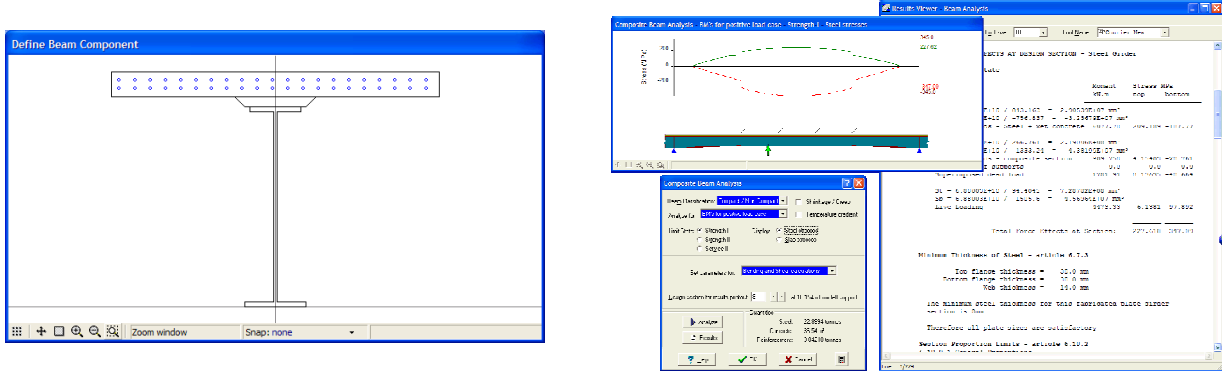


Beam Design Modules for British Standards: B.01_{BS}, B.03_{BS}, B.04_{BS} and B.05_{BS}



This is a set of four modules for code checking bridge beams

- B.01 – Steel/Concrete composite beams**
- B.03 – Pre-cast pre-tensioned beams**
- B.04 – Reinforced concrete beams**
- B.05 – Post-tensioned concrete beams**

These modules provide code checking in accordance with BS 5400-3:2000 (B.01) and BS 5400-4 and BD 44/95 (B.03, B.04 and B.05). The section properties used in the code checking are calculated from section module S.01. They integrate with the structural analysis modules in order to produce fast iterations on the analysis/design cycle. Detailed hand-calculation style reports are produced wherever possible.

Beams can have multiple cross-sections, multiple stages of construction and multiple material properties. All these variations are accounted for when calculation section properties and, in the case of the integrated analysis, member stiffness.

Beam sections can be defined using standard pre-defined beams (such as “Y” beams), or any sections defined using the tools of section module S.01.

There are several benefits to these modules:

- ⇒ The integration with analysis means that one model serves many purposes, and this saves time in defining several different models, saves time in calculating section properties, saves time in transferring results from analysis to code checking, and finally ensures a consistent model.
- ⇒ All the results are displayed graphically, so it is possible to see where design problems occur, and the scale of their magnitude. This makes it easy to make design corrections and check that they have the desired effect.
- ⇒ If the corrections change either the dead weight of the beam or its stiffness, it is simple to re-run the analysis in order to determine the new load effects, and thus re-check the beam with its correct loads. This ensures that the right model is associated with the right loads, and that the design has the correct data throughout.
- ⇒ Wherever possible a mimic of an engineer's hand calculations are created, in order to allow the user to see why and how results are calculated. This allows the user to check the program, and to develop confidence in using it, as well as conforming to many quality standards that require a hard copy of the design calculations.

Module Specifications B.01 – Design of steel/concrete composite beams

- Graphical Section generator and beam elevation generator for composite beams comprising:
 - Rolled steel beam section or I section plate girder
 - Rectangular concrete slab on top of girder
 - One or two layers of reinforcement in the slab
 - Rectangular or trapezoidal concrete haunch between the steel girder and concrete slab.
 - Concrete slab edge detail of any shape.
 - Option for top flange cast into slab
 - Intermediate lateral restraints to compression flanges (unlimited number).
 - Web stiffeners (unlimited number).
- The beam elevation may comprise an unlimited number of different sections specified at different locations along the beam. In addition the elevation of the bottom flange may be described using a series of straight lines, arcs or parabola.
- Loadings which may be specified are ULS & SLS bending moments, shear forces and axial loads for:
 - Differential temperature secondary moments - positive case.
 - Differential temperature secondary moments - reverse case.
 - Shrinkage modified by creep secondary moments.
 - Settlement of supports.
 - Soil pressure.
 - Temperature restraint.
 - Construction stages (up to 3 allowed) for staged concreting along the elevation of the beam.
- Superimposed dead load.
- Superimposed dead load, non-structural concrete.
- String course dead load
- Bending Moments and associated Shear Force for worst hogging and worst sagging load cases (any number of load cases)
- Worst Shear Force and associated Bending Moments (any number of load cases).
- Shear Force range for fatigue.
- The live loading items may be given for Combinations 1 and 3.
- The load effects data may be entered by:
 - Direct entry on screen.
 - Reading from ASCII text file.
 - Generating from applied trapezoidal beam loads.
 - Direct transfer from Sam analysis module results, if licensed.
- Calculation to BS 5400-3:2000 as modified by BD 13/04 and BS 5400-5:1979 (as modified by BD 16/82 and Amendment No 1) for ULS and SLS, combination 1 and combination 3, for the following options:
 - Bending Moments during construction
 - Bending Moments for worst hogging or worst sagging load case
 - Shear Force
 - Shear Force + associated Bending Moments (Interaction plot may be produced)
 - Longitudinal Shear Force
 - Shrinkage modified by creep, primary stresses.
 - Differential temperature primary stresses.
- Graphical results plot which is the most appropriate from:
 - Permissible stresses and actual stresses
 - Plastic moment and actual moment
 - Unity and 'performance ratio'
- Sections are assessed as compact or non-compact and the appropriate calculations performed. The user may override this assessment.
- Logical selection of loadings during design (e.g. differential shrinkage/creep included only if adverse).
- Effective length calculations for either:
 - restraints fully effective
 - restraints not fully effective
 - torsional restraints
- The following code clauses are included in the design:
 - BS 5400-3:2000/BD13/04 - 4.2; 4.3; 8.1; 8.2; 8.4; 9.1-9.9 (excluding 9.9.6 and references to fatigue, longitudinally stiffened webs and flanges, flanges curved or sloping in elevation; U-frame restraints).
 - BD 16/82 (BS 5400 Part 5) - 5.2.2 to 5.2.5; 5.3.1; 5.3.3; 5.4; 6.3.
- Fully detailed hand calculation style output is produced for all the calculations listed above.

Module Specifications B.03 – Design of pre-tensioned pre-stressed concrete beams

- Graphical Section generator and beam elevation generator for beams comprising:
 - Standard pre-cast concrete beams:
 - Comprehensive libraries for UK, USA and Australian ranges.
 - User defined pre-cast concrete beam shape.
 - Standard in situ concrete beam.
 - User defined in situ concrete shapes (e.g. for parapet upstands).
 - Additional steel reinforcement.
- Graphical tendon editor for fast insertion and removal at standard locations, or de-bonding, or deflecting. The editor is accessible directly from calculation screens allowing fast modification and repeat analyses.
- The beam elevation may comprise an unlimited number of different sections specified at different locations along the beam, with varying soffit and/or crown heights.
- Loadings which may be specified are ULS & SLS bending moments, shear forces and axial loads for:
 - Differential temperature secondary moments - positive case.
 - Differential temperature secondary moments - reverse case.
- Shrinkage modified by creep secondary moments.
- Settlement of supports.
- Soil pressure.
- Temperature restraint.
- Beam erection (eg temporary supports).
- Construction stages (up to 3 superimposed stages allowed, stage 1 may be split into 2 longitudinal stages)
- Superimposed dead load.
- Superimposed dead load, non-structural concrete.
- Bending Moments and associated Shear Force for worst hogging and worst sagging load cases (any number of load cases)
- Worst Shear Force and associated Bending Moments (any number of load cases).
- The live loading items may be given for Combinations 1 and 3.
- The load effects data may be entered by:
 - Direct entry on screen
 - Reading from ASCII text file
 - Generating from applied trapezoidal beam loads.
 - Direct transfer from Sam analysis module results, if licensed.
- Tendon layouts and debond / deflect details can be automatically optimised using a variety of parameters.
- Calculation to BS 5400 Part 4 or BD 44/95 (where applicable) for ULS and SLS, combination 1 and combination 3 as appropriate, for the following options:
 - Bending Moments at transfer
 - Bending Moments during erection
 - Bending Moments at construction stages
 - Live load Bending Moments and associated Shear Forces
 - Live load Shear Force + associated Bending Moments
 - Longitudinal Shear Force
 - Shrinkage modified by creep, primary stresses.
 - Differential temperature primary stresses.
- Graphical results plot of permissible stresses and actual stresses (or permissible and actual moments (ULS) or permissible and actual shear forces as appropriate)
- Logical selection of loadings during design (eg differential shrinkage/creep included only if adverse).
- The following code clauses are included in the design:
 - BS 5400 Part 4 - 4.1.1; 4.2; 4.3; 6.3.2; 6.3.3.1; 6.3.4; 6.7.2; 6.7.4; 7.4 (excluding references to Class 3, deflection, fatigue, durability, steam curing)
- Fully detailed hand calculation style output and tabular summaries are produced for all the calculations listed above.

Beam Design Modules for British Standards: B.01_{BS}, B.03_{BS}, B.04_{BS} and B.05_{BS} (continued)

Module Specifications B.04 – Design of reinforced concrete beams

- Graphical Section generator and beam elevation generator for beams comprising:
 - Parametric shapes:
 - Rectangle, Circle, Annulus, Voided Slab, H, I, L, T, U, X, Z.
 - Regular polygons
 - Standard pre-cast concrete beams:
 - Comprehensive libraries for UK, USA and Australian ranges.
 - User defined concrete shape.
- Beam elevation generator for beams with varying soffit profile. The soffit profile may be built up from:
 - A series of straight lines
 - Circular arcs
 - Parabola
- The beam elevation may comprise an unlimited number of different sections specified at different locations along the beam. Up to 20 individual shapes may be used for sections within the beam.
- Graphical reinforcement editor for fast definition of reinforcement. Includes options for bent up bars (at one or both ends) for resisting shear; bars parallel to the soffit; horizontal bars. The editor is accessible directly from the calculations screen, allowing fast modification and repeat analyses.
- Loadings which may be specified are ULS & SLS bending moments, shear forces and axial loads for:
 - Differential temperature secondary moments - positive case.
 - Differential temperature secondary moments - reverse case.
 - Settlement of supports.
 - Soil pressure.
 - Temperature restraint.
 - Beam erection (e.g. temporary supports).
 - Superimposed dead load.
 - Superimposed dead load, non-structural concrete.
 - Bending Moments and associated Shear Force for worst hogging and worst sagging load cases (any number of load cases)
 - Worst Shear Force and associated Bending Moments (any number of load cases).
 - The live loading items may be given for Combinations 1 and 3.
- The load effects data may be entered by:
 - Direct entry on screen.
 - Reading from ASCII text file.
 - Generating from applied trapezoidal beam loads.
 - Direct transfer from Sam analysis module results, if licensed.
- Calculation to BS 5400 Part 4 or BD 44/95 (where applicable) for ULS and SLS, combination 1 and combination 3 as appropriate, for the following options:
 - Section properties
 - Bending Moments at construction stages
 - Live load bending moments.
 - Shear forces (with associated bending moments where appropriate)
 - Early thermal cracking
 - Differential temperature primary stresses.
- Graphical results plot of permissible concrete and reinforcement stresses and actual stresses (or permissible and actual moments (ULS) or permissible and actual shear forces as appropriate)
- Logical selection of loadings during design (eg differential temperature included only if adverse).
- The following code clauses are included in the design:
 - BS 5400 Part 4 - 4.1.1; 4.2; 4.3; 4.5; 5.3.2.1; 5.3.3; 5.8.8.2 (excluding references to deflection, fatigue, durability)
- Fully detailed hand calculation style output and tabular summaries are produced for all the calculations listed above.
- For assessments to BD 44/95:
 - Check for tensile failure may be ignored.
 - Material strengths and partial factors are user controlled parameters.
 - BD 44/95 crack width option is provided.

Module Specifications B.05 – Design of post-tensioned pre-stressed concrete beams

- Graphical Section generator for beams with all the features of module B.04 as described above. In addition:
 - Up to 4 stages of concrete construction may be defined at a single cross section. (There is no limit to the number of construction stages along the elevation)
 - The first stage of concrete may be defined as pre-cast or in situ.
- Beam elevation generator for beams with varying soffit profile with all the features of module B.04 as described above.
- The beam elevation may comprise an unlimited number of different sections specified at different locations along the beam. Up to 20 individual shapes may be used for sections within the beam.
- The beam elevation, once defined, may be divided into any number of longitudinal segments for purposes of generating construction sequences (e.g. with segmental construction)
- An unlimited number of spans may be defined in a single data set.
- Graphical tendon editor for tendon location and 2D or 3D profile definition. No limit to the number of tendons, which may be defined as external or internal and may be stressed at one or both ends. The tendon editor is accessible directly from calculation screens allowing fast modification and repeat analyses.
- Construction of the beam may be defined in detail allowing for:
 - Addition of concrete in section or elevation
 - Individual tendon partial or full stressing / de-stressing / re-stressing / grouting
 - Addition or removal of construction loading
- Loadings which may be specified are ULS & SLS bending moments, shear forces and axial loads for:
 - Differential temperature secondary moments - positive case.
 - Differential temperature secondary moments - reverse case.
 - Temperature restraint.
 - Shrinkage modified by creep secondary moments.
 - Settlement of supports.
 - Soil pressure.
 - Construction Sequence Loading (any number allowed)
 - Superimposed dead load (any number allowed, for automatic selection of the most adverse).
 - Superimposed dead load, non-structural concrete.
 - Bending Moments and associated Shear Force for live load cases (any number of load cases)
 - Shear Force and associated Bending Moments for live load cases (any number of load cases)
 - The live loading items may be given for Combinations 1 and 3.
- Secondary effects of pre-stress may be associated with any construction sequence load, or live load case.
- The load effects data may be entered by:
 - Direct entry on screen
 - Cut-and-Paste from a spreadsheet with the same table format.
 - Generating from applied trapezoidal beam loads.
 - Direct transfer from Sam analysis module results, if licensed (including secondary pre-stress effects, and elastic deformation effects).
- Calculation of post-tensioning losses
- Calculation check of tendon geometry.
- Calculation of section geometry and stresses allowing for:
 - The presence of defined tendon ducts prior to grouting
 - Offset of tendons due to bunching in ducts
- Calculation of stresses allows for elastic deformation loss of pre-stress according to defined construction sequence.
- Calculation to BS 5400 Part 4 or BD 44/95 (where applicable) for ULS and SLS, combination 1 and combination 3 as appropriate, for the following options:
 - Each Construction sequence stage
 - Live load Bending Moments and associated Shear Forces
 - Live load Shear Force + associated Bending Moments
 - Differential temperature primary stresses.
 - Shrinkage modified by creep, primary stresses.
- Graphical results plot of permissible stresses and actual stresses (or permissible and actual moments (ULS) or permissible and actual shear forces as appropriate)
- Logical selection of loadings during design (eg differential positive or reverse included)
- The following code clauses are included in the design:
 - BS 5400 Part 4 - 4.1.1; 4.1.2, 4.2; 4.3; 6.3.2; 6.3.3.1; 6.3.4; 6.7.2; 6.7.3 (excluding references to deflection, fatigue, durability, steam curing)
- Fully detailed hand calculation style output and tabular summaries are produced for all the calculations listed above.
- For assessments to BD 44/95:
 - Material strengths and partial factors are user controlled parameters.
 - BD 44/95 shear calculations option is provided.