INTERNATIONAL UNIVERSITY OF AFRICA

CIVIL ENGINEERING DEPARTMENT

ANALYSIS AND DESIGN OF STEEL WORKS

GRADE 4

7TH SEMESTER

Lecture No 2

BEAMS

PART 2

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On beams we always have moment and shear *then* for the design of beam we have to consider them together

How ??????

Let start with a beam which the section is classified as plastic
the ultimate moment Mult from the analysis and the ultimate shear is Qult

EXAMPLE

A beam simply supported with a uniformly distrusted load and Assume the factored moment from analysis M_{ult}= 122.1 kN.m and Assume the factored Shear from analysis Q_{ult}= 77.7 KN   Steel S275
And the beam is fully restrained along its length by deck slab

STEP 1 SELECT SECTION

Trick

$$\text{Plastic modulus } S = \frac{M}{p_y} = \frac{122.1 \times 10^3}{275} = 444\ \text{cm}^3,$$

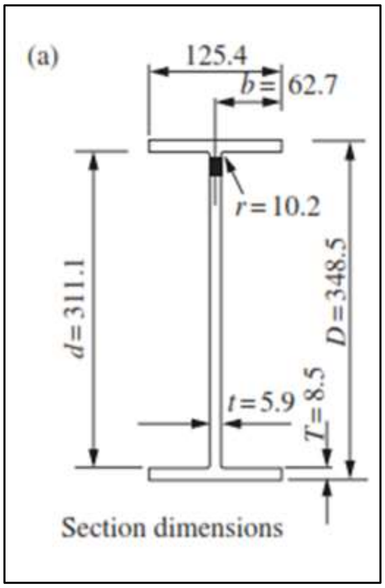
Try use *UB 365x127 x 33* → *See corus sections table inclosed in the lecture as separate file*

Table 5. Universal Beams *(continued)*

Designation: Serial size	Designation: Mass per unit length	Depth of section D	Width of section B	Thickness: Web t	Thickness: Flange T	Root radius r	Depth between fillets d	Area of section r	Second moment of area x-x axis	Second moment of area y-y axis	Radius of gyration x-x axis	Radius of gyration y-y axis	Elastic modulus x-x axis	Elastic modulus y-y axis	Plastic modulus x-x axis	Plastic modulus y-y axis	Ratio D/T
mm	kg/m	mm	mm	mm	mm	mm	mm	cm^2	cm^4	cm^4	cm	cm	cm^3	cm^3	cm^3	cm^3	
356 × 127	39	325.8	126.0	6.5	10.7	10.2	311.1	49.4	10 087	357	14.29	2.69	571.8	56.6	653.6	88.68	33.1
	33	348.5	125.4	5.9	8.5	10.2	311.1	41.8	8 200	280	14.00	2.59	470.6	44.7	539.8	70.24	41.0

S_x=539.8 cm3. Z_x =470.6 cm3 I_x=8200 cm4
D/T=41,   d=311.1 mm,   t= 5.9 mm

d/t= 311/5.9=527



Then STEP 2

Classify the section use these below simple tables since the section is rolled

Table 9 — Design strength p_y

Steel grade	Thickness[a] less than or equal to mm	Design strength p_y N/mm²
S 275	16	275
	40	265
	63	255
	80	245
	100	235
	150	225
S 355	16	355

Compression element		*Ratio*	*Limiting value*		
			Class 1 plastic	*Class 2 compact*	*Class 3 semi-compact*
Outstand element of compression flange	*Rolled section*	*b/T*	9ε	10ε	15ε
Web with neutral axis at mid-depth		*d/t*	80ε	100ε	120ε

The parameter, $\varepsilon = (275/p_y)^{0.5}$

$$\varepsilon = (275/p_y)^{0.5} = 1.0$$
$$b/T = 62.7/8.5 = 7.37 < 9$$
$$d/T = 311.1/5.9 = 52.7 < 80$$

How to calculate the shear capacity?

Section is classified as plastic

STEP 3

Check wither the shear at max moment is low or high shear

- *Low shear if the applied shear Fv< 60% than the shear capacityPv*
- *High shear if shear capacity > 60% applied shear*

Shear capacity Pv

$$P_v = 0.6 p_y A_v$$

in which A_v is the shear area, taken as follows:

a) rolled I, H and channel sections, load parallel to web:	tD
b) welded I-sections, load parallel to web:	td
c) rectangular hollow sections, load parallel to webs:	$AD/(D + B)$
d) welded box sections, load parallel to webs:	$2td$
e) rolled T-sections, load parallel to web:	tD
f) welded T-sections, load parallel to web:	$t(D - T)$
g) circular hollow sections:	$0.6A$
h) solid bars and plates:	$0.9A$

In the example py=272 N/mm2 Av=tD=5.9x3458=204022 mm2

Pv= 0.6x(275x204022/1000)=5610.6kN greater than 77kN

Low shear

Low shear

Provided that the shear force F_v does not exceed 60 % of the shear capacity P_v:

— for class 1 plastic or class 2 compact cross-sections:

$M_c = p_y S$

— for class 3 semi-compact sections:

$M_c = p_y Z$ or alternatively $M_c = p_y S_{eff}$

Then for this example

This is a plastic section.

The moment capacity is $p_y S \leq 1.2 p_y Z$

$$p_y S_x = 275 \times 539.8 \times 10^{-3} = 148.4\,\text{kN m},$$
$$1.2 p_y Z_x = 1.2 \times 275 \times 470.6 \times 10^{-3} = 155.3\,\text{kN m}.$$

The section is satisfactory for the moment.