Tekla Structural Designer 2021

Design Codes Reference: Australian Standards

May 2021

Contents

1 Australian Standards

1.1 Loading to AS/NZS 1170.0 and AS 1170.1 (Australian Standards)

This handbook provides a general overview of how loadcases and combinations are created in Tekla Structural Designer when an Australian Standards (AS) head code is applied. The **Combination Generator** for AS loading is also described.

Click the links below to find out more:

- Loadcases (page 3)
- Combinations (page 5)

Loadcases (Australian Standards)

Click the links below to find out more:

- Loadcase types (page 3)
- Self weight (page 4)
- Imposed and roof imposed loads (page 5)
- Wind loads (page 5)

Loadcase types (Australian Standards)

The following loadcase types can be created:

Loadcase Type	Calculated Automatically	Include in the Combination Generator	Imposed Load Reductions	Pattern Load
self weight (beams, columns and walls)	yes/no	yes/no	N/A	N/A
slab wet	yes/no	N/A	N/A	N/A
slab dry	yes/no	yes/no	N/A	N/A
dead	N/A	yes/no	N/A	N/A
imposed	N/A	yes/no	yes/no	yes/no
roof imposed	N/A	yes/no	N/A	N/A
wind	N/A	yes/no	N/A	N/A
snow	N/A	yes/no	N/A	N/A
snow drift	N/A	yes/no	N/A	N/A
temperature	N/A	N/A	N/A	N/A
settlement	N/A	N/A	N/A	N/A

As shown above, self weight loads can all be determined automatically. However, other gravity loadcases have to be applied manually as you build the structure.

Self weight (Australian Standards)

Self weight - excluding slabs loadcase

Tekla Structural Designer automatically calculates the self weight of the structural beams/columns for you. The **Self weight - excluding slabs** loadcase is pre-defined for this purpose. Its loadcase type is fixed as “Selfweight”. It cannot be edited and by default it is added to each new load combination.

Self weight of concrete slabs

Tekla Structural Designer expects the wet and dry weight of concrete slab to be defined in separate loadcases. This is required to ensure that members are designed for the correct loads at construction stage and post construction stage.

The **Slab self weight** loadcase is pre-defined for the dry weight of concrete post construction stage, its loadcase type is fixed as “Slab Dry”.

There is no pre-defined loadcase for the wet weight of concrete slab at construction stage, but if you require it for the design of any composite beams in the model the loadcase type should be set to “Slab Wet”.

Tekla Structural Designercan automatically calculate the above weights for you taking into account the slab thickness, the shape of the deck profile and wet/dry concrete densities. It does not explicitly take account of the weight of any reinforcement but will include the weight of decking. Simply click the **Calc Automatically** check box when you create each loadcase. When calculated in this way you can't add extra loads of your own into the loadcase.

If you normally make an allowance for ponding in your slab weight calculations, Tekla Structural Designer can also do this for you. After selecting the composite slabs, you are able to review the slab item properties - you will find two ways to add an allowance for ponding (under the slab parameters heading). These are:

- as a value, by specifying the average increased thickness of slab
- or, as a percentage of total volume.

Using either of these methods the additional load is added as a uniform load over the whole area of slab.

Imposed and roof imposed loads (Australian Standards)

Imposed load reductions

Reductions can be applied to imposed loads to take account of the unlikelihood of the whole building being loaded with its full design imposed load. Reductions can not however, be applied to roof imposed loads.

Imposed loads are only automatically reduced on:

- Columns of any material
- Concrete walls, mid-pier or meshed

Tekla Structural Designer does not automatically apply imposed load reductions to floors. For steel beams, concrete beams, slabs and mats it is however possible to define the level of imposed load reduction manually via the beam/slab item properties.

Wind loads (Australian Standards)

The AS 1170.2 Wind wizard...

NOTE The **Wind Wizard** is not included in this release.

Simple wind loading

Simple wind loads can be applied via element or structure loads.

Combinations (Australian Standards)

Once your loadcases have been generated as required, you then combine them into load combinations; these can either be created manually, by clicking **Add...** - or with the assistance of the Combinations Generator (page 6), by clicking **Generate...**

Click the links below to find out more:

- Manually defined combinations (page 6)
- Notional horizontal forces (NHFs) (page 6)
- Combination generator (page 6)
- Combination classes (page 7)

Manually defined combinations (Austalian Standards)

As you build up combinations manually, the combination factors are automatically adjusted as loadcases are added and removed from the combination.

Notional horizontal forces (NHFs) (Australian Standards)

NHF's are automatically derived from the loadcases within the current combination, their magnitude being calculated as 0.2% of the factored vertical load that passes through any beam/column intersection in the structure.

NOTE The values of the NHFs may vary for each load combination.

They are applied to the structure in the building directions 1 and 2 as follows:

- NHF Dir1+
- NHF Dir1-
- NHF Dir2+
- NHF Dir2-

The net result is that any combination is able to have up to 2 Notional Loads applied within it - one from Dir1 (+ or -) and one from Dir2 (+ or -). Note however, that Dir1+ can not be added with Dir1- (and similarly Dir2+ can not be added with Dir2-).

Combination generator (Australian Standards)

Accessed via the **Generate...** command, this automatically sets up combinations for both strength and serviceability.

Combination generator - Combinations

The first page of the generator lists the combinations applicable (with appropriate strength factors).

The following basic load combinations are created:

- 1.35 (Permanent)
- 1.2 (Permanent) + 1.5 (Imposed)
- 1.2 (Permanent) + 1.5 (Ψ_l * Long-term Imposed)
- 1.2 (Permanent) + 1.0 (Wind) + 1.0 (Ψ_C * Imposed)
- 0.9 (Permanent) + 1.0 (Wind)

NOTE Temperature and settlement loadcase types are not included in the **Generate...** command - these need to be added manually.

The combination names are generated automatically.

Combination generator - Service

This page indicates which combinations are to be checked for serviceability and the factors applied.

The following basic load combinations are created:

- 1.0 (Permanent)
- 1.0 (Ψ_S * Imposed)
- 1.0 (Ψ_l * Imposed)
- 1.0 (Wind)

Combination generator - NHF

The last page is used to set up the notional horizontal forces. You can specify NHF's and factors in each of four directions. For each direction selected, a separate NHF combination will be generated.

Any combination with wind in is automatically greyed.

Click **Finish** to see the list of generated combinations.

Combination classes (Australian Standards)

Having created your combinations you classify them as either Gravity combinations or Lateral combinations, and also (where applicable) indicate whether they are to be checked for strength or service conditions, or both.

NOTE If generated via the Combinations Generator they are classified for you automatically.

You also have the option to make any of the combinations inactive.

1.2 Steel design to AS 4100

Tekla Structural Designer designs steel members and composite members to a range of international codes. This reference guide specifically describes the design methods applied when the steel design and composite design resistance codes are set as AS 4100 and AS 2327.1 respectively.

Unless explicitly noted otherwise, all clauses, figures and tables referred to are from AS 4100-1998/Amdt 1-2012 (Ref. 1); apart from the Composite Beam section, within which references are to AS 2327.1-2003 (Ref. 2) unless otherwise stated.

Click the links below to find out more:

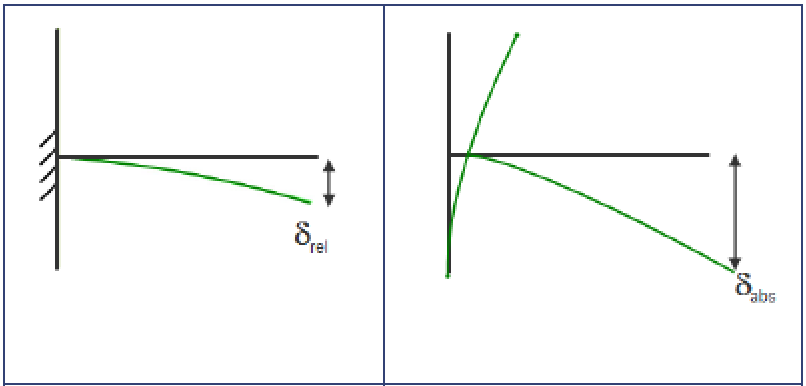
- Basic principles (page 8)
- Steel beam design (page 9)
- Composite beam design (page 15)
- Steel column design (page 15)
- Steel brace design (page 22)

Basic principles (AS 4100)

Deflection checks (AS 4100)

Relative and Absolute Deflections

Tekla Structural Designer calculates both ***relative*** and ***absolute*** deflections. Relative deflections measure the internal displacement occurring within the length of the member and take no account of the support settlements or rotations, whereas absolute deflections are concerned with deflection of the structure as a whole. The absolute deflections are the ones displayed in the structure deflection graphics. The difference between ***relative*** and ***absolute*** deflections is illustrated in the cantilever beam example below.



Relative Deflection	Absolute Deflection

Relative deflections are given in the member analysis results graphics and are the ones used in the member design.

Steel beam design to AS 4100

Click the links below to find out more:

Design method (Beams: AS 4100)

Unless explicitly stated all calculations are in accordance with the relevant sections of AS 4100 (Ref. 1). You may find the Commentary (Ref. 3) to the Standard published by Standards Australia International useful.

Steel beam limitations and assumptions (Beams: AS 4100)

The following limitations apply:

- continuous beams (more than one span) must be co-linear in the plane of the web within a small tolerance (sloping in elevation is allowed),

- only doubly symmetric prismatic sections (that is rolled or plated I- and H-sections) and channel sections are fully designed,

The following assumptions apply:

- All supports are considered to provide torsional restraint, that is lateral restraint to both flanges. This cannot be changed. It is assumed that a beam that is continuous through the web of a supporting beam or column together with its substantial moment resisting end plate connections is able to provide such restraint.
- If, at the support, the beam oversails the supporting beam or column then the detail is assumed to be such that the bottom flange of the beam is well connected to the supporting member and, as a minimum, has torsional stiffeners provided at the support.
- In the Tekla Structural Designer model, when not at supports, coincident restraints to both flanges are assumed when one or more members frame into the web of the beam at a particular position and the cardinal point of the center-line model of the beam lies in the web. Otherwise, only a top flange or bottom flange restraint is assumed. Should you judge the actual restraint provided by the in-coming members to be different from to what has been assumed, you have the flexibility to edit the restraints as required.
- Intermediate lateral restraints to the top or bottom flange are assumed to be capable of transferring the restraining forces back to an appropriate system of bracing or suitably rigid part of the structure.
- It is assumed that you will make a rational and “correct” choice for the effective lengths between restraints for both LTB and compression buckling. **The default value for the effective length factor of 1.0 may be neither correct nor safe.**

Ultimate limit state (strength) (Beams: AS 4100)

The checks relate to doubly symmetric prismatic sections (that is rolled and welded I- and H-sections), to singly symmetric sections i.e. Channel sections, and to doubly symmetric hollow sections i.e. CHS, RHS and SHS. Other section types are not currently covered.

The strength checks relate to a particular point on the member and are carried out at regular intervals along the member and at 'points of interest'.

Click the links below to find out more:

- Classification (page 11)
- Shear capacity (page 11)
- Moment capacity (Section) (page 11)
- Combined bending & shear capacity (Section) (page 12)
- Axial capacity (Section) (page 12)

Classification (Beams: AS 4100)

General

The classification of the cross section is in accordance with AS 4100. Beams can be classified for flexure about either principal axis as:

- Compact
- Non-compact
- Slender

Slender sections about either axis will not be designed in Tekla Structural Designer.

All unacceptable classifications are either failed in check mode or rejected in design mode.

Shear capacity (Beams: AS 4100)

The shear check is performed according to AS 4100 Clause 5.11.

For rolled and welded I- and H-sections, and for Channel sections, an approximately uniform shear stress distribution is assumed when calculating major axis shear capacity (to Clause 5.11.2). For these same sections a non-uniform shear stress distribution is assumed when calculating minor axis shear capacity (to Clause 5.11.3), with a shear stress ratio f^*_{vm} / f^*_{va} = 1.5

For hollow sections a non-uniform shear stress distribution is assumed when calculating both major and minor axis shear capacity (to Clause 5.11.3). For a CHS section the nominal shear yield capacity is taken per Clause 5.11.4, while RHS and SHS sections assume a shear stress ratio f^*_{vm} / f^*_{va} = 3 * (2 * b + d) / [2 * (3 * b + d)] for major axis shear capacity and f^*_{vm} / f^*_{va} = 3 * (2 * d + b) / [2 * (3 * d + b)] for minor axis shear capacity.

Shear buckling

For rolled and welded I- and H-sections, and for Channel sections, about the major axis, and also for RHS and SHS sections about both axes, when the shear panel depth to thickness ratio exceeds $82/\sqrt{(f_y/250)}$ then the shear buckling capacity will be calculated per Clause 5.11.5.1 assuming an unstiffened shear panel.

Note that for rolled and welded I- and H-sections, and for channel sections, f_y will be taken as the yield strength of the web based on t_w.

Moment capacity (Section) (Beams: AS 4100)

The (section) moment capacity check is performed according to AS 4100 clause 5.1 for the moment about the x-x axis (Mx) and about the y-y axis (My), at the point under consideration.

For (member) moment capacity refer to the section Lateral torsional buckling resistance (Member moment capacity).

Note that for all section types, the effective section modulus about the major axis (Z_{ex}) will be based on the minimum slenderness ratio considering both flange and web. Internally Tekla Structural Designer will calculate the following:

- flange slenderness ratio, $z_f = (\lambda_{ey} - \lambda_{ef}) / (\lambda_{eyf} - \lambda_{epf})$
- web slenderness ratio, $z_w = (\lambda_{eyw} - \lambda_{ew}) / (\lambda_{eyw} - \lambda_{epw})$

For sections which have flexure major class either Compact or Non-compact, the effective section modulus about the major axis (Zex) will then be calculated by:

- $Z_{ex} = Z_x + [MIN(z_f, z_w, 1.0) * (Z_c - Z_x)]$ where $Z_c = MIN(S_x, 1.5 * Z_x)$

Note that for Channel sections under minor axis bending:

- if there is single curvature with the flange tips in compression then Z_{ey} will be based on Z_{eyR}
- if there is single curvature with the web in compression then Z_{ey} will be based on Z_{eyL}
- if there is double curvature then Z_{ey} will be based on the minimum of Z_{eyR} and Z_{eyL}

Combined bending & shear capacity (Section) (Beams: AS 4100)

The combined bending & shear capacity check is performed according to AS 4100 clause 5.12.3, assuming bending is resisted by the whole of the cross-section, for the coincident major shear and moment about the x-x axis (M_x) and minor shear and moment about the y-y axis (M_y), at the point under consideration.

Note that if the (section) moment capacity is found to be less than the design moment then the combined bending & shear check will automatically be set as Fail.

Axial capacity (Section) (Beams: AS 4100)

The (section) axial capacity check is performed according to AS 4100 clause 6.1 for axial compression, or clause 7.1 for axial tension, using the gross cross-section area for A_n in both cases.

Note that member (axial compression) capacity is a buckling check and as such is considered under the heading Compression buckling

Ultimate limit state (buckling) (Beams: AS 4100)

Click the links below to find out more:

- Lateral torsional buckling resistance (Member moment capacity) (page 13)
- Compression buckling resistance (Member capacity under axial compression) (page 13)

Lateral torsional buckling resistance (Member moment capacity) (Beams: AS 4100)

For beams with major axis bending, a Lateral torsional buckling (LTB) check is required, except in the following circumstances:

- when the segment critical flange is continuously restrained for LTB, or
- when bending exists about the minor axis only, or
- when the section is a CHS, or
- when the segment length satisfies the relevant limit given in clause 5.3.2.4 of AS 4100

In the latter case, when calculating the limiting LTB length, the ratio β_m will be taken as -0.8 if the segment has major axis bending induced by transverse load within its length, and the ratio of end moments otherwise.

The LTB resistance (member moment capacity) check is performed according to AS 4100 clause 5.6

Note that the moment modification factor α_m will be calculated from the equation given in AS 4100 clause 5.6.1.1 (a) (iii) except for cantilevers, where α_m will be 0.25 if the free end moment is greater than the ignore forces major moment, and 1.0 otherwise.

The twist restraint factor k_t will be determined by consideration of the LTB cross-section restraints at either end of the segment, per Table 5.6.3(1) of AS 4100

The load height factor k_l will default to 1.4 for a non-cantilever and 2.0 for a cantilever.

The lateral rotation factor k_r will default to 1.0.

Compression buckling resistance (Member capacity under axial compression) (Beams: AS 4100)

For most structures, all the members resisting axial compression need checking to ensure adequate resistance to buckling about both the major and minor axis. Since the axial force can vary throughout the member and the strut buckling lengths in the two planes do not necessarily coincide, both axes are checked. Because of the general nature of a beam-column, it may not always be safe to assume that the combined actions check will always govern.

Hence the compression resistance check is performed independently from the other strength and buckling checks.

The compression buckling resistance (member capacity under axial compression) check is performed according to AS 4100 clause 6.3

The default value of effective length factor is 1.0. Different values can apply in the major and minor axis. Beams are less affected by sway than columns but the effectiveness of the incoming members to restrain the beam in both position and direction is generally less than for columns. Hence, it is less likely that effective length factors greater than 1.0 will be required but equally factors less than 1.0 may not easily be justified. Nevertheless, it is your responsibility to adjust the value from 1.0 and to justify such a change.

Combined actions resistance (Beams: AS 4100)

NOTE Important Note. Clause 8.2 of AS 4100 defines the design bending moments to be used in the combined actions checks as either amplified moments from a first order linear elastic analysis or the moments resulting directly from a second order elastic analysis. Tekla Structural Designer will not provide amplified moments from a first order linear elastic analysis and you are expected to switch to second order analysis to complete the design for combined actions.

Click the links below to find out more:

- Combined actions resistance - Section capacity (page 14)
- Combined actions resistance - Member capacity (page 14)

Combined actions resistance - Section capacity (Beams: AS 4100)

The combined actions section capacity check is performed according to AS 4100 clause 8.3

The higher tier equations will be used automatically if the conditions for their use are met.

Note that if the design axial force exceeds the design axial section capacity then the check will automatically be set as Fail.

In the section capacity check, the design forces are those which are coincident at any one point along the member.

Combined actions resistance - Member capacity (Beams: AS 4100)

The combined actions member capacity check is performed according to AS 4100 clause 8.4

The higher tier equations will be used automatically if the conditions for their use are met.

In the higher tier equation for M_i, the ratio β_m will be based on the relevant strut length; if the strut length has bending induced by transverse load within its length then β_m will be taken as -1.0, and the ratio of end moments otherwise.

In the higher tier equation for M_{ox}, the ratio β_m will be based on the LTB segment length, and taken as the ratio of end moments.

Note that if the design axial force exceeds the design axial member capacity then the check will automatically be set as Fail.

In the member capacity check, the design forces are the maxima in the design length being considered, where the design lengths are based on the major and minor strut lengths within a loop of LTB lengths.

Therefore, since any one design length will comprise both major and minor strut lengths, the design axial force for each design length will be taken as the maximum axial compression or axial tension force from the major and minor strut lengths considered together.

Since both axial compression and axial tension are to be considered, but make use of different equations, then in cases where both axial forces exist within a design length the compression equations and tension equations will both be evaluated and the worst case of the two will be reported.

Note that in bi-axial bending cases, zero axial force will be treated as compression.

Web openings (Beams: AS 4100)

The checks for beams with web openings are not included in this release.

Serviceability limit state (Beams: AS 4100)

Beams are assessed for deflection. Only the total load deflection is active by default, with a span/over value assigned of 250 per Table B1 of AS 4100.

Composite beam design to AS 2327.1

The design of composite beams is not included in this release.

Steel column design to AS 4100

Click the links below to find out more:

- Design method (page 16)

- Ultimate limit state (strength) (page 16)
- Combined bending and shear capacity (section) (page 18)
- Ultimate limit state (buckling) (page 18)
- Combined actions resistance (page 20)
- Serviceability limit state (page 21)

Design method (Columns: AS 4100)

Unless explicitly stated all calculations are in accordance with the relevant sections of AS 4100 (Ref. 1). You may find the Commentary (Ref. 3) to the Standard published by Standards Australia International useful.

Ultimate limit state (strength) (Columns: AS 4100)

The checks relate to doubly symmetric prismatic sections (that is rolled and welded I- and H-sections), to singly symmetric sections i.e. Channel sections, and to doubly symmetric hollow sections i.e. CHS, RHS and SHS. Other section types are not currently covered. The strength checks relate to a particular point on the member and are carried out at regular intervals along the member and at 'points of interest'.

NOTE Hollow sections: The checks for CHS, RHS and SHS relate to “hot-finished hollow sections” only - “cold-formed hollow sections” are not included in this release.

Click the links below to find out more:

- Classification (page 16)
- Shear capacity (page 17)
- Moment capacity (section) (page 17)
- Combined bending and shear capacity (section) (page 18)
- Axial capacity (section) (page 18)

Classification (Columns: AS 4100)

The flexural classification of the cross section is in accordance with AS 4100 Columns can be classified for flexure about either principal axis as:

- Compact
- Non-compact
- Slender

Slender sections about either axis will not be designed in Tekla Structural Designer.

All unacceptable classifications are either failed in check mode or rejected in design mode.

Shear capacity (Columns: AS 4100)

The shear check is performed according to AS 4100 clause 5.11.

For rolled and welded I- and H-sections, and for channel sections, an approximately uniform shear stress distribution is assumed when calculating major axis shear capacity (to clause 5.11.2). For these same sections a non-uniform shear stress distribution is assumed when calculating minor axis shear capacity (to clause 5.11.3), with a shear stress ratio f^*_{vm} / f^*_{va} = 1.5

For hollow sections a non-uniform shear stress distribution is assumed when calculating both major and minor axis shear capacity (to clause 5.11.3). For a CHS section the nominal shear yield capacity is taken per clause 5.11.4, while RHS and SHS sections assume a shear stress ratio f^*_{vm} / f^*_{va} = 3 * (2 * b + d) / [2 * (3 * b + d)] for major axis shear capacity and f^*_{vm} / f^*_{va} = 3 * (2 * d + b) / [2 * (3 * d + b)] for minor axis shear capacity.

Shear buckling

For rolled and welded I- and H-sections, and for channel sections, about the major axis, and also for RHS and SHS sections about both axes, when the shear panel depth to thickness ratio exceeds 82/√(f_y/250) then the shear buckling capacity will be calculated per clause 5.11.5.1 assuming an unstiffened shear panel.

Note that for rolled and welded I- and H-sections, and for channel sections, f_y will be taken as the yield strength of the web based on t_w.

Moment capacity (section) (Columns: AS 4100)

The (section) moment capacity check is performed according to AS 4100 clause 5.1 for the moment about the x-x axis (M_x) and about the y-y axis (M_y), at the point under consideration.

For (member) moment capacity refer to the section Lateral torsional buckling resistance (Member moment capacity).

Note that for all section types, the effective section modulus about the major axis (Z_{ex}) will be based on the minimum slenderness ratio considering both flange and web. Internally Tekla Structural Designer will calculate the following:

- flange slenderness ratio, $z_f = (\lambda_{ey} - \lambda_{ef}) / (\lambda_{eyf} - \lambda_{epf})$
- web slenderness ratio, $z_w = (\lambda_{eyw} - \lambda_{ew}) / (\lambda_{eyw} - \lambda_{epw})$

For sections which have flexure major class either Compact or Non-compact, the effective section modulus about the major axis (Z_{ex}) will then be calculated by:

- $Z_{ex} = Z_x + [MIN(z_f, z_w, 1.0) * (Z_c - Z_x)]$ where $Z_c = MIN(S_x, 1.5 * Z_x)$

Note that for Channel sections under minor axis bending:

- if there is single curvature with the flange tips in compression then Z_{ey} will be based on Z_{eyR}
- if there is single curvature with the web in compression then Z_{ey} will be based on Z_{eyL}
- if there is double curvature then Z_{ey} will be based on the minimum of Z_{eyR} and Z_{eyL}

Eccentricity Moments

Eccentricity moment will be added algebraically to the coincident real moment (at top or bottom of column stack) only if the resulting 'combined' moment has a larger absolute magnitude than the absolute real moment alone.

The resulting 'combined' design moment (major and/or minor) will be that used in moment capacity, combined bending & shear, LTB, and combined actions checks.

Combined bending and shear capacity (section) (Columns: AS 4100)

The combined bending and shear capacity check is performed according to AS 4100 clause 5.12.3, assuming bending is resisted by the whole of the cross-section, for the coincident major shear and moment about the x-x axis (M_x) and minor shear and moment about the y-y axis (M_y), at the point under consideration. The design moments may include eccentricity moments - see Moment capacity (section): Eccentricity Moments.

Note that if the (section) moment capacity is found to be less than the design moment then the combined bending and shear check will automatically be set as Fail.

Axial capacity (section) (Columns: AS 4100)

The (section) axial capacity check is performed according to AS 4100 clause 6.1 for axial compression, or Clause 7.1 for axial tension, using the gross cross-section area for A_n in both cases.

Note that member (axial compression) capacity is a buckling check and as such is considered under the heading Compression buckling resistance (Member capacity under axial compression).

Ultimate limit state (buckling) (Columns: AS 4100)

Click the links below to find out more:

- Lateral torsional buckling resistance (Member moment capacity) (page 19)
- Compression buckling resistance (Member capacity under axial compression) (page 19)

Lateral torsional buckling resistance (Member moment capacity) (Columns: AS 4100)

For beams with major axis bending, a Lateral Torsional Buckling (LTB) check is required, except in the following circumstances:

- when the segment critical flange is continuously restrained for LTB, or
- when bending exists about the minor axis only, or
- when the section is a CHS, or
- when the segment length satisfies the relevant limit given in clause 5.3.2.4 of AS 4100

In the latter case, when calculating the limiting LTB length, the ratio β_m will be taken as -0.8 if the segment has major axis bending induced by transverse load within its length, and the ratio of end moments otherwise.

The LTB resistance (member moment capacity) check is performed according to AS 4100 clause 5.6

Note that the moment modification factor α_m will be calculated from the equation given in AS 4100 clause 5.6.1.1 (a) (iii) except for cantilevers, where α_m will be 0.25 if the free end moment is greater than the ignore forces major moment, and 1.0 otherwise.

The design moment may include eccentricity moment - see Moment Capacity (Section): Eccentricity Moments - but note in particular that the ratio β_m and the moment modification factor α_m will be based on real moments only.

The twist restraint factor k_t will be determined by consideration of the LTB cross-section restraints at either end of the segment, per Table 5.6.3(1) of AS 4100

The load height factor k_l will default to 1.4 for a non-cantilever and 2.0 for a cantilever.

The lateral rotation factor k_r will default to 1.0.

Compression buckling resistance (Member capacity under axial compression) (Columns: AS 4100)

For most structures, all the members resisting axial compression need checking to ensure adequate resistance to buckling about both the major and minor axis. Since the axial force can vary throughout the member and the strut buckling lengths in the two planes do not necessarily coincide, both axes are checked. Because of the general nature of a beam-column, it may not always be safe to assume that the combined actions check will always govern. Hence the compression resistance check is performed independently from the other strength and buckling checks.

The compression buckling resistance (member capacity under axial compression) check is performed according to AS 4100 clause 6.3

The default value of effective length factor is 1.0 Different values can apply in the major and minor axis. Beams are less affected by sway than columns but the effectiveness of the incoming members to restrain the beam in both position and direction is generally less than for columns. Hence, it is less likely that effective length factors greater than 1.0 will be required but equally factors less than 1.0 may not easily be justified. Nevertheless, it is your responsibility to adjust the value from 1.0 and to justify such a change.

Combined actions resistance (Columns: AS 4100)

NOTE important Note. Clause 8.2 of AS 4100 defines the design bending moments to be used in the combined actions checks as either amplified moments from a first order linear elastic analysis or the moments resulting directly from a second order elastic analysis. Tekla Structural Designer will not provide amplified moments from a first order linear elastic analysis and you are expected to switch to second order analysis to complete the design for combined actions.

Click the links below to find out more:

- Combined actions resistance - Section capacity (page 20)
- Combined actions resistance - Member capacity (page 20)

Combined actions resistance - Section capacity (Columns: AS 4100)

The combined actions section capacity check is performed according to AS 4100 clause 8.3

The higher tier equations will be used automatically if the conditions for their use are met.

Note that if the design axial force exceeds the design axial section capacity then the check will automatically be set as Fail.

In the section capacity check, the design forces are those which are coincident at any one point along the member.

Combined actions resistance - Member capacity (Columns: AS 4100)

The combined actions member capacity check is performed according to AS 4100 clause 8.4

The higher tier equations will be used automatically if the conditions for their use are met.

In the higher tier equation for M_i, the ratio β_m will be based on the relevant strut length; if the strut length has bending induced by transverse load within its length then β_m will be taken as -1.0, and the ratio of end moments otherwise.

In the higher tier equation for M_{ox}, the ratio β_m will be based on the LTB segment length, and taken as the ratio of end moments, using real moments only.

In the member capacity check, the design forces are the maxima in the design length being considered, where the design lengths are based on the major and minor strut lengths within a loop of LTB lengths.

Therefore, since any one design length will comprise both major and minor strut lengths, the design axial force for each design length will be taken as the maximum axial compression or axial tension force from the major and minor strut lengths considered together.

Note that if the design axial force exceeds the design axial member capacity then the check will automatically be set as Fail.

Since both axial compression and axial tension are to be considered, but make use of different equations, then in cases where both axial forces exist within a design length the compression equations and tension equations will both be evaluated and the worst case of the two will be reported.

Note that in bi-axial bending cases, zero axial force will be treated as compression.

Serviceability limit state (Columns: AS 4100)

The column is assessed for sway and the following values are reported for each stack:

- Sway X (mm) and λ_{critx}
- Sway Y (mm) and λ_{crity}
- Twist i.e. Sway X-Y (non-dimensional ratio)

Depending on the reported λ_{crit} the column is classified as Sway or Non sway accordingly.

NOTE A sway assessment is only performed for the column if the Lambda Crit Check box is checked on the Column Properties dialog.

If very short columns exist in the building model these can distort the overall sway classification for the building. For this reason you may apply engineering judgement to uncheck the Lambda Crit Check box for those columns for which a sway assessment would be inappropriate

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Steel brace design to AS 4100

Click the links below to find out more:

- Design method (page 22)
- Classification (page 22)
- Axial capacity (section) (page 22)
- Compression buckling resistance (Member capacity under axial compression) (page 23)

Steel brace design to AS 4100

Design method (Braces: AS4100)

Unless explicitly stated all brace calculations are in accordance with the relevant sections of AS 4100 (Ref. 1).

A basic knowledge of the design methods for braces in accordance with the design code is assumed.

Hollow sections

The checks for CHS, RHS and SHS relate to “hot-finished hollow sections” only - “cold-formed hollow sections” are not included in this release.

Classification (Braces: AS 4100)

No classification is required for braces.

Axial capacity (section) (Braces: AS 4100)

The (section) axial capacity check is performed according to AS 4100 clause 6.1 for axial compression, or clause 7.1 for axial tension, using the gross cross-section area for A_n in both cases.

Note that member (axial compression) capacity is a buckling check and as such is considered under the heading Compression Buckling.

Compression buckling resistance (Member capacity under axial compression) (Braces: AS 4100)

The compression buckling resistance (member capacity under axial compression) check is performed according to AS 4100 clause 6.3

The default effective length factor in each axis is 1.0

References (AS 4100)

1. **Standards Australia International**. AS 4100-1998/Amdt 1-2012: Steel structures. **SAI 2012**.
2. **Standards Australia International**. AS 2327.1-2003: Composite structures. Part 1: Simply supported beams. **SAI 2003**.
3. **Standards Australia International**. AS 4100 Supp1-1999: Steel structures – Commentary. (Supplement to AS 4100-1998). **SAI 1999**.
4. **Standards Australia International/Standards New Zealand**. AS/NZS 1170.0:2002 (Including Amendments Nos.1,2,4 and 5). Structural design actions. Part 0: General principles. **SAI/NZS 2011**.
5. **Standards Australia International/Standards New Zealand**. AS/NZS 1170.1:2002 (Including Amendments Nos.1 and 2). Structural design actions. Part 1: Permanent, imposed and other actions. **SAI/NZS 2009**.
6. **Standards Australia International/Standards New Zealand**. AS/NZS 1170.2:2011 (Including Amendments Nos.1 and 2). Structural design actions. Part 2: Wind actions. **SAI/NZS 2012**.

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