LUSAS
Civil & Structural




Civil and structural engineering analysis software


UK Headquarters

LUSAS

LUSAS is the trading name of Finite Element Analysis Ltd - a UK-based company that specialises in the development and marketing of high quality, specialist engineering analysis software. Our range of software products, based on the LUSAS finite element system, provide accurate and reliable solutions for all types of linear and nonlinear stress, dynamic, and thermal / field analysis problems. LUSAS users are provided with a first class technical support service and our Engineering Consultancy division offers specialist finite element consultancy services to all branches of the engineering industry.

For structural engineering analysis and design we provide the following software application products:

LUSAS Bridge

for all aspects of bridge engineering analysis, design, and assessment.

LUSAS Civil & Structural

for building, civil, structural, nuclear and offshore engineering.

LUSAS Composite

for the design of FRP or structural composites

LUSAS Academic

for educational establishments for teaching and research use

Note that selected LUSAS Bridge and LUSAS Civil & Structural products include geotechnical and soil-structure interaction capabilities.

LUSAS Civil & Structural

LUSAS Civil & Structural is available in a choice of software levels; Civil & Structural LT, Civil & Structural, and Civil & Structural Plus, to suit your needs.

1	2	3
LUSAS Civil & Structural LT	LUSAS Civil & Structural	LUSAS Civil & Structural Plus
for frame analysis	for general analysis	for advanced analysis

All levels of LUSAS software use the same user interface and terminology, so training costs can be minimised and users can be introduced to LUSAS at the most appropriate level for the work they need to do.

There is full data compatibility across the product range allowing easy migration of a model to a more advanced analysis when required without any data conversion or remodelling.

Software options

These extend the capabilities of particular LUSAS software products according to your needs.

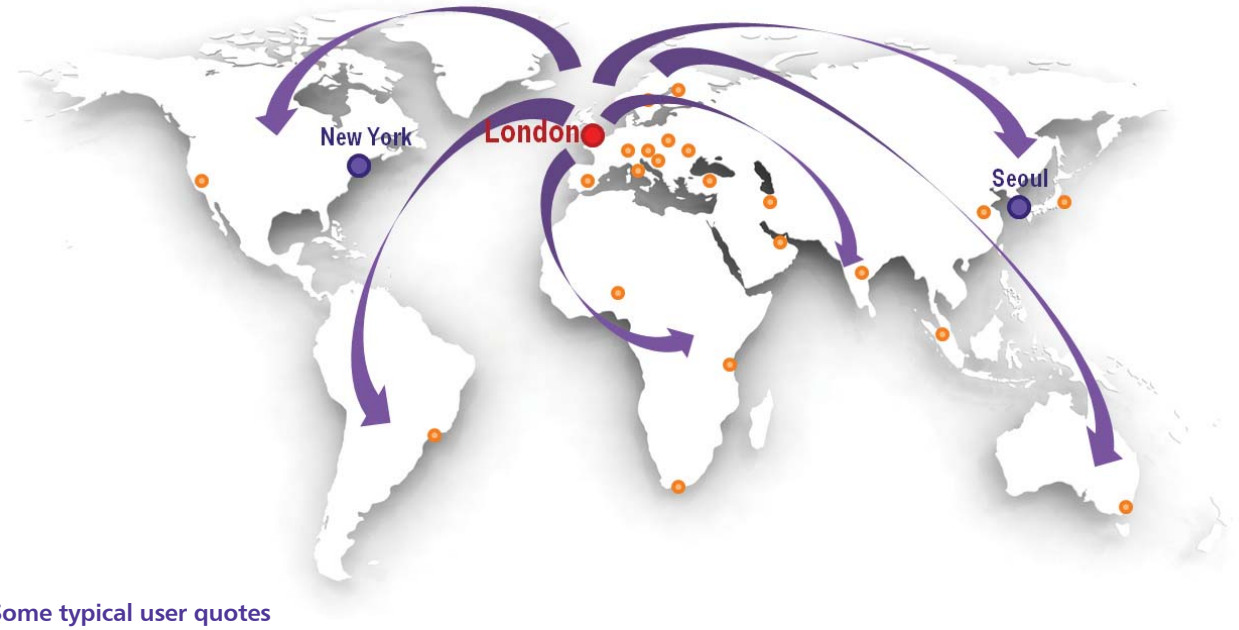
LUSAS Software Option available for purchase for use with a particular Software Product	Software Product: Civil & Structural LT	Civil & Structural	Civil & Structural Plus
Fast Solvers		●	●
Vehicle Load Optimisation			
Steel and Composite Deck Designer			●
IMDplus Analysis		●	●
Nonlinear Analysis			●
Dynamic Analysis			●
Thermal/Field Analysis			●
Heat of Hydration Analysis			●
Rail Track Analysis			

Cover image: Dubai Metro light rail project.

Global coverage, users and support

LUSAS software is marketed and supported globally by LUSAS and also through a network of distributors and resellers that cover every continent.

Used by thousands of users, LUSAS is highly regarded in the civil, structural and bridge engineering industries, as demonstrated by an impressive list of clients, which include many of the top international consultancies. LUSAS is also used extensively by government agencies, local authorities and smaller to medium-size consultants, many of whom find that the advanced analysis facilities not only expand their capabilities but also give them a competitive edge. Universities and research institutions use the academic version of LUSAS, which provides a steady supply of proficient LUSAS users to support your use of the software in your industry.



Some typical user quotes

"The technical support I received on my enquiry (and the ones that followed on the same model) was excellent - beyond all expectations!"

"I was impressed with the LUSAS help desk. The responses I received were very detailed, informative and helpful. The support provided really assisted me with a modelling process that I hadn't done before."

"The help provided to me was perfect, thanks very much. Good support as usual from LUSAS."

LUSAS Civil & Structural

LUSAS Civil & Structural is a world-leading finite element analysis software application for the analysis, design and assessment of all types of structures. Whether you need to carry out a straightforward linear static analysis of a simple structural frame, a dynamic analysis of a masonry or concrete building, or a detailed geometrically nonlinear staged erection analysis of a cable stayed structure, LUSAS Civil & Structural provides all the facilities you need.

LUSAS Civil & Structural is available in a choice of software levels to suit your analysis needs. Each uses the same Windows user interface, and has modelling wizards, comprehensive loading facilities for easy and rapid model generation, load application and combining of loadcase results for design checking. Extensive results processing, viewing and report generation facilities give you ultimate control over what you plot and print from your analysis. In short, LUSAS Civil & Structural software handles simple frames with ease and has a full range of additional software options and features for more advanced structures.

For all types of structure:

- Building frames / space frames
- Simple / complex slabs
- Masts / towers
- Grandstands / stadia
- Storage tanks / silos
- Cooling towers / chimneys
- Dams
- Docks / piers / jetties
- Tunnels / retaining structures
- Caissons / gravity base structures

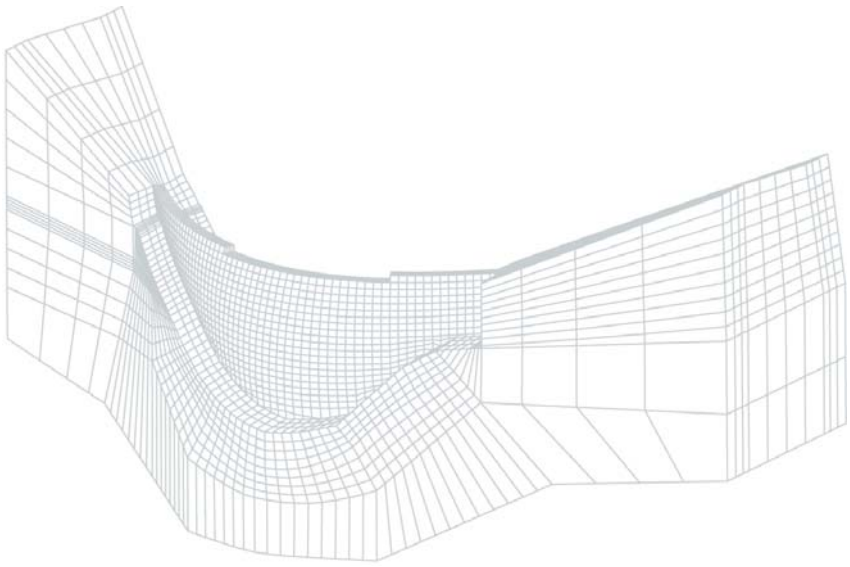
Used for:

- Innovative new design
- Cost-saving re-design
- Structural assessment
- Development of retrofit solutions
- Erection / demolition engineering

Why use LUSAS Civil & Structural?

LUSAS Civil & Structural provides cost-effective structural modelling and analysis (including soil-structure interaction) of any structure, in one software package. Global and local modelling is feature-based and allows mixing of element types in the same model. Advanced nonlinear geometry, material and contact modelling is a key strength, and the software can also be customised to suit your requirements by using the LUSAS Programmable Interface.

Overall, LUSAS is an established and trusted provider to industry leaders, and LUSAS Technical Support is stated, by its users, to be simply: "The best in the business."



The features and capabilities described in this brochure summarize those of the LUSAS Civil & Structural software range. Separate details list the capabilities of each particular product.




Modelling in general

LUSAS Civil & Structural has an easy to use, associative Modeller for modelling / results processing and a fully integrated Solver that can also be used independently.

■ The user interface is a full native Windows implementation providing an Open Interface to ActiveX compliant Windows software such as Excel, Access, Word and other software.

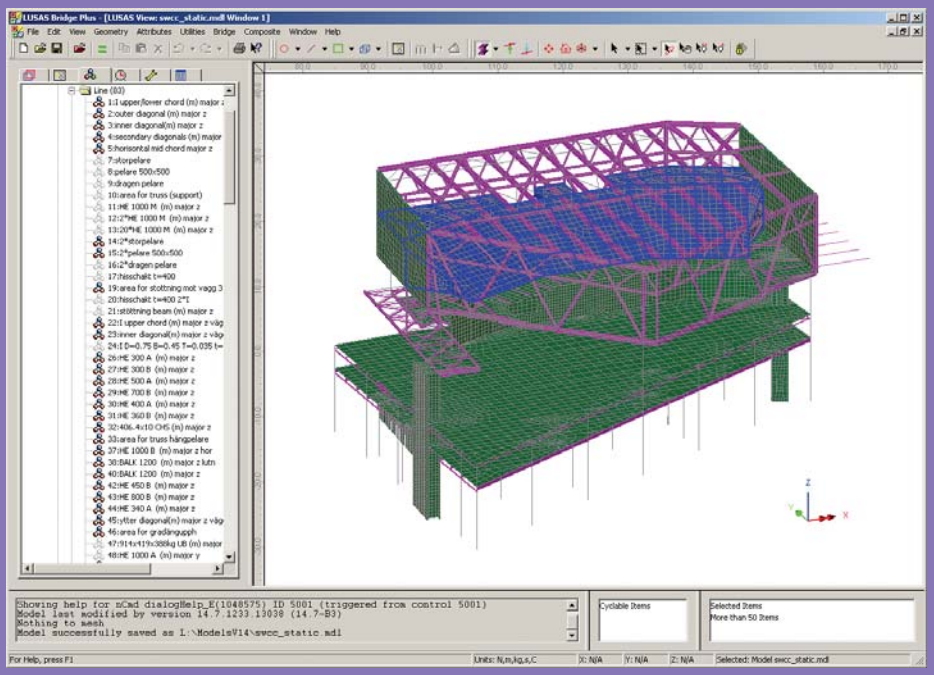
■ Customisation of menus, toolbars and dialogs plus the ability to create your own wizards with Visual Basic Scripting provides limitless potential to tailor the software to specific needs.

■ Models are formed of layers where the visibility and properties of each layer can be controlled and accessed via the layer name held in a Layer treeview, one of a number of treeviews used to organise and access model data.

■ Models are created using feature-based geometry methods (points, lines, surfaces and volumes). CAD import / export is also supported. Model features may be grouped together to aid with manipulation, or with the assignment of attribute data.

■ Model attributes such as thickness, material, loading etc. can be named explicitly. Once defined they appear in an attributes treeview ready to be assigned to selected geometry of the model using the "drag and drop" technique.

■ Automatic meshing with with an easy-to-use mesh refinement capability.



■ Built-in associativity, a key feature of the LUSAS Modeller, ensures that if the model geometry is amended, all assigned loadings, supports, mesh and other attributes are automatically updated to suit.

■ Fleshing (the visualisation of assigned thicknesses or section shapes) helps to ensure that the thicknesses and eccentricities of slabs and the orientation of beam members are correctly defined.

■ Datatips reveal useful model information such as input units expected on dialogs, or assigned properties when the cursor is positioned over of a geometry feature.

■ The OpenGL implementation provides fast graphical displays. Multiple graphical windows allow simultaneous displays of different parts of the model at different orientations. Powerful cursor selection options and pan, zoom, dynamic rotation and pre-defined views allow for easy viewing and editing of your model.

■ A multi-level undo/redo facility allows quick modelling corrections to be made.

■ Detailed on-line dialog help links to additional reference manual material to provide you with the most appropriate level of assistance at all times.




Section libraries and property calculators

Section libraries and a range of section property calculators assist with straightforward modelling of line beam models.

Section libraries and calculators

- Steel section libraries include those for use in the United States of America, United Kingdom, Europe, China, Korea, Canada, Australia and others.

- Common standard section shapes such as rectangular, circular, I-shape, T-shape, L-shape, C-shape and Z-shape sections can be easily user-defined.

- A precast beam section generator calculates section properties for a range of country and region-specific precast concrete beams. Slab contribution can be included.

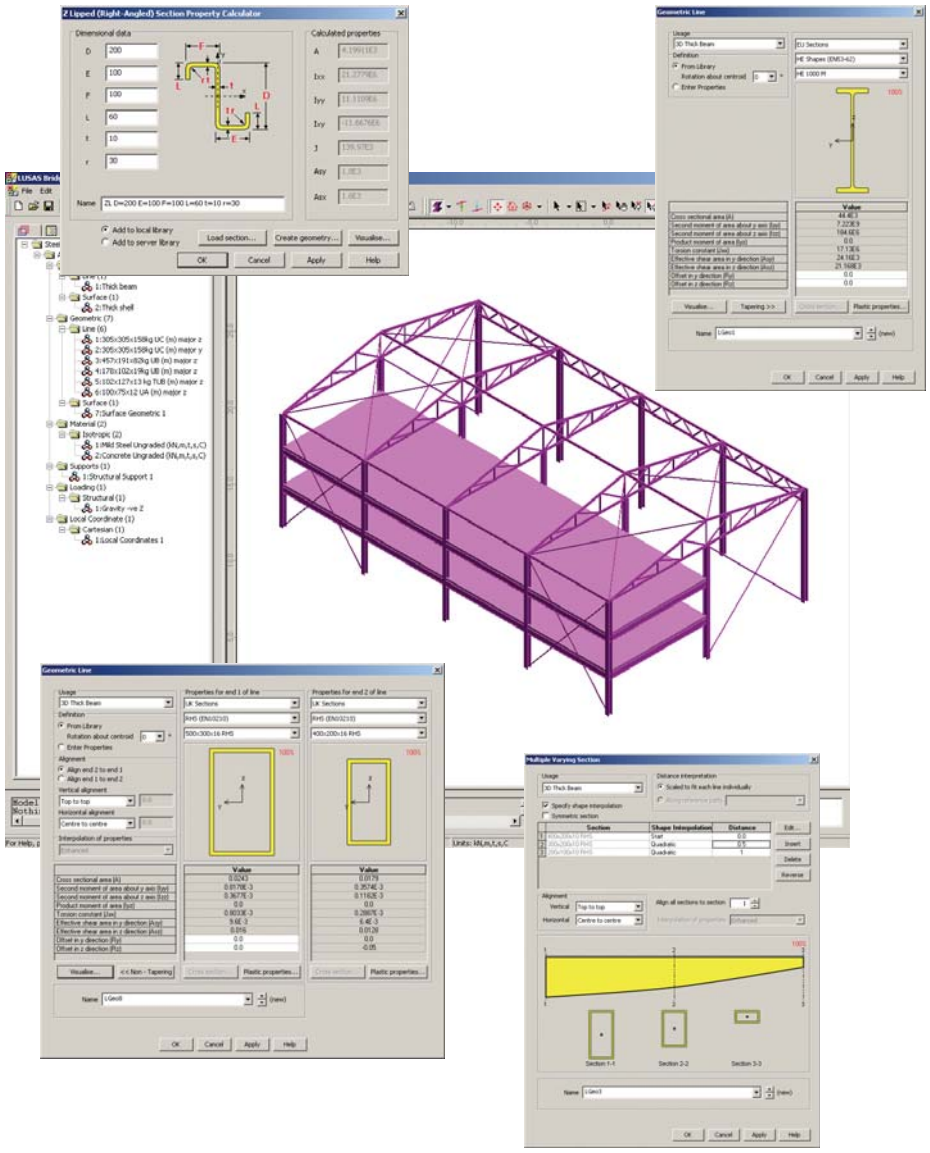
- Section property data for any drawn shape or collection of section shapes can be calculated using an arbitrary section property calculator.

- Section properties of simple or complex, single or multiple box cross sections (with / without voids) can be calculated from entered values.

- Tapering beams can be easily defined by simply specifying section properties for each end.

- Multiple varying sections can be defined along a path of lines allowing for straightforward building of models comprising beams of constantly varying cross-sectional thicknesses.

- A library browser permits transfer of attribute data, such as mesh, geometric, material, etc., between models



Design of one of the largest canopy roof structures in the world, involving static, dynamic and thermal assessment of the roof for in-service loadings, to ensure the necessary strength, stability and dynamic response was achieved.

Advanced elements, materials and solvers

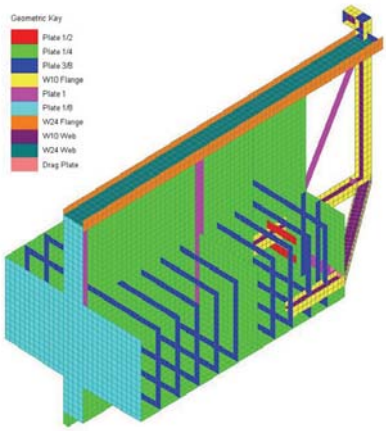
Unrivalled state-of-the-art linear and quadratic element libraries; advanced material models; linear, nonlinear and seismic isolator joint models; and direct, eigen and fast solver options allow all types of structural engineering problem to be modelled and solved as efficiently as possible.

Advanced element libraries

- Beams, plates and shells for ordinary reinforced concrete, prestressed concrete, steel and composite construction.
- Solid elements for detailed modelling and studying local effects.
- Elements for cabled stayed and suspension structures.
- Joint elements for linear and nonlinear modelling.

Solvers

- Direct and eigen solvers are provided as a minimum in all software products.
- A Fast Solvers option provides additional solvers for use with particular LUSAS Civil & Structural products.



Advanced general material models

- Isotropic models: plastic, creep, damage, shrinkage, viscous, two-phase.
- Orthotropic models: plastic, creep, damage, shrinkage, viscous, two-phase.
- Anisotropic and rigidity models.
- Temperature dependent models.
- Concrete models with opening and closing of cracks, concrete crushing, and strain softening based on fracture energy in 2D/3D.
- Concrete creep and shrinkage to CEB-FIP Model Code 1990, Eurocode 2, and creep only for Chinese codes
- Concrete heat of hydration modelling.
- User-defined models and others.

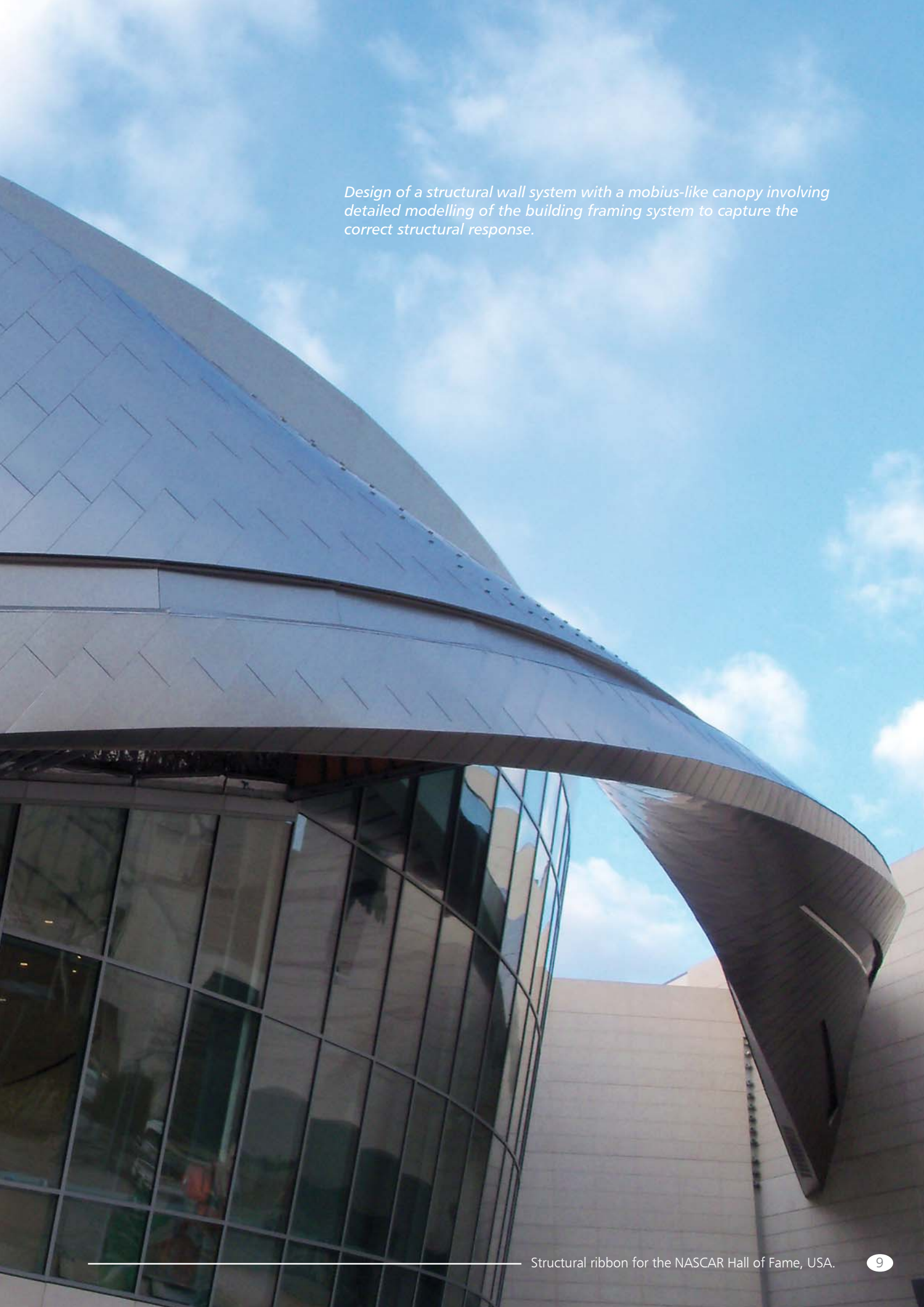
Geotechnical material models

- Constitutive soil models include Tresca, von Mises, Drucker Prager, Mohr Coulomb, Modified Cam Clay, and others for use in all types of soil-structure interaction modelling.
- Volumetric deformation soil model (includes consolidation).

Joint material models

These are used in conjunction with joint elements to fully define the properties for linear, nonlinear and seismic isolator joints.

- Linear joint models include those for spring stiffness only and for general joint properties having spring stiffness, mass, coefficient of linear expansion and damping factor. User-defined force/displacement and axial force dependent curves are supported.
- Nonlinear joint models include elasto-plastic uniform tension and compression with isotropic hardening, elasto-plastic general with isotropic hardening, smooth and frictional contact, nonlinear user-defined, and others.
- Seismic isolator joint models include viscous dampers (Kelvin and Four Parameter Solid), lead rubber bearings with plastic yield and biaxial hysteretic behaviour, friction pendulum system with pressure and velocity dependent friction coefficient and biaxial hysteretic behaviour, and others.



Design of a structural wall system with a mobius-like canopy involving detailed modelling of the building framing system to capture the correct structural response.

Structural ribbon for the NASCAR Hall of Fame, USA.




Load types and combinations

LUSAS Civil & Structural provides a comprehensive range of general loading types to cater for most circumstances. Envelope and load combination facilities help you get the most from your results.

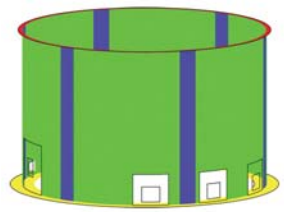
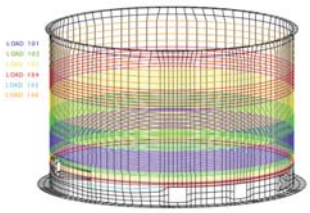
Structural, prescribed and thermal loads are feature based loads that are assigned to the model geometry and are effective over the whole of the feature to which they are assigned. Discrete loads are feature independent. Variations in loading can be applied to all feature load types according to the feature on which they have been assigned.

General load types

- Structural loadings include gravity, concentrated, distributed, face, temperature, stress/strain, and beam loads.
- Prescribed loading options allow initial displacements, velocity or acceleration to be specified.
- Discrete loads distribute a loading pattern over full or partial areas of the model.
- Load trains are defined using a compound load facility.
- Thermal loads describe temperature or heat input
- Variations in load can be applied to all feature load types

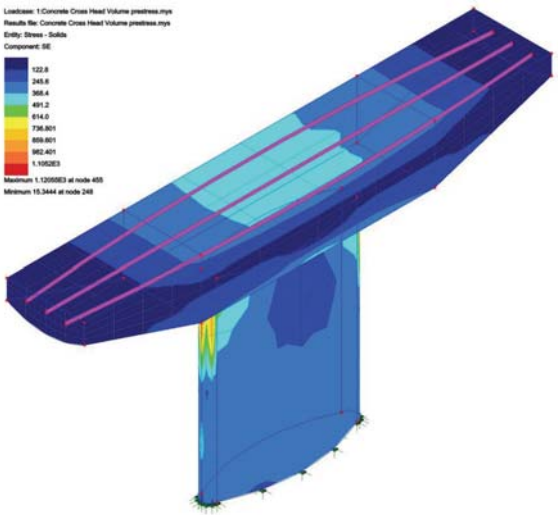
Envelopes and Combinations

- Basic load combinations allow for manual definition of loadcases and load factors.
- Envelopes of multiple loadcases create maximum and minimum results.
- Smart Combinations generate maximum and minimum results, taking account of adverse and relieving effects, substantially reducing the number of combinations and envelopes required.

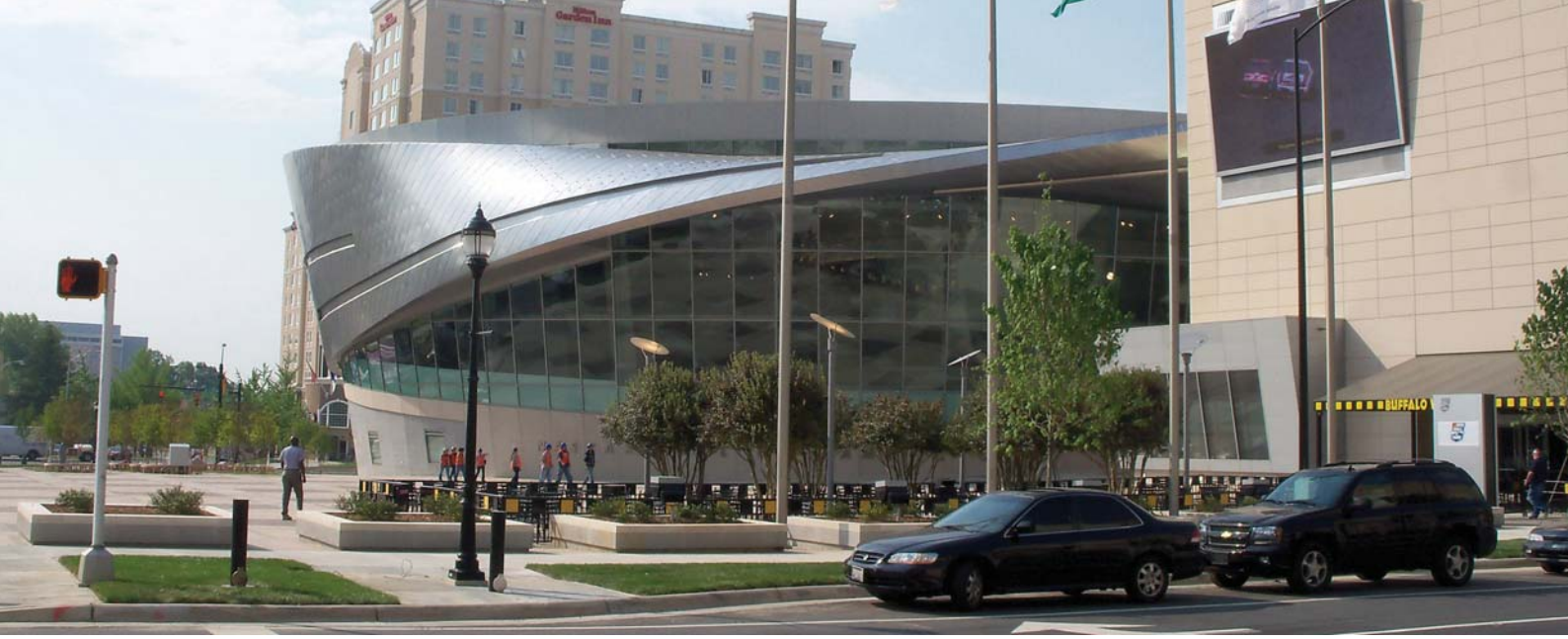



Prestress and post tensioning

- Single and multiple tendon prestress wizards in LUSAS calculate equivalent nodal loading due to tendon prestressing or post-tensioning and assign these forces automatically to the elements within a model.
- The multiple tendon prestress wizard takes into account elastic shortening due to stressing of other tendons according to the design code used, or to user-defined percentage losses.
- Tendon profiles can be defined in 3D space or in two 2D planes, to suit local practice.
- Computation of tendon forces can be carried out in accordance with various regional codes including AASHTO, Eurocode, China and others.



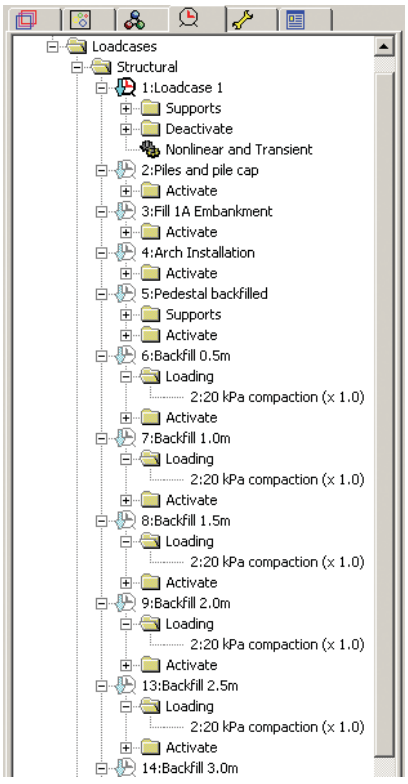
Static, dynamic and nonlinear analysis of a 170m high concrete, steel and composite viewing tower.



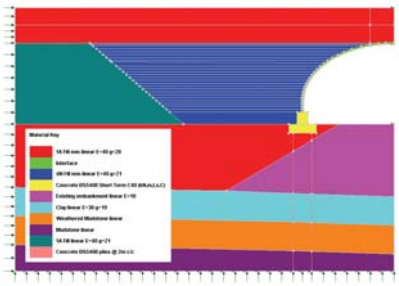
Staged construction modelling

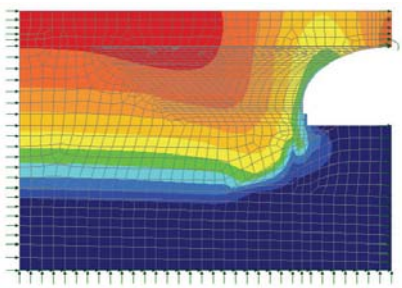
With LUSAS you can model the step-by-step construction or dismantling of your structure over time, and evaluate the effects of structural changes, load applications, and time-dependent material changes. Also with LUSAS, unlike some software, only one model file need be created and this can contain all of the information required to carry out an analysis of every stage of construction. The effects of geometric and material nonlinearity, and time-dependent material effects such as creep and shrinkage can all be included.

A complete staged construction modelling process for a model is controlled in the Analyses panel of the LUSAS treeview. When modelling, groups of elements and their associated attributes can be activated and deactivated, with supports being carried forward between loadcases, introduced or removed to accurately represent each stage. Camber, displacement history, and incremental displacement results tables can be produced for selected model locations and for any specified results loadcases.



- Full staged construction modelling with beams, shells and solid elements.
- Full activation and deactivation of elements.
- Add or remove supports as required during the construction sequence.
- Sliding bearings may be modelled using nonlinear contact (slidelines).
- Support and loading facilities including temporary/traveller loads.
- Apply loads anywhere onto any model.
- Change loading/stress/strain over time and lock-in stresses between stages.
- Prescribed displacements or jacking loads may be used as spans are completed.
- Time-dependent material properties include stress related concrete creep and shrinkage for CEB-FIP, Eurocode and Chinese creep model codes.
- Custom time-dependent curves for particular material properties and codes
- Use single or multi-tendon wizards to define and assign tendon properties and time-stages to features of a model.
- Steel relaxation, time effect on elastic modulus, tendon post-tensioning losses from creep, shrinkage, and superimposed loads.
- Cumulative effects can be reported separately for each loadcase, such as post-tensioning effects, or for the effects of just creep and shrinkage.
- Incremental effects can also be specified allowing you to view and assess the net changes to the structure since the previous stage.





Modelling and analysis of the main towers of the UK's first urban cable car to enable a Category 3 design check to be carried out to Eurocodes.

Geotechnical / soil-structure modelling

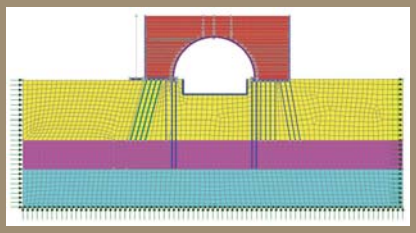
Unlike some structural analysis software, LUSAS Civil & Structural analysis software provides a range of soils-specific and general structural engineering analysis tools to allow finite element modelling of both ground and structure in a single model. State-of-the-art element libraries, advanced material models, and linear and nonlinear joint models, allow a range of soil-structure engineering problems to be solved.

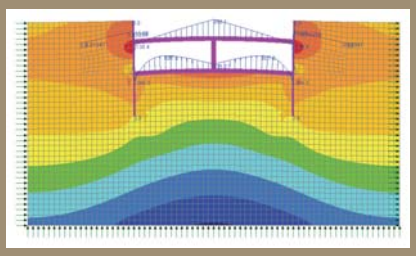
■ Useful geotechnical capabilities make use of a range of soil models. Residual soil stress varying with depth can be accommodated providing useful facilities for soil-structure interaction for integral bridges and culverts. Rock joints, pore water pressure dissipation, consolidation modelling, geotechnical problems involving long term excavation, construction in clays, and temporary works can all be solved.

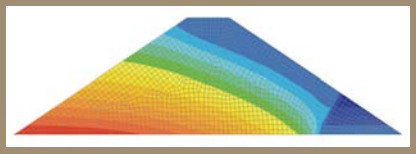
■ Constitutive soils models include Tresca, Von Mises, Drucker Prager, Mohr Coulomb, and Modified Cam Clay. Two-phase material properties can be added to selected materials to permit modelling the deformation of undrained/fully saturated and fully-drained/unsaturated porous media, and slow consolidation process. Draining and filling curves can also be specified for partially drained materials.

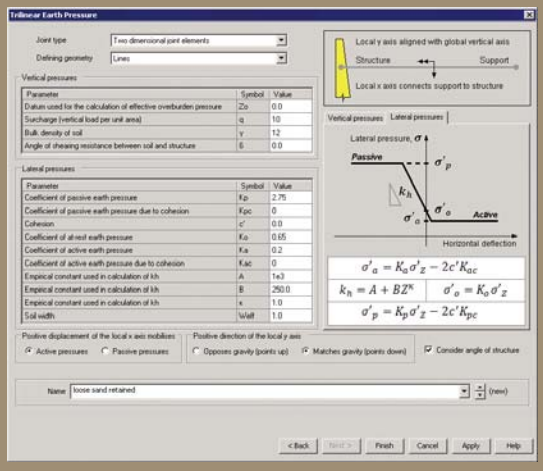
■ Nonlinear springs model active/passive soil joints. Interface meshes permit joining of the soil / structure. Gain / loss of contact, and skin friction can be considered.

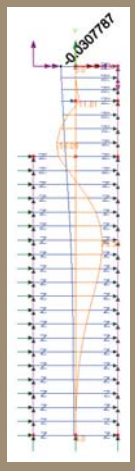
■ A tri-linear active / passive earth pressure joint material wizard simplifies the modelling of a variety of soil-structure interaction problems, creating a piecewise linear joint material attribute with properties that vary with depth. Multiple attributes can be defined to represent layers of soil or changes in properties due to the presence of water.











Use for:

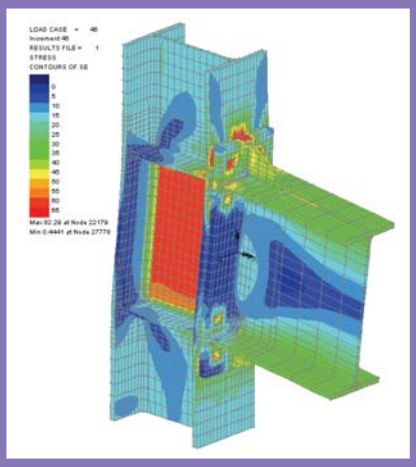
- General soil-structure interaction
- Integral bridges / retaining walls
- Pile and pile group analysis
- Tunnelling / cut and cover tunnels
- Excavation and construction
- Embankment / slope stability
- Settlement and consolidation
- Dewatering and seepage analysis
- Modal and time-history dynamics

Dynamic crowd loading assessment of an unusual, relatively lightweight X-frame grandstand.

Analysis capabilities

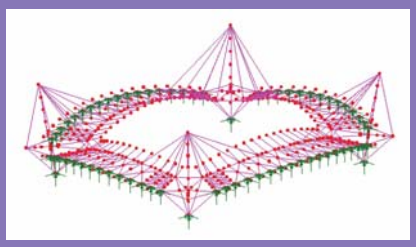
When modelling your structure, multiple analyses can be defined and solved independently from within one model. This means that, in most cases, there is no need to create separate models, and maintain clone copies of a model, in order to analyse and view results for different analysis requirements.

The main analysis capabilities of LUSAS Civil & Structural are summarised here.



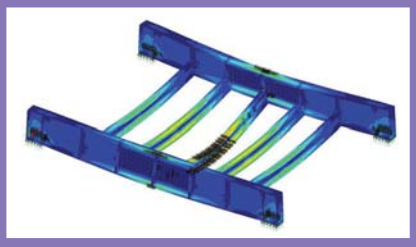
Linear static
Stresses, strains, displacements, moments, shears and axial forces that result from static loading are easily calculated, displayed and output from any model.

Cable tuning analysis
The cable tuning analysis facility calculates load factors for cables in order to achieve defined target values set for various feature types or results components. An 'exact' method, an optimisation facility and two best-fit solution methods are provided.



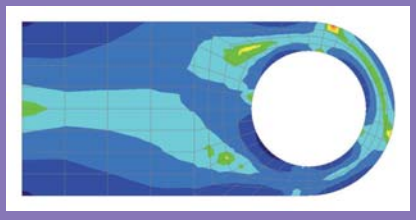
Target values analysis
The target values facility is a post-processing tool that provides a general method of varying load factors in a linear analysis to try and achieve target values defined for particular feature types or results components.

Buckling
LUSAS carries out elastic critical buckling, which is required for the calculation of member resistances. Often it is also required by some codes to determine if a second-order analysis needs to be carried out. If so, a full nonlinear buckling analysis can be undertaken.



■ For structural assessment, detailed buckling analysis with LUSAS can often reveal additional 'hidden' capacity and prove load capacity.

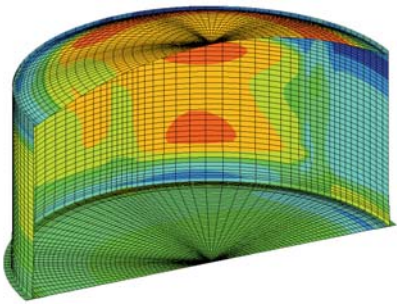
■ For new structures, linear and nonlinear buckling analysis using LUSAS can investigate girder stability during erection, look at the effects of a slab casting sequence, and also help to optimise the size of the web and flange plates, bracing, stiffeners and position of any temporary supports used.



Fatigue
Fatigue calculations can be carried out using the total life approach. Fatigue life may be expressed in terms of the damage that is done to the structure by a prescribed loading sequence or as the number of repeats of a sequence that will cause failure.

Dynamics

LUSAS Civil & Structural excels in solving seismic and general dynamics problems. The natural frequency of structures, the effect of dynamic loading, such as crowds in sports stadiums and auditoriums, structural response due to earthquake or impact loading, and blast loading can all be readily assessed.



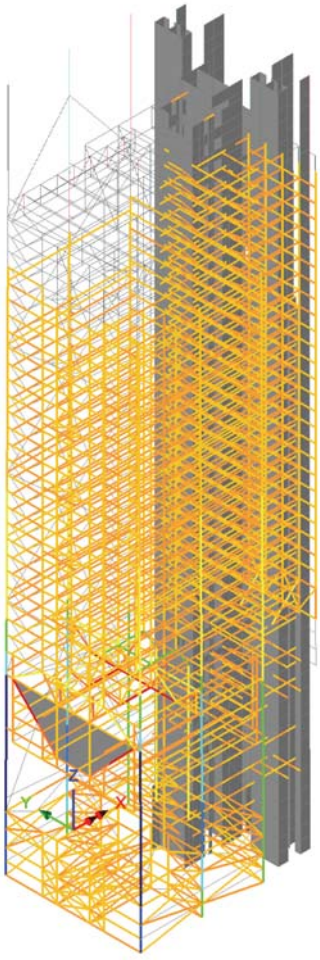
Interactive Modal Dynamics (Modal superposition)

Interactive Modal Dynamics (IMD) allows the natural vibration behaviour of a structure to be combined with a loading regime in order to calculate the dynamic response of a structure to a range of applied excitations. The use of IMD produces results an order of magnitude faster than traditional time-step solutions. Multiple and more advanced loading events (including moving loads, moving mass and moving sprung mass, and seismic analysis can be modelled with IMDPlus and other software options.

Nonlinear

LUSAS Civil & Structural handles geometric nonlinearity, material nonlinearity and contact nonlinearity to accurately model the structural behaviour. Local and global nonlinear analysis with LUSAS helps ensure that structures are designed economically and safely for any imposed loading. Automatic nonlinear solution procedures simplify the analysis process for applications such as:

- Time-dependent dynamic analysis
- Lift-off of bearings and halving joints
- Bearing analysis
- Elasto-plastic large deflection plate buckling
- Concrete cracking
- Concrete creep with recovery
- Thermal loading
- Impact / collapse assessments
- 'Push-over' analysis
- Excavation and construction
- Soil-structure interaction



Thermal / field analysis

The Thermal / Field software option contains extensive facilities for both simple and advanced steady state, and transient thermal / field analyses.

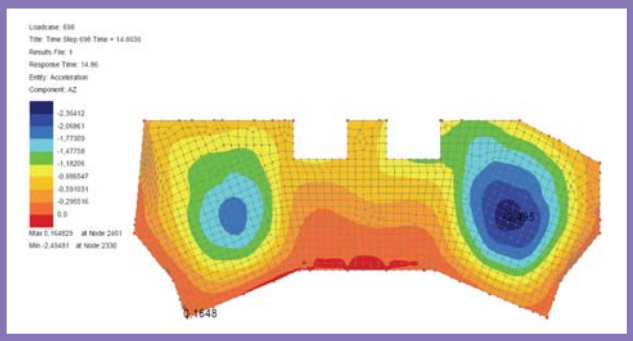
Heat of hydration

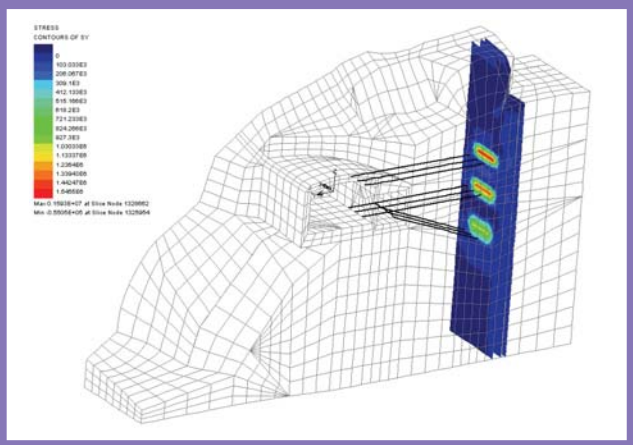
Modelling of heat of concrete hydration can be carried out for a variety of cement types using the using the Heat of Hydration option. Effects due to the addition of fly ash and ground granulated blast furnace slag can also be included.

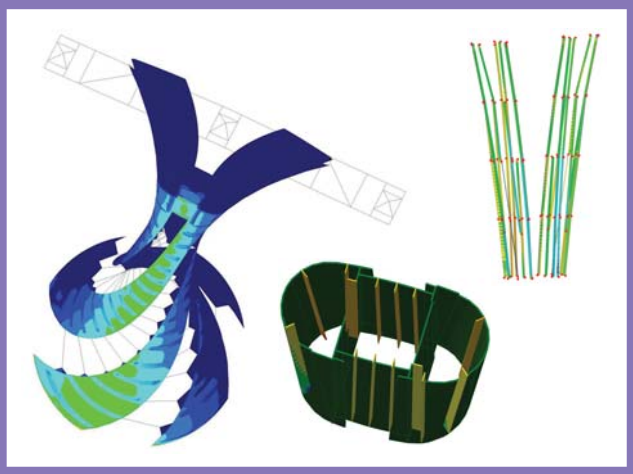
Viewing results

LUSAS Civil & Structural has a host of easy to use results processing and viewing facilities to help you get the most from your analysis.

- Results for all or selected parts of a model can be viewed using separate layers for diagram, contour, vector and discrete value data.
- Loadcases are selected on a window basis, allowing multiple views of the model, with each window displaying results for different loadcases.
- Basic load combinations allow for manual definition of loadcases to be included and load factors to be used.
- Smart Combinations generate maximum and minimum results, taking account of adverse and relieving effects, substantially reducing the number of combinations and envelopes required.
- Envelopes of multiple loadcases provide maximum and minimum results.
- Bending moment and shear force diagrams can be plotted and structural deflections visualised.
- Contour ranges and vector/diagram scales can be controlled locally in each window or set globally to apply to all windows.
- Results can be displayed in global or local directions, in element directions, or at any specified orientation
- Results can be plotted on deformed or undeformed mesh plots, and on fleshed or unfleshed beam sections.
- Multiple slices may be cut through 3D solid models on arbitrary planes and made visible or invisible in any window.
- Results can be selectively output to spreadsheet applications for additional calculation and graphing uses
- For concrete modelling, plotting of crack width contours, and values can be carried out for supported design codes.

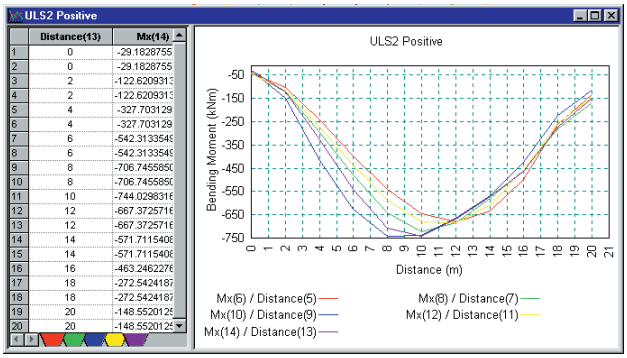






Graphing

A graph wizard provides a step-by-step means of selecting results data to be drawn on a graph. Arbitrary line sections may also be taken through any surface model or on a slice cut through a three dimensional solid model.

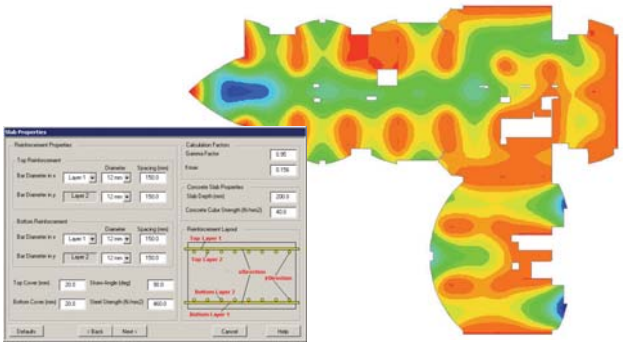


Animations

Animations of results - particularly useful for animating construction stages, mode shapes, viewing of structural response to moving loads and seismic events, and for investigating the spread of concrete cracking or yielded material - can be created and saved as AVI files for use in other Windows applications.

Slab Design

The LUSAS RC Slab Designer is for use with reinforced concrete slabs (without prestressing) that are modelled using plate or shell elements. It enables contours and values that indicate flexural reinforcement requirements at Ultimate Limit State (ULS) to be plotted and plots design crack widths at Serviceability Limit State (SLS) for those design codes that support this.

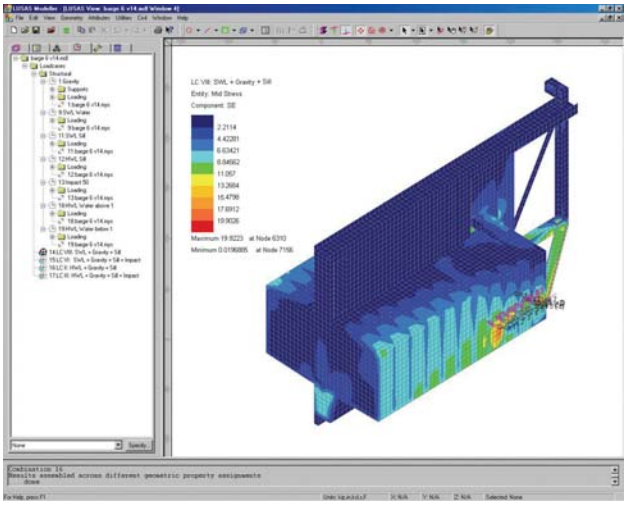


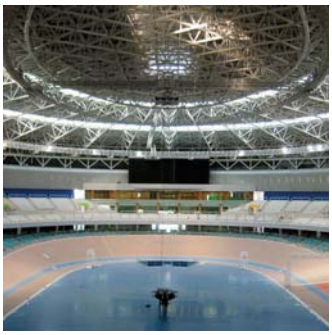
Design codes supported include:

- AASHTO LRFD
- AS5100-5-2004
- AS3600-2009
- BS5400-4, BS8007 and BS8110
- CAN/CSA S6-06
- Eurocode EN1992-1-1 and EN1992-2
- IRC: 112-2011 and CBC-1997
- SS CP65: Part 1 and 2: 1999

Report generator

Report templates hold user-defined information to generate customised reports. One-click reports can be created for selected members, and general modelling, loadcase and results data can be selected for inclusion in a main report on an element, feature type, group, and loadcase basis. Screenshots, saved images of model, graphs, and one-click reports can also be included. Each time a report is created, up to date modelling and results data are extracted ensuring model and report compatibility at all times. Report data may be exported to Excel spreadsheets, Word, PDF and other formats.





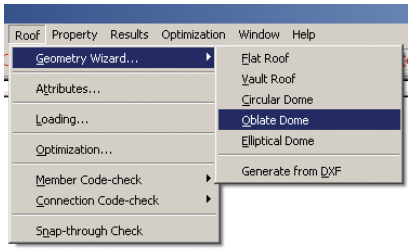
Software customisation

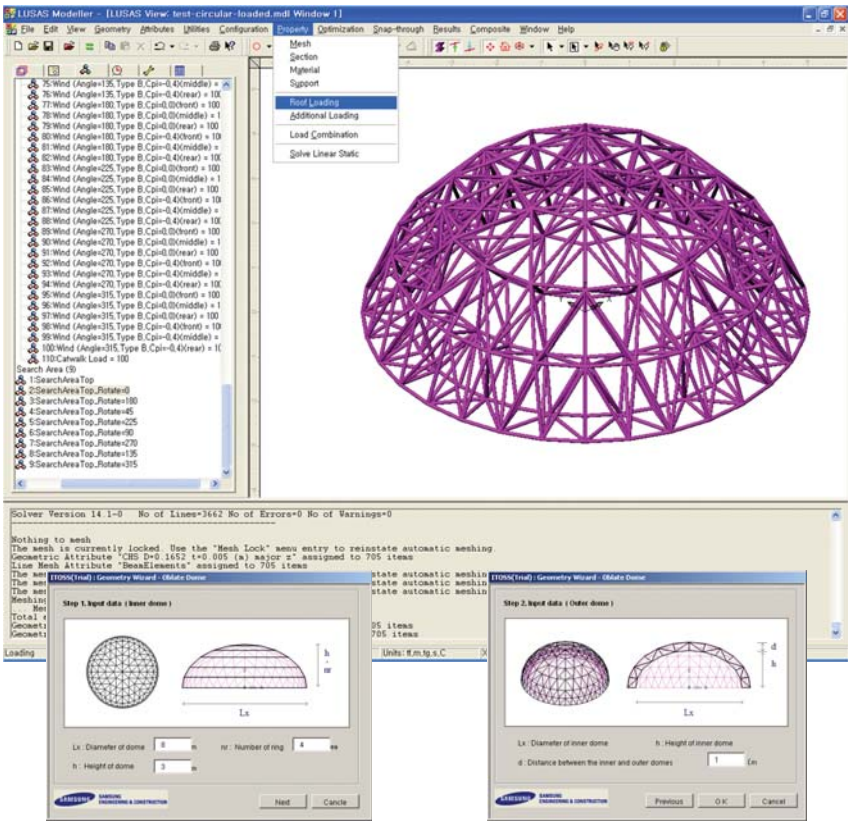
The LUSAS Programmable Interface (LPI) and a user-defined results calculation facility provide the means to customise modelling and results processing tasks to your specific requirements and provide the opportunity for you to carry out structural optimisation and simple checks to particular design codes.

LUSAS Programable Interface (LPI)

By using VBScript to access LUSAS facilities and functionality, user-defined menu items and dialogs can be created, direct links to Word and Excel can be made for data transfer, and repetitive tasks can be automated.

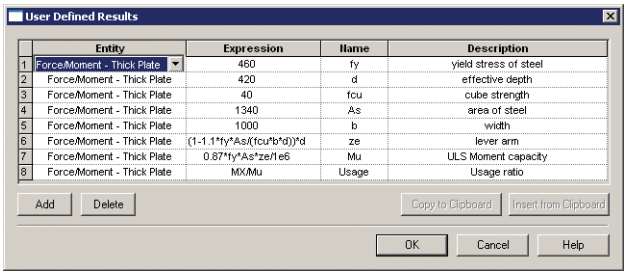
For modelling, the parameterisation of all sorts of structures such as space frame roofs, tanks, culverts and wind farm bases is possible. For results processing, simple design checks can be made and reinforcement quantities can be calculated. When used with automated iterative analysis, structural member sizes and configurations can be optimised.





User-defined Results

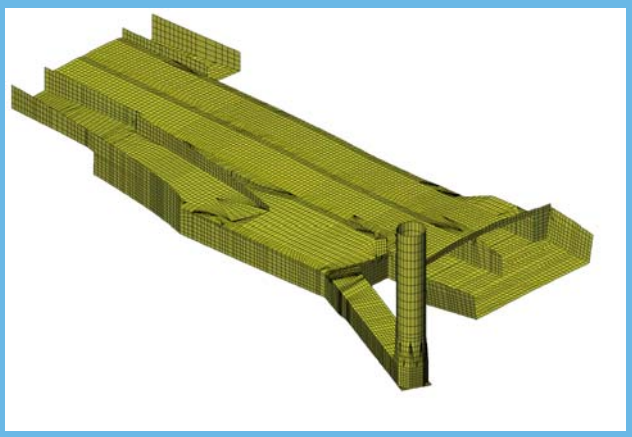
An in-built user-defined results calculation facility allows LUSAS model and results parameters to be used in arithmetic expressions to give spreadsheet-style capabilities. However, unlike external spreadsheet calculations, because LUSAS calculations are based upon current model and results data, the values can be automatically recalculated if the model data is edited or if results change. All LUSAS results processing, viewing, animating, graphing, printing and report facilities can be used with any user-defined results components.



Analysis of irregular-shaped cast in situ reinforced concrete slabs, providing accurate contour plots of reinforcement bar diameters to aid with the detailing of each unique floor slab arrangement.

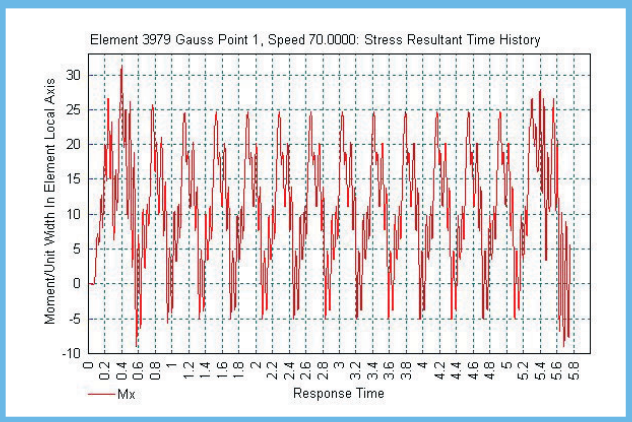
Software options

The analysis capabilities of particular LUSAS Civil & Structural software products can be extended by using the following software options.



Fast solvers
Fast multifrontal, parallel and eigen solvers can provide solutions several times faster than the standard supplied solvers for certain analysis problems. The Fast Solvers option includes:

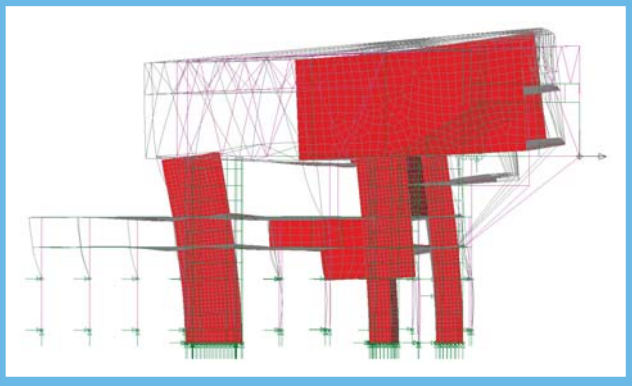
- Fast Multifrontal Direct Solver
- Fast Multifrontal Block Lanczos Eigensolver
- Fast Parallel Direct Solver
- Fast Parallel Iterative Solver
- Complex Eigensolver



IMDPlus
The IMDPlus option extends the Interactive Modal Dynamics (IMD) techniques available in all LUSAS products, and which model a single loading event in a single direction, to allow multiple loading events with more advanced loading conditions to be solved. IMDPlus is used for two primary uses: seismic response analysis of 2D and 3D structures subjected to acceleration time histories of support motion, and for the analysis of 3D structures, such as bridges, subjected to constant moving vehicle or train loads, or moving mass or moving sprung masses.

Nonlinear analysis
The Nonlinear analysis software option provides the very latest powerful techniques for solving problems having:

- Geometric nonlinearity (large deformations, finite rotations and large strains)
- Material nonlinearity (concrete, steel, rubber and geotechnical material models)
- Contact nonlinearity (point and surface).

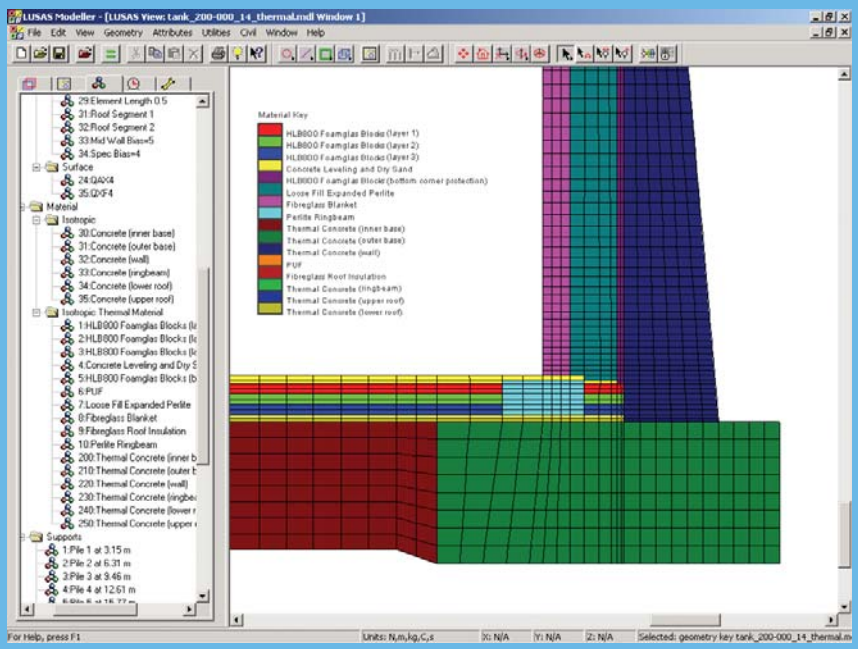


The Nonlinear option can be used to solve a multitude of problems having large deformations, high levels of material nonlinearity and complex boundary conditions. It can also be combined with the LUSAS Dynamic and Thermal / Field software options to solve problems in which the effects of time and temperature are important.

...in summary

Dynamic analysis
Straightforward modal dynamics problems can be solved using Interactive Modal Dynamics (IMD) techniques which are provided in selected LUSAS Civil & Structural products. The Dynamics option contains the facilities required to solve a wider range of dynamic problems in the time domain with a step-by-step solution.

Additionally, by combining the LUSAS Dynamic and LUSAS Nonlinear options both high and low velocity nonlinear impact problems can be solved using either implicit or explicit solution techniques.



Fast Solvers
- Multifrontal Direct Solver
- Multifrontal Block Lanczos Eigensolver
- Parallel Direct and Iterative Solvers
- Complex Eigensolver

IMDplus
- Fast multiple event evaluation
- Seismic response analyses
- Moving load / moving mass analyses

Nonlinear
- Geometric nonlinearity
- Material nonlinearity
- Contact nonlinearity
- Automatic solution procedures

Dynamic
- Spectral and forced response
- Transient implicit dynamics
- Nonlinear dynamics
- Modal or Rayleigh damping

Thermal / Field
- Steady state and transient
- Temperature distribution / dissipation
- Coupled thermal-structural

Heat of Hydration
- Model a variety of cement types
- Include effects of fly ash and slag

Thermal / Field analysis
The Thermal / Field software option contains extensive facilities for both simple and advanced steady state, and transient thermal / field analyses. By combining the LUSAS Thermal / Field option with other appropriate LUSAS options, heat transfer due to conduction, convection and radiation can be analysed. In addition, the effects due to phase change of material may also be included.

Heat of hydration
Modelling of heat of concrete hydration can be carried out for a variety of cement types using the using the Heat of Hydration option. Effects due to the addition of fly ash and ground granulated blast furnace slag can also be included. When used in conjunction with Nonlinear, Dynamic, and Thermal software options the heat of concrete hydration can be computed during a thermo-mechanical coupled analysis, and the temperatures and degree of hydration can be read into the mechanical analysis.




Software, support and consultancy services

Software availability
Whether your analysis requirements are simple or advanced, LUSAS software can be configured with various levels and options to meet your needs, all of which are fully integrated and easily upgradeable. The configuration can also provide for extra copies of the Modeller independent of the Solver and can be made available as fixed or network (floating) licences over both LAN and WAN for flexible access.

Training services
Detailed LUSAS application training courses get you up-to-speed and also ensure you have sufficient knowledge of the relevant facilities to tackle the analyses you want to do.

Technical support
Our dedicated hot-line technical support engineers will help you to meet your deadlines and to make the most of your company's investment. They are experts in providing sound modelling and analysis advice to fellow structural engineers in a friendly and informative manner and are regularly praised by clients for providing good and informative assistance.

Web-based support
The LUSAS web site User Area contains a wealth of technical information. Tips and tricks, frequently asked questions and other useful details are provided to assist you in your modelling and analysis tasks. Software scripts and the latest versions of LUSAS software can be downloaded for instant use.

Quality assurance
The accurate and reliable results you get from LUSAS Civil & Structural come not only from our continuous development program but also from our use of an automatic installation and testing system. With our quality control procedures, designed to comply with ISO 9001, you can use each new improved version of LUSAS with the same confidence as the last.

Consultancy services
If you need more assistance than that available through the hot-line service, then our team of engineering consultants can help. Whether you have a difficult analysis to carry out or need help with a peak workload, our rapid and cost-effective service will ensure you get the best out of your designs.

Related software
LUSAS Bridge software is available for all types of bridge analysis, design and assessment. This provides access to other software options such as Vehicle Load Optimisation and Rail Track-Structure Interaction analysis.

Find out more
Clients worldwide are benefiting from the commercial advantage that LUSAS gives them and testimonials on their use of the software speak for themselves. Whilst this brochure provides only a broad overview of the main facilities and benefits of using LUSAS Civil & Structural, detailed information sheets on key features, analysis capabilities and real-life uses of the software are also available.

For more details, or to arrange a demonstration, please contact LUSAS or your local distributor and find out just what LUSAS Civil & Structural could do for you.

LUSAS

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