
LUSAS
Infrastructure design software
New features and enhancements in Version 17
simplify | collaborate | design

LUSAS Version 17

Version 17.0 of LUSAS sees steel frame design and vehicle load optimisation capabilities extended, prestress enhancements, additional creep and shrinkage models, and new facilities for soil-structure interaction modelling. New attribute viewing and editing features simplify the management and editing of assignments, improving general usability and enabling faster editing.

Steel Frame Design

Perform steel design checks to EN1993-2: 2006 Eurocode 3: Design of steel structures - Part 2: Steel Bridges.

Use a steel designer that is much more than a summary checker. Calculations are transparent, revealing every step, every clause reference, and every formula.

Efficiently apply LUSAS to the simplest as well as the more complex structures for which it is renowned. Bring your teams together in one system. Simplify steel design checking.

Produce repeatable output and documentation with greater control. Reissue quickly and automatically after model editing or project revision.

Prestress / Post-Tensioning

More accurately model post-tensioned structures by now using shells as well as beams or volumes. Incorporate time-stage with creep and shrinkage.

Define and assign tendon loading via a drag-and-drop attribute that references both tendon profile and property data.

Solve for prestress loading as part of solving a model, not separately.

Graph prestress losses using the Graph wizard, and report on all prestress data by adding a Prestress chapter to a model report.

Benefit from the improved ways to view and edit tendon loading, property and profile data, either one-by-one or as a set.

Soil-Structure Interaction

Carry-out soil-structure interaction analysis with an expanded range of soil models.

New Duncan-Chang material model added to the existing range, which includes Tresca, Von Mises, Drucker Prager, Mohr Coulomb, and Modified Cam Clay.

Easily calculate initial stress states providing K_0 data and apply to any ground profile.

Represent a pilecap sitting on a group of piles in a global (3D) model by using the new matrix properties joint option.

Model the variation of soil properties with depth by defining soil profile variations. Single, multiple, in-plane or out-of-plane profiles are supported. LUSAS interpolates to derive properties between defined locations.

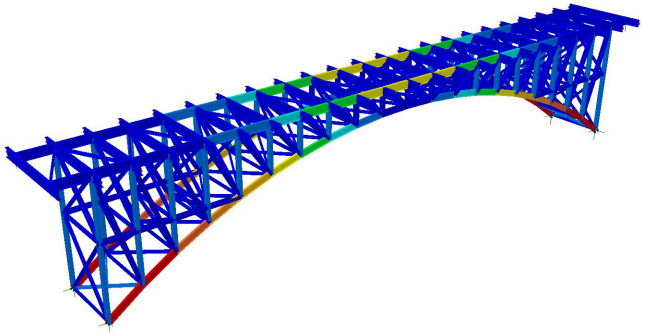
Steel Frame Design improvements

Steel design to EN1993-2: 2006 Eurocode 3 added

Steel frame design is now supported to EN1993-2: 2006 Eurocode 3: Design of steel structures - Part 2: Steel Bridges.

Eurocode National Annexes currently supported are:

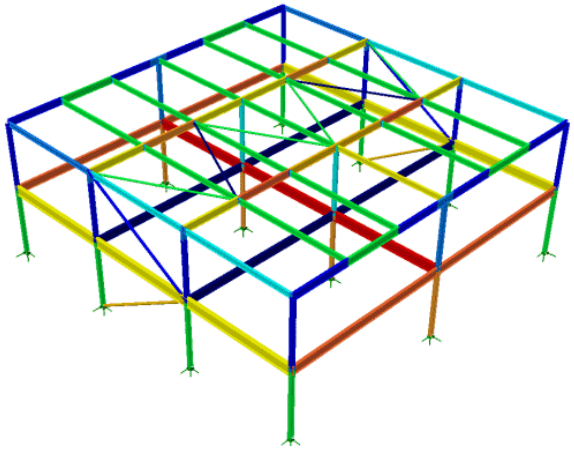
- Eurocode Recommended Values (EN 1993-2:2006)
- Finland (SFS-EN 1993-2/NA:2010)
- Ireland (I.S. EN 1993-2/NA:2010)
- United Kingdom (BS EN 1993-2:2006/ NA+A1:2012)



Steel design to EN1993-1-1 enhanced

Steel frame design to EN1993-1-1: 2005+A1:2014- EN 1993-1-1:2005 Eurocode 3: Design of steel structures – Part 1-1: General rules and rules for buildings has been enhanced:

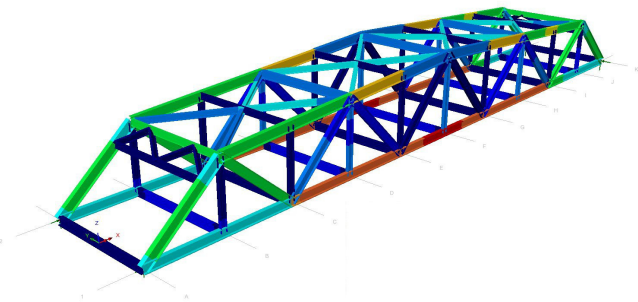
- Class 4 sections are now supported.
- Shear buckling of I-sections is now supported.
- The reduced design plastic resistance moment allowing for shear force, as given by expression (6.30) of EN1993-1-1 for I-sections with equal flanges, has been extended to include class 3 sections.



Steel design to AASHTO LFRD 7th edition enhanced

The Steel Frame Design attribute dialog for the AASHTO LRFD 7th Edition code has been updated to separate the input of buckling properties into those for compression buckling and those for flexural buckling.

As a result, it is now possible to specify a user-defined unbraced / buckling length for compression buckling, and a user-defined unbraced length for flexural buckling.



Prestress / Post-tensioning improvements

Prestress / post-tension modelling easier to use

The single tendon and multiple tendon prestress wizards, used in previous versions to generate prestress loading, have been retired. Instead, a tendon loading attribute, which references tendon profile and tendon property data, is defined having a specified prestress force and associated jacking and loss details. Once defined, this tendon loading attribute is added to the Attributes Treeview, where it can be directly assigned to selected line, surface or volume features in a model consistently with all other attribute assignments made within LUSAS.

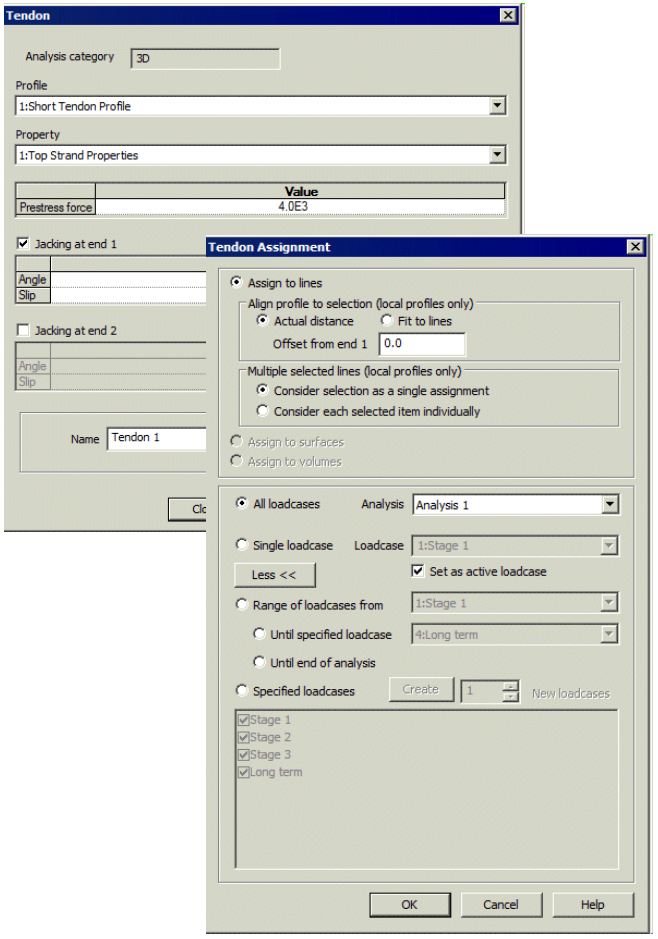
Tendon loading assignment options state how the tendon loading is to be applied and, for assignment to lines, mapping and offset options can be used, as well as specifying in which loadcase(s) the tendon loading should apply.

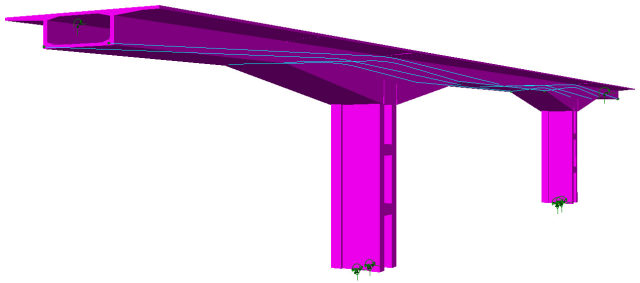
- In version 17, prestress loading is now calculated as a part of solving a model. When solved, LUSAS still calculates equivalent nodal loading from the assigned prestress tendon loads and assigns these forces automatically to selected features (and hence nodes and elements) of the model for a specified loadcase. The discrete loads and the applied forces / moments calculated are not created as attributes in the treeview but can be reproduced / viewed for checking purposes.

- Tendon properties, profile, loading, losses and setting-out data for all tendons defined and assigned in a model can now be reported upon by adding a prestress chapter to a model report.

- Graphs of prestress losses in tendons are now produced using the graph wizard.

- Editing of tendon loading, property and profile data has been improved and can be done by individual selection of one or more attributes, or by selection of the parent folder containing a set of attributes.





■ Prestress loading and editing is further enhanced by general viewing and editing enhancements made. Copy and paste from spreadsheet into grid cells is supported.

Legacy tendon data

When opening pre-version 17 models with tendon data note:

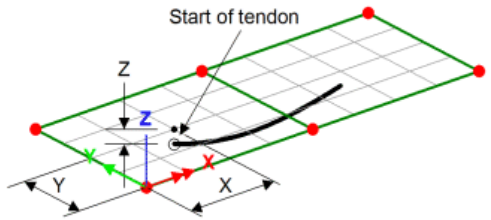
■ Single tendon prestress wizard generated data is not converted automatically to the latest tendon modelling data structures. Tendon properties, profiles and discrete load data generated by the wizard is retained.

■ Multiple tendon prestress wizard generated data is converted automatically to the latest tendon modelling data structures, with tendon properties, profiles and loadings all being updated and assigned to the correct features.

Prestress loading now supported by plain stress, plane strain, shell and solid elements

The prestress loading capability has been extended to allow assignment to surfaces modelled with plane stress, plane strain and shell elements, and volumes modelled with solid elements.

Assignment of tendon loads to a surface or volume modelled with these elements requires a tendon profile to be defined using 'Global coordinates' on the Tendon Profile dialog.



Creep and Shrinkage material models

For use with the prestress facility, and for general use, two new creep and shrinkage material models have been added:

■ AASHTO LRFD 7th edition

- Creep loss can be calculated with reference to either article 5.4.2.3.2 or the commentary clause C5.4.2.3.2-2.
- Shrinkage loss can be calculated with reference to equation 5.4.2.3.2-2 or the commentary clause C5.4.2.3.2-2

■ IRC112-2011

- Creep calculations are carried out to IRC:112-2011 clause 6.4.2.7 and Annexure A2, but elevated or reduced temperatures during curing are not considered.
- Shrinkage effects can be included in accordance with clause 6.4.2.6 and Annexure A2 clause A2.6.

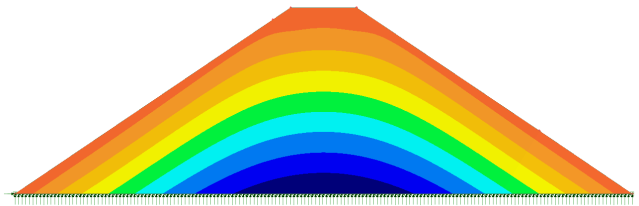
Both models can be used with beam elements, 2D/3D continuum elements, semi-loof and thick shells, and composite solid elements. For both, creep and shrinkage is only strictly applicable to beams, however, in LUSAS the creep equations have been extended to 2D and 3D stress states.

Geotechnical / Soil-Structure Interation improvements

Duncan-Chang soil material model added

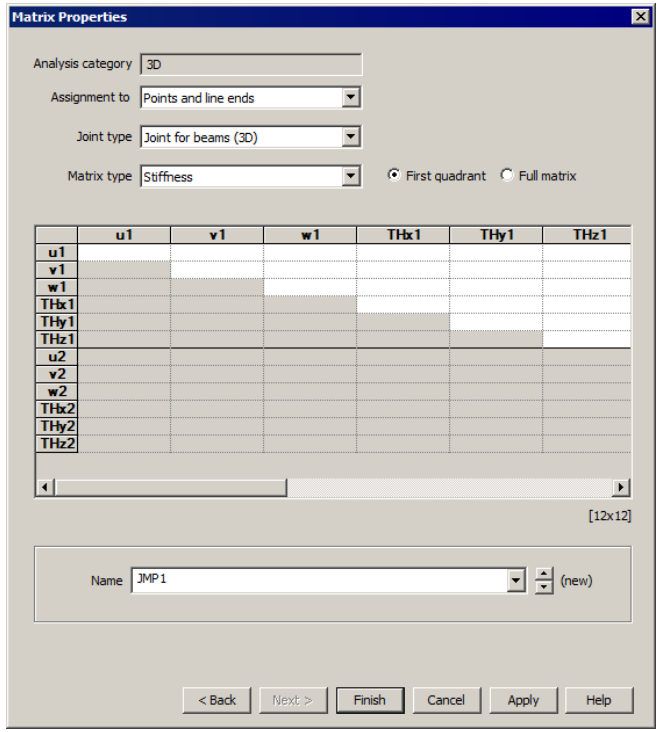
The Duncan-Chang soil material model is a simple model whose parameters are calculated by curve fitting triaxial test data over a range of cell pressures. It takes an incremental elastic approach in which Young's modulus and Poisson's ratio are evaluated from current stresses. A predictor step is used to determine whether the soil is loading or unloading, following which, corresponding values of Young's modulus and Poisson's ratio are calculated for use in the incremental elastic modulus matrix.

The model can be used with standard continuum elements as well as the two-phase elements. The modelling parameters required can be evaluated in standard laboratory tests.



Matrix properties for joint elements

The definition of symmetrical matrix properties (stiffness, mass or damping) to specify a joint representing a pilecap sitting on a group of piles in a global (3D) model is now supported. This is achieved by selecting the Attributes > Material > Joint menu item and choosing the Matrix properties option.

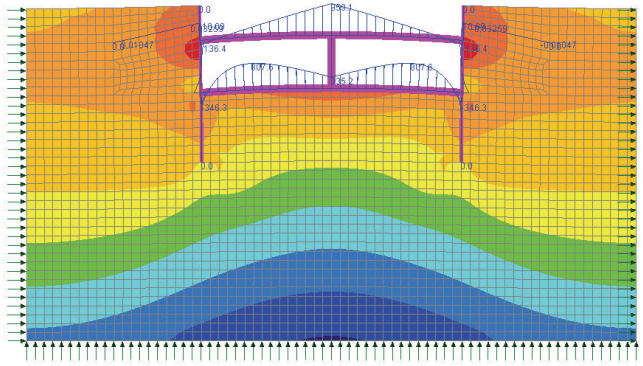


Initialisation of ground conditions (K_0)

K_0 data can now be defined for material models used in soil analyses, principally, elastic models, Modified Mohr-Coulomb, Duncan-Chang and Modified Cam-clay.

Both the Duncan-Chang and Modified Cam-clay models need the definition of an initial stress state to calculate an initial stiffness. The initial stresses in the soil can be calculated by providing K_0 data.

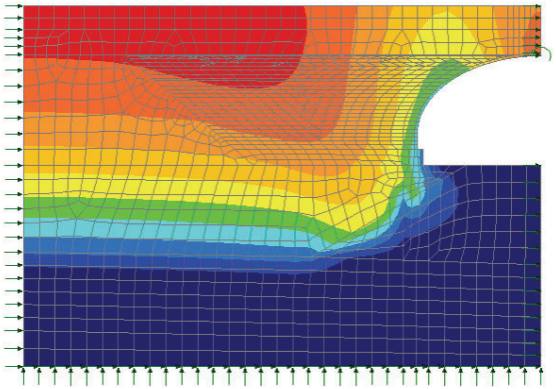
On element activation, the effective vertical stresses in the soil are calculated from the soil weight and any additional loads such as overburden. Horizontal stresses are then calculated using the K_0 value.

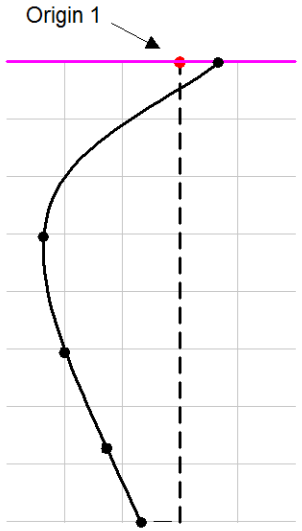


Profile variations

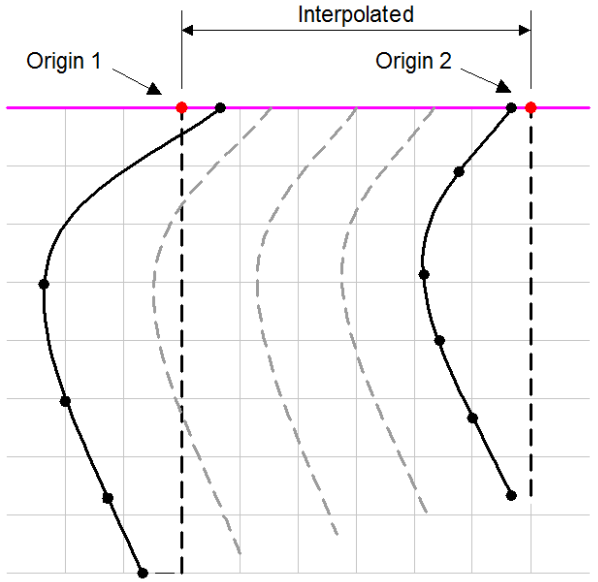
Modelling of the variation of material properties at any location in a model can now be achieved by defining a profile variation. A typical use is modelling the variation of soil properties with depth, as obtained by borehole data.

A profile variation is defined by sets of values against distance, but any number of profile lines in or out-of-plane may be grouped to form a profile set variation. When used to define particular material properties in a supported material model, material properties for elements in any region of a model can be calculated by LUSAS by interpolating between the distance and values defined for each element between each profile variation location.

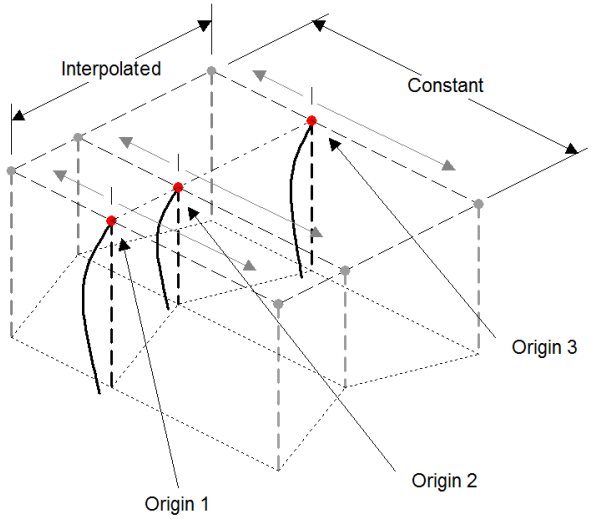




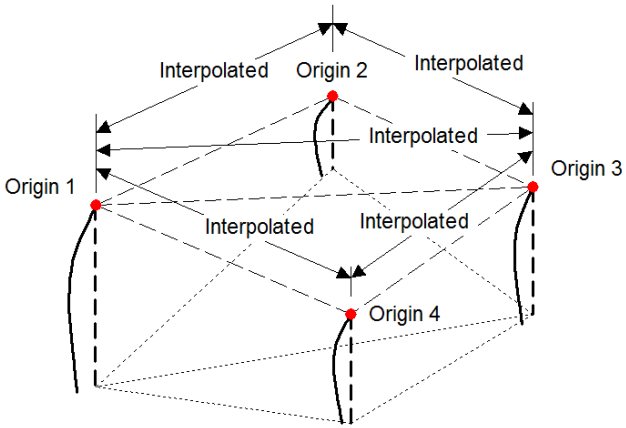
Single profile variation (variation with depth only)



In-plane set of two (or more) profile variations (variation with depth interpolated in-plane only)



In-plane set of profile variations in a 3D model (variation with depth is only interpolated in the plane of the profile set)



Out-of-plane set of profile variations in a 3D model (variation with depth is interpolated in 3 dimensions)

Some general improvements...

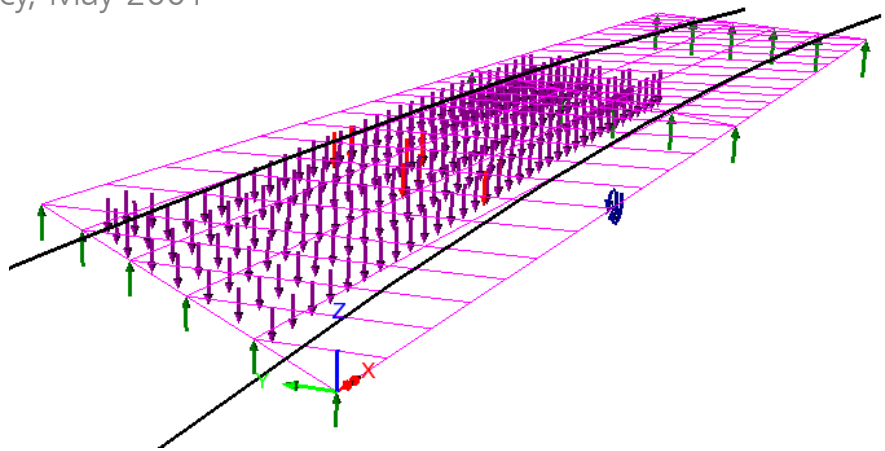
More Traffic Load Optimisation codes added

■ **Finland LO 24/2014** - Application of the Eurocode - Bridge loads and design criteria - NCCI 1, Liikenneviraston (Finnish Transport Agency), Helsinki.

■ **Norway - NS EN1991-2.2004 NA 2010 + NA-rundskriv 07-2015,** permitting traffic loading to:

- NS-EN 1991-2.2003 NA 2010 Eurokode 1: Laster på konstruksjoner - Del 2: Trafikklast på bruer
- NS EN 1990-2002 A1 2005 NA 2016 Eurokode: Grunnlag for prosjektering av konstruksjoner
- NA Circular 07/2015 Traffic Load in manual N400 Bruprosjektering State Highways Authority of Norway

■ **United Kingdom - BD 21/01 Annexes D and E** - The Assessment Of Highway Bridges And Structures Design Manual for Roads and Bridges, Volume 3, Section 4, Part 3, Highways Agency, May 2001



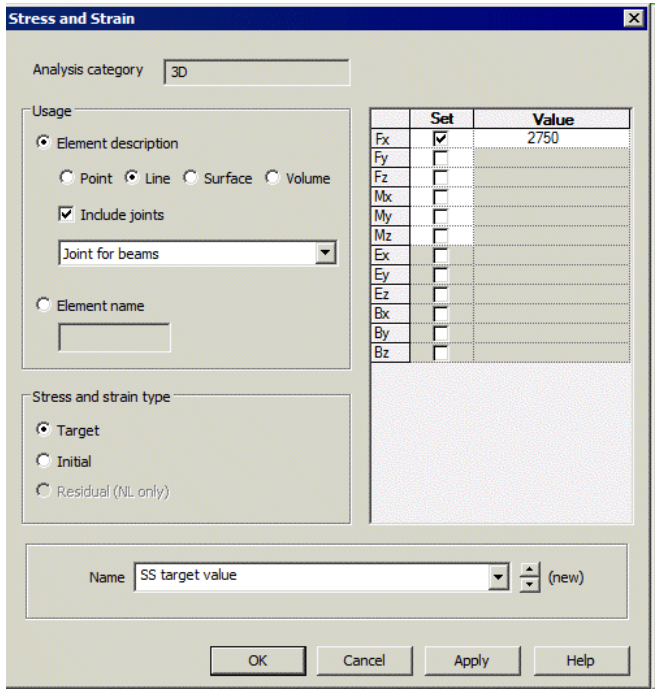
Design codes already supported by TLO

- Australia: AS5100-2: 2004, AS5100-7: 2004 (Austroads)
- Canada CAN/CSA-S6-06 (Design)
- China: JTG D62-2015
- Denmark: DS/EN 1991:2 DK NA:2015
- Europe: EN1991-2 Recommended values
- Ireland: EN1991-2
- Italy: EN1991-2
- New Zealand (Transit New Zealand Bridge Manual)
- Poland: EN1991-2
- Saudi Arabia: MOMRA Bridges Design Specifications
- Sweden: EN1991-2 (2009), EN1991-2 (2011), TDOK 2013:0267 Version 3.0
- South Africa: TMH7
- United Kingdom: EN1991-2, BA34/90, BD21/01, BD37/01 (Road+Rail), BD86/11, BS5400 Rail Railtrack document RT/CE/025
- United States of America: AASHTO LRFD (7th and 6th Edition) and AASHTO Standard Specifications (17th Edition)

Stress and strain target values (for cables)

Stress and Strain loading now includes a Target option. This defines a value for a results component for a feature that will be obtained exactly when a solve is done. This facility is primarily for use when a specified jacking force is required to be applied to one end of a line representing a cable.

Note that target values are only appropriate for linear materials.

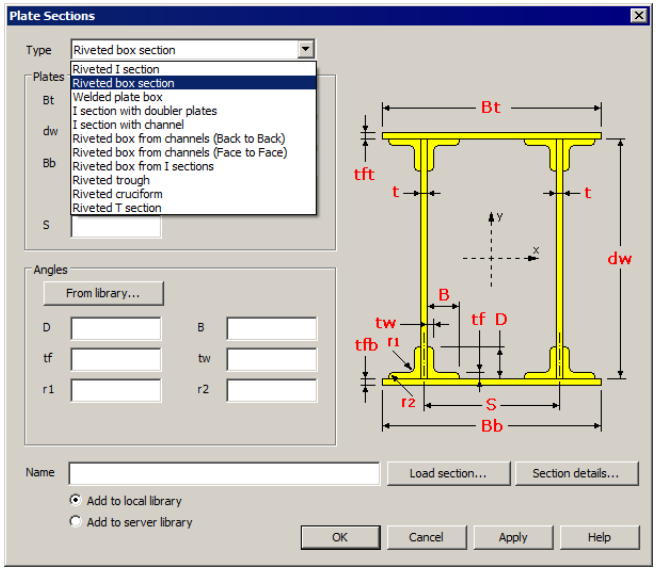


Section property calculation of plated sections

The Plate Section Property Calculator allows definition of section geometry for a range of riveted or welded section types.

It supports:

- Riveted I, T, and box sections
- Riveted trough and cruciform
- Riveted box from I sections / channels
- I-section with channel, or doubler plates
- Welded plate box



Additions / changes to steel section library

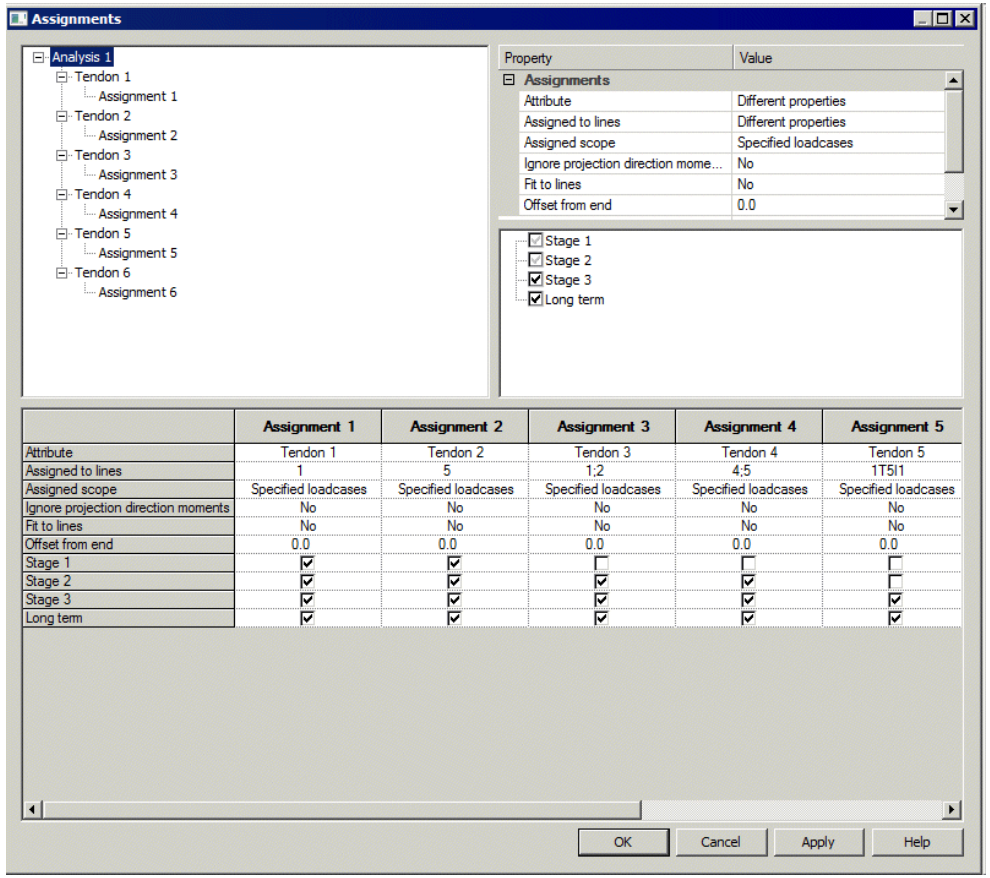
- Indian steel section library added
- New Zealand steel section library added
- Australian taper flange beams updated

Sections already supported

- Australian steel sections and precast Super-T beams
- Canadian steel sections and precast 'I' beams
- China steel sections
- EU steel sections
- KS steel sections including Korean rail sections
- New Zealand steel sections and precast Super-T beams
- UK steel sections and a range of precast beams
- USA steel sections and and a range of precast beams

Improved viewing and editing of attribute assignments

The new Assignments editor is displayed when one or more attributes of the same type are selected for editing in the Attributes treeview. The editor can also be accessed from any assignments that exist in the loadcases panel of the Analyses Treeview. It allows simultaneous viewing, editing and management of any number of attribute assignments. Grid data can be copied to and from spreadsheets.

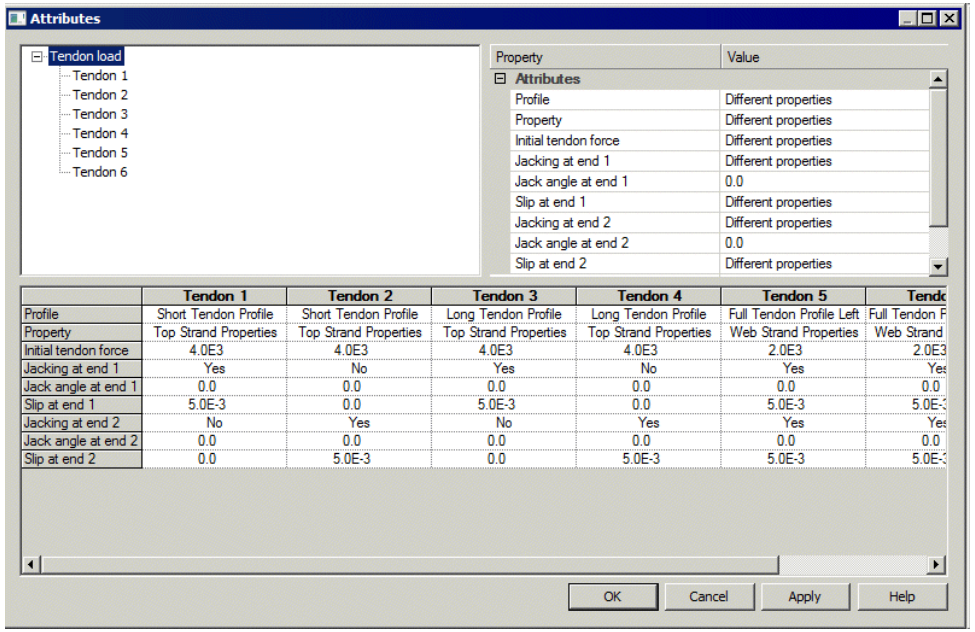


Improved viewing and editing of multiple load attributes

The new Attributes editor is presented for particular structural loading attributes, when two or more of the same loading type is selected for editing in the Attributes Treeview by using the Edit context menu item. This can be by individual selection, or by selection of the parent folder containing them (providing no other different load types are present in that folder).

The dialog enables easy editing of loading data for a range of structural load types, and grid data can be copied to and from spreadsheets.

The Attributes editor is of particular use when editing tendon loading values when carrying out prestress modelling.

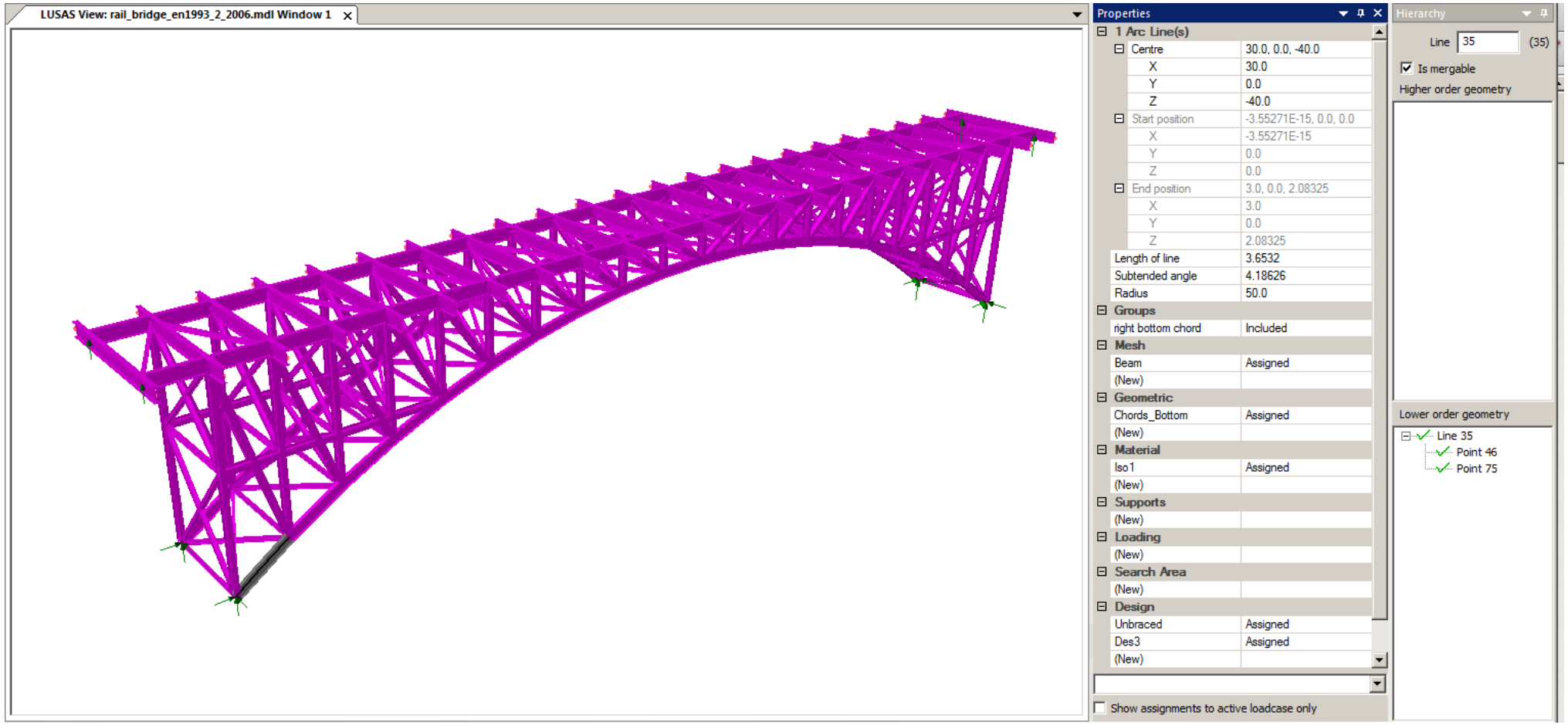


New Properties panel

The Properties panel displays the current properties of any number of selected geometry features (points, lines, surface, volumes) and selected mesh objects (nodes, edges, elements, faces) and displays the attributes which are assigned to those selected items. It allows for changing the properties of selected features/objects and for assigning or deassigning attributes to and from those items. Unlike the Properties dialog that it replaces, the new facility allows modification of any number of features at the same time.

New Hierarchy panel

The Hierarchy panel lists the higher and lower order features/objects of the currently selected single geometry feature or mesh object. Selection of a feature within the hierarchy panel will update the panel to show the hierarchy for that feature.



Summary of all new features and enhancements in LUSAS Version 17

Steel design

- Steel design to EN1993-2 (Bridges) added
- Steel design to EN1993-1-1 (Buildings) enhanced
- Steel design to AASHTO LRFD 7th edition enhanced

Traffic Load Optimisation

- Finland LO 24/2014 added
- Norway NS EN1991-2:2003/NA:2010 added
- United Kingdom BD2101 Annex D and E added

Prestress

- Prestress modelling restructured
- Easier editing of data and assignments
- Prestress loading now supported by shell elements

Material modelling

- AASHTO LRFD 7th edition creep and shrinkage material model
- IRC112-2011 creep and shrinkage material model
- Duncan-Chang soil material model added
- Matrix property definition for joint elements
- Initialisation of ground conditions
- Profile variations in soil

General enhancements

- Section property calculation of a range of plated sections
- Indian steel section library added
- New Zealand steel section library added
- Australian taper flange beam properties updated
- Stress and strain target values for cables
- Improved editing of assignments
- Editing of multiple load attributes now supported
- Discrete load projection over area for shell models
- New Properties panel
- New Hierarchy panel

Element library

- Updated to reflect Modeller enhancements

Documentation

- Generally updated

Updated worked examples

- Linear analysis of a post tensioned bridge
- Segmental construction of a post tensioned bridge
- Drained nonlinear analysis of a retaining wall

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LUSAS

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