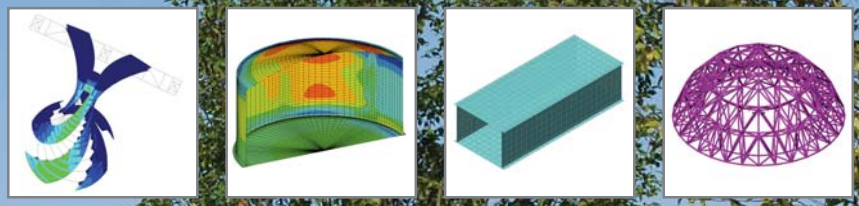
LUSAS
Finite Element Analysis



Customisation and Automation using the LUSAS Programmable Interface (LPI)

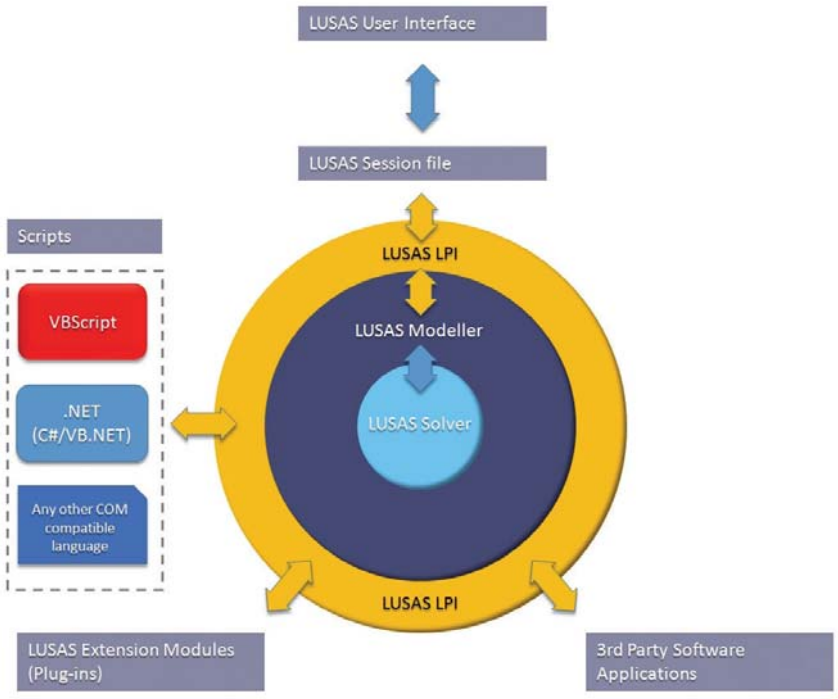
LUSAS Programmable Interface

The LUSAS Programmable Interface (LPI) allows the customisation and automation of modelling and results processing tasks and creation of user-defined menu items, dialogs and toolbars as a means to access those user-defined resources. It can also be used for transferring data between LUSAS and other software applications, and to control other programs from within LUSAS Modeller, or control LUSAS Modeller from other programs.

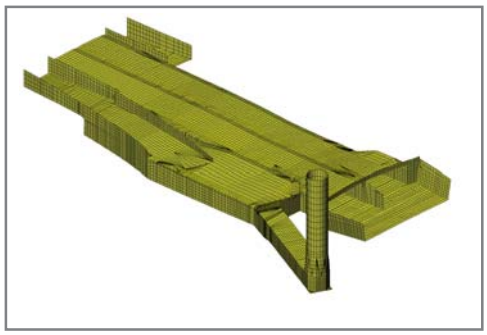
With LUSAS LPI, any user can automate the creation of complete structures, either in LUSAS or from third-party software, carrying out design checks, optimising members and outputting graphs, spreadsheets of results and custom reports. Because everything carried out by a user is recorded in a LUSAS Modeller session file, anything that LUSAS can do can also be controlled by another application via the LUSAS Programmable Interface. This means that you can view and edit a recorded session, parameterise those commands, turn them into sub-routines, add loops and other functions to the scripts and create a totally different application or program - using the proven core technology of LUSAS.

Languages supported
By using any ActiveX compliant scripting language, such as VB.Net, C#, VBScript, C++, Python, Perl, JScript etc. to access LUSAS facilities and functionality, you can:

- Create user-defined menu items, dialogs and toolbars
- Interrogate all aspects of a LUSAS model
- Customise modelling operations
- Create parameterised models
- Automate repetitive tasks
- Import CAD geometry and properties
- Make direct links to Microsoft Word / Excel, or other programs for import or export of data
- Perform simple / codified design checks, and when used with automated iterative analysis, optimise structural member sizes and configurations, slab reinforcement quantities, etc.

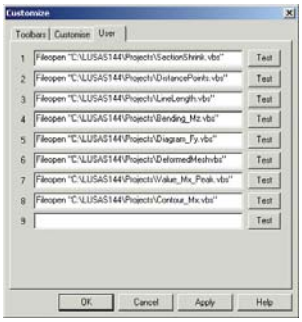


Use the LUSAS Programmable Interface to:
- Customise and automate Modeller operations
- Transfer data between LUSAS and other programs
- Control other programs from LUSAS, and control LUSAS from other programs

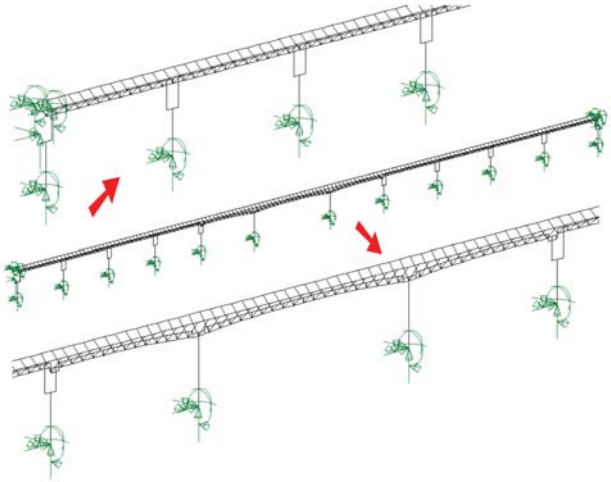


LUSAS Script files

In their simplest form script files are used to store a sequence of LUSAS commands for later playback. Some examples of use include the creation of start-up templates to pre-load the Attributes Treeview of the LUSAS Modeller user interface with selected attributes for a particular analysis; the setting of default mesh or material types, or preferred colour schemes; or defining specific model orientations for use when saving model views for use in reports.

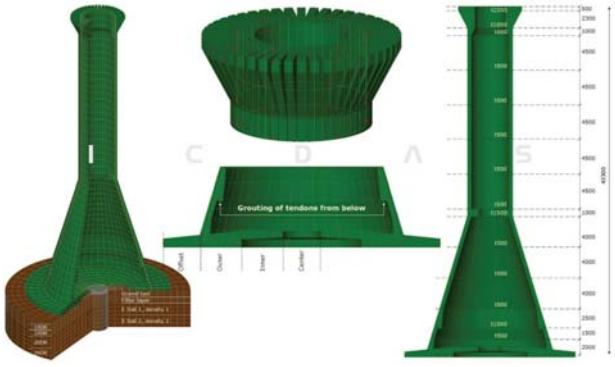


When LUSAS is run, a session file is created recording each step of the model generation in Visual Basic Script (.VBS) - one of the most commonly used and easily understood languages. Editing of a session file can be used to define a similar model with new parameters. When the script is re-run in LUSAS, a new user-defined model can be easily and rapidly generated from the parameters defined. A Macro Recorder facility in LUSAS also provides the means to record a sub-set of commands for a task, for saving and re-use. User-generated scripts can be controlled by creating dialogs that may include parametric variables, check boxes, drop-downs etc.



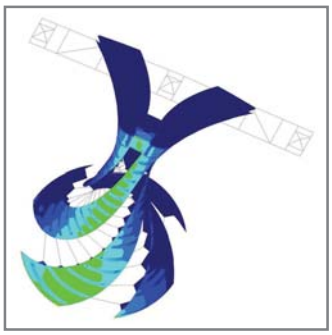
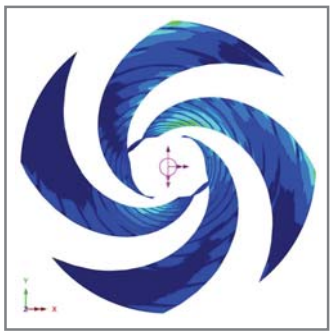
Varied uses of scripts include reading of geometric data, such as column dimensions, section properties and span lengths / storey heights etc., from a spreadsheet to automatically build multi-span bridge or building models; rapid generation of parametrically-idealised wind farm base structures, or for automating the creation of numerous load combinations and envelopes; and for slicing through a model to create results for multiple loadcases, which can be automatically plotted on graphs and in reports.

A set of example scripts are provided in LUSAS to assist in the understanding of standard concepts including file handling, how to access LUSAS geometry / attribute data, and how to import / export data from / to Microsoft Word or Excel, or other programs.



Visual Basic, as well as JScript, Python and Perl are known as interpreted languages - meaning that there is no need for compilers to be used.



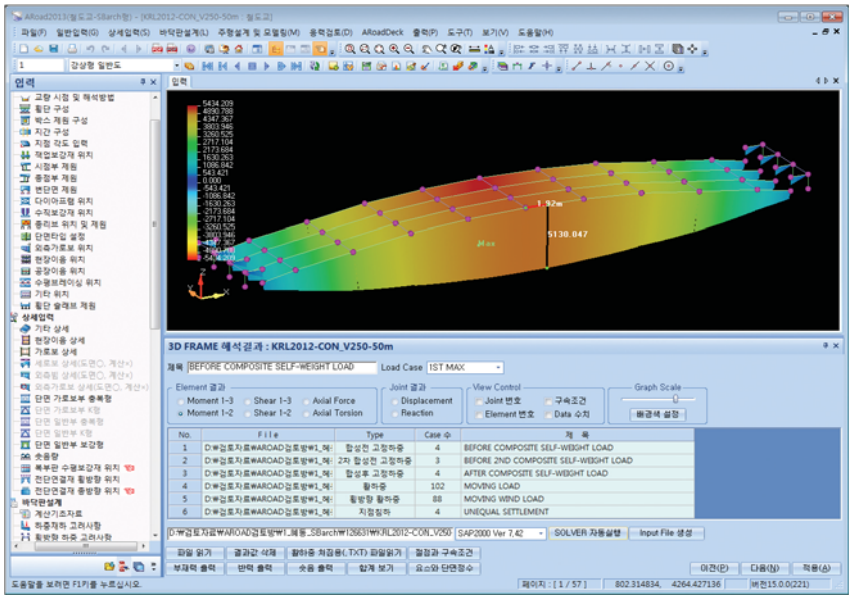



Component Technology

The LUSAS Programmable Interface allows interfacing with other compatible Windows programs through a Component Object Model (COM) interface. This defines a set of rules by which two programs can communicate and allows controlling those programs as if they were part of LUSAS Modeller. LUSAS can also be used as a component of another system (running transparently if required) providing modelling capabilities, analysis solutions and results viewing and processing options for that application.

Examples include controlling external programs for inputting data into LUSAS, such as importing CAD geometry and properties for data sharing, as well as for exporting data for post-processing uses, such as exporting results into cells in a spreadsheet for additional calculations to be carried out. Typical uses of LUSAS as a component of another system include using LUSAS as a part of an automated BIM design system to allow customised design checks to be made within LUSAS before saving selected model / results data in a BIM platform, such as REVIT or Bentley.

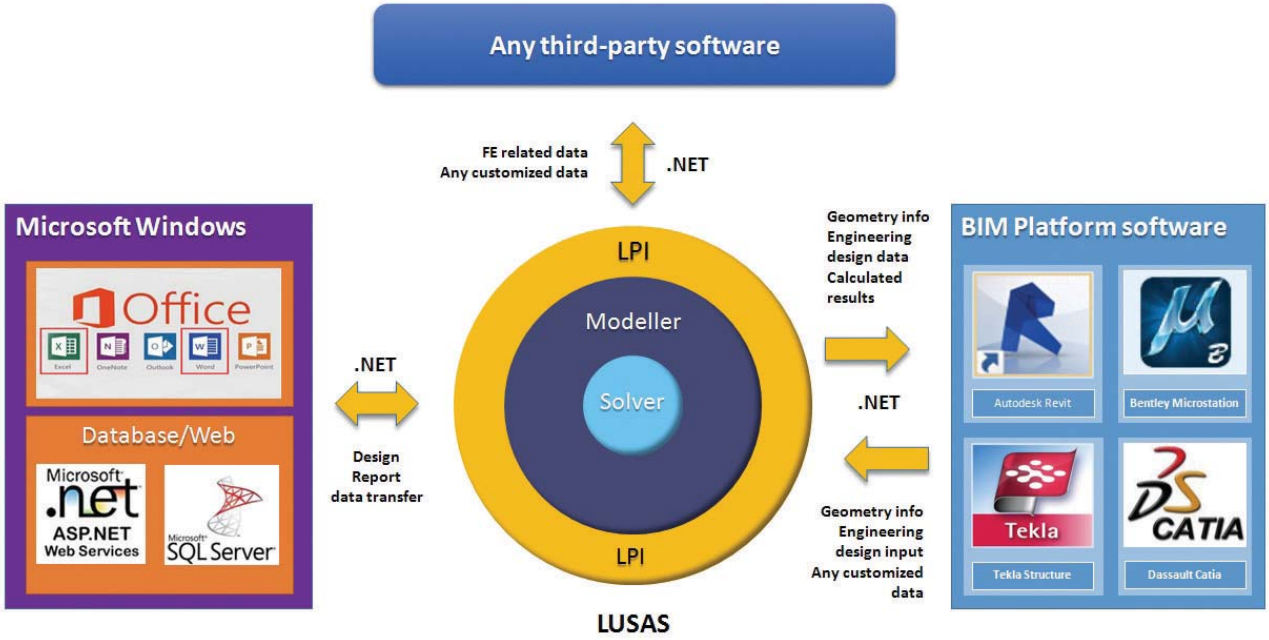
This more advanced customisation and use of LUSAS can make use of VB.NET, which (along with C# and C++ languages) requires compiling before use. However, the main benefit of using these languages over interpreted languages, such as VB Scripting, is that they are more powerful and provide standard plug-ins, controls and libraries of subroutines - avoiding the need to write them in-house.



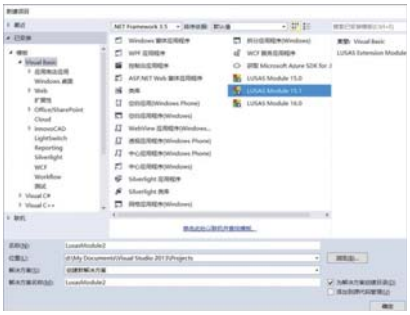
LUSAS being used to provide results for a third-party application.

Emirates Air Line (London Cable Car)

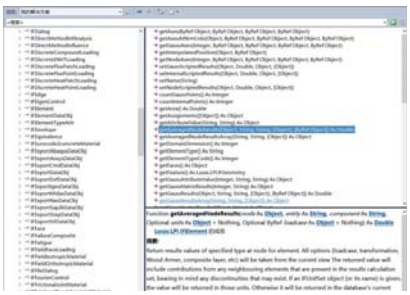
Programmable Interface Architecture



LUSAS provides a .NET project template (also known as a plug-in), which can be customised by users to 'interrogate' LUSAS Modeller. This allows the exchange of design report data with particular Microsoft applications; the exchange of geometry design and results data with BIM platform software; and exchange of FE related and any customised data with third-party software applications.

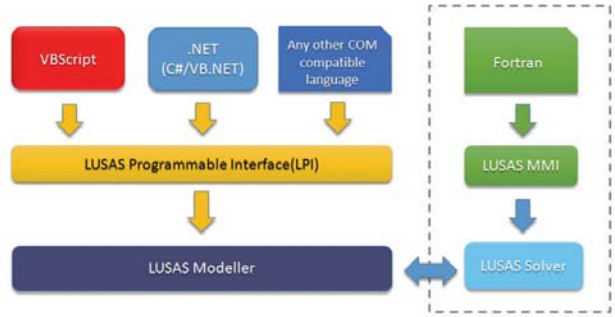


Overall, LUSAS provides a rich programmable interface, with hundreds of programming interfaces (each having associated subroutines) that provide an LPI user with total control over all aspects of a LUSAS model - and not just for the attribute and geometric data. As an example, it is possible to use the interfaces to query a model and extract element results, perform design code-related calculations, and then either export those results into a spreadsheet format, or to make them available within LUSAS Modeller to enable contouring of those results using standard results processing and viewing facilities.

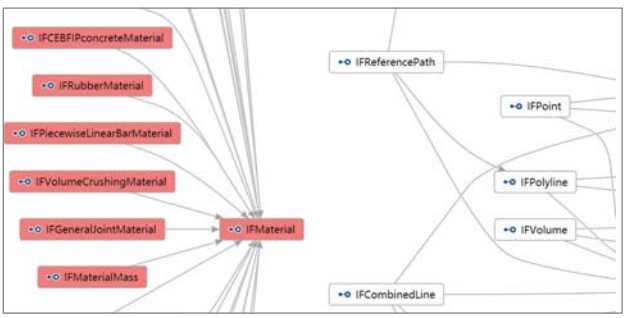


LUSAS Material Model Interface

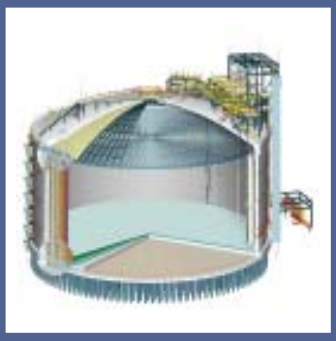
In addition to the accessing and customising LUSAS Modeller via the LUSAS Programmable Interface, user-defined material models (written in Fortran) can be compiled and built into a customised LUSAS Solver executable by using the LUSAS Material Model Interface (LUSAS MMI).

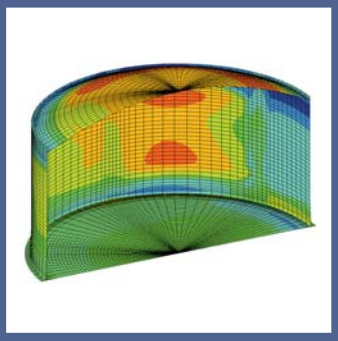


Schematic of LPI and LUSAS Material Model Interface



LPI is Object Oriented

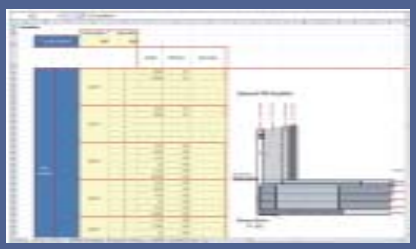




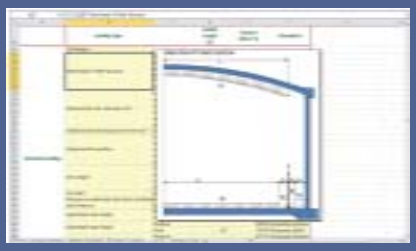
Case study: Automated LNG tank analysis

FEA Korea used VB.NET to create an LNG software wizard, which helps automate the modelling and analysis of above ground full containment Liquified Natural Gas tanks. These tanks are typically comprised of a nickel steel inner tank sitting on an insulated concrete base slab supported by small diameter piles at close centres, and have a post-tensioned concrete outer wall.

A spreadsheet with separate worksheets is used to enter structural dimensions for base slab, wall, and ring beams, details of corner protection, and insulation lengths and thicknesses. Material properties, boundary conditions and structural, thermal loading, and prestress loadings are also defined.

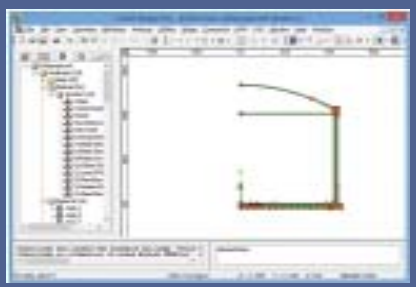


The LNG Wizard creates fully meshed 2D axisymmetric models with individual model features grouped and named according to type. Loadings and defined support conditions are also automatically assigned to the appropriate regions of the model.



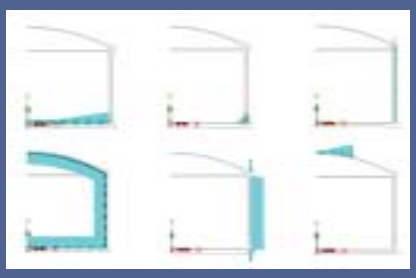
For LNG tank design numerous finite element analyses are carried out including:

- Static analysis
- Wind loading
- Modal and seismic analysis
- Temperature modelling
- Leakage modelling
- Prestress / post-tensioning
- Burn-out modelling
- Relief valve heat flux modelling
- Soil-structure interaction

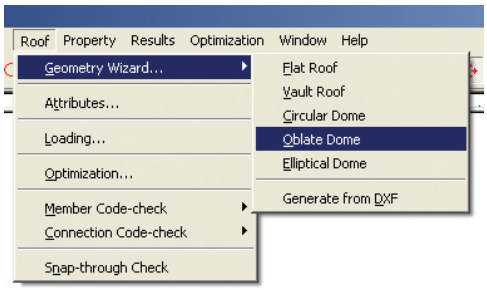


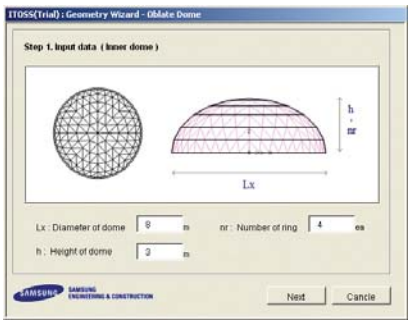
For static analysis, numerous static linear analysis loadcases are defined for various parts of the structure with the roof, the walls, the base slab etc being loaded independently. Load combinations then allow the effects of the multiple loadcases to be assessed.

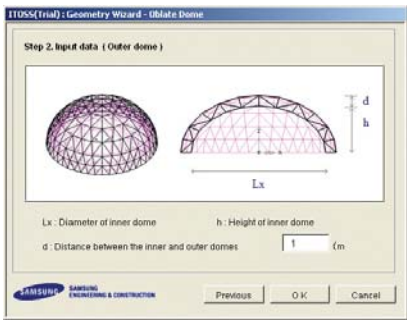
For thermal modelling, a semi-coupled steady state thermal analyses of LNG tank outer walls with insulation is performed. For this, an initial stress-free temperature is applied to all elements, and combinations of environmental conditions are considered for both the air and base temperatures.



Leakage modelling investigates the effect of LNG spillage from the inner steel tank onto the Polyurethane Foam (PUF) insulation on the inside of the outer concrete tank at different heights. For this, the tank insulation is assumed to have been completely destroyed up to each level of the LNG under consideration. 2D axisymmetric solid field and continuum elements model the tank outer walls and insulation down to the top of each leakage level. A semi-coupled steady state thermal analysis is carried out to assess the effects of the leakage.

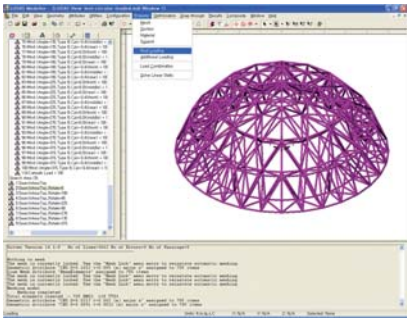




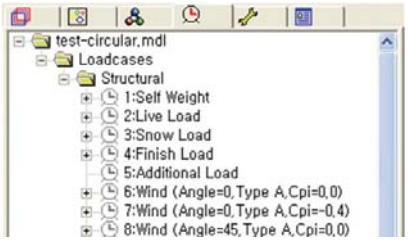


Case study: Optimised steel dome modelling

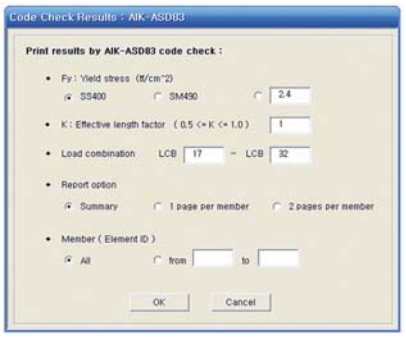
FEA Korea wrote VB scripts to automatically model and optimise the members in a chosen steelwork dome arrangement on behalf of its client, Samsung Engineering and Construction. Roof types supported by the software wizard included a flat truss roof, a vaulted roof, and also circular, oblate, and elliptical domes.

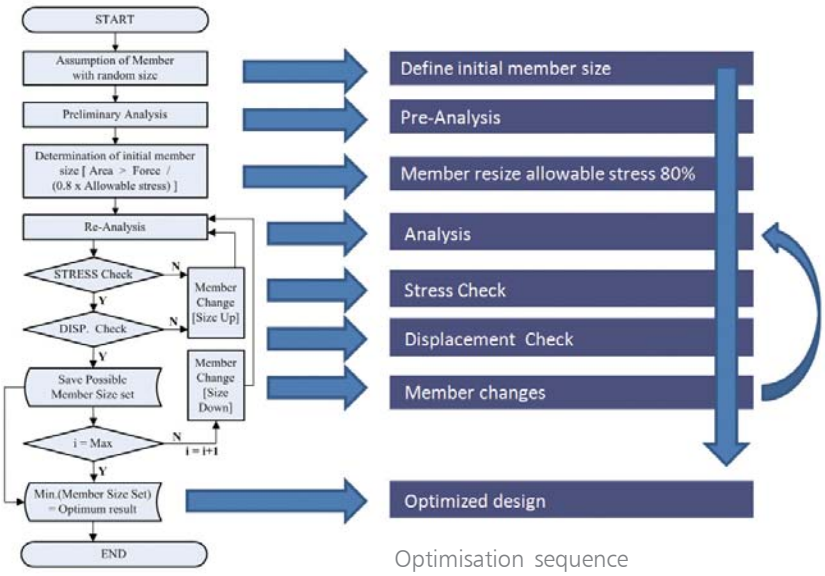


Span lengths and dimensional data are user-defined for a chosen roof type. A preliminary LUSAS analysis is used to assign initial section properties for each member based upon a specified initial stress ratio. Optimisation target parameters are then defined. From user-defined values, loadings appropriate to the chosen design code are created and applied automatically to the relevant parts of the model. A stress check and a displacement check then take place to see if member sizes need to be increased from their initial sizes, prior to saving the resulting member sizes as a possible set for use. An iterative procedure than checks to see if any members can be reduced in size before saving a set of minimum member sizes as an optimum result.

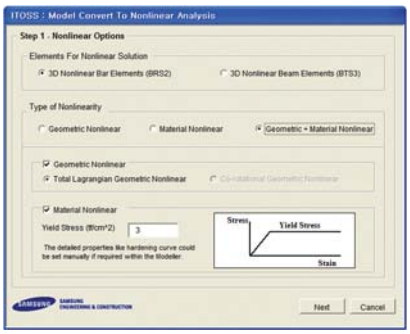


For serviceability checks a model is automatically converted into one with elements suitable for either an eigen buckling analysis where buckling checks can be carried out for distributed, concentrated or user-defined loadings, or for one suitable for either a material, geometric, or material and geometric nonlinear analysis. Graphs, diagram plots, and reporting can be output for code-checked results, deflections, connections and many other results quantities.





Optimisation sequence



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..

Used Globally

Used by thousands globally, 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, as well as government agencies, local authorities and smaller to medium-size consultants.

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.

Find out more

Clients worldwide are benefiting from the commercial advantage that using LUSAS gives them and testimonials on their use of the software speak for themselves. A range of LUSAS product brochures, detailed information sheets on key features and analysis capabilities, and case study sheets on real-life uses of the software are available. Please contact LUSAS for more details.

LUSAS

Issue 1.

LUSAS, Forge House, 66 High Street, Kingston upon Thames, Surrey, KT1 1HN, UK
Tel: +44 (0)20 8541 1999 | Fax: +44 (0)20 8549 9399 | Email: info@lusas.com | www.lusas.com