

Package ‘civilR’

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Author Alena Fournier-Carrie & Marc Fournier-Carrie

Maintainer Marc Fournier-Carrie <marc@shadowboxingskills.com>

Description Civil Engineering R package

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civilR

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R topics documented:

all_member_sizes	2
axial_compression_force	3
axial_compression_force_given_member	4
calculated_NEd	5
check_all_member_sizes	5
check_local_buckling_resistance_about_zz_axis	6
check_overall_buckling_resistance_about_yy_axis	8
check_overall_buckling_resistance_about_zz_axis	9
civilR	11
combined_vertical_load	11
compute_output_table	12
convert_member_dimensions_string_to_elements	12
convert_member_dimensions_to_string	13
effective_length_of_member	13

effective_second_moment_of_area	14
Euler_buckling_load	14
extract_member_dimensions	15
first_order_bending_moment	15
imperfection_factor_yy	16
imperfection_factor_zz	16
import_reference_BlueBook_tables	17
maximum_shear_force_in_the_lacing	17
max_compressive_axial_force_in_chords	18
overall_buckling_resistance_about_axis	19
plastic_resistance_of_cross_section_to_compression	19
read_input_table	20
relative_slenderness	20
second_order_bending_moment	21
shear_force_at_support	21
shear_stiffness	22
slenderness_reduction_factor	22
temperature_load	23
trial_member_size	23
yield_strength	24

Index	25
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all_member_sizes	<i>Extract a vector of all member sizes</i>
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Description

Extract a vector of all member sizes for specified steel grade (S355/S275) and member type (UC/UB)

Usage

```
all_member_sizes(steel_grade, member_type, list_reference_tables)
```

Arguments

steel_grade	steel_grade [N/mm^2], categorical: 'S355' or 'S275'
member_type	member_type, categorical: 'UC' or 'UB'
list_reference_tables	List of reference tables

Value

Vector of all member sizes [height (mm) x width (mm) x mass (kg/m)]

axial_compression_force

Calculate the axial compression force

Description

Compute Axial Compression Force, N_{ed} [kN], for member without including Temperature effect. Used as trial for the top level strut where temperature changes could not be neglected. As well can be used to calculate final N_{ed} for struts from low levels of excavation, where temperature effect could be neglected.

Usage

```
axial_compression_force(isTopLevel = T, DL = 1, LL = 1, L = 12.5,
    P = 247, theta = 90, spacing = 6, Lcry = 12.7, Lcrz = 1,
    steel_grade = "S355", member_type = "UB", alpha_T = 1.2e-05,
    delta_T = 10, k_T = 0.8, E = 210, AL = 50, gamma = 1.35,
    list_reference_tables)
```

Arguments

isTopLevel	Is member located at top level? [boolean]
DL	Dead load / self-weight of member [kN/m]
LL	Live load / imposed load [kN/m]
L	Total length of member [m]
P	Axial compression force of member per meter [kN/m]
theta	Angle to wall [deg]
spacing	spacing [m]
Lcry	critical length major axis [m]
Lcrz	critical length minor axis [m]
steel_grade	steel_grade [N/mm ²], categorical: 'S355' or 'S275'
member_type	member_type, categorical: 'UC' or 'UB'
alpha_T	Thermal coef. of expansion [degC]
delta_T	Change in temperature from the Installation temperature [degC]
k_T	Coefficient Of Temperature Effect [dimensionless]
E	Young's Modulus of Elasticity [GPa]
AL	Accidental Impact Load [kN/m]
gamma	Partial factor for action [dimensionless], as per EN 1990:2002 standard
list_reference_tables	List of reference tables

Details

First of all function check which combination govern in ULS (Ultimate Limit State) without including Temperature load, TL [kN]. Then include TL calculations for Load Combinations applying partial factors based on the Table A1.2(B), EN1990-2002, p53 Compare maximum from ULS and ALS to define which mistake could govern.

Value

- N_{ed} Axial compression force [kN]
- TL Temperature Load [kN]

axial_compression_force_given_member

Calculate the axial compression force for a given member size

Description

Compute Axial Compression Force, N_{ed} [kN], for member without including Temperature effect. Used as trial for the top level strut where temperature changes could not be neglected. As well can be used to calculate final N_{ed} for struts from low levels of excavation, where temperature effect could be neglected.

Usage

```
axial_compression_force_given_member(isTopLevel = T, Ned_no_TL = 6987,
    member_size, alpha_T = 1.2e-05, delta_T = 10, k_T = 0.8, E = 210,
    list_reference_tables)
```

Arguments

isTopLevel	Is member located at top level? [boolean]
alpha_T	Thermal coef. of expansion [$degC$]
delta_T	Change in temperature from the Installation temperature [$degC$]
k_T	Coefficient Of Temperature Effect [dimensionless]
E	Young's Modulus of Elasticity [GPa]
list_reference_tables	List of reference tables

Details

First of all function check which combination govern in ULS (Ultimate Limit State) without including Temperature load, TL [kN]. Then include TL calculations for Load Combinations applying partial factors based on the Table A1.2(B), EN1990-2002, p53 Compare maximum from ULS and ALS to define which mistake could govern.

Value

- N_{ed} Axial compression force [kN]
- TL Temperature Load [kN]

calculated_NEd	<i>Generate calculated NEd</i>
----------------	--------------------------------

Description

Generate calculated N_{Ed} , N_{Ed_c} [kN].

Usage

calculated_NEd(N_b_Rd, Ieff, MEd, h0, A)

Arguments

N_b_Rd	Overall buckling resistance of the struts about the axis [kN]
Ieff	Effective second moment of area [mm^4]
MEd	Second order moment [$kN.m$]
h0	Distance between centroids of chords [m]
A	Cross-section area of strut [cm^2]

Value

N_{Ed_c} Calculated N_{Ed} [kN]

check_all_member_sizes	<i>Generate a table with all member sizes and apply all checks on each of them</i>
------------------------	--

Description

Generate a table with all member sizes and apply all checks on each of them

Usage

```
check_all_member_sizes(steel_grade = "S355", member_type = "UB",
  k = 0.8, L = 12.5, E = 210, h0 = 1000, Lch = 1000, Ad = 1140,
  n = 2, isTopLevel = T, alpha_T = 1.2e-05, delta_T = 10,
  k_T = 0.8, Ned_no_TL = 6987, LL, AL, Lcry, Lcrz, m1,
  strut_name = "strut #",
  base_file_name = "tables/input/all_member_sizes_checked",
  export_xlsx = T)
```

Arguments

steel_grade	steel_grade [N/mm^2], categorical: 'S355' or 'S275'
member_type	member_type, categorical: 'UC' or 'UB'
k	Coefficient [dimensionless]
L	Total length of member [m]
E	Young's Modulus of Elasticity [GPa]

h0	Distance between centroids of chords [mm]
Lch	Length of chord [mm]
Ad	Section area of diagonal (lacing), [cm ²]
n	Number of planes of lacing, default [n = 2]
isTopLevel	Is member located at top level? [boolean]
alpha_T	Thermal coef. of expansion [degC]
delta_T	Change in temperature from the Installation temperature [degC]
k_T	Coefficient Of Temperature Effect [dimensionless]
Ned_no_TL	Axial Compressional Force without Temperature Load [kN]
LL	Live load / imposed load [kN/m]
AL	Accidental Impact Load [kN/m]
Lcry	critical length about major axis [m]
Lcrz	critical length minor axis [m]
ml	Lacing weight [kN/m]
strut_name	Strut name
export_xlsx	Boolean to export Excel spreadsheet or not [T/F]
file_name	Path and file name of the output table

Value

- *df* Dataframe containing relevant input and all computed data
- *optimal_member_size* Optimal member size [height (mm) x width (mm) x mass (kg/m)]
- *optimal_TL* Optimal Temperature Load [kN]
- *optimal_Ned* Optimal @param Ned_no_TL Axial Compressional Force with Temperature Load [kN]

check_local_buckling_resistance_about_zz_axis

Perform check #3, calculating the local buckling resistance of struts about minor z - z axis

Description

Calculate the local buckling resistance of member about minor $z - z$ axis, based on EC3 Approach.

$$L_e = kL_{ch}$$

[mm] where L is the critical length for buckling about minor axis $z - z$ Steps of the check performed for laced struts:

1. Plastic resistance of the cross-section to compression [kN]

$$N_{pl,Rd,ch} = 2(Afy)$$

2. The Euler buckling load $[kN]$

$$N_{cr,ch} = \frac{\pi^2 E I_{zz}}{L_e^2}$$

3. Relative slenderness [dimensionless]

$$\bar{\lambda}_{ch} = \sqrt{\frac{N_{pl,Rd,ch}}{N_{cr,ch}}}$$

4. Calculate Φ_{ch} parameter for slenderness reduction factor

$$\Phi_{ch} = 0.5 \left[1 + \alpha (\bar{\lambda}_{ch} - 0.2) + \bar{\lambda}_{ch}^2 \right]$$

5. Slenderness reduction factor [dimensionless]

$$X_{ch} = \frac{1}{\Phi_{ch} + \sqrt{\Phi_{ch}^2 - \bar{\lambda}_{ch}^2}}$$

6. Output overall buckling resistance of the struts about $z - z$ minor axis $[kN]$

$$N_{b,Rd,ch} = X_{ch} N_{pl,Rd,ch}$$

The partial factors γ_M that are applied to resistance of members to instability: $\gamma_{M_1} = 1$

Usage

```
check_local_buckling_resistance_about_zz_axis(trial_member_size,
      member_type, steel_grade, k, Lch, E, list_reference_tables)
```

Arguments

trial_member_size	Trial member size
member_type	member_type, categorical: 'UC' or 'UB'
steel_grade	steel_grade $[N/mm^2]$, categorical: 'S355' or 'S275'
k	Coefficient [dimensionless]
Lch	Length of chord $[mm]$
E	Young's Modulus of Elasticity $[GPa]$
list_reference_tables	List of reference tables

Value

- $N_{b,Rd,X}$ Local buckling resistance of struts about $z - z$ axis $[kN]$
- f_y
- $N_{pl,Rd}$
- N_{cr}
- $\bar{\lambda}$
- α_{yy}
- X

check_overall_buckling_resistance_about_yy_axis

Perform check #1, calculating the overall buckling resistance of member about major y – y axis

Description

Calculate the overall buckling resistance of member about $y - y$ axis, based on EC3 Approach.

$$L_e = kL$$

[mm] where L is the critical length for buckling about major axis $y - y$ Steps of the check performed for laced struts:

1. Plastic resistance of the cross-section to compression [kN]

$$N_{pl,Rd} = 2(A f_y)$$

2. The Euler buckling load [kN]

$$N_{cr,X} = \frac{\pi^2 E I_{yy}}{L_e^2}$$

3. Relative slenderness [dimensionless]

$$\bar{\lambda}_X = \sqrt{\frac{N_{pl,Rd}}{N_{cr,X}}}$$

4. Calculate Φ_X parameter for slenderness reduction factor

$$\Phi_X = 0.5 \left[1 + \alpha (\bar{\lambda}_X - 0.2) + \bar{\lambda}_X^2 \right]$$

5. Slenderness reduction factor [dimensionless]

$$X_x = \frac{1}{\Phi_X + \sqrt{\Phi_X^2 - \bar{\lambda}_X^2}}$$

6. Output overall buckling resistance of the struts about $y - y$ axis [kN]

$$N_{b,Rd,X} = X_X N_{pl,Rd}$$

The partial factors γ_M that are applied to resistance of members to instability: $\gamma_{M1} = 1$

Usage

```
check_overall_buckling_resistance_about_yy_axis(trial_member_size,
member_type, steel_grade, k, L, E, list_reference_tables)
```


Arguments

trial_member_size	Trial member size
member_type	member_type, categorical: 'UC' or 'UB'
steel_grade	steel_grade [N/mm^2], categorical: 'S355' or 'S275'
k	Coefficient [dimensionless]
L	Total length of member [m]
E	Young's Modulus of Elasticity [GPa]
list_reference_tables	List of reference tables

Value

- $N_{b,Rd,X}$ Overall buckling resistance of struts about major y-y axis [kN]
- $N_{b,Rd,X}$
- f_y
- $N_{pl,Rd}$
- $N_{cr,X}$
- $N_{cr,X}$
- λ_X
- α_{yy}
- X

check_overall_buckling_resistance_about_zz_axis

Perform check #2, calculating the overall buckling resistance of struts about major z - z axis

Description

Calculate the overall buckling resistance of member about $z - z$ axis, based on EC3 Approach.

$$L_e = k L$$

[mm] where L is the critical length for buckling about major axis $z - z$ Steps of the check performed for laced struts:

1. Plastic resistance of the cross-section to compression [kN]

$$N_{pl,Rd} = 2(A f_y)$$

2. The Euler buckling load [kN]

$$N_{cr,Y} = \frac{\pi^2 E I_{eff}}{L_e^2}$$

3. Relative slenderness [dimensionless]

$$\bar{\lambda}_Y = \sqrt{\frac{N_{pl,Rd}}{N_{cr,Y}}}$$

4. Calculate Φ_Y parameter for slenderness reduction factor

$$\Phi_Y = 0.5 \left[1 + \alpha (\bar{\lambda}_Y - 0.2) + \bar{\lambda}_Y^2 \right]$$

5. Slenderness reduction factor [dimensionless]

$$X_Y = \frac{1}{\Phi_Y + \sqrt{\Phi_Y^2 - \bar{\lambda}_Y^2}}$$

6. Output overall buckling resistance of the struts about $z - z$ axis [kN]

$$N_{b,Rd,Y} = X_Y N_{pl,Rd}$$

The partial factors γ_M that are applied to resistance of members to instability: $\gamma_{M_1} = 1$

Usage

```
check_overall_buckling_resistance_about_zz_axis(trial_member_size,
        member_type, steel_grade, k, L, E, h0, list_reference_tables)
```

Arguments

trial_member_size	Trial member size
member_type	member_type, categorical: 'UC' or 'UB'
steel_grade	steel_grade [N/mm^2], categorical: 'S355' or 'S275'
k	Coefficient [dimensionless]
L	Total length of member [m]
E	Young's Modulus of Elasticity [GPa]
h0	Distance between centroids of chords [mm]
list_reference_tables	List of reference tables

Value

- $N_{b,Rd,Y}$ Overall buckling resistance of struts about z-z axis [kN]
- f_y
- $N_{pl,Rd}$
- I_{eff}
- $N_{cr,Y}$
- $\bar{\lambda}_Y$
- α_{yy}
- X

civilR

*Package civilR***Description**

Civil Engineering package.

combined_vertical_load *USL vs ALS verical load combinations***Description**

USL vs ALS verical load combinations

Usage

```
combined_vertical_load(DL, LL, AL)
```

Arguments

DL	Dead load / self-weight of member [kN/m]
LL	Live load / imposed load [kN/m]
AL	Accidental Impact Load [kN/m]

Details

Calculation steps are as follows:

1. $ULS : F = (1.35 DL + 1.5 LL + 1.5 TL)$
2. $ALS : F = (1.0 DL + 0.7 LL + 1.0 AL)$
3. $ALS : F = (1.0 DL + 0.6 LL + 1.0 AL + 0.5 TL)$

Value

combined_vertical_load [kN/m]

compute_output_table	<i>Export output table to Excel file</i>
----------------------	--

Description

Export output table to Excel file.

Usage

```
compute_output_table(file_name = "tables/input/output_processed_table.xlsx",
export_xlsx = T)
```

Arguments

file_name	Path and file name of the output table
export_xlsx	Boolean to export Excel spreadsheet or not [T/F]

Value

None

convert_member_dimensions_string_to_elements	<i>Convert individual member dimensions to a string</i>
--	---

Description

Convert individual member dimensions to a string.

Usage

```
convert_member_dimensions_string_to_elements(s)
```

Arguments

s	String of the member dimensions
---	---------------------------------

Value

- h Member height [mm]
- b Member width [mm]
- m Member weight [kg/m]

convert_member_dimensions_to_string

Convert the member size individual dimensions to a standard string

Description

Generate a combined string from given three individual elements, separated by "x".

Usage

convert_member_dimensions_to_string(h, b, m)

Arguments

h	Member height [mm]
b	Member width [mm]
m	Member mass [kg/m]

Value

String of the member dimensions

effective_length_of_member

Calculate the effective length of member

Description

Calculate the effective length of member, L_e [m].

Usage

effective_length_of_member(k, L)

Arguments

k	Effective length coefficient [dimensionless]
L	Length of strut between restraints [m]

Value

L_e Effective length of strut [m]

effective_second_moment_of_area

Calculate the effective second moment of area

Description

Compute the effective second moment of area [mm^4]. I_{eff} is a function of the distance between the centroids of the chords and the section area of a chord, calculated as $I_{eff} = 0.5 h_0^2 A$.

Usage

effective_second_moment_of_area(h0, A)

Arguments

h0	Distance between centroids of chords [mm]
A	Cross-section area of strut [cm^2]

Value

I_{eff} Effective second moment of area [mm^4]

Euler_buckling_load

Calculate the Euler buckling load

Description

Calculate the Euler buckling load [kN]

$$N_{cr,ch} = \frac{\pi^2 E I}{L_e^2}$$

Usage

Euler_buckling_load(Le, E, I)

Arguments

Le	Effective length of strut [mm]
E	Young modulus [MPa or MN/m^2]
I	- check 1: I_{yy} , second moment of area Axis $y - y$ [cm^4]. Check 2: I_{eff} , Effective second moment of area [mm^4]. Check 3: I_{eff} or I_{zz} [mm^4]

Value

N_{cr} Euler buckling load [kN]

 extract_member_dimensions

Extract dimensions from reference table

Description

Function that looks into the Blue Book <https://www.steelforlifebluebook.co.uk/> for dimensions and properties.

Usage

```
extract_member_dimensions(h, b, m, member_type, list_reference_tables)
```

Arguments

h	Member height [mm]
b	Member width [mm]
m	Member mass [kg/m]
member_type	Member type, 'UB' or 'UC'
list_reference_tables	List of reference tables

Value

- A Area of section [cm^2]
- tw Thickness of web [mm]
- tf Thickness of flange [mm]
- I_{yy} Second moment of area axis $y - y$ [cm^4]
- sh Depth of section [mm]
- sb Width of section [mm]
- I_{zz} Second moment of area axis $z - z$ [cm^4]

 first_order_bending_moment

Calculate first order bending moment about major axis $y - y$ [kN.m]

Description

Calculate first order bending moment about major axis $y - y$ [kN.m]

Usage

```
first_order_bending_moment(combined_vertical_load, L)
```

combined_vertical_load	combined_vertical_load [kN/m]
L	Length of strut between restraints [m]

Calculated as

$$M_{Ed}^I = 0.08 F L_{cr,y}^2$$

 M_{Ed}^I First order bending moment [kN.m]

imperfection_factor_yy *Calculate the imperfection factor α_{yy} for rolled section [dimensionless]*

Calculate the imperfection factor α_{yy} for rolled section [dimensionless].

imperfection_factor_yy(h, b, tf)

h	Member height [mm]
b	Member width [mm]
tf	thickness of the flange [mm]

 α_{yy} Imperfection factor for $y - y$ axis [dimensionless]

imperfection_factor_zz *Calculate the imperfection factor α_{zz} for rolled section*

Calculate the imperfection factor α_{zz} for rolled section.

```
imperfection_factor_zz(h, b, tf)
```


Arguments

h	Member height [mm]
b	Member width [mm]
tf	thickness of the flange [mm]

Value

α_{zz} Imperfection factor for $z - z$ axis [dimensionless]

import_reference_BlueBook_tables

Import Reference BlueBook Tables from Excel files

Description

Import Reference BlueBook Tables from Excel files.

Usage

import_reference_BlueBook_tables()

Arguments

None

Value

List of 4 BlueBook reference tables

maximum_shear_force_in_the_lacing

Calculate the maximum shear force in the lacing

Description

Calculate the maximum shear force in the lacing, V_{Ed} [kN] (for a laced strut subject to a compressive axial force only)

$$V_{Ed} = \pi \frac{M_{Ed}}{L}$$

Usage

maximum_shear_force_in_the_lacing(MEd, L)

Arguments

MEd	Second order moment [kN.m]
L	Length of strut between restraints [m]

Value

V_{Ed} Maximum shear force in the lacing [kN] (for a laced strut subject to a compressive axial force only)

max_compressive_axial_force_in_chords

Maximum compressive axial force in the chords

Description

Determine maximum compressive axial force in the chords at mid-length of the strut, N_{ch,E_d} [kN]

Usage

```
max_compressive_axial_force_in_chords(trial_member_size, member_type,
    steel_grade, k, L, n, Ad, Lch, E, h0, Ned, list_reference_tables,
    isTopLevel, DL, LL, AL, TL, Lcry)
```

Arguments

trial_member_size	Trial member size
member_type	member_type, categorical: 'UC' or 'UB'
steel_grade	steel_grade [N/mm^2], categorical: 'S355' or 'S275'
k	Coefficient of length as function of wall rigidity [dimensionless]
L	Length between two restraints [m]
n	Number of lacing planes, default [$n = 2$]
Ad	Section area of diagonal (lacing), [cm^2]
Lch	Length of chord of between restrains (lace points) [m]
E	Young modulus [GPa or GN/m^2]
h0	Distance between centroids of chords [m]
Ned	Axial compression Force [kN]
list_reference_tables	List of reference tables
isTopLevel	Is member located at top level? [boolean]
DL	Dead load / self-weight of member [kN/m]
LL	Live load / imposed load [kN/m]
AL	Accidental Impact Load [kN/m]
TL	Temperature load [kN/m]
Lcry	critical length about major axis [m]

Value

- N_{ch,E_d} Maximum compressive axial force in the chords [kN]
- S_v
- $N_{cr,ch}$
- M_{E_d}

overall_buckling_resistance_about_axis

Calculate the overall buckling resistance of the member about the axis

Description

General case to compute the overall buckling resistance of the member, N_{b,R_d} [kN], about the axis, calculated as:

$$N_{b,R_d} = X N_{pl,R_d}$$

Usage

overall_buckling_resistance_about_axis(X, N_pl_Rd)

Arguments

X	Slenderness reduction factor [dimensionless]
N_pl_Rd	Plastic resistance of the cross-section to compression [kN]

Value

N_{b,R_d} Overall buckling resistance of the struts about the axis [kN]

plastic_resistance_of_cross_section_to_compression

Calculate the plastic resistance of the cross-section to compression

Description

Calculate the plastic resistance of the cross-section to compression [N], based on cross-section area A and yield strength f_y .

Usage

plastic_resistance_of_cross_section_to_compression(A, fy)

Arguments

A	Cross-section area of the strut [cm ²]
fy	Yield strength [kN/mm ²]

Value

N_{pl,R_d} Plastic resistance of the cross-section to compression [N]

read_input_table	<i>Read input table from given Excel file</i>
------------------	---

Description

Read input table from given Excel file.

Usage

```
read_input_table(file_name = "tables/input/trial1_kotik.xlsx")
```

Arguments

file_name	Path and file name of the input table
-----------	---------------------------------------

Value

Input table

relative_slenderness	<i>Calculate the relative slenderness</i>
----------------------	---

Description

Calculate the relative slenderness [dimensionless]

$$\bar{\lambda} = \sqrt{\frac{N_{pl,Rd}}{N_{cr}}}$$

Usage

```
relative_slenderness(N_pl_Rd, Ncr)
```

Arguments

N_pl_Rd	Plastic resistance of the cross-section to compression [kN]
Ncr	Euler buckling load [kN]

Value

$\bar{\lambda}$ Relative slenderness [dimensionless]

second_order_bending_moment

Calculate the second order bending moment

Description

Compute the second order bending moment, M_{Ed} [kN.m]. The maximum bending moment, including the bow imperfection and the second order effects, calculated as:

$$M_{Ed} = \frac{N_{Ed} e_0 + M_{Ed}^I}{1 - \frac{N_{Ed}}{N_{cr,Y}} - \frac{N_{Ed}}{S_v}}$$

Usage

```
second_order_bending_moment(L, Ned, Sv, Ncr, DL, LL, AL)
```

Arguments

L	Length of strut between restraints [m]
Ned	axial_compression_force [kN]
Sv	Shear stiffness for K-shape lacing [kN]
Ncr	Euler buckling load from check #2 global zz [kN]
DL	Dead load / self-weight of member [kN/m]
LL	Live load / imposed load [kN/m]
AL	Accidental Impact Load [kN/m]

Value

M_{Ed} Second order moment [kN.m]

shear_force_at_support *Shear force at support calculation*

Description

Generate Shear force at support V_{Ed} [kN].

Usage

```
shear_force_at_support(DL, LL, L, AL)
```

Arguments

DL	Dead load / self-weight of member [kN/m]
LL	Live load / imposed load [kN/m]
L	Length of strut between restraints [m]
AL	Accidental Impact Load [kN/m]

Value

V_{Ed} Shear force at support [kN]

shear_stiffness	<i>Calculate the shear stiffness for K-shape lacing</i>
-----------------	---

Description

Calculate the shear stiffness for K-shape lacing $[kN]$. The expression of shear stiffness is:

$$S_v = \frac{n E A_d L_{ch} h_0^2}{d^3}$$

Usage

```
shear_stiffness(n = 2, Ad, Lch, E, h0)
```

Arguments

n	Number of planes of lacing, default $[n = 2]$
Ad	Section area of diagonal (lacing), $[cm^2]$
Lch	Length of chord of between restrains (lace points) $[m]$
E	Young modulus $[GPa \text{ or } GN/m^2]$
h0	Distance between centroids of chords $[m]$

Value

S_v Shear stiffness for K-shape lacing $[kN]$

slenderness_reduction_factor	<i>Calculate the slenderness reduction factor</i>
------------------------------	---

Description

Calculate the slenderness reduction factor X [dimensionless] for the general case.

$$\Phi = 0.5 [1 + \alpha (\bar{\lambda} - 0.2) + \bar{\lambda}^2]$$

$$X = \frac{1}{\Phi + \sqrt{\Phi^2 - \bar{\lambda}^2}}$$

Usage

```
slenderness_reduction_factor(alpha, lambda_bar)
```

Arguments

alpha	Check #1: imperfection factor α_{yy} for rolled section [dimensionless]. Check 2 & 3: imperfection factor α_{zz} for rolled section [dimensionless]
lambda_bar,	Relative slenderness $\bar{\lambda}$ [dimensionless]

Value

X Slenderness reduction factor [dimensionless]

temperature_load	Calculate the temperature load
------------------	--------------------------------

Description

Calculate Temperature Load as a function of a surface changes of temperature, TL [*kN*]. Usually used for calculation of Axial Compression Force for the top level member.

$$TL = \alpha_T \delta_T k_T E A$$

Usage

```
temperature_load(alpha_T = 1.2e-05, delta_T = 10, k_T = 0.8,
                 E = 210, A = 94.4)
```

Arguments

alpha_T	Thermal coefficient of expansion [<i>degC</i>]
delta_T	Change in temperature from the Installation temperature [<i>degC</i>]
k_T	Coefficient Of temperature effect [dimensionless]
E	Young's Modulus of Elasticity [<i>GPa</i> or <i>GN/m2</i>]
A	Sectional area from table for given member size [<i>cm2</i>]

Value

TL Temperature load [*kN*]

trial_member_size	Determine member size
-------------------	-----------------------

Description

Find optimized designation [height (mm) x width (mm) x mass (kg/m)] (also called member size) for given Axial Compression Force and critical length for major and minor axis. Searching into the tables based on the 'Compression' tables of the Blue Book <https://www.steelforlifebluebook.co.uk/>

Usage

```
trial_member_size(Lcry, Lcrz, Ned, steel_grade, member_type,
                 list_reference_tables)
```

Arguments

Lcry	critical length major axis [<i>m</i>]
Lcrz	critical length minor axis [<i>m</i>]
Ned	Axial compression force [<i>kN</i>]
steel_grade	steel_grade [<i>N/mm2</i>], categorical: 'S355' or 'S275'
member_type	member_type, categorical: 'UC' or 'UB'
list_reference_tables	List of reference tables

Value

Member size [height (mm) x width (mm) x mass (kg/m)]

yield_strength	<i>Calculate the yield strength</i>
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Description

Calculate the yield strength, f_y [N/mm^2]

Usage

yield_strength(tw, tf, steel_grade)

Arguments

- tw Thickness of the web [mm]
- tf Thickness of the flange [mm]
- steel_grade steel_grade [N/mm^2], categorical: 'S355' or 'S275'

Value

f_y Yield strength [N/mm^2]

Examples

yield_strength(tw=47.6, tf=77, steel_grade="S355")

Index

`all_member_sizes`, [2](#)
`axial_compression_force`, [3](#)
`axial_compression_force_given_member`, [4](#)

`calculated_NEd`, [5](#)
`check_all_member_sizes`, [5](#)
`check_local_buckling_resistance_about_zz_axis`,
[6](#)
`check_overall_buckling_resistance_about_yy_axis`,
[8](#)
`check_overall_buckling_resistance_about_zz_axis`,
[9](#)
`civilR`, [11](#)
`civilR-package (civilR)`, [11](#)
`combined_vertical_load`, [11](#)
`compute_output_table`, [12](#)
`convert_member_dimensions_string_to_elements`,
[12](#)
`convert_member_dimensions_to_string`, [13](#)

`effective_length_of_member`, [13](#)
`effective_second_moment_of_area`, [14](#)
`Euler_buckling_load`, [14](#)
`extract_member_dimensions`, [15](#)

`first_order_bending_moment`, [15](#)

`imperfection_factor_yy`, [16](#)
`imperfection_factor_zz`, [16](#)
`import_reference_BlueBook_tables`, [17](#)

`max_compressive_axial_force_in_chords`,
[18](#)
`maximum_shear_force_in_the_lacing`, [17](#)

`overall_buckling_resistance_about_axis`,
[19](#)

`plastic_resistance_of_cross_section_to_compression`,
[19](#)

`read_input_table`, [20](#)
`relative_slenderness`, [20](#)

`second_order_bending_moment`, [21](#)

`shear_force_at_support`, [21](#)
`shear_stiffness`, [22](#)
`slenderness_reduction_factor`, [22](#)

`temperature_load`, [23](#)
`trial_member_size`, [23](#)

`yield_strength`, [24](#)