7	17.8	16.8	15.9	14.9	13.1	11.5	10.2	8.98	7.96	7.09	6.35	5.71	5.16
5UA	16.8	15.9	14.9	14.1	13.2	12.4	11.6	10.8	9.47	8.28	7.27	6.42	5.69	5.07	4.54	4.09	3.70

Notes: (1) For 150 x 90 angles and above: Grade 300.
(2) For 125 x 75 angles and below: Grade 250.
(3) Grade 300 refers to BHP Grade 300PLUS™. See Note (1) on page 2-2.

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PART 9 CONNECTIONS – BOLTS/WELDS/ STANDARDISED STRUCTURAL CONNECTIONS

PAGE

PART 9 CONNECTIONS – BOLTS/WELDS/ STANDARDISED STRUCTURAL CONNECTIONS

9.1 Bolts

9.1.1 AS 4100 Requirements

The general requirements and definitions for bolted connections are set out in Clause 9.1 and 9.2, of AS 4100. Clause 9.3 of AS 4100 sets out the requirements for the design of bolts. Clause 9.4 of AS 4100 should be used for assessing the strength of a bolt group. Design detail requirements for bolts are given in Clause 9.6 of AS 4100.

9.1.2 Bolt Types and Bolting Categories

The system of bolting category designation identifies the bolt being used by using its strength grade designation (4.6 or 8.8) and identifies the installation procedure by a supplementary letter (S– snug; T– full tensioning to AS 4100). For 8.8/T categories, the type of joint is identified by an additional letter (F– friction type joint; B– bearing type joint). See Table 9.1.2 for a summary of bolt types and bolting procedures.

Category 4.6/S refers to commercial bolts of Strength Grade 4.6 conforming to AS 1111, tightened using a standard wrench to a "snug tight" condition.

Category 8.8/S refers to any bolt of Strength Grade 8.8, tightened using a standard wrench to a "snug tight" condition in the same way as for category 4.6/S. Essentially, these bolts are used as higher grade commercial bolts in order to increase the capacity of certain connection types. In practice, they will normally be high strength structural bolts of Grade 8.8 to AS 1252.

Categories 8.8/TF and 8.8/TB (or 8.8/T when referring generally to both types) refer specifically to high strength structural bolts of Strength Grade 8.8 conforming to AS 1252, *fully tensioned in a controlled manner to the requirements of AS 4100 (Clause 15.2).*

For additional data on dimensions and masses of Commercial and High Strength Structural bolts, nuts and washers refer to Part 10 : Detailing Parameters of this publication. Further relevant information on bolt types, bolting categories and other aspects of bolting can be found in "Bolting of Steel Structures", 3rd Edition, AISC (see Ref.[1] in Section 9.4).

9.1.3 Design Capacities of Commonly Used Bolts

Two symbols are incorporated into the bolting category designations 4.6/S, 8.8/S, 8.8/TB. They are:–

N : bolt in shear with threads i**N**cluded in the shear plane (eg 8.8 N/S)
X : bolt in shear with threads e**X**cluded from the shear plane (eg 8.8 X/S)

For bolts, the following tables of design capacity have been derived using the following expressions:

$N_{tf} = A_s f_{uf}$
$V_{fn} = 0.62 f_{uf} k_r A_c$ (k_r =1.0 Clause 9.3.2.1 of AS 4100)
$V_{fx} = 0.62 f_{uf} k_r A_o$ (k_r =1.0 Clause 9.3.2.1 of AS 4100)
$V_{sf} = \mu n_{ei} N_{ti} k_h$ (see 9.1.3(c) for μ, n_{ei}, N_{ti}, k_h used)

and where applicable, for the ply in bearing

$V_b = 3.2 d_f t_p f_{up}$ (local bearing failure)
$V_b = a_e t_p f_{up}$ (end plate tearout failure)

Note: The appropriate design capacity factor, ϕ (from Table 3.4 and Clause 3.5.5 of AS 4100), is *included* in the respective design capacity table.

TABLE 9.1.2: Bolt Types and Bolting Categories

	Details of bolt used					
Bolting Category	**Strength Grade**	**Minimum Tensile Strength (MPa)**	**Minimum Yield Strength (MPa)**	**Name**	**Australian Standard**	**Method of Tensioning/ Remarks**
4.6/S	4.6	400	240	Commercial	AS 1111	Use **S**nug tightened. Least costly and most commonly available is Grade 4.6 bolt.
8.8/S	8.8	830	660	High Strength Commercial	AS 1252	Bolts used are **S**nug tightened. The high strength structural has a large bolt head and nut because it is designed to withstand full tensioning (see 8.8/T category description). However, it can also be used in a snug tight condition.
8.8/TF	8.8	830	660	High Strength Structural Bolt – Fully **T**ensioned **F**riction TypeJoint	AS 1252	In both applications, bolts are fully **T**ensioned to the requirements of AS 4100. Cost of tensioning is an important consideration in the use of these bolting categories.
8.8/TB	8.8	830	660	High Strength Structural Bolt – Fully **T**ensioned **B**earing Type Joint	AS 1252	

9.1.3(a) Design Capacities of Commonly Used Bolts – Strength Limit State

COMMERCIAL BOLTS –
4.6/S BOLTING CATEGORY

GRADE 4.6

TABLE 9.1.3(a): Design Capacities
(f_{uf} = 400 MPa)

Bolt Size	Axial Tension ϕN_{tf}	Shear Values (Single Shear)	
		Threads included in Shear Plane – N ϕV_{fn}	Threads excluded from Shear Plane – X ϕV_{fx}
	kN	kN	kN
M12	27.0	15.1	22.4
M16	50.2	28.6	39.9
M20	78.4	44.6	62.3
M24	113	64.3	89.7
M30	180	103	140
M36	261	151	202
	ϕ = 0.8	ϕ = 0.8	
		4.6N/S	4.6X/S

Important Note on 4.6/S Bolting Category

Values for the threads excluded case are provided for the sake of completeness.

However, in practical structural bolting situations it is never worthwhile considering 4.6X/S category – 8.8N/S is always more economic.

Note: Bearing/Plate Tearout Design Capacity – For all reasonable combinations of ply thickness, bolt diameter and end distance, the design capacity for a ply in bearing (ϕV_b) exceeds both ϕV_{fn} and ϕV_{fx}.

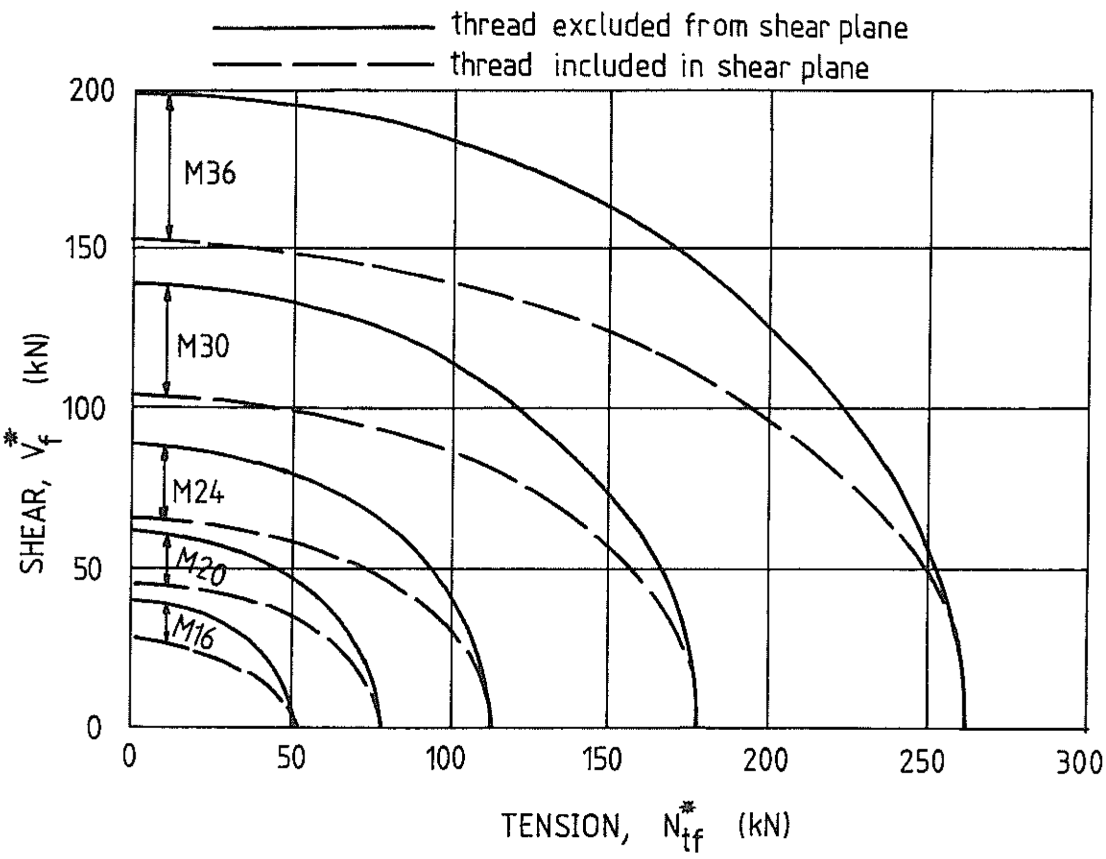


Figure 9.1.3(a): Shear – Tension Interaction Diagram

9.1.3(b) Design Capacities of Commonly Used Bolts – Strength Limit State

HIGH STRENGTH STRUCTURAL BOLTS
8.8/S, 8.8/TB, 8.8/TF BOLTING CATEGORIES

GRADE 8.8

TABLE 9.1.3(b): Design Capacities
(f_{uf} = 830 MPa)

Bolt Size	Axial Tension ϕN_{tf}	Single Shear: Threads included in Shear Plane ϕV_{fn}	Single Shear: Threads excluded from Shear Plane ϕV_{fx}	Bearing in kN ϕV_b for t_p: 6	8	10
	kN	kN	kN			
M16	104	59.3	82.7	122	162	203
M20	163	92.6	129	152	203	253
M24	234	133	186	182	243	304
M30	373	214	291	228	304	380
M36	541	313	419	274	355	456
	ϕ = 0.8	ϕ = 0.8, 8.8N/S	ϕ = 0.8, 8.8X/S	ϕ = 0.9, f_{up} = 440 MPa		

Plate Tearout in kN — ϕV_b for t_p & a_e of:

	t_p = 6			t_p = 8			t_p = 10			t_p = 12		
a_e	35	40	45	35	40	45	35	40	45	35	40	45
ϕV_b	83	95	107	111	127	143	139	158	178	166	190	124

$a_e > a_{emin}$ = 1.5 d_f; ϕ = 0.9; f_{up} = 440 MPa

Note: The above table lists the design capacity of a ply in bearing for Grade 300 (f_{up} = 440 MPa) steel only. For listings and guidance on design capacities for ply failure in other grades of steel refer to Section 9.1.4.

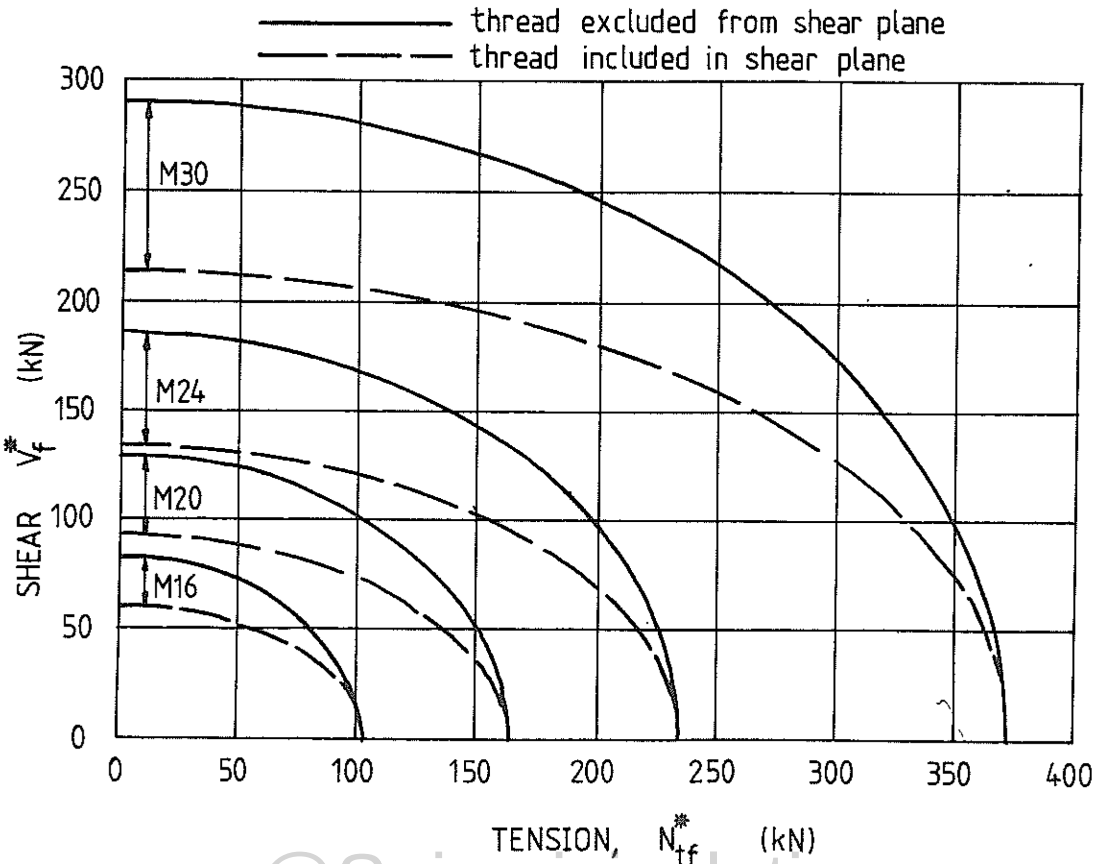


Figure 9.1.3(b): Shear – Tension Interaction Diagram

9.1.3(c) Design Capacities of Commonly Used Bolts – Serviceability Limit State

HIGH STRENGTH STRUCTURAL BOLTS
8.8/TF BOLTING CATEGORIES

GRADE 8.8

TABLE 9.1.3(c): Design Capacities
Slip factor, $\mu = 0.35$
Number of effective interfaces, $n_{ei} = 1$
Capacity factor, $\phi = 0.7$ – for bolt serviceability limit state
(Clause 3.5.5 of AS 4100)

Bolt Size	Bolt Tension at Installation, N_{ti}	Axial Tension ϕN_{tf}	Design Capacity in Shear, ϕV_{sf}, for $k_h = 1$	$k_h = 0.85$	$k_h = 0.7$
	kN	kN	kN	kN	kN
M16	95	66.5	23.3	19.8	16.3
M20	145	101	35.5	30.2	24.9
M24	210	147	51.5	43.7	36.0
M30	335	234	82.1	69.8	57.5
M36	490	343	120	102	84.1

Note: N_{ti} is given in Clause 15.2.5.1 of AS 4100

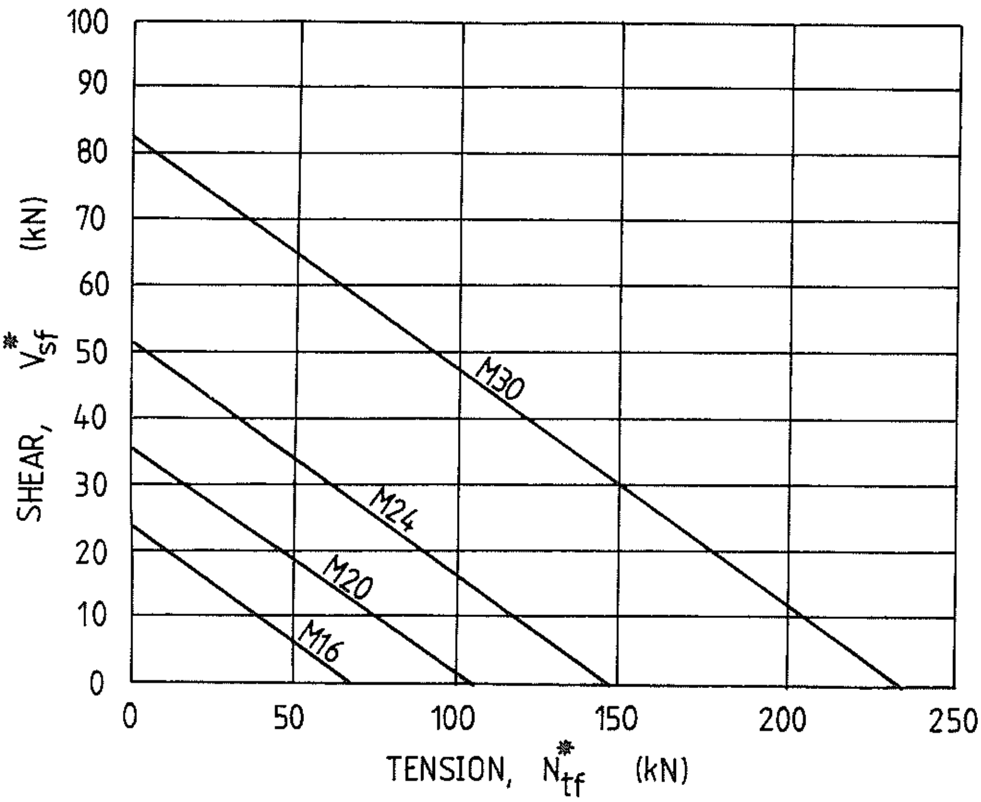


Figure 9.1.3(c): Shear – Tension Interaction Diagram
$k_h = 1.0$

9.1.4 Minimum Edge Distance In Direction of a Component Force / Ply in Bearing

For a bolt bearing on a ply the design bearing capacity for the ply, ϕV_b, is the *lesser* of the design bearing capacity due to plate tearout (see eqn. 9.1.4(a)) and the design bearing capacity due to ply local bearing failure (see eqn. 9.1.4(b)).

Table 9.1.4 lists the design bearing capacity of a ply, ϕV_b, derived from the minimum edge distance, a_e, and is based on the plate tearout criteria of Eqn. 9.3.2.4(2) of AS 4100, i.e.:

$$\phi V_b = \phi a_e t_p f_{up} \qquad \text{– eqn. 9.1.4(a)}$$

where a_e = minimum distance from the edge of a hole to the edge of a ply in the direction of the component force plus half the bolt diameter

The edge of the ply should be deemed to include the edge of an adjacent fastener hole.

The above edge distance provision is intended to apply to the simple situations in connections as shown in Fig. 9.1.4-1(a) as well as more complicated situations, e.g. Fig. 9.1.4-1(b) where the edge distance and end distances are not directly related to the direction of the applied force as those in Fig 9.1.4-1(a).

Consider the bolt group in an angle cleat connection as shown in Fig. 9.1.4-2. The bottom bolt in the connection applies a resultant force (V^*_{fB}) to the web of the beam at an angle θ_1. The resultant force (V^*_{fB}) and the angle (θ_1) can be calculated using conventional methods based on a 'linear' method analysis and taking account of eccentricity (Ref.[2] in Section 9.4).

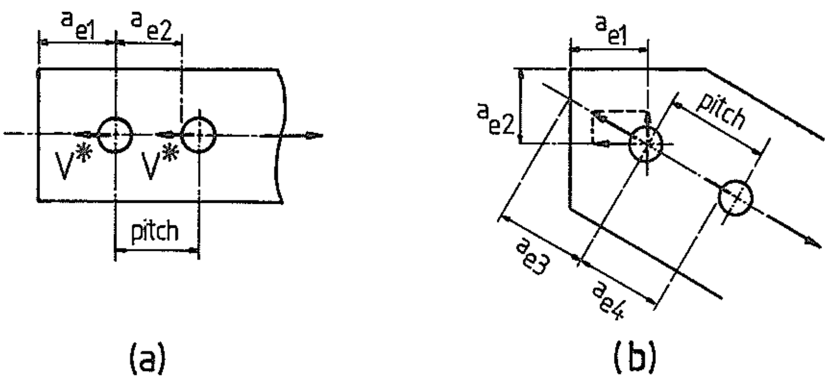


Figure 9.1.4-1

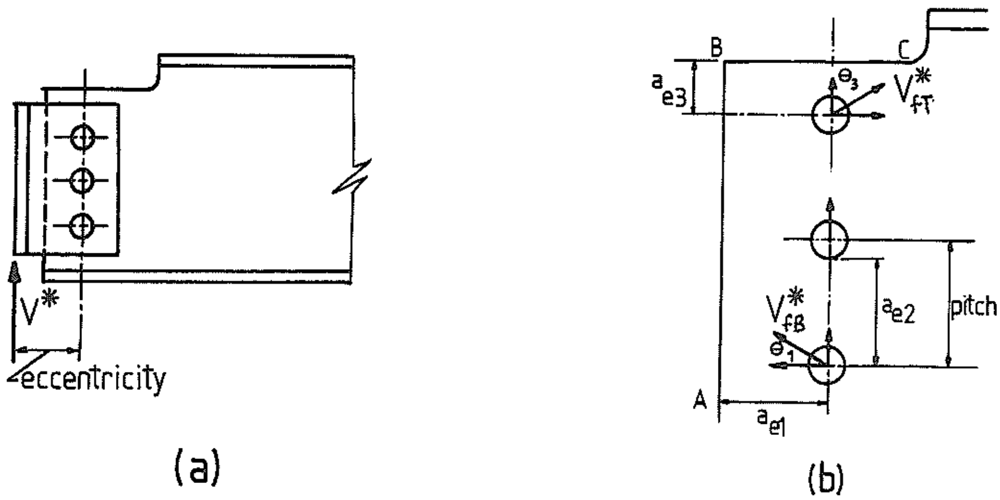


Figure 9.1.4-2

TABLE 9.1-3

DESIGN BEARING CAPACITY

t_p	Form	Grade	f_{up}	Design Bearing Capacity, ϕV_b (kN)									
				a_e (mm)									
mm			MPa	25	30	35	40	45	50	55	60	65	70
6	P	400	480	64.8	77.8	90.7	104	117	130	143	156	168	181
6	P	350	450	60.8	72.9	85.0	97.2	109	122	134	146	158	170
6	P	300	430	58.0	69.7	81.3	92.9	104	116	128	139	151	163
6	P	250	410	55.3	66.4	77.5	88.6	99.6	111	122	133	144	155
6	S	350	480	64.8	77.8	90.7	104	117	130	143	156	168	181
6	S	300	440	59.4	71.3	83.2	95.0	107	119	131	143	154	166
6	S	250	410	55.3	66.4	77.5	88.6	99.6	111	122	133	144	155
8	P	400	480	86.4	104	121	138	156	173	190	207	225	242
8	P	350	450	81.0	97.2	113	130	146	162	178	194	211	227
8	P	300	430	77.4	92.9	108	124	139	155	170	186	201	217
8	P	250	410	73.8	88.6	103	118	133	148	162	177	192	207
8	S	350	480	86.4	104	121	138	156	173	190	207	225	242
8	S	300	440	79.2	95.0	111	127	143	158	174	190	206	222
8	S	250	410	73.8	88.6	103	118	133	148	162	177	192	207
10	P	400	480	108	130	151	173	194	216	238	259	281	302
10	P	350	450	101	122	142	162	182	203	223	243	263	284
10	P	300	430	96.8	116	136	155	174	194	213	232	252	271
10	P	250	410	92.3	111	129	148	166	185	203	221	240	258
10	S	350	480	108	130	151	173	194	216	238	259	281	302
10	S	300	440	99.0	119	139	158	178	198	218	238	257	277
10	S	250	410	92.3	111	129	148	166	185	203	221	240	258
12	P	400	480	130	156	181	207	233	259	285	311	337	363
12	P	350	450	122	146	170	194	219	243	267	292	316	340
12	P	300	430	116	139	163	186	209	232	255	279	302	325
12	P	250	410	111	133	155	177	199	221	244	266	288	310
12	S	350	480	130	156	181	207	233	259	285	311	337	363
12	S	300	440	119	143	166	190	214	238	261	285	309	333
12	S	250	410	111	133	155	177	199	221	244	266	288	310
16	P	400	480	173	207	242	277	311	346	380	415	449	484
16	P	350	450	162	194	227	259	292	324	356	389	421	454
16	P	300	430	155	186	217	248	279	310	341	372	403	433
16	P	250	410	148	177	207	236	266	295	325	354	384	413
16	S	350	480	173	207	242	277	311	346	380	415	449	484
16	S	300	440	158	190	222	253	285	317	348	380	412	444
16	S	250	410	148	177	207	236	266	295	325	354	384	413
20	P	400	480	216	259	302	346	389	432	475	518	562	605
20	P	350	450	203	243	284	324	365	405	446	486	527	567
20	P	300	430	194	232	271	310	348	387	426	464	503	542
20	P	250	410	185	221	258	295	332	369	406	443	480	517
20	S	350	480	216	259	302	346	389	432	475	518	562	605
20	S	300	440	198	238	277	317	356	396	436	475	515	554
20	S	250	410	185	221	258	295	332	369	406	443	480	517
24	P	400	480	259	311	363	415	467	518	570	622	674	726
24	P	350	450	243	292	340	389	437	486	535	583	632	680
24	P	300	430	232	279	325	372	418	464	511	557	604	650
24	P	250	410	221	266	310	354	399	443	487	531	576	620
24	S	350	480	259	311	363	415	467	518	570	622	674	726
24	S	300	440	238	285	333	380	428	475	523	570	618	665
24	S	250	410	221	266	310	354	399	443	487	531	576	620
25	P	400	480	270	324	378	432	486	540	594	648	702	756
25	P	350	450	253	304	354	405	456	506	557	606	658	709
25	P	300	430	242	290	337	387	435	484	532	581	629	677
25	P	250	410	231	277	323	369	415	461	507	554	600	646
25	S	350	480	270	324	378	432	486	540	594	648	702	756
25	S	300	440	248	297	347	396	446	495	545	594	644	693
25	S	250	410	231	277	323	369	415	461	507	554	600	646
28	P	400	480	302	363	423	484	544	605	665	726	786	847
28	P	350	450	284	340	397	454	510	567	624	680	737	794
28	P	300	430	271	325	379	433	488	542	596	650	704	759
28	P	250	410	258	310	362	413	465	517	568	620	672	723
28	S	350	480	302	363	423	484	544	605	665	726	786	847
28	S	300	440	277	333	388	444	499	554	610	665	721	776
28	S	250	410	258	310	362	413	465	517	568	620	672	723
32	P	400	480	346	415	484	553	622	691	760	829	899	968
32	P	350	450	324	389	454	518	583	648	713	778	842	907
32	P	300	430	310	372	433	495	557	619	681	743	805	867
32	P	250	410	295	354	413	472	531	590	649	709	768	827
32	S	350	480	346	415	484	553	622	691	760	829	899	968
32	S	300	440	317	380	444	507	570	634	697	760	824	887
32	S	250	410	295	354	413	472	531	590	649	709	768	827
36	P	400	480	389	467	544	622	700	778	855	933	1010	1090
36	P	350	450	365	437	510	583	656	729	802	875	948	1020
36	P	300	430	348	418	488	557	627	697	766	836	906	975
36	P	250	410	332	399	465	531	598	664	731	797	863	930
36	S	350	480	389	467	544	622	700	778	855	933	1010	1090
36	S	300	440	356	428	499	570	642	713	784	855	927	998
36	S	250	410	332	399	465	531	598	664	731	797	863	930
40	P	400	480	432	518	605	691	778	864	950	1040	1120	1210
40	P	350	450	405	486	567	648	729	810	891	972	1050	1130
40	P	300	430	387	464	542	619	697	774	851	929	1010	1080
40	P	250	410	369	443	517	590	664	738	812	886	959	1030
40	S	350	480	432	518	605	691	778	864	950	1040	1120	1210
40	S	300	440	396	475	554	634	713	792	871	950	1030	1110
40	S	250	410	369	443	517	590	664	738	812	886	959	1030

Notes:
(1) **Check also ply local bearing failure criteria.**
(2) For intermediate values of a_e use linear interpolation.
(3) For the “Form” column of the table, P = Plate; S = Section.
(4) Grade 300 for sections refers to BHP Grade 300PLUS™.

Edge distance a_{e1} is determined in the following way:–

(i) the minimum distance from edge A-B, to the centre of the fastener is the distance along the line perpendicular to the edge and through the centre of the fastener;

(ii) the component of V^*_{fB} in the direction of the closest edge is $V^*_{fB}\cos\theta_1$. Thus,

$$V^*_{fB}\cos\theta_1 \leq \phi a_{e1} f_{up} t_p \quad \text{or} \quad a_{e1} \geq \frac{V^*_{fB}\cos\theta_1}{\phi f_{up} t_p}$$

Similarly, the end distance a_{e2} would be required to satisfy

$$V^*_{fB}\sin\theta_1 \leq \phi a_{e2} f_{up} t_p \quad \text{or} \quad a_{e2} \geq \frac{V^*_{fB}\sin\theta_1}{\phi f_{up} t_p}$$

The top bolt in the connection would be treated in the following manner:–

(i) for edge B-C, the component of force towards the closest edge is $V^*_{fT}\cos\theta_3$, so that

$$V^*_{fT}\cos\theta_3 \leq \phi a_{e2} f_{up} t_{up} \quad \text{or} \quad a_{e3} \geq \frac{V^*_{fT}\cos\theta_3}{\phi f_{up} t_p}$$

(ii) for edge A-B, the component of force in the direction perpendicular to the edge A-B is away from the edge and is not considered.

A check should <u>also</u> be done on the possibility of ply local bearing failure, refer to Eqn. 9.3.2.4(1) of AS 4100, i.e.:

$$\phi V_b = \phi 3.2 d_f t_p f_{up} \qquad \text{– eqn. 9.1.4(b)}$$

The method above would be used for this check.

The design bearing capacity of a ply, ϕV_b, is the <u>lesser</u> of eqns 9.1.4(a) and 9.1.4(b).

The design bearing force on a ply at a bolt, V^*_b, must satisfy the following:

$$V^*_b \leq \phi V_b \qquad \text{where } \phi = 0.9 \text{ (Table 3.4 of AS 4100).}$$

9.1.5 Design Details for Bolts

Consideration must also be given to the Code requirements for design details for bolts (Clause 9.6 of AS 4100) which prescribes minimum/maximum pitch and minimum/maximum edge distance. Table 9.1.5 lists the minimum edge distance from the centre of a fastener to the edge of a plate or the flange of a rolled section.

TABLE 9.1.5: AS 4100 – Minimum Edge Distances

Nominal Diameter of Fastener	Sheared or Hand Flame Cut Edge	Rolled Plate; Machine Flame Cut, Sawn or Planed Edge	Rolled Edge of a Rolled Section
mm	mm	mm	mm
12	21	18	15
16	28	24	20
20	35	30	25
24	42	36	30
30	53	45	38
36	63	54	45

9.1.6 Strength Limit State Assessment of a Bolt Group

For the assessment of the strength of a bolt group in compliance with AS 4100 see Ref.[2] of Section 9.4.

9.2 Welds

9.2.1 AS 4100 Requirements

The general requirements for welded connections are set out in Clause 9.1 of AS 4100. Clause 9.7 of AS 4100 sets out the requirements for the design of welds. Clause 9.8 of AS 4100 should be used for assessing the strength of a weld group.

9.2.2 Weld Quality

Complete Penetration Butt Welds

GP (general purpose) $\phi = 0.6$ (Table 3.4 of AS 4100)

Category GP may be selected where the weld is essentially statically loaded and is not loaded above 66.7% of the design capacity of a SP weld.

SP (structural purpose) $\phi = 0.9$ (Table 3.4 of AS 4100)

Category SP shall be selected where a GP quality weld is not appropriate.

The cut-off value of 66.7% for this weld type is due to the ratio of GP to SP capacity factors (ϕ), i.e.:

$$0.6/0.9 \times 100 = 66.7\%$$

Fillet Weld / Incomplete Penetration Butt Weld / Plug or Slot Weld / Weld Group

GP (general purpose) $\phi = 0.6$ (Table 3.4 of AS 4100)

Category GP may be selected where the weld is essentially statically loaded and is not loaded above 75% of the design capacity of a SP weld.

SP (structural purpose) $\phi = 0.8$ (Table 3.4 of AS 4100)

Category SP shall be selected where a GP quality weld is not appropriate.

The cut-off value of 75% for these weld types is due to the ratio of GP to SP capacity factors (ϕ), i.e.:

$$0.6/0.8 \times 100 = 75\%$$

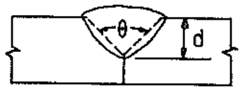
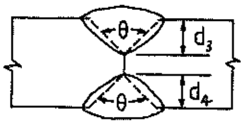
9.2.3 Strength Limit State Assessment of Butt Welds

(a) *Complete penetration butt welds, category SP:* Where a category SP complete penetration butt weld is used, no detailed analysis of the weld strength is required. Due to this, the design capacity of a category SP, complete penetration butt weld, is considered as being equal to the nominal capacity of the weaker part of the parts being joined, multiplied by the appropriate capacity factor, ϕ (=0.9).

For a category GP complete penetration butt weld, the designer must be satisfied that this weld can properly transmit the imposed loads in the strength limit state condition by taking into account the increased defects permitted in the weld. Again, the design capacity is equal to the nominal capacity of the weaker part multiplied by the appropriate capacity factor, ϕ (=0.6)

The design throat thickness for a complete penetration butt weld shall be the size of the weld.

(b) *Incomplete penetration butt weld:* The design capacity of an incomplete-penetration butt weld shall be calculated as for a fillet weld using the design throat thickness determined in accordance with Clause 9.7.2.3(b) of AS 4100. Following is a summary of this clause for prequalified preparations as specified in AS 1554.1 :

Joint Type	θ or t_t	Manual metal arc	Submerged arc	Flux-cored arc	Gas-shielded metal-arc
Single-V butt weld 	θ	45,60	60	50,60	50,60
	t_t	45: d−3 60: d	d	d−3	d−3
Double-V butt weld 	θ	45,60	60	50,60	50,60
	t_t	45: d_3+d_4-6	d_3+d_4	d_3+d_4-6	d_3+d_4-6

NOTE: 1) t_t = design throat thickness.
2) For other types of butt welds see Table 4.4(B), AS 1554.1

TABLE 9.2.3

Clauses 9.7.2.3(b)(ii) and 9.7.2.3(b)(iii) of AS 4100 should be referred to for non-prequalified preparations for incomplete penetration butt welds.

The effective length of a butt weld is taken as the length of the continuous full size weld. The effective area of a butt weld is calculated from the product of the effective length and the design throat thickness.

9.2.4 Strength Limit State Assessment of Fillet Welds

In the design of fillet welds using AS 4100, for

- the size of a fillet weld (t_w,or t_{w1},t_{w2}) refer to Clauses 9.7.3.1, 9.7.3.2 and 9.7.3.3 of AS 4100;
- the calculation of *design throat thickness* (t_t) refer to Clause 9.7.3.4 of AS 4100;
- the calculation of *effective length* refer to Clause 9.7.3.5 of AS 4100.

Design Capacities of Fillet Welds: A fillet weld subject to a design force per unit length of weld, v_w^*, shall satisfy:

$$v_w^* \leq \phi v_w$$

where v_w^* = the vectorial sum of the design forces per unit length on the effective area of the weld

v_w = nominal capacity of a fillet weld per unit length

= $0.6 f_{uw} t_t k_r$

ϕ = capacity factor (Table 3.4 of AS 4100 or Section 9.2.2 of these tables)

and

f_{uw} = nominal tensile strength of the weld metal (Table 9.7.3.10(1) of AS 4100)

t_t = design throat thickness

k_r = reduction factor for a welded lap connection (Table 9.7.3.10(2) of AS 4100)

The effective area of a fillet weld is the product of the effective length and the design throat thickness.

Tables 9.2.4-1 and 9.2.4-2 lists the design capacity, ϕv_w, of an equal leg fillet weld for varying weld size (t_w) and weld category (SP or GP). These values are derived from the design capacity side of the above strength limit state inequality, so that

$$\phi v_w = \phi 0.6 f_{uw} t_t k_r$$

where the reduction factor to account for the length of a welded lap connection (k_r) is taken as unity (Table 9.7.3.10(2) of AS 4100).

Notation used in Tables 9.2.4-1 and 9.2.4-2:

1) t_t = design throat thickness = $t_w / \sqrt{2}$; t_w = leg size

2) f_{uw} = nominal tensile strength of the weld metal.

Table 9.2.4-1: Design Capacities of Equal Leg Fillet Welds
Category SP, ϕ = 0.8

Weld Size (mm)		Design Capacity per unit length of weld, ϕv_w (kN/mm)	
t_w	t_t	E41XX/W40X	E48XX/W50X
3	2.12	0.417	0.489
4	2.83	0.557	0.652
5	3.54	0.696	0.815
6	4.24	0.835	0.978
8	5.66	1.11	1.30
10	7.07	1.39	1.63
12	8.49	1.67	1.96
		f_{uw} = 410 MPa	f_{uw} = 480 MPa

Table 9.2.4-2: Design Capacities of Equal Leg Fillet Welds
Category GP, ϕ = 0.6

Weld Size (mm)		Design Capacity per unit length of weld, ϕv_w (kN/mm)	
t_w	t_t	E41XX/W40X	E48XX/W50X
3	2.12	0.313	0.367
4	2.83	0.417	0.489
5	3.54	0.522	0.611
6	4.24	0.626	0.733
8	5.66	0.835	0.978
10	7.07	1.04	1.22
12	8.49	1.25	1.47
		f_{uw} = 410 MPa	f_{uw} = 480 MPa

Remarks on (equal) fillet weld leg sizes, t_w:

1) for t_w = 3-5 mm : Used for a minimum size fillet weld (Table 9.7.3.2 of AS 4100)

2) for t_w = 6-8 mm : Sizes preferred for standard connections – single pass welds.

3) for t_w = 10-12 mm : Not recommended for all cases – cannot be guaranteed as single pass welds. Check with fabricator before specifying.

9.2.5 Strength Limit State Assessment of a Weld Group

For the assessment of the strength of a fillet weld group in compliance with AS 4100 see Ref.[2] of Section 9.4.

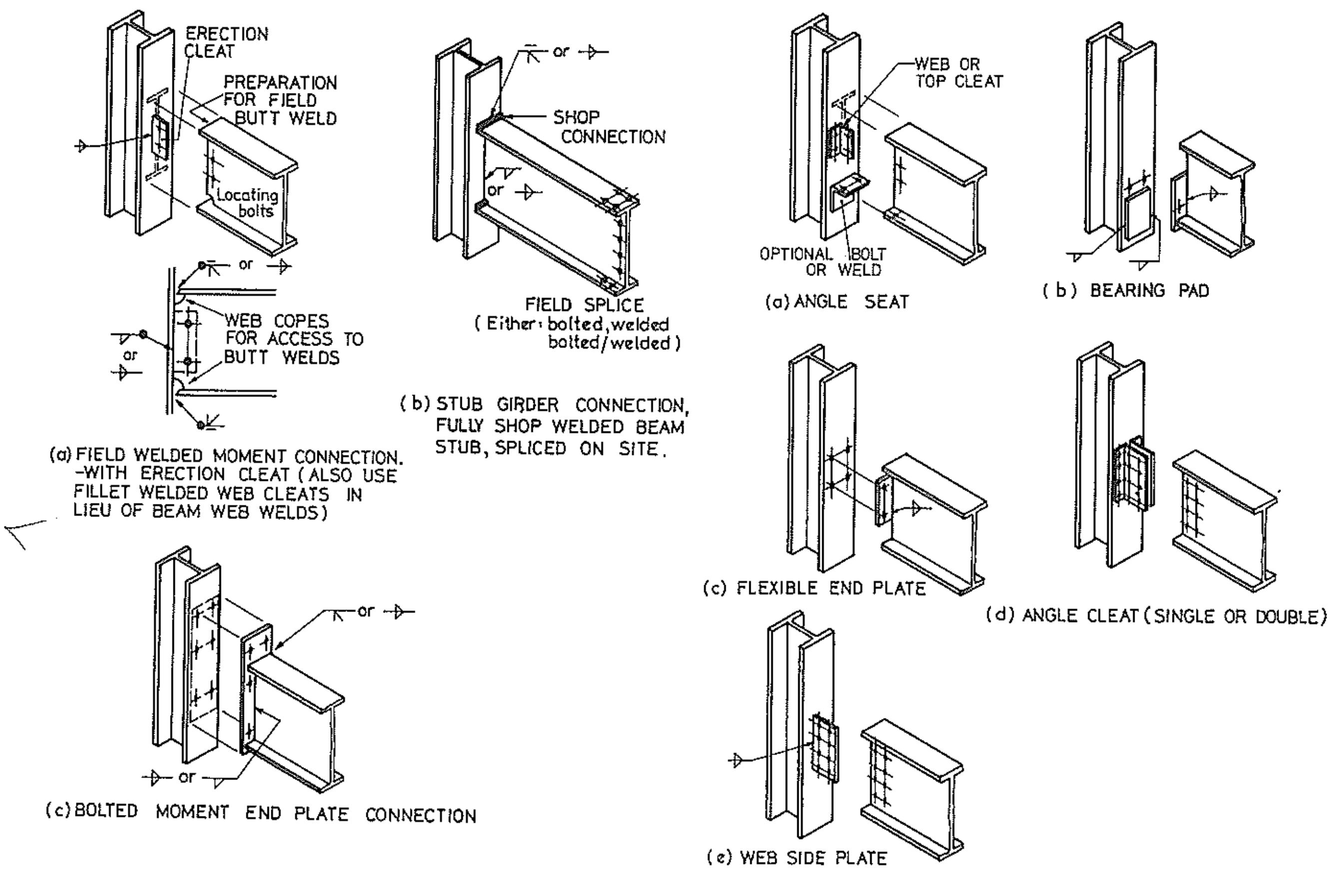
9.3 Standardised Structural Connections

This Section provides a brief summary only; full details can be found in the references listed in Section 9.4.

9.3.1 Standard Components

The components used in any connection are selected from a range of standard flat bars and angles. Using these standard components, it has been possible to develop a standardised connection detail and design capacity tables for each connection type. This has very real advantages, since it enables the designer to adopt a rational approach to connection selection and design.

9.3.2 Standardised Structural Connections



Rigid Connections **Flexible Connections**

Figure 9.3.2

9.3.3 Standard Parameters

GAUGE LINES

70mm **90mm** **140mm**

PITCH

70mm

BOLTS

20mm diameter (designated M20)

HOLES

22mm diameter

BOLT TYPE

High strength structural bolts (to AS 1252)
(threads included in shear plane)

WELDING ELECTRODES

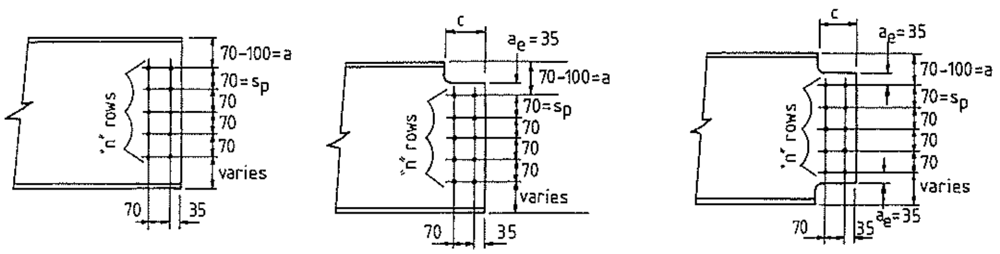
W50X (continuous wire) **E48XX** (rods)

FILLET WELDS

6mm **8mm**

Figure 9.3.3-1: Standard Parameters

Bolting Layout for Supported Members



(a) Square end, Uncoped **(b) Single Web Coped End, SWC** **(c) Double Web Coped End, DWC**

Note: All beam end preparations may have a single line of bolts in lieu of the two lines shown above.

Bolting Layouts

Figure 9.3.3-2: Standard End Preparations

9.4 References

[1] A. Firkins & T.J. Hogan, "Bolting of Steel Structures" – 3rd Ed., *Australian Institute of Steel Construction*, 1991.

[2] T.J. Hogan & I.R. Thomas, "Design of Structural Connections", 4th Ed., *Australian Institute of Steel Construction*, 1994.

[3] "Standardised Structural Connections", 3rd Ed., *Australian Institute of Steel Construction*, 1985.

[4] "Design Capacity Tables for Structural Steel", 1st Ed., *Australian Institute of Steel Construction*, 1991.

Suggested reference:

- AS 4100 Supplement 1 – 1990 "Steel Structures – Commentary (Supplement to AS 4100-1990)", *Standards Australia*, 1990. Specific reference to Sections C9, C14 and C15.

PART 10 DETAILING PARAMETERS

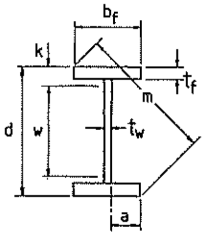


TABLE 10.1-1

WELDED BEAMS

RATIONALISED DIMENSIONS FOR DETAILING

Designation	Depth of Section d	Flange Width b_f	Flange Thickness t_f	Web Thickness t_w	Web Thickness $\frac{t_w}{2}$	Dimensions a	Dimensions w	Dimensions k	Dimensions m
kg/m	mm	mm	mm	mm	mm	mm	mm	mm	mm
1200WB455	1200	500	40	16	8	242	1104	48	1300
423	1192	500	36	16	8	242	1104	44	1293
392	1184	500	32	16	8	242	1104	40	1285
342	1184	400	32	16	8	192	1104	40	1250
317	1176	400	28	16	8	192	1104	36	1242
278	1170	350	25	16	8	167	1104	33	1221
249	1170	275	25	16	8	130	1104	33	1202
1000WB322	1024	400	32	16	8	192	944	40	1099
296	1016	400	28	16	8	192	944	36	1092
258	1010	350	25	16	8	167	944	33	1069
215	1000	300	20	16	8	142	944	28	1044
900WB282	924	400	32	12	6	194	848	38	1007
257	916	400	28	12	6	194	848	34	1000
218	910	350	25	12	6	169	848	31	975
175	900	300	20	12	6	144	848	26	949
800WB192	816	300	28	10	5	145	748	34	869
168	810	275	25	10	5	133	748	31	855
146	800	275	20	10	5	133	748	26	846
122	792	250	16	10	5	120	748	22	831
700WB173	716	275	28	10	5	133	648	34	767
150	710	250	25	10	5	120	648	31	753
130	700	250	20	10	5	120	648	26	743
115	692	250	16	10	5	120	648	22	736

Note: Dimensions may not add correctly due to rounding.

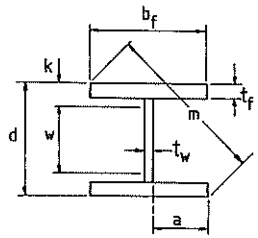


TABLE 10.1-2

WELDED COLUMNS

RATIONALISED DIMENSIONS FOR DETAILING

Designation	Depth of Section d	Flange Width b_f	Flange Thickness t_f	Web Thickness t_w	Web Thickness $\frac{t_w}{2}$	Dimensions a	Dimensions w	Dimensions k	Dimensions m
kg/m	mm	mm	mm	mm	mm	mm	mm	mm	mm
500WC440	480	500	40	40	20	230	384	48	693
414	480	500	40	32	16	234	384	48	693
383	472	500	36	32	16	234	384	44	688
340	514	500	32	25	13	238	434	40	717
290	506	500	28	20	10	240	434	36	711
267	500	500	25	20	10	240	434	33	707
228	490	500	20	20	10	240	434	28	700
400WC361	430	400	40	40	20	180	334	48	587
328	430	400	40	28	14	186	334	48	587
303	422	400	36	28	14	186	334	44	581
270	414	400	32	25	13	188	334	40	576
212	400	400	25	20	10	190	334	33	566
181	390	400	20	20	10	190	334	28	559
144	382	400	16	16	8	192	334	24	553
350WC280	355	350	40	28	14	161	259	48	499
258	347	350	36	28	14	161	259	44	493
230	339	350	32	25	13	163	259	40	487
197	331	350	28	20	10	165	259	36	482

Note: Dimensions may not add correctly due to rounding.

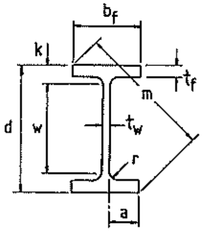


TABLE 10.1-3

UNIVERSAL BEAMS

RATIONALISED DIMENSIONS FOR DETAILING

Designation	Depth of Section d	Flange Width b_f	Flange Thickness t_f	Web Thickness t_w	Web Thickness $\frac{t_w}{2}$	Dimensions a	Dimensions w	Dimensions k	Dimensions m	Dimensions r
kg/m	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
610UB125	612	229	20	12	6	109	544	34	653	14
113	607	228	17	11	6	108	544	31	648	14
101	602	228	15	11	5	109	544	29	644	14
530UB 92.4	533	209	16	10	5	99	474	30	573	14
82.0	528	209	13	10	5	100	474	27	568	14
460UB 82.1	460	191	16	10	5	91	406	27	498	11
74.6	457	190	15	9	5	90	406	26	495	11
67.1	454	190	13	9	4	91	406	24	492	11
410UB 59.7	406	178	13	8	4	85	358	24	444	11
53.7	403	178	11	8	4	85	358	22	440	11
360UB 56.7	359	172	13	8	4	82	310	24	398	11
50.7	356	171	12	7	4	82	310	23	395	11
44.7	352	171	10	7	3	82	310	21	391	11
310UB 46.2	307	166	12	7	3	80	261	23	349	11
40.4	304	165	10	6	3	79	261	22	346	11
32.0	298	149	8	6	3	72	256	21	333	13
250UB 37.3	256	146	11	6	3	70	217	20	295	9
31.4	252	146	9	6	3	70	217	18	291	9
25.7	248	124	8	5	3	60	208	20	277	12
200UB 29.8	207	134	10	6	3	64	170	19	247	9
25.4	203	133	8	6	3	64	170	17	243	9
22.3	202	133	7	5	3	64	170	16	242	9
18.2	198	99	7	5	2	47	162	18	221	11
180UB 22.2	179	90	10	6	3	42	141	19	201	9
18.1	175	90	8	5	3	43	141	17	197	9
16.1	173	90	7	5	2	43	141	16	195	9
150UB 18.0	155	75	10	6	3	35	120	18	172	8
14.0	150	75	7	5	3	35	120	15	168	8

Note: Dimensions may not add correctly due to rounding.

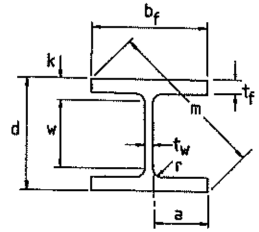


TABLE 10.1-4

UNIVERSAL COLUMNS

RATIONALISED DIMENSIONS FOR DETAILING

Designation	Depth of Section d	Flange Width b_f	Flange Thickness t_f	Web Thickness t_w	Web Thickness $\frac{t_w}{2}$	Dimensions a	Dimensions w	Dimensions k	Dimensions m	Dimensions r
kg/m	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
310UC158	327	311	25	16	8	148	244	42	451	17
137	321	309	22	14	7	148	244	38	445	17
118	315	307	19	12	6	148	244	35	440	17
96.8	308	305	15	10	5	148	244	32	433	17
250UC 89.5	260	256	17	11	5	123	197	31	365	14
72.9	254	254	14	9	4	123	197	28	359	14
200UC 59.5	210	205	14	9	5	98	159	26	293	11
52.2	206	204	13	8	4	98	159	24	290	11
46.2	203	203	11	7	4	98	159	22	287	11
150UC 37.2	162	154	12	8	4	73	121	20	223	9
30.0	158	153	9	7	3	73	121	18	220	9
23.4	152	152	7	6	3	73	121	16	215	9
100UC 14.8	97	99	7	5	3	47	63	17	139	10

Note: Dimensions may not add correctly due to rounding.

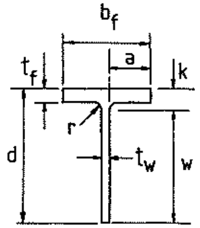


TABLE 10.1-5

TEES CUT FROM UNIVERSAL BEAMS

RATIONALISED DIMENSIONS FOR DETAILING

Designation	Cut from Universal Beam Section	Depth of Section d	Flange Width b_f	Flange Thickness t_f	Web Thickness t_w	Web Thickness $\frac{t_w}{2}$	Dimensions a	Dimensions w	Dimensions k	Dimensions r
kg/m	kg/m	mm	mm	mm	mm	mm	mm	mm	mm	mm
305BT62.5	610UB125	305	229	20	12	6	109	271	34	14
56.5	113	303	228	17	11	6	108	271	31	14
50.5	101	300	228	15	11	5	109	271	29	14
265BT46.3	530UB 92.4	266	209	16	10	5	99	236	30	14
41.0	82.0	263	209	13	10	5	100	236	27	14
230BT41.1	460UB 82.1	229	191	16	10	5	91	202	27	11
37.3	74.6	228	190	15	9	5	90	202	26	11
33.6	67.1	226	190	13	9	4	91	202	24	11
205BT29.9	410UB 59.7	202	178	13	8	4	85	178	24	11
26.9	53.7	200	178	11	8	4	85	178	22	11
180BT28.4	360UB 56.7	178	172	13	8	4	82	154	24	11
25.4	50.7	177	171	12	7	4	82	154	23	11
22.4	44.7	175	171	10	7	3	82	154	21	11
155BT23.1	310UB 46.2	153	166	12	7	3	80	129	23	11
20.2	40.4	151	165	10	6	3	79	129	22	11
16.0	32.0	148	149	8	6	3	72	127	21	13
125BT18.7	250UB 37.3	127	146	11	6	3	70	107	20	9
15.7	31.4	125	146	9	6	3	70	107	18	9
12.0	25.7	123	124	8	5	3	60	103	20	12
100BT14.9	200UB 29.8	103	134	10	6	3	64	84	19	9
12.7	25.4	101	133	8	6	3	64	84	17	9
11.2	22.3	100	133	7	5	3	64	84	16	9
9.1	18.2	98	99	7	5	2	47	80	18	11
90BT11.1	180UB 22.2	89	90	10	6	3	42	70	19	9
9.1	18.1	87	90	8	5	3	43	70	17	9
8.1	16.1	86	90	7	5	2	43	70	16	9
75BT 9.0	150UB 18.0	77	75	10	6	3	35	59	18	8
7.0	14.0	74	75	7	5	3	35	59	15	8

Notes: (1) A 1 mm cutting allowance has been provided off each split tee.
(2) Dimensions may not add correctly due to rounding.

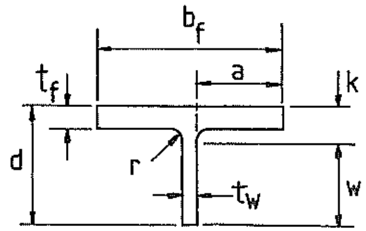


TABLE 10.1-6

TEES CUT FROM UNIVERSAL COLUMNS

RATIONALISED DIMENSIONS FOR DETAILING

Designation	Cut from Universal Column Section	Depth of Section d	Flange Width b_f	Flange Thickness t_f	Web Thickness t_w	Web Thickness $\frac{t_w}{2}$	Dimensions a	Dimensions w	Dimensions k	Dimensions r
kg/m	kg/m	mm	mm	mm	mm	mm	mm	mm	mm	mm
155CT79.0	310UC158	163	311	25	16	8	148	121	42	17
68.5	137	159	309	22	14	7	148	121	38	17
59.0	118	156	307	19	12	6	148	121	35	17
48.4	96.8	153	305	15	10	5	148	121	32	17
125CT44.8	250UC 89.5	129	256	17	11	5	123	98	31	14
36.5	72.9	126	254	14	9	4	123	98	28	14
100CT29.8	250UC 59.5	104	205	14	9	5	98	78	26	11
26.1	52.2	102	204	13	8	4	98	78	24	11
23.1	46.2	101	203	11	7	4	98	78	22	11
75CT18.6	150UC 37.2	80	154	12	8	4	73	60	20	9
15.0	30.0	78	153	9	7	3	73	60	18	9
11.7	23.4	75	152	7	6	3	73	59	16	9
50CT 7.4	100UC 14.8	48	99	7	5	3	47	31	17	10

Notes: (1) A 1 mm cutting allowance has been provided off each split tee.
(2) Dimensions may not add correctly due to rounding.

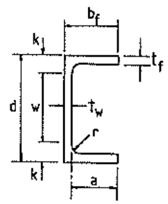


TABLE 10.1-7

PARALLEL FLANGE CHANNELS

RATIONALISED DIMENSIONS FOR DETAILING

Designation	Mass per m	Depth of Section d	Flange Width b_f	Flange Thickness t_f	Web Thickness t_w	Dimensions a	Dimensions w	Dimensions k	Dimensions r
	kg/m	mm	mm	mm	mm	mm	mm	mm	mm
380 PFC	55.2	380	100	18	10	90	317	32	14
300 PFC	40.1	300	90	16	8	82	240	30	14
250 PFC	35.5	250	90	15	8	82	196	27	12
230 PFC	25.1	230	75	12	7	89	182	24	12
200 PFC	22.9	200	75	12	6	69	152	24	12
180 PFC	20.9	180	75	11	6	69	134	23	12
150 PFC	17.7	150	75	10	6	69	111	20	10

Note: Dimensions may not add correctly due to rounding.

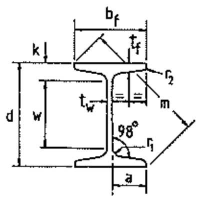


TABLE 10.1-9

TAPER FLANGE BEAMS

RATIONALISED DIMENSIONS FOR DETAILING

Designation	Mass per m	Depth of Section d	Flange Width b_f	Flange Thickness t_f	Web Thickness t_w	Web Thickness $\frac{t_w}{2}$	Dimensions a	Dimensions w	Dimensions k	Dimensions m	Dimensions r_1	Dimensions r_2
	kg/m	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
125 TFB	13.1	125	65	9	5	3	30	92	17	141	8	4
100 TFB	7.20	100	45	6	4	2	21	74	13	110	7	3

Note: Dimensions may not add correctly due to rounding.

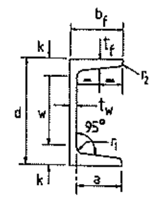


TABLE 10.1-8

TAPER FLANGE CHANNELS

RATIONALISED DIMENSIONS FOR DETAILING

Designation	Mass per m	Depth of Section d	Flange Width b_f	Flange Thickness t_f	Web Thickness t_w	Dimensions a	Dimensions w	Dimensions k	Dimensions r_1	Dimensions r_2
	kg/m	mm	mm	mm	mm	mm	mm	mm	mm	mm
125 TFC	13.4	125	65	8	6	59	93	16	8	4
100 TFC	9.34	100	50	8	5	45	69	16	8	4
75 TFC	6.65	75	40	7	5	35	46	15	8	4

Note: Dimensions may not add correctly due to rounding.

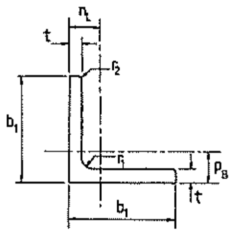


TABLE 10.1-10

EQUAL ANGLES

RATIONALISED DIMENSIONS FOR DETAILING

Designation: Leg Size $b_1 \times b_1$	Designation: Ration'd Thick-ness	Mass per m	Dimensions: Actual Thickness t	Dimensions: r_1	Dimensions: r_2	Centre of area $p_B = n_L$
mm mm	mm	kg/m	mm	mm	mm	mm
200 x 200 x	26EA	76.8	26.0	18	5	59
	20EA	60.1	20.0	18	5	57
	18EA	54.4	18.0	18	5	56
	16EA	48.7	16.0	18	5	55
	13EA	40.0	13.0	18	5	54
150 x 150 x	19EA	42.1	19.0	13	5	44
	16EA	35.4	15.8	13	5	43
	12EA	27.3	12.0	13	5	42
	10EA	21.9	9.5	13	5	41
125 x 125 x	16EA	29.1	15.8	10	5	37
	12EA	22.5	12.0	10	5	35
	10EA	18.0	9.5	10	5	34
	8EA	14.9	7.8	10	5	34
100 x 100 x	12EA	17.7	12.0	8	5	29
	10EA	14.2	9.5	8	5	28
	8EA	11.8	7.8	8	5	28
	6EA	9.2	6.0	8	5	27
90x 90 x	10EA	12.7	9.5	8	5	26
	8EA	10.6	7.8	8	5	25
	6EA	8.22	6.0	8	5	24
75x 75 x	10EA	10.5	9.5	8	5	22
	8EA	8.73	7.8	8	5	21
	6EA	6.81	6.0	8	5	21
	5EA	5.27	4.6	8	5	20
65 x 65 x	10EA	9.02	9.5	6	3	20
	8EA	7.51	7.8	6	3	19
	6EA	5.87	6.0	6	3	18
	5EA	4.56	4.6	6	3	18
55 x 55 x	6EA	4.93	6.0	6	3	16
	5EA	3.84	4.6	6	3	15
50 x 50 x	8EA	5.68	7.8	6	3	15
	6EA	4.46	6.0	6	3	15
	5EA	3.48	4.6	6	3	14
	3EA	2.91	3.0	6	3	13
45 x 45 x	6EA	3.97	6.0	5	3	13
	5EA	3.10	4.6	5	3	13
	3EA	2.06	3.0	5	3	12
40 x 40 x	6EA	3.50	6.0	5	3	12
	5EA	2.73	4.6	5	3	11
	3EA	1.83	3.0	5	3	11
30 x 30 x	6EA	2.56	6.0	5	3	10
	5EA	2.01	4.6	5	3	9
	3EA	1.35	3.0	5	3	8
25 x 25 x	6EA	2.08	6.0	5	3	8
	5EA	1.65	4.6	5	3	8
	3EA	1.12	3.0	5	3	7

Note: Dimensions may not add correctly due to rounding.

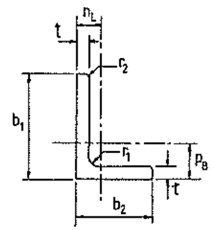
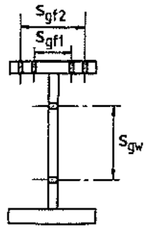


TABLE 10.1-11

UNEQUAL ANGLES

RATIONALISED DIMENSIONS FOR DETAILING

Designation: Leg Size $b_1 \times b_2$	Designation: Ration'd Thick-ness	Mass per m	Dimensions: Actual Thickness t	Dimensions: r_1	Dimensions: r_2	Centre of area: p_B	Centre of area: n_L
mm mm	mm	kg/m	mm	mm	mm	mm	mm
150 x 100 x	12UA	22.5	12.0	10	5	49	24
	10UA	18.0	9.5	10	5	48	23
150 x 90 x	16UA	27.9	15.8	10	5	52	23
	12UA	21.6	12.0	10	5	51	21
	10UA	17.3	9.5	10	5	50	20
	8UA	14.3	7.8	10	5	49	20
125 x 75 x	12UA	17.7	12.0	8	5	43	18
	10UA	14.2	9.5	8	5	42	17
	8UA	11.8	7.8	8	5	42	17
	6UA	9.16	6.0	8	5	41	16
100 x 75 x	10UA	12.4	9.5	8	5	32	19
	8UA	10.3	7.8	8	5	31	19
	6UA	7.98	6.0	8	5	30	18
75 x 50 x	8UA	7.23	7.8	7	3	25	13
	6UA	5.66	6.0	7	3	24	12
	5UA	4.40	4.6	7	3	24	12
65 x 50 x	8UA	6.59	7.8	6	3	21	14
	6UA	5.16	6.0	6	3	20	13
	5UA	4.02	4.6	6	3	20	12



GAUGE LINES FOR WELDED SECTIONS

TABLE 10.2-1(A)

Section	M20				M24			
	Flange	s_{gf1}	Flange	s_{gf2}	Flange	s_{gf1}	Flange	s_{gf2}
WELDED BEAMS								
1200WB455-392	140	90	280	420	140	90	280	
1200WB342-278	140	90	280		140	90	280	
1200WB249	140	90			140	90		
1000WB322-258	140	90	280		140	90	280	
1000WB215	140	90			140	90		
900WB282,218	140	90	280		140	90	280	
900WB175	140	90			140	90		
800WB	140	90			140	90		
700WB	140	90			140	90		
WELDED COLUMNS								
500WC	140		280	420	140		280	
400WC	140		280		140		280	
350WC	140				140			
Preference	1	2	1	2	1	2	1	2

Note: All Dimensions are in mm.

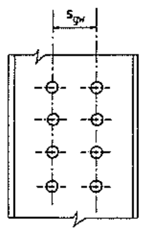


TABLE 10.2-1(B)

Section	Web s_{gw}					
	M20			M24		
WELDED BEAMS						
1200WB	140	90	70	140	90	70
1000WB	140	90	70	140	90	70
900WB	140	90	70	140	90	70
800WB	140	90	70	140	90	70
700WB	140	90	70	140	90	70
WELDED COLUMNS						
500WC	140	90	70	140	90	70
400WC	140	90	70	140	90	70
350WC	140	90	70	140	90	70
Preference	1	2	3	1	2	3

Note: All Dimensions are in mm.

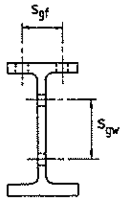
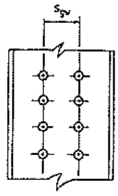


TABLE 10.2-2

GAUGE LINES FOR UNIVERSAL SECTIONS



Section	Flange s_{gf}				Web s_{gw}					
	M20		M24		M20			M24		
UNIVERSAL BEAMS										
610UB	140	90	140	90	140	90	70	140	90	70
530UB	140	90	140	90	140	90	70	140	90	70
460UB	90	140	90		90	70	140	90	70	140
410UB	90	70	90		90	70	140	90	70	140
360UB,310UB	90	70	90		90	70	140	90	70	140
310UB32.0	70				90	70	140			
250UB	70	90			70	90	140	70	90	140
250UB25.7*	70				70	90				
200UB	70				70	90		70	90	
200UB18.2*	50				70	90				
180UB	b				70	90		70	90	
150UB	b				70			70		
UNIVERSAL COLUMNS										
310UC	140	90	140	90	90	70	140	90	70	140
250UC	140	90	140	90	90	70	140	90	70	140
200UC	140	90	140	90	90	70		90	70	
150UC	90	70	90		70			70		
100UC	60		b		c			c		
Preference	1	2	1	2	1	2	3	1	2	3

Notes: * Gauge listed for 250UB25.7and 200 UBl8.2 are for M16 bolts.
b — indicates that the flange will not accommodate this size of bolt.
c — indicates that the web will not accommodate two lines of bolts with a gauge of 50mm or more.
All Dimensions are in mm.

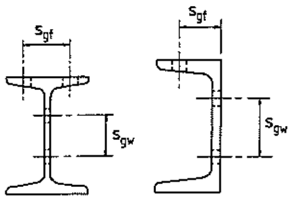
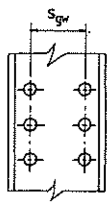


TABLE 10.2-3

GAUGE LINES FOR TAPER FLANGE BEAMS AND CHANNELS



Section	Flange s_{gf}			Web s_{gw}								
	M16	M20	M24	M16			M20			M24		
TAPER FLANGE BEAMS												
125 x 65	b			50			50			c		
100 x 45	b			c			c			c		
PARALLEL FLANGE CHANNELS												
380 x 100	55	55	55	140	90	70	140	90	70	140	90	70
300 x 90	55	55	b	140	90	70	140	90	70	140	90	70
250 x 90	55	55	b	140	90	70	140	90	70	140	90	70
230 x 75	45	45	b	140	90	70	90	70		90	70	
200 x 75	45	45	b	90	70		90	70		90	70	
180 x 75	45	45	b	70	90		70	90		70		
150 x 75	45	45	b	70			65			55		
TAPER FLANGE CHANNELS												
125 x 65	35	b	b	50			c			c		
100 x 50	b	b	b	c			c			c		
75 x 40	b	b	b	c			c			c		
Preference	1	1	1	1	2	3	1	2	3	1	2	3

Notes: b — indicates that the flange will not acommodate this size of bolt.
c — indicates that the web will not accommodate two lines of bolts with a guage of 50mm or more.
All Dimensions are in mm.

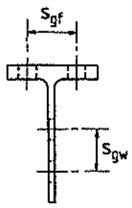
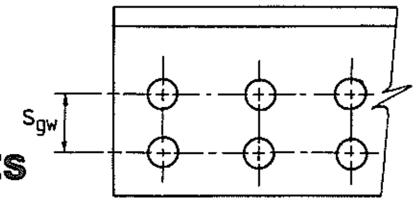


TABLE 10.2-4



GAUGE LINES FOR STRUCTURAL TEES
cut from Universal Sections

Section	Flange s_{gf} M20		Flange s_{gf} M24		Web s_{gw} M20			Web s_{gw} M24		
TEES from Universal Beams										
305BT	140	90	140	90	140	90	70	140	90	70
265BT	140	90	140	90	140	90	70	140	90	70
230BT	90	140	90		90	70	140	90	70	140
205BT	90	70	90		90	70	140	90	70	140
180BT	90	70	90		90	70	140	90	70	140
155BT	90	70	90		70			70		
155BT 16.0	70				70					
125BT	70	90			50			c		
125BT 12.9*	70				50					
100BT	70				c			c		
100BT 9.1*	50				c					
90BT	b				c			c		
75BT	b				c			c		
TEES from Universal Columns										
155CT	140	90	140	90	70			60		
125CT	140	90	140	90	50			c		
100CT	140	90	140	90	c			c		
75CT	90	70	90		c			c		
Preference	1	2	1	2	1	2	3	1	2	3

Notes: * Gauges listed for 125BT12.9 and 100BT 9.1 are for M16 bolts.
b — indicates that the flange will not accommodate this size of bolt.
c — indicates that the web will not accommodate two lines of bolts with a gauge of 50mm or more.
All Dimensions are in mm.

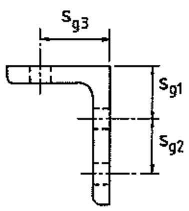
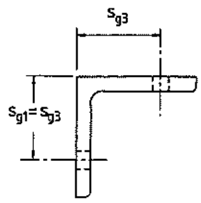


TABLE 10.2-5



GAUGE LINES FOR ANGLES

Nominal leg length	s_{g1}	s_{g2}	s_{g3}	Bolt
200	75	75	120	M24
150	55	55	90	M20
125	45	50	75	M20

Nominal leg length	s_{g3}	Bolt
100	55	M20
90	55	M20
75	45	M20
65	35	M16
55	35	M16
50	30	M16

NOTES TO ALL TABLES OF GAUGE LINES:

1. The gauges given are suitable for general use in member detailing. When angles are used as *components in connections*, gauge lines may be varied from the values given above in order to suit a particular connection. See Part 9 for a summary of AISC Standardised Structural Connections and standard components.
2. The bolt diameters listed are the maximum that can be accommodated on the thickest angles of each leg length, using either —
   (a) high strength structural bolts with washers to AS 1252; or
   (b) commercial bolts with 'large series' washers to AS 1237.
   For thinner legs and commercial bolts with 'normal series' washers, it may be possible to accommodate a larger bolt diameter.

TABLE 10.3-1

DIMENSIONS OF COMMERCIAL BOLTS (AS 1111, AS 1112, AS 1237)

BOLT										NUT			WASHER	
Nom. dia.	Thread pitch	Thread run-out	Shank dia.	Width across flats	Width across corners	Height of head	Areas			Width across flats	Width across corners	Height of normal nuts	Outside dia.	Nominal thickness
							core	tensile stress	shank					
		max.	nom.	max.	nom.	ave.	A_c	AS	AD	max.	nom.	ave.	max.	
M12	1.75	8.75	12	18	21	8	76.2	84.3	113	18	21	11	24	2.5
M16	2.0	10	16	24	28	10	144	157	201	24	28	15	30	3
M20	2.5	12.5	20	30	35	13	225	245	314	30	35	18	37	3
M24	3.0	15	24	36	42	15	324	353	452	36	42	21	44	4
M30	3.5	17.5	30	46	53	19	519	561	706	46	53	25	56	4
M36	4.0	20	36	55	63	23	759	817	1016	55	63	30	66	5

Note: All dimensions in mm or mm².

TABLE 10.3-2

DIMENSIONS OF HIGH STRENGTH STRUCTURAL BOLTS (AS 1252)

BOLT										NUT			WASHER	
Nom. dia.	Thread pitch	Thread run-out	Shank dia.	Width across flats	Width across corners	Height of head	Areas			Width across flats	Width across corners	Height of normal nuts	Outside dia.	Nominal thickness
							core	tensile stress	shank					
		max.	nom.	max.	nom.	ave.	A_c	A_s	A_D	max.	nom.	ave.	max.	
M16	2.0	6.0	16	27	31	10	144	157	201	27	31	17	34	4
M20	2.5	7.5	20	32	37	13	225	245	314	32	37	21	39	4
M24	3.0	9.0	24	41	47	15	324	353	452	41	47	25	50	4
M30	3.5	10.5	30	50	58	19	519	561	706	50	58	31	60	4
M36	4.0	12.0	36	60	69	23	759	817	1016	60	69	37	72	4

Note: All dimensions in mm or mm².

TABLE 10.4-1

MASSES OF BOLTS COMMERCIAL BOLTS

TABLE 10.4-2

MASSES OF BOLTS HIGH STRENGTH STRUCTURAL BOLTS

approximate masses in kilograms per 1000

Table 10.4-1: Commercial bolts

Length under head in mm	NOMINAL SIZE OF BOLT					
	M12	M16	M20	M24	M30	M36
40	64.1	129	214			
45	68.5	137	227			
50	72.9	144	239	377		
55	77.3	153	251	395		
60	81.7	160	264	412		
65	86.1	168	276	429		
70	90.5	176	288	447		
75	95.0	184	300	464		
80	100	192	313	481		
90	109	207	337	516	930	
100	118	223	362	550	986	1371
110	127	239	387	585	1042	1451
120	136	255	411	620	1098	1531
130	145	270	436	654	1154	1610
140	154	286	460	689	1210	1690
150	163	302	485	723	1266	1770
160				758	1322	1850
170					1378	1930
180					1434	2009
190					1490	2089
200						2169
Approximate mass in kg of 1000 nuts	15.9	32.9	59.8	104	209	352

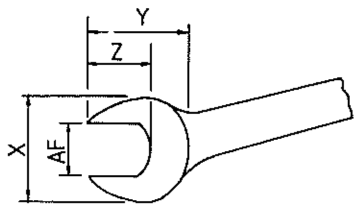
Table 10.4-2: High strength structural bolts

Length under head in mm	NOMINAL SIZE OF BOLT		
	M16	M20	M24
40	152	247	
45	160	260	
50	168	272	491
55	176	285	509
60	184	297	527
65	192	310	545
70	199	322	562
75	207	334	580
80	215	346	598
90	231	371	633
100			669
110			704
120			739
130			
140			
150			
160			
170			
180			
190			
200			
Approximate mass in kg of 1000 nuts	55.7	95.3	194

Source: "Metric Practice for Structural Steelwork", 3rd Edn., Publication No. 5/79, British Constructional Steelwork Association.

DIMENSIONS OF WRENCHES

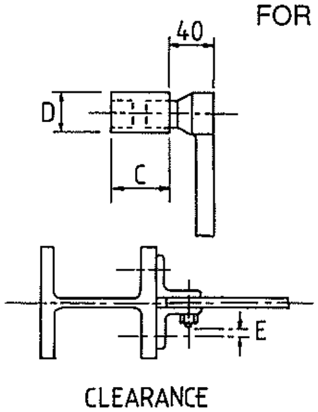
DIMENSIONS OF OPEN ENDED WRENCHES FOR DETERMINING ERECTION CLEARANCES 4.6/S and 8.8/S PROCEDURES



AF = dimension across flats to suit bolt.

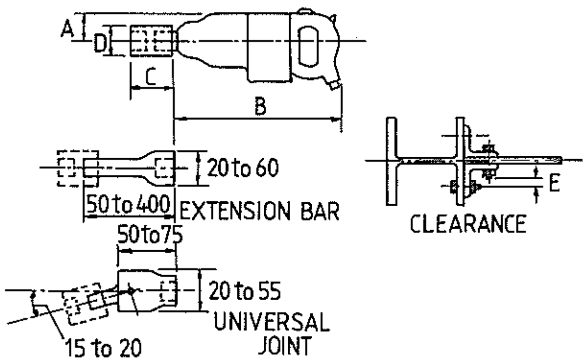
Bolt Size	Clearance X	Clearance Y	Clearance Z
16	52	45	28
20	65	56	35
24	78	67	41
30	99	85	53
36	118	102	63

DIMENSIONS OF SOCKETS – HAND WRENCHES FOR DETERMINING ERECTION CLEARANCES 8.8/TF AND 8.8/TB PROCEDURES



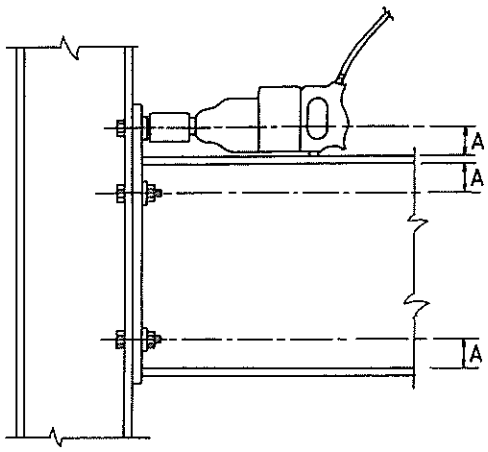
Normal Sockets *			Clearance
Bolt Size	C	D	E
16	50	38	25
20	60	45	30
24	80	57	35

DIMENSIONS OF SOCKETS – IMPACT WRENCHES FOR DETERMINING ERECTION CLEARANCES 8.8/TF AND 8.8/TB PROCEDURES



Larger sizes (M30, M36) of the high strength structural bolt should be treated with caution, especially when full tensioning to the requirements of AS 4100 Clause 15.2.5, since on-site-tensioning can be difficult and requires special equipment to achieve the minimum bolt tensions specified in AS 4100

	Capacity	B	A
Normal Wrenches	to 24	to 450 some to 600	54
Heavy Wrences			65



Normal Sockets *			Clearance E
Bolt Size	C	D	
16	50	38	25
20	60	45	30
24	80	57	35
30	90	70	40
36	100	80	45

* Deep length sockets are also available with greater length but same diameter as above. Bolt diameters above M24 cannot be tensioned with a hand wrench.

PART 11 FLOOR PLATES

PAGE

TABLES

PART 11 FLOOR PLATES

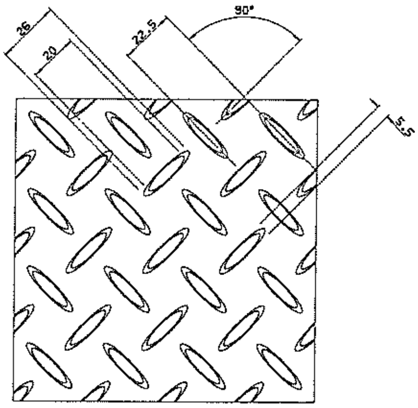
11.1 Details

Floor plate is characterised by a raised angular pattern (see Pattern Details below) rolled on to one surface. The pattern facilitates cleaning and draining while retaining the required non-slip characteristics. The nominal thickness of floor plate is exclusive of the raised pattern (see note on 'Mass of Floor Plate' below).

Pattern Details

Pattern Notes:

1. All dimensions are in millimetres and are approximate.
2. Pattern projections are approximately 1.5 mm in height.



BHP Steel floor plate pattern

Floor Plates – Preferred Width, Thickness and Length Combinations

Preferred Length in metres

Preferred Width (mm)	Preferred Thickness (mm)					
	3	5	6	8	10	12
1200	6	6	6	–	–	–
1500	–	6	6	6	–	–
1800	–	–	6	6	6	6

TABLE 11.1

Mass of Floor Plate

When calculating the design mass of floor plate, add 2.0 kg/m^2 to the mass of plain plate of the same dimensions.

11.2 Design Formulae

Table 11.2 gives the design formulae for the *Maximum Design Bending Moment, M^*_m*, and the *Maximum Deflection*, Δ, of plates with various support conditions. These formulae have been referenced from:

- *Theory of Plates and Shells*, Timoshenko, S. and Woinowsky-Krieger, S., McGraw-Hill, 2nd Edition,1959.
- *Roark's Formulas for Stress and Strain*, Young, W.C., McGraw-Hill, 6th Edition, 1989.

Note:

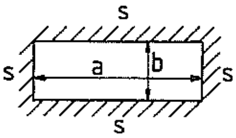
1) The self weight of the plate has *not* been deducted from these formulae.

2) For highly concentrated loads the designer must also check the transverse shear design actions which have not been tabulated.

TABLE 11.2

Floor Plate Shape	Loading	Maximum Design Bending Moment, M_m^* Maximum Design Deflection, Δ^*

Floor Plate Shape (cases 1 and 2):



t = thickness
a = long side
b = short side

1. Uniform, q^*

At centre:

$$M_m^* = \beta\, q^* b^2 \qquad \Delta^* = \alpha \frac{q^* b^4}{E t^3}$$

a/b	1.0	1.2	1.4	1.6	1.8	2.0	3.0	4.0	5.0	∞
α	.0443	.0616	.0770	.0906	.102	.111	.134	.140	.143	.142
β	.0479	.0627	.0775	.0862	.0948	.102	.119	.124	.125	.125

2. Central concentrated P^*, (modelled as a uniform load over a small concentric circle of radius r_o)

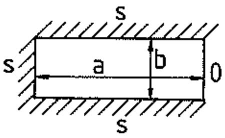
At centre: $M_m^* = \dfrac{P^*}{4\pi}\left[1.3 \log_e \left(\dfrac{2b}{\pi r_o'}\right) + \beta\right]$

(see Note 2 below for a description of r_o')

$$\Delta^* = \alpha \frac{P^* b^2}{E t^3}$$

a/b	1.0	1.2	1.4	1.6	1.8	2.0	∞
α	.127	.148	.162	.172	.177	.181	.185
β	.435	.650	.789	.875	.927	.958	1.00

Floor Plate Shape (cases 3 and 4):



t = thickness
a = long side
b = short side

3. Uniform, q^*

At centre of free edge:

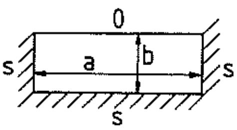
$$M_m^* = \beta q^* b^2 \qquad \Delta^* = \alpha \frac{q^* b^4}{E t^3}$$

a/b	1.0	1.1	1.2	1.3	1.4	1.5	2.0	3.0	∞
α	.140	.146	.151	.155	.157	.160	.165	.166	.166
β	.112	.117	.121	.124	.126	.128	.132	.133	.133

4. Central concentrated, P^*

No solution readily available.

Floor Plate Shape (cases 5 and 6):



t = thickness
a = long side
b = short side

5. Uniform, q^*

At centre of free edge:

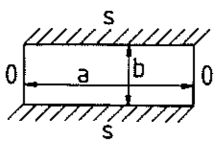
$$M_m^* = \beta q^* a^2 \qquad \Delta^* = \alpha \frac{q^* a^4}{E t^3}$$

a/b	1.0	1.1	1.2	1.3	1.4	1.5	2.0
α	.140	.135	.126	.119	.112	.106	.0775
β	.112	.107	.100	.094	.088	.083	.060

6. Central concentrated, P^*

No solution readily available.

Floor Plate Shape (cases 7 and 8):



t = thickness
a = simply supported edge length
b = free length

7. Uniform, q^*

At centre of free edge:

$$M_m^* = \beta q^* b^2 \qquad \Delta^* = \alpha \frac{q^* b^4}{E t^3}$$

a/b	0.5	1.0	2.0	∞
α	.158	.165	.166	.166
β	.126	.132	.133	.133

Note as $a/b \longrightarrow 0$
then $\alpha \longrightarrow 0.156$
and $\beta \longrightarrow 0.125$

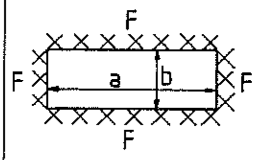
8. Central concentrated, P^*

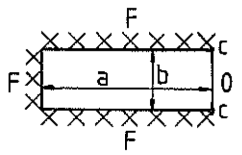
No solution readily available.

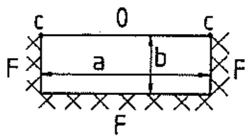
Note: 1) Notation for Support Conditions: ///s – simple support along edge.
o – unsupported, free edge.

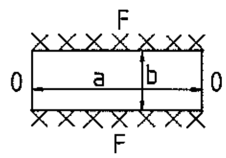
2) For concentrated loads, r_o' is the equivalent radius of contact for a load concentrated on a very small area and is given by $r_o' = \sqrt{(1.6 r_o^2 + t^2)} - 0.675t$ if $r_o < 0.5t$ and $r_o' = r_o$ if $r_o \geq 0.5t$ (r_o is the radius of the load area).

TABLE 11.2 (cont'd)

<table>
<tr><th>Floor Plate Shape</th><th>Loading</th><th>Maximum Design Bending Moment, M_m^*
Maximum Design Deflection, Δ^*</th></tr>
<tr><td rowspan="2">

t = thickness
a = long side
b = short side</td>
<td>9. Uniform, q^*</td>
<td>At centre of long edge: $M_m^* = \beta q^* b^2$
At centre of plate: $\Delta^* = \alpha \dfrac{q^* b^4}{Et^3}$
<table>
<tr><td>a/b</td><td>1.0</td><td>1.2</td><td>1.4</td><td>1.6</td><td>1.8</td><td>2.0</td><td>∞</td></tr>
<tr><td>α</td><td>.0138</td><td>.0188</td><td>.0226</td><td>.0251</td><td>.0268</td><td>.0277</td><td>.0284</td></tr>
<tr><td>β</td><td>.0513</td><td>.0639</td><td>.0726</td><td>.0780</td><td>.0812</td><td>.0829</td><td>.0833</td></tr>
</table></td></tr>
<tr><td>10. Central concentrated, P^*</td>
<td>At centre of long edge: $M_m^* = \beta P^*$
At centre of plate: $\Delta^* = \alpha \dfrac{P^* b^2}{Et^3}$
<table>
<tr><td>a/b</td><td>1.0</td><td>1.2</td><td>1.4</td><td>1.6</td><td>1.8</td><td>2.0</td><td>∞</td></tr>
<tr><td>α</td><td>.0612</td><td>.0706</td><td>.0755</td><td>.0777</td><td>.0786</td><td>.0788</td><td>.0792</td></tr>
<tr><td>β</td><td>.126</td><td>.149</td><td>.160</td><td>.165</td><td>.167</td><td>.167</td><td>.168</td></tr>
</table></td></tr>
<tr><td rowspan="2">

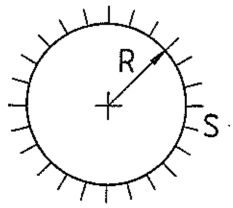
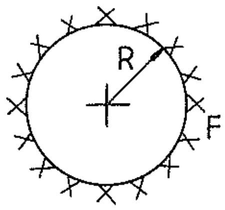
t = thickness
a = long side
b = short side</td>
<td>11. Uniform, q^*</td>
<td>At point 'C': $M_m^* = \beta q^* b^2$
At centre of free edge: $\Delta^* = \alpha \dfrac{q^* b^4}{Et^3}$
<table>
<tr><td>a/b</td><td>1.0</td><td>1.25</td><td>1.50</td></tr>
<tr><td>α</td><td>.0364</td><td>.0377</td><td>.0366</td></tr>
<tr><td>β</td><td>.0853</td><td>.0867</td><td>.0842</td></tr>
</table></td></tr>
<tr><td>12. Central concentrated, P^*</td><td>No solution readily available.</td></tr>
<tr><td rowspan="2">

t = thickness
a = long side
b = short side</td>
<td>13. Uniform, q^*</td>
<td>At point 'C': $M_m^* = \beta q^* a^2$
At centre of free edge: $\Delta^* = \alpha \dfrac{q^* a^4}{Et^3}$
<table>
<tr><td>a/b</td><td>1.00</td><td>1.11</td><td>1.25</td><td>1.43</td><td>1.67</td></tr>
<tr><td>α</td><td>.0364</td><td>.0353</td><td>.0336</td><td>.0319</td><td>.0296</td></tr>
<tr><td>β</td><td>.0853</td><td>.0836</td><td>.0812</td><td>.0782</td><td>.0745</td></tr>
</table></td></tr>
<tr><td>14. Central concentrated, P^*</td><td>No solution readily available.</td></tr>
<tr><td rowspan="2">

t = thickness
a = long side
b = short side</td>
<td>15. Uniform, q^*</td>
<td>Approximate bending moment and deflection distribution to that of a plate bent to a cylindrical surface.
Along fixed edge: $M_m^* = q^* \dfrac{b^2}{12}$
At centre of free edge: $\Delta^* = \dfrac{q^* b^4}{6400 \times 10^3 t^3}$</td></tr>
<tr><td>16. Central concentrated, P^*</td><td>No solution readily available.</td></tr>
</table>

Note: 1) Notation for Support Conditions: XXXF – fixed support along edge.
O – unsupported, free edge.

TABLE 11.2 (cont'd)

Floor Plate Shape	Loading	Maximum Design Bending Moment, M_m^* Maximum Design Deflection, Δ^*
	17. Uniform, q^*	At centre of plate: $M_m^* = 0.206 q^* R^2$ $\Delta^* = 0.695 \frac{q^* R^4}{E t^3}$
t = thickness	18. Central concentrated, P^*	At centre of plate: $M_m^* = \frac{P^*}{6} [1.30 (0.485 \log_e \left(\frac{R}{t}\right) + 0.52) + 0.48]$ $\Delta^* = 0.550 \frac{P^* R^2}{E t^3}$
	19. Uniform, q^*	At plate circumference: $M_m^* = 0.125 q^* R^2$ (in radial direction) At centre of plate: $\Delta^* = 0.171 \frac{q^* R^4}{E t^3}$
t = thickness	20. Central concentrated, P^*	At plate circumference: $M_m^* = \frac{P}{6} [1.30 (0.485 \log_e \left(\frac{R}{t}\right) + 0.52)]$ At centre of plate: $\Delta^* = 0.220 \frac{P^* R^2}{E t^3}$

Note: 1) Notation for Support Conditions: / / / S – Simple support around circumference
XXXF – Fixed support around circumference.

11.3 Maximum Design Loads

11.3.1 Plate Properties

The following design capacity tables have been determined from the following **plate material criteria**:

- **Grade 250 Plate to AS 3678**
- **Modulus of Elasticity, E = 200 x 10^3 MPa**

11.3.2 General Notes on Tables 11.3-1 to 11.3-14

A check should be made on the plate strength and serviceability limit states. Usually, the design of floor plates in two-way bending will be governed by the serviceability limit state.

The notation used in these Tables are:

D_{sv}	deflection factor (= Δ^*/q^* or Δ^*/P^*) for serviceability limit state
P^*	design central concentrated load for strength or serviceability limit state
P^*_{st}	maximum design load for strength limit state
q^*	design uniformly distributed load for strength or serviceability limit state
q^*_{st}	maximum design uniformly distributed load for strength limit state

Δ_m^* maximum design deflection due to serviceability design loads (q^* or P^*)

Δ_{ml} maximum design deflection limit for serviceability limit state

ϕ capacity factor (=0.9)

The designer must include plate self weight multiplied by the appropriate load factor when determining the plate design loads (i.e. P^* and q^*). *Note that the design loads P^* and q^* are different for the strength and serviceability limit states.*

11.3.3 Strength Limit State

No specific clauses are given for floor plates in AS 4100 but some guidance is given in AS 4100 Supplement 1-1990. For the strength limit state, floor plates may be designed as compact sections with full lateral restraint, ie. $Z_e = 1.5Z$. The plate design moment capacity, ϕM_s, is determined by

$$\phi M_s = \phi f_y Z_e$$

Maximum design loads (q^*_{st} and P^*_{st}) for the various load and support situations have been determined from ϕM_s and the elastic relationship between load and moment given in Section 11.2. The maximum design loads are given in Tables 11.3-1 to 11.3-14. When using these tables, the following procedure should be used.

(i) assess the strength limit state *design load* (q^* or P^*);

(ii) determine the *maximum design load* (q^*_{st} *or* P^*_{st} – whichever is applicable) from Tables 11.3-1 to 11.3-14;

(iii) the following strength limit state inequality must be satisfied –

$$q^* \leq q^*_{st} \quad or \quad P^* \leq P^*_{st}$$

If this is not satisfied, a change in one of the plate or loading parameters is required and steps (i) to (iii) repeated. The above inequality would be on the conservative side if an analysis by a failure criterion (Yield Line, Von Mises, etc) was also undertaken.

11.3.4 Serviceability Limit State

When using Tables 11.3-1 to 11.3-14 the following method should be used when examining the serviceability limit state:

(i) determine the serviceability limit state *design load* (q^* or P^*);

(ii) assess the maximum design deflection limit (Δ_{ml}) for the serviceability limit state;

(iii) either, calculate the *maximum design deflection* (Δ_m^*) from the relevant design formulae of Section 9.2 above, or determine the *deflection factor* (D_{sv}) from Tables 11.3-1 to 11.3-14, and multiply by q^*_{sv} or P^*_{sv} (whichever is applicable) to get the maximum design deflection (Δ_m^*), i.e.

$$\Delta_m^* = D_{sv} \times (q^* \text{ or } P^*)$$

(iv) the following inequality must be satisfied –

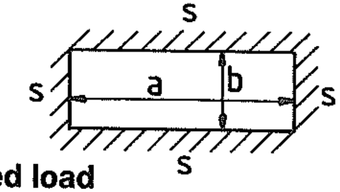
$$\Delta_m^* \leq \Delta_{ml}$$

If this is not satisfied, a change in one of the plate or loading parameters is required and steps (i) to (iv) repeated.

Note: The designer must ensure that there is no plate yielding under serviceability loads.

FLOOR PLATES
GRADE 250

MAXIMUM DESIGN LOADS FOR PLATES SIMPLY SUPPORTED ON FOUR SIDES



uniformly distributed load

TABLE 11.3-1

Uniform Load Over Whole Floor Plate									
Thick-ness t	f_y	Dimen-sion	Maximum Design Load, q^*_{sl} (kPa) Deflection factor D_{sv} (mm/kPa) for Dimension a (mm)						
mm	MPa	mm	600	800	1000	1200	1600	2000	2400
5	280	600	91.3 0.230	60.3 0.373	49.1 0.489	42.9 0.575	38.6 0.655	36.3 0.705	35.3 0.726
		800		51.4 0.726	37.1 1.07	30.1 1.37	24.1 1.82	22.3 2.01	20.7 2.20
		1000			32.9 1.77	25.1 2.46	18.3 3.62	15.4 4.44	14.5 4.81
		1200				22.8 3.67	15.1 5.96	12.3 7.83	10.7 9.21
6	280	600	132 0.133	86.8 0.216	70.7 0.283	61.8 0.333	55.6 0.379	52.2 0.408	50.8 0.420
		800		74.0 0.420	53.4 0.621	43.3 0.795	34.7 1.05	32.1 1.16	29.8 1.27
		1000			47.3 1.03	36.2 1.43	26.3 2.10	22.2 2.57	20.8 2.78
		1200				32.9 2.13	21.7 3.45	17.7 4.53	15.4 5.33
8	280	600	234 0.0561	154 0.0910	126 0.119	110 0.140	98.8 0.160	92.8 0.172	90.3 0.177
		800		132 0.177	94.9 0.262	77.0 0.335	61.8 0.444	57.0 0.490	52.9 0.536
		1000			84.2 0.433	64.3 0.602	46.8 0.885	39.5 1.08	37.1 1.17
		1200				58.5 0.897	38.6 1.46	31.4 1.91	27.5 2.25
10	260	600	339 0.0287	224 0.0466	182 0.0612	159 0.0719	143 0.0819	135 0.0881	131 0.0907
		800		191 0.0907	138 0.134	112 0.172	89.6 0.227	82.7 0.251	76.8 0.274
		1000			122 0.222	93.3 0.308	67.9 0.453	57.4 0.555	53.8 0.601
		1200				84.8 0.459	56.0 0.745	45.6 0.979	39.8 1.15
		1600					47.7 1.45	34.4 2.14	27.9 2.75
12	260	600	489 0.0166	322 0.0270	263 0.0354	229 0.0416	206 0.0474	194 0.0510	189 0.0525
		800		275 0.0525	198 0.0776	161 0.0993	129 0.132	119 0.145	111 0.159
		1000			176 0.128	134 0.178	97.7 0.262	82.6 0.321	77.4 0.348
		1200				122 0.266	80.6 0.431	65.7 0.566	57.4 0.666
		1600					68.7 0.840	49.6 1.24	40.2 1.59

Note: Grade 250 Steel Plate to AS 3678.

central concentrated load

TABLE 11.3-2

Concentrated Load at Centre of Plate									
Thick-ness t	f_y	Dimen-sion	Maximum Design Load, P^*_{sl} (kN) Deflection factor D_{sv} (mm/kN) for Dimension a (mm)						
mm	MPa	mm	600	800	1000	1200	1600	2000	2400
5	280	600	5.28 1.83	4.88 2.27	4.71 2.50	4.64 2.61	4.59 2.66	4.59 2.66	4.59 2.66
		800		5.28 3.25	4.95 3.88	4.78 4.28	4.64 4.63	4.59 4.74	4.59 4.74
		1000			5.28 5.08	5.00 5.92	4.73 6.88	4.64 7.24	4.59 7.40
		1200				5.28 7.32	4.88 9.06	4.71 10.0	4.64 10.4
6	280	600	7.61 1.06	7.03 1.31	6.78 1.45	6.68 1.51	6.61 1.54	6.61 1.54	6.61 1.54
		800		7.61 1.88	7.13 2.24	6.88 2.47	6.68 2.68	6.61 2.74	6.61 2.74
		1000			7.61 2.94	7.20 3.43	6.81 3.98	6.68 4.19	6.61 4.28
		1200				7.61 4.23	7.03 5.24	6.78 5.79	6.68 6.03
8	280	600	13.5 0.446	12.5 0.553	12.1 0.611	11.9 0.636	11.8 0.650	11.8 0.650	11.8 0.650
		800		13.5 0.794	12.7 0.947	12.2 1.04	11.9 1.13	11.8 1.16	11.8 1.16
		1000			13.5 1.24	12.8 1.45	12.1 1.68	11.9 1.77	11.8 1.81
		1200				13.5 1.79	12.5 2.21	12.1 2.44	11.9 2.55
10	260	600	19.6 0.229	18.1 0.283	17.5 0.313	17.2 0.326	17.1 0.333	17.1 0.333	17.1 0.333
		800		19.6 0.406	18.4 0.485	17.7 0.534	17.2 0.579	17.1 0.592	17.1 0.592
		1000			19.6 0.635	18.6 0.740	17.6 0.860	17.2 0.905	17.1 0.925
		1200				19.6 0.914	18.1 1.13	17.5 1.25	17.2 1.30
		1600					19.6 1.63	18.4 1.94	17.7 2.14
12	260	600	28.3 0.132	26.1 0.164	25.2 0.181	24.8 0.189	24.6 0.193	24.6 0.193	24.6 0.193
		800		28.3 0.235	26.5 0.281	25.6 0.309	24.8 0.335	24.6 0.343	24.6 0.343
		1000			28.3 0.367	26.7 0.428	25.3 0.498	24.8 0.524	24.6 0.535
		1200				28.3 0.529	26.1 0.656	25.2 0.724	24.8 0.754
		1600					28.3 0.941	26.5 1.12	25.6 1.24

Notes: (1) The values listed in this table are based on the formula in Loading configuration 2 on page 11-3. The ratio of b (= the length of the short side of the plate), to r'_o (= the equivalent radius of contact) in this equation is taken as 20, ie. $b/r'_o = 20$.
(2) Grade 250 Steel Plate to AS 3678.

FLOOR PLATES GRADE 250

MAXIMUM DESIGN LOADS FOR PLATES SIMPLY SUPPORTED ON THREE SIDES, FREE ON ONE SIDE

uniformly distributed load

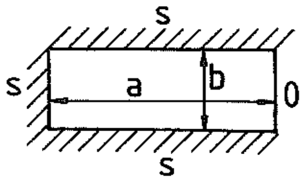


TABLE 11.3-3

Uniform Load Over Whole Floor Plate — Short Side Free

Thickness t	f_y	Dimension	Maximum Design Load, q^* (kPa) Deflection factor D_{sv} (mm/kPa) for Dimension a (mm)						
mm	MPa	mm	600	800	1000	1200	1600	2000	2400
5	280	600	39.1 0.726	35.1 0.807	33.8 0.838	33.1 0.855	33.0 0.859	32.9 0.861	32.9 0.861
		800		22.0 2.29	20.1 2.51	19.2 2.62	18.6 2.70	18.6 2.71	18.5 2.72
		1000			14.1 5.60	13.0 6.04	12.2 6.44	11.9 6.60	11.9 6.62
		1200				9.77 11.6	8.77 12.9	8.46 13.4	8.29 13.7
6	280	600	56.3 0.420	50.5 0.467	48.7 0.485	47.7 0.495	47.5 0.497	47.4 0.498	47.4 0.498
		800		31.6 1.33	28.9 1.45	27.7 1.52	26.8 1.56	26.7 1.57	26.6 1.57
		1000			20.3 3.24	18.7 3.50	17.6 3.73	17.2 3.82	17.1 3.83
		1200				14.1 6.72	12.6 7.47	12.2 7.76	11.9 7.92
8	280	600	100 0.177	89.8 0.197	86.6 0.205	84.8 0.209	84.4 0.210	84.2 0.210	84.2 0.210
		800		56.3 0.560	51.4 0.612	49.2 0.640	47.7 0.660	47.5 0.662	47.4 0.664
		1000			36.0 1.37	33.3 1.47	31.3 1.57	30.5 1.61	30.5 1.62
		1200				25.0 2.84	22.5 3.15	21.6 3.27	21.2 3.34
10	260	600	145 0.0907	130 0.101	126 0.105	123 0.107	122 0.107	122 0.108	122 0.108
		800		81.6 0.287	74.6 0.313	71.4 0.328	69.2 0.338	69.0 0.339	68.7 0.340
		1000			52.2 0.700	48.3 0.755	45.4 0.805	44.3 0.825	44.2 0.827
		1200				36.3 1.45	32.6 1.61	31.4 1.68	30.8 1.71
		1600					20.4 4.59	18.7 5.01	17.9 5.24
12	260	600	209 0.0525	188 0.0584	181 0.0606	177 0.0619	176 0.0621	176 0.0622	176 0.0622
		800		118 0.166	107 0.181	103 0.190	99.7 0.196	99.3 0.196	99.0 0.197
		1000			75.2 0.405	69.6 0.437	65.4 0.466	63.8 0.477	63.6 0.479
		1200				52.2 0.840	46.9 0.934	45.2 0.970	44.3 0.990
		1600					29.4 2.65	26.9 2.90	25.7 3.03

Note: Grade 250 Steel Plate to AS 3678.

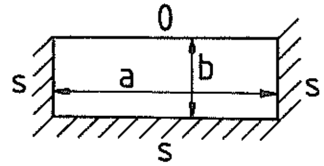


TABLE 11.3-4

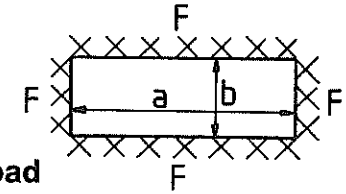
Uniform Load Over Whole Floor Plate — Long Side Free

Thickness t	f_y	Dimension	Maximum Design Load, q^* (kPa) Deflection factor D_{sv} (mm/kPa) for Dimension a (mm)						
mm	MPa	mm	600	800	1000	1200	1600	2000	2400
5	280	600	39.1 0.726	26.7 1.91	20.9 3.86	18.2 6.43			
		800		22.0 2.29	16.2 4.90	13.2 8.79	10.3 20.3		
		1000			14.1 5.60	10.9 10.5	7.85 26.3	6.56 49.6	
		1200				9.77 11.6	6.69 30.6	5.23 61.8	4.56 103
6	280	600	56.3 0.420	38.5 1.11	30.1 2.23	26.3 3.72			
		800		31.6 1.33	23.4 2.84	19.0 5.09	14.8 11.8		
		1000			20.3 3.24	15.8 6.05	11.3 15.2	9.45 28.7	
		1200				14.1 6.72	9.63 17.7	7.53 35.7	6.56 59.5
8	280	600	100 0.177	68.5 0.467	53.5 0.942	46.7 1.57			
		800		56.3 0.560	41.6 1.20	33.7 2.15	26.3 4.96		
		1000	36.0	28.0	20.1 1.37	16.8 2.55	6.42	12.1	
		1200				25.0 2.84	17.1 7.47	13.4 15.1	11.7 25.1
10	260	600	145 0.0907	99.4 0.239	77.7 0.483	67.7 0.804			
		800		81.6 0.287	60.3 0.613	48.9 1.10	38.1 2.54		
		1000			52.2 0.700	40.6 1.31	29.1 3.29	24.4 6.20	
		1200				36.3 1.45	24.8 3.82	19.4 7.72	16.9 12.9
		1600					20.4 4.59	15.1 9.80	12.2 17.6
12	260	600	209 0.0525	143 0.138	112 0.279	97.5 0.465			
		800		118 0.166	86.8 0.354	70.5 0.636	54.8 1.47		
		1000			75.2 0.405	58.5 0.756	42.0 1.90	35.1 3.59	
		1200				52.2 0.840	35.8 2.21	28.0 4.47	24.4 7.44
		1600					29.4 2.65	21.7 5.67	17.6 10.2

Note: Grade 250 Steel Plate to AS 3678.

FLOOR PLATES
GRADE 250

MAXIMUM DESIGN LOADS FOR PLATES FIXED ON FOUR SIDES



uniformly distributed load

TABLE 11.3-5

Thickness t	f_y	Dimension	Uniform Load Over Whole Floor Plate: Maximum Design Load, q^*_{sl} (kPa) Deflection factor D_{sv} (mm/kPa) for Dimension a (mm)						
mm	MPa	mm	600	800	1000	1200	1600	2000	2400
5	280	600	**85.3** 0.0715	**62.8** 0.111	**55.3** 0.133	**52.8** 0.144	**52.5** 0.147	**52.5** 0.147	**52.5** 0.147
		800		**48.0** 0.226	**37.2** 0.324	**32.7** 0.391	**29.7** 0.454	**29.5** 0.465	**29.5** 0.465
		1000			**30.7** 0.552	**24.6** 0.752	**20.2** 1.00	**19.0** 1.11	**18.9** 1.14
		1200				**21.3** 1.14	**15.7** 1.77	**13.8** 2.13	**13.2** 2.30
6	280	600	**123** 0.0414	**90.4** 0.0640	**79.7** 0.0770	**76.0** 0.0831	**75.6** 0.0852	**75.6** 0.0852	**75.6** 0.0852
		800		**69.1** 0.131	**53.6** 0.187	**47.1** 0.226	**42.7** 0.263	**42.5** 0.269	**42.5** 0.269
		1000			**44.2** 0.319	**35.5** 0.435	**29.1** 0.581	**27.4** 0.641	**27.2** 0.657
		1200				**30.7** 0.662	**22.6** 1.02	**19.9** 1.23	**19.0** 1.33
8	280	600	**218** 0.0175	**161** 0.0270	**142** 0.0325	**135** 0.0351	**134** 0.0359	**134** 0.0359	**134** 0.0359
		800		**123** 0.0552	**95.3** 0.0790	**83.7** 0.0954	**76.0** 0.111	**75.6** 0.114	**75.6** 0.114
		1000			**78.6** 0.135	**63.1** 0.184	**51.7** 0.245	**48.6** 0.271	**48.4** 0.277
		1200				**54.6** 0.279	**40.2** 0.432	**35.4** 0.520	**33.8** 0.561
10	260	600	**317** 0.0089	**233** 0.0138	**206** 0.0166	**196** 0.0179	**195** 0.0184	**195** 0.0184	**195** 0.0184
		800	**178**	**138** 0.0283	**121** 0.0404	**110** 0.0488	**110** 0.0567	**110** 0.0582	**110** 0.0582
		1000			**114** 0.0690	**91.5** 0.0940	**75.0** 0.125	**70.6** 0.139	**70.2** 0.142
		1200				**79.2** 0.143	**58.3** 0.221	**51.4** 0.266	**49.0** 0.287
		1600					**44.5** 0.452	**34.6** 0.647	**30.3** 0.782
12	260	600	**456** 0.0052	**336** 0.0080	**296** 0.0096	**282** 0.0104	**281** 0.0107	**281** 0.0107	**281** 0.0107
		800		**257** 0.0164	**199** 0.0234	**175** 0.0283	**159** 0.0328	**158** 0.0337	**158** 0.0337
		1000			**164** 0.0399	**132** 0.0544	**108** 0.0726	**102** 0.0802	**101** 0.0822
		1200				**114** 0.0828	**83.9** 0.128	**74.0** 0.154	**70.6** 0.166
		1600					**64.1** 0.262	**49.8** 0.375	**43.7** 0.452

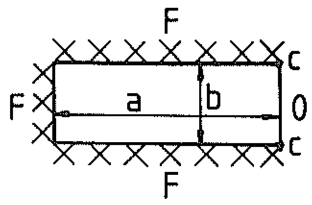
Note: Grade 250 Steel Plate to AS 3678.

central concentrated load

TABLE 11.3-6

Thickness t	f_y	Dimension	Concentrated Load at Centre of Plate: Maximum Design Load, P^*_{sl} (kN) Deflection factor D_{sv} (mm/kN) for Dimension a (mm)						
mm	MPa	mm	600	800	1000	1200	1600	2000	2400
5	280	600	**12.5** 0.881	**10.1** 1.06	**9.51** 1.12	**9.43** 1.13	**9.38** 1.14	**9.38** 1.14	**9.38** 1.14
		800		**12.5** 1.57	**10.4** 1.84	**9.69** 1.96	**9.43** 2.02	**9.38** 2.03	**9.38** 2.03
		1000			**12.5** 2.45	**10.6** 2.82	**9.55** 3.11	**9.43** 3.15	**9.38** 3.17
		1200				**12.5** 3.53	**10.1** 4.25	**9.51** 4.49	**9.43** 4.54
6	280	600	**18.0** 0.510	**14.5** 0.616	**13.7** 0.650	**13.6** 0.657	**13.5** 0.660	**13.5** 0.660	**13.5** 0.660
		800		**18.0** 0.907	**14.9** 1.06	**14.0** 1.13	**13.6** 1.17	**13.5** 1.17	**13.5** 1.17
		1000			**18.0** 1.42	**15.2** 1.63	**13.7** 1.80	**13.6** 1.82	**13.5** 1.83
		1200				**18.0** 2.04	**14.5** 2.46	**13.7** 2.60	**13.6** 2.63
8	280	600	**32.0** 0.215	**25.8** 0.260	**24.3** 0.274	**24.1** 0.277	**24.0** 0.278	**24.0** 0.278	**24.0** 0.278
		800		**32.0** 0.383	**26.6** 0.449	**24.8** 0.479	**24.1** 0.493	**24.0** 0.495	**24.0** 0.495
		1000			**32.0** 0.598	**27.1** 0.689	**24.4** 0.759	**24.1** 0.770	**24.0** 0.773
		1200				**32.0** 0.861	**25.8** 1.04	**24.3** 1.10	**24.1** 1.11
10	260	600	**46.4** 0.110	**37.4** 0.133	**35.3** 0.140	**35.0** 0.142	**34.8** 0.143	**34.8** 0.143	**34.8** 0.143
		800		**46.4** 0.196	**38.6** 0.230	**36.0** 0.245	**35.0** 0.252	**34.8** 0.253	**34.8** 0.253
		1000			**46.4** 0.306	**39.3** 0.353	**35.5** 0.389	**35.0** 0.394	**34.8** 0.396
		1200				**46.4** 0.441	**37.4** 0.532	**35.3** 0.562	**35.0** 0.567
		1600					**46.4** 0.783	**38.6** 0.919	**36.0** 0.980
12	260	600	**66.9** 0.0638	**53.9** 0.0769	**50.8** 0.0812	**50.4** 0.0821	**50.1** 0.0825	**50.1** 0.0825	**50.1** 0.0825
		800		**66.9** 0.113	**55.5** 0.133	**51.8** 0.142	**50.4** 0.146	**50.1** 0.147	**50.1** 0.147
		1000			**66.9** 0.177	**56.5** 0.204	**51.1** 0.225	**50.4** 0.228	**50.1** 0.229
		1200				**66.9** 0.255	**53.9** 0.308	**50.8** 0.325	**50.4** 0.328
		1600					**66.9** 0.453	**55.5** 0.532	**51.8** 0.567

Note: Grade 250 Steel Plate to AS 3678.



FLOOR PLATES GRADE 250

MAXIMUM DESIGN LOADS FOR PLATES FIXED ON THREE SIDES, FREE ON ONE SIDE

uniformly distributed load

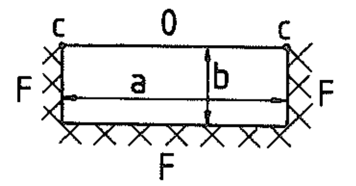


TABLE 11.3-7

Uniform Load Over Whole Floor Plate — Short Side Free

Each cell gives the maximum design load, q^*_{sl} (kPa), and below it the deflection factor D_{sv} (mm/kPa).

Thickness t (mm)	f_y (MPa)	Dimension (mm)	600	800	1000	1200	1600	2000	2400
5	280	600	**51.3** 0.189	**52.2** 0.194					
		800		**28.9** 0.596	**29.4** 0.618	**29.2** 0.600			
		1000			**18.5** 1.46	**18.8** 1.50			
		1200				**12.8** 3.02	**13.1** 3.10		
6	280	600	**73.9** 0.109	**75.2** 0.112					
		800		**41.5** 0.345	**42.4** 0.357	**42.1** 0.347			
		1000			**26.6** 0.843	**27.0** 0.867			
		1200				**18.5** 1.75	**18.8** 1.79		
8	280	600	**131** 0.0461	**134** 0.0472					
		800		**73.9** 0.146	**75.4** 0.151	**74.8** 0.146			
		1000			**47.3** 0.355	**48.0** 0.366			
		1200				**32.8** 0.737	**33.4** 0.756		
10	260	600	**191** 0.0236	**194** 0.0242					
		800		**107** 0.0745	**109** 0.0772	**109** 0.0750			
		1000			**68.6** 0.182	**69.7** 0.187			
		1200				**47.6** 0.377	**48.5** 0.387		
		1600					**26.8** 1.19	**27.3** 1.24	**27.1** 1.20
12	260	600	**274** 0.0136	**279** 0.0140					
		800		**154** 0.0431	**157** 0.0447	**156** 0.0434			
		1000			**98.8** 0.105	**100** 0.108			
		1200				**68.6** 0.218	**69.8** 0.224		
		1600					**38.6** 0.690	**39.4** 0.715	**39.1** 0.694

Note: Grade 250 Steel Plate to AS 3678.

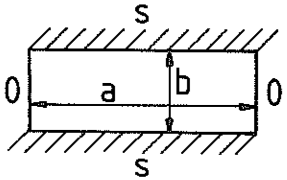
TABLE 11.3-8

Uniform Load Over Whole Floor Plate — Long Side Free

Each cell gives the maximum design load, q^*_{sl} (kPa), and below it the deflection factor D_{sv} (mm/kPa).

Thickness t (mm)	f_y (MPa)	Dimension (mm)	600	800	1000	1200	1600	2000	2400
5	280	600	**51.3** 0.189	**30.8** 0.538	**21.1** 1.19				
		800		**28.9** 0.596	**19.4** 1.34	**14.2** 2.59			
		1000			**18.5** 1.46	**13.3** 2.84	**8.14** 7.94		
		1200				**12.8** 3.02	**7.71** 8.60	**5.28** 19.0	
6	280	600	**73.9** 0.109	**44.4** 0.311	**30.4** 0.686				
		800		**41.5** 0.345	**27.9** 0.778	**20.4** 1.50			
		1000			**26.6** 0.843	**19.2** 1.64	**11.7** 4.59		
		1200				**18.5** 1.75	**11.1** 4.98	**7.61** 11.0	
8	280	600	**131** 0.0461	**78.9** 0.131	**54.1** 0.289				
		800		**73.9** 0.146	**49.7** 0.328	**36.3** 0.632			
		1000				**47.3** 0.355	**34.1** 0.693	**20.8** 1.94	
		1200					**32.8** 0.737	**19.7** 2.10	**13.5** 4.63
10	260	600	**191** 0.0236	**115** 0.0672	**78.5** 0.148				
		800		**107** 0.0745	**72.0** 0.168	**52.7** 0.324			
		1000			**68.6** 0.182	**49.5** 0.355	**30.2** 0.992		
		1200				**47.6** 0.377	**28.6** 1.08	**19.6** 2.37	
		1600					**26.8** 1.19	**18.0** 2.69	**13.2** 5.18
12	260	600	**274** 0.0136	**165** 0.0389	**113** 0.0857				
		800		**154** 0.0431	**104** 0.0972	**75.9** 0.187			
		1000			**98.8** 0.105	**71.3** 0.205	**43.5** 0.574		
		1200				**68.6** 0.218	**41.2** 0.622	**28.2** 1.37	
		1600					**38.6** 0.690	**25.9** 1.56	**19.0** 3.00

Note: Grade 250 Steel Plate to AS 3678.



FLOOR PLATES GRADE 250

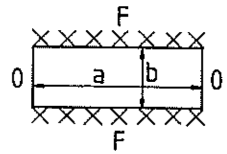
MAXIMUM DESIGN LOADS FOR PLATES SIMPLY SUPPORTED ON TWO SIDES, FREE ON TWO SIDES

uniformly distributed load

TABLE 11.3-9

Uniform Load Over Whole Floor Plate									
Thick-ness t	f_y	Dimen-sion	Maximum Design Load, q^*_l (kPa) Deflection factor D_{sv} (mm/kPa) for Dimension a (mm)						
mm	MPa	mm	600	800	1000	1200	1600	2000	2400
5	280	600	33.1 0.855	33.1 0.857	33.0 0.859	32.9 0.861	32.9 0.861	32.9 0.861	32.9 0.861
		800		18.6 2.70	18.6 2.71	18.6 2.71	18.5 2.72	18.5 2.72	18.5 2.72
		1000			11.9 6.60	11.9 6.61	11.9 6.62	11.8 6.64	11.8 6.64
		1200				8.29 13.7	8.27 13.7	8.24 13.7	8.22 13.8
6	280	600	47.7 0.495	47.6 0.496	47.5 0.497	47.4 0.498	47.4 0.498	47.4 0.498	47.4 0.498
		800		26.8 1.56	26.8 1.57	26.7 1.57	26.6 1.57	26.6 1.57	26.6 1.57
		1000			17.2 3.82	17.2 3.82	17.1 3.83	17.1 3.84	17.1 3.84
		1200				11.9 7.92	11.9 7.94	11.9 7.95	11.8 7.97
8	280	600	84.8 0.209	84.6 0.209	84.4 0.210	84.2 0.210	84.2 0.210	84.2 0.210	84.2 0.210
		800		47.7 0.660	47.6 0.661	47.5 0.662	47.4 0.664	47.4 0.664	47.4 0.664
		1000			30.5 1.61	30.5 1.61	30.4 1.62	30.3 1.62	30.3 1.62
		1200				21.2 3.34	21.2 3.35	21.1 3.35	21.1 3.36
10	260	600	123 0.107	123 0.107	122 0.107	122 0.108	122 0.108	122 0.108	122 0.108
		800		69.2 0.338	69.1 0.338	69.0 0.339	68.7 0.340	68.7 0.340	68.7 0.340
		1000			44.3 0.825	44.3 0.826	44.1 0.828	44.0 0.830	44.0 0.830
		1200				30.8 1.71	30.7 1.71	30.6 1.72	30.5 1.72
		1600					17.3 5.41	17.3 5.41	17.2 5.42
12	260	600	177 0.0619	177 0.0620	176 0.0621	176 0.0622	176 0.0622	176 0.0622	176 0.0622
		800		99.7 0.196	99.5 0.196	99.3 0.196	99.0 0.197	99.0 0.197	99.0 0.197
		1000			63.8 0.477	63.7 0.478	63.5 0.479	63.3 0.480	63.3 0.480
		1200				44.3 0.990	44.2 0.992	44.1 0.994	44.0 0.996
		1600					24.9 3.13	24.9 3.13	24.8 3.14

Note: Grade 250 Steel Plate to AS 3678.



FLOOR PLATES GRADE 250

MAXIMUM DESIGN LOADS FOR PLATES FIXED ON TWO SIDES, FREE ON TWO SIDES

uniformly distributed load

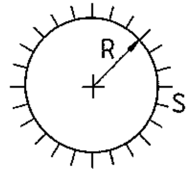
TABLE 11.3-10

Uniform Load Over Whole Floor Plate			
Thick-ness t	f_y	Dimen-sion	Maximum Design Load q^*_l (kPa) Deflection factor D_{sv} (mm/kPa)
mm	MPa	mm	
5	280	600	52.5 0.162
		800	29.5 0.512
		1000	18.9 1.25
		1200	13.1 2.59
6	280	600	75.6 0.0938
		800	42.5 0.296
		1000	27.2 0.723
		1200	18.9 1.50
8	280	600	134 0.0396
		800	75.6 0.125
		1000	48.4 0.305
		1200	33.6 0.633
10	260	600	195 0.0203
		800	110 0.0640
		1000	70.2 0.156
		1200	48.8 0.324
		1600	27.4 1.02
12	260	600	281 0.0117
		800	158 0.0370
		1000	101 0.0904
		1200	70.2 0.188
		1600	39.5 0.593

Note: Grade 250 Steel Plate to AS 3678.

FLOOR PLATES
GRADE 250

MAXIMUM DESIGN LOADS FOR CIRCULAR PLATES SIMPLY SUPPORTED AROUND CIRCUMFERENCE



uniformly distributed load

TABLE 11.3-11

Thick-ness t	f_y	Uniform Load Over Whole Floor Plate: Maximum Design Load, q^*_{si} (kPa) Deflection factor D_{sv} (mm/kPa) for Radius (mm)						
mm	MPa	600	800	1000	1200	1600	2000	2400
5	280	21.2 3.60	11.9 11.4	7.65 27.8	5.31 57.6	2.99 182	1.91 445	1.33 922
6	280	30.6 2.09	17.2 6.59	11.0 16.1	7.65 33.4	4.30 105	2.75 257	1.91 534
8	280	54.4 0.880	30.6 2.78	19.6 6.79	13.6 14.1	7.65 44.5	4.89 109	3.40 225
10	260	78.9 0.450	44.4 1.42	28.4 3.47	19.7 7.21	11.1 22.8	7.10 55.6	4.93 115
12	260	114 0.261	63.9 0.824	40.9 2.01	28.4 4.17	16.0 13.2	10.2 32.2	7.10 66.7

Note: Grade 250 Steel Plate to AS 3678.

central concentrated load

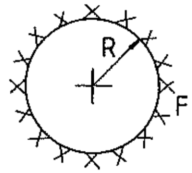
TABLE 11.3-12

Thick-ness t	f_y	Concentrated Load at Centre of Plate: Maximum Design Load, P^*_{si} (kN) Deflection factor D_{sv} (mm/kN) for Radius (mm)						
mm	MPa	600	800	1000	1200	1600	2000	2400
5	280	2.26 7.92	2.17 14.1	2.10 22.0	2.05 31.7	1.97 56.3	1.92 88.0	1.87 127
6	280	3.35 4.58	3.21 8.15	3.11 12.7	3.03 18.3	2.91 32.6	2.82 50.9	2.76 73.3
8	280	6.24 1.93	5.96 3.44	5.76 5.37	5.61 7.73	5.38 13.8	5.22 21.5	5.09 30.9
10	260	9.39 0.990	8.96 1.76	8.65 2.75	8.41 3.96	8.06 7.04	7.81 11.0	7.61 15.8
12	260	14.0 0.573	13.3 1.02	12.8 1.59	12.5 2.29	11.9 4.07	11.5 6.37	11.2 9.17

Note: Grade 250 Steel Plate to AS 3678.

FLOOR PLATES
GRADE 250

MAXIMUM DESIGN LOADS FOR CIRCULAR PLATES FIXED AROUND CIRCUMFERENCE



uniformly distributed load

TABLE 11.3-13

Thick-ness t	f_y	Uniform Load Over Whole Floor Plate: Maximum Design Load, q^*_{si} (kPa) Deflection factor D_{sv} (mm/kPa) for Radius (mm)						
mm	MPa	600	800	1000	1200	1600	2000	2400
5	280	35.0 0.886	19.7 2.80	12.6 6.84	8.75 14.2	4.92 44.8	3.15 109	2.19 227
6	280	50.4 0.513	28.3 1.62	18.1 3.96	12.6 8.21	7.09 25.9	4.54 63.3	3.15 131
8	280	89.6 0.216	50.4 0.684	32.3 1.67	22.4 3.46	12.6 10.9	8.06 26.7	5.60 55.4
10	260	130 0.111	73.1 0.350	46.8 0.855	32.5 1.77	18.3 5.60	11.7 13.7	8.13 28.4
12	260	187 0.064	105 0.203	67.4 0.495	46.8 1.03	26.3 3.24	16.8 7.92	11.7 16.4

Note: Grade 250 Steel Plate to AS 3678.

central concentrated load

TABLE 11.3-14

Thick-ness t	f_y	Concentrated Load Over Whole Floor Plate: Maximum Design Load, P^*_{si} (kN) Deflection factor D_{sv} (mm/kN) for Radius (mm)						
mm	MPa	600	800	1000	1200	1600	2000	2400
5	280	2.56 3.17	2.44 5.63	2.35 8.80	2.29 12.7	2.19 22.5	2.12 35.2	2.07 50.7
6	280	3.80 1.83	3.62 3.26	3.49 5.09	3.39 7.33	3.24 13.0	3.14 20.4	3.06 29.3
8	280	7.12 0.773	6.76 1.38	6.50 2.15	6.31 3.09	6.02 5.50	5.82 8.59	5.66 12.4
10	260	10.8 0.396	10.2 0.704	9.81 1.10	9.50 1.58	9.06 2.82	8.74 4.40	8.50 6.34
12	260	16.1 0.229	15.2 0.407	14.6 0.637	14.1 0.917	13.4 1.63	13.0 2.55	12.6 3.67

Note: Grade 250 Steel Plate to AS 3678.

PART 12 RAILS

TABLES

References:

"Hot Rolled and Structural Products – 1994 Edition", BHP Steel, 1994.

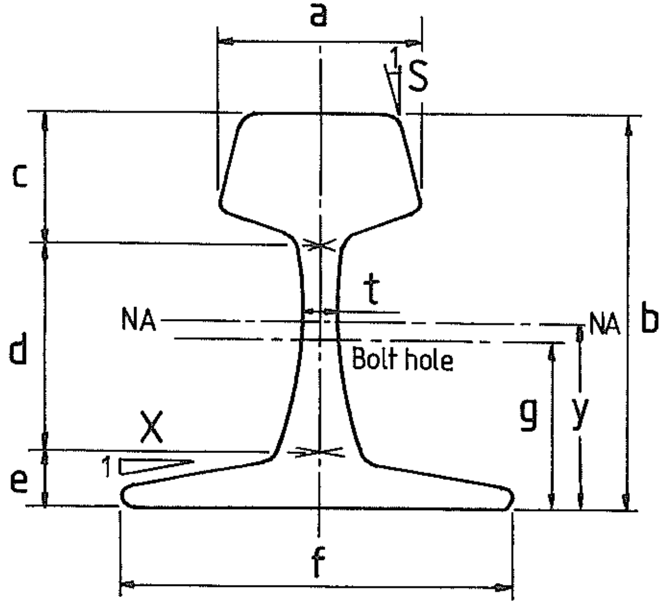


TABLE 12-1

RAILS
DIMENSIONS AND PROPERTIES

Designation	Mass per m	a	b	c	d	e	f	g	S	t	X	y	Total Area A_g	About x-axis I_x	About x-axis Head Z_x	About x-axis Foot Z_x	Designation
	kg/m	mm	mm	mm	mm	mm	mm	mm		mm		mm	mm²	10^6mm⁴	10^3mm³	10^3mm³	
RE68	67.6	74.6	185.7	49.2	106.3	30.2	152.4	78.6	40	17.5	4	98.4	8614	39.5	391.7	463.8	RE68
AS60	61.0	70.0	170.0	49.0	93.0	28.0	146.0	74.5	20	16.5	4	79.1	7770	29.4	323.2	371.4	AS60
AS50	50.8	70.0	154.0	45.0	84.0	25.0	127.0	67.0	20	15.0	4	74.8	6470	20.1	254.1	269.3	AS50
AS41	40.7	63.5	136.5	40.5	74.6	21.4	127.0	60.3	—	13.1	5	67.5	5187	13.2	184.4	204.5	AS41

PART 13 GANTRY GIRDERS/MONORAIL BEAMS

TABLES

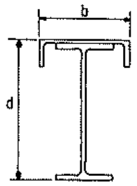
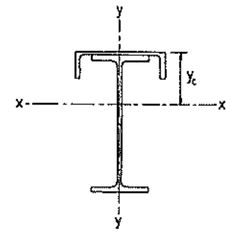


TABLE 13-1

GANTRY GIRDERS

COMPOSITION AND DIMENSIONS AND PROPERTIES



Composed of: Beam	Composed of: Top Flange Channel	Approx. size d x b	Mass per m	Area A_g	y_c	About x-axis: I_x	About x-axis: Top Z_x	About x-axis: Bot Z_x	About x-axis: r_x	About y-axis: I_y	About y-axis: r_y	About y-axis: Top F I_y	About y-axis: Top F Z_y	Torsion Constant J	Warping Constant I_w
		mm mm	kg/m	mm^2	mm	10^6mm^4	10^3mm^3	10^3mm^3	mm	10^6mm^4	mm	10^6mm^4	10^3mm^3	10^3mm^3	10^9mm^6
				WELDED BEAMS with PARALLEL FLANGE CHANNELS											
1200WB249	380PFC	1180 x 380	304	38700	492	8240	16800	12000	461	239	78.5	195	1030	4870	38100
800WB168	380PFC	820 x 380	223	28400	319	3290	10300	6560	340	238	91.7	195	1030	3590	17900
146		810 x 380	201	25600	305	2790	9150	5530	330	221	92.9	186	981	2190	14000
122		802 x 380	178	22600	288	2270	7880	4420	317	193	92.4	173	908	1410	8630
700WB173	380PFC	726 x 380	228	29000	286	2690	9410	6100	304	249	92.6	200	1050	4720	15400
150		720 x 380	205	26100	274	2300	8380	5160	297	217	91.1	184	970	3300	10700
130		710 x 380	186	23600	261	1950	7470	4340	287	204	92.9	178	936	2020	8330
115		702 x 380	170	21600	249	1670	6710	3690	278	193	94.6	173	908	1370	6540
				UNIVERSAL BEAMS with PARALLEL FLANGE CHANNELS											
610UB125	380PFC	622 x 380	180	23000	228	1400	6140	3550	247	191	91.2	171	902	2020	4950
113		617 x 380	169	21500	220	1270	5770	3190	243	186	93.1	169	889	1590	4290
101		612 x 380	157	20000	211	1130	5350	2820	238	181	95.2	166	875	1240	3590
530UB 92.4	380PFC	543 x 380	148	18800	183	833	4540	2320	210	176	96.6	164	861	1230	2370
82.0		538 x 380	137	17500	175	737	4210	2030	205	172	99.1	162	851	985	1970
530UB 92.4	300PFC	541 x 300	133	16900	200	776	3880	2270	214	96.3	75.5	84.4	562	1050	2070
82.0		536 x 300	122	15600	192	685	3570	1990	210	92.5	77.1	82.4	550	803	1700
460UB 82.1	300PFC	468 x 300	122	15600	169	528	3120	1760	184	91.1	76.5	81.8	545	982	1240
74.6		465 x 300	115	14600	163	484	2960	1600	182	89.1	78.1	80.8	538	810	1100
67.1		462 x 300	107	13700	157	436	2770	1430	179	86.9	79.8	79.7	531	661	942
410UB 59.7	300PFC	411 x 300	99.8	12700	137	323	2350	1160	159	84.4	81.5	78.4	523	619	638
53.7		411 x 300	93.8	12000	131	287	2180	1030	155	82.6	83.1	77.5	517	517	534
360UB 56.7	300PFC	367 x 300	96.8	12300	121	241	2000	983	140	83.5	82.3	78.0	520	622	460
50.7		364 x 300	90.8	11600	116	217	1880	877	137	82.1	84.2	77.2	515	526	397
44.7		360 x 300	84.8	10800	110	191	1740	764	133	80.5	86.3	76.5	510	447	330

Notes: (1) I_y Top F = I_x of channel + (I_y of Universal or Welded Beam)/2
(2) Z_y Top F = (I_y Top F)/(b/2)