

EXTREME^{3.1} LOADING[®]

F O R S T R U C T U R E S

**The Practicing Engineer's Solution for
Advanced Nonlinear Dynamic Analysis**

www.extremeloading.com



About Extreme Loading for Structures

ASI's Extreme Loading® for Structures (ELS) is the first advanced nonlinear structural analysis tool to be designed specifically for practicing engineers. Most of the features found in ELS have been developed based on requests by engineers with real projects. ELS delivers high-end structural analysis found only in "scientific" software tools in an efficient engineer-friendly package.

Advanced Structural Analysis

ELS improves the way structural engineers perform structural analysis. This is because ELS is the first structural analysis tool for engineers that can follow the complete material behavior from the elastic to plastic stages including: cracking, large displacements, complete element separation and collapse. It will also simulate the effects of falling debris.

New in Version 3.1

This new version of Extreme Loading® for Structures reinforces the fact that ELS is a practical easy-to-use software program created for practicing engineers who have complex projects with non-traditional load cases. The majority of features provided in version 3.1 are advanced input methods proposed by software users who wanted additional tools to help them create and solve more complex models. Additional features have been added to provide ease-of-use and versatility for everyday projects.

Modeling Features

The Extreme Loading® for Structures 3.1 Modeler follows an intuitive process of modeling that allows users to quickly and easily create structures in both 2-D and 3-D modes for with:

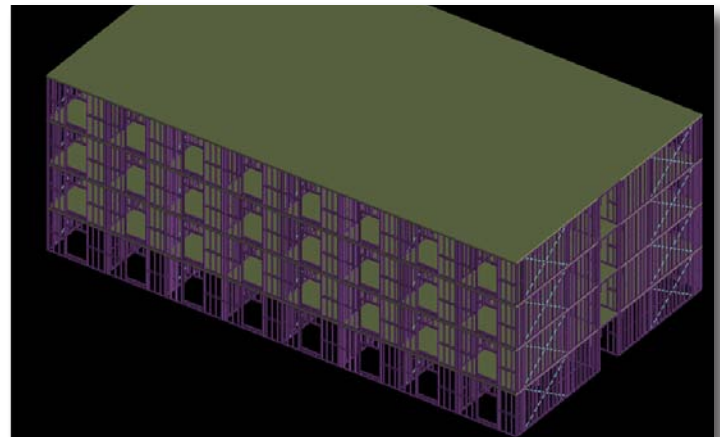
- **Full 3-D Modeling:** build and modify your models in a 3-D environment. All commands are now enabled to work in any view.
- **Active Planes:** specify active planes to simplify creating 3-D models.
- **Enhanced Window Options:** create multiple windows with cascade and tile options or dynamically view your model using snippet view.
- **Enhanced Show/Hide:** select, show, and hide objects using multiple filtering criteria.
- **Pick Command:** specify the coordinates of any point you need by simply selecting it using the pick command available in all dialog boxes.
- **ELS Import/Export:** allow users to import and export all or part of an ELS model from one ELS file to another.
- **Import 3-D Meshes:** save time wasted on creating complex models by importing meshes and input data from industry standard tools. Data exchange options include:
 - Import structural components from Autodesk® Revit® Structure (2008, 2009 & 2010)** and Bentley® MicroStation(*.dgn)

- 10 Commercial FEM software programs:

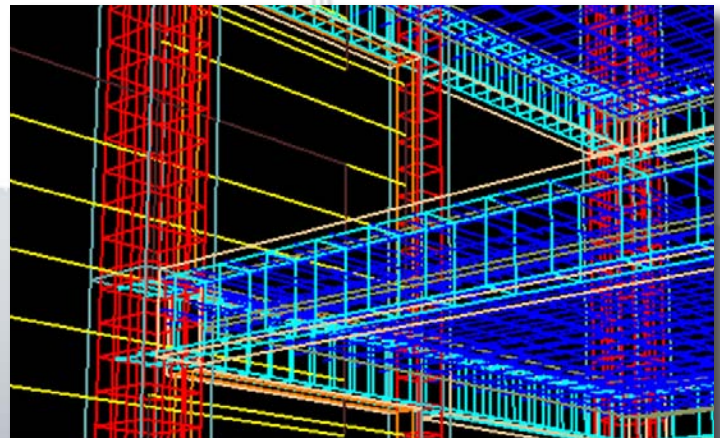
• Abaqus	• I-DEAS	• SAP 2000
• ANSYS	• LS-Dyna	• STAAD
• ETABS	• NASTRAN	• Patran
• Gambit		

- Additional import file types include *.dxf & *.stl
- Import reference attachments from *.jpg images or single frames of *.avi movies

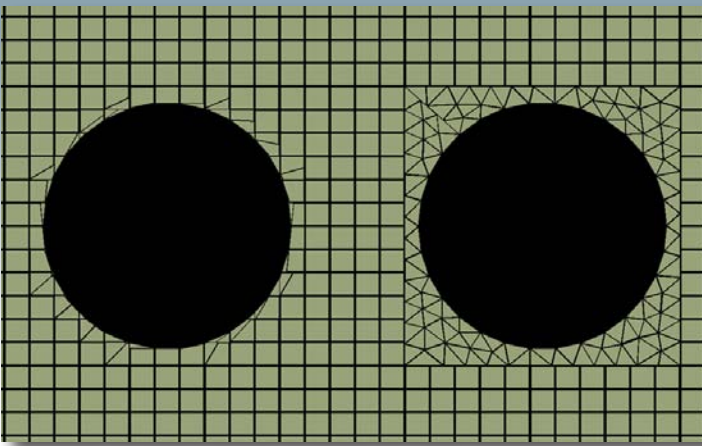
- **Pre-defined Styles (Building Component s):** saves time by allowing the user to edit standard building components rather than creating them from scratch.
 - AISC Steel Sections
 - Custom Built-up Steel Sections
 - Cold Formed Steel Sections***
 - Columns
 - Girders
 - Slabs
 - Walls
 - Windows
 - Reinforcement
- **Templates:** create models for trusses, towers, domes, and multi-story buildings with solid or flat slabs using built-in templates.
- **Custom reinforcement:** model custom reinforcement bars, variably spaced stirrups, and steel sections.
- **Built-up Steel Sections:** convert draft objects into steel sections.



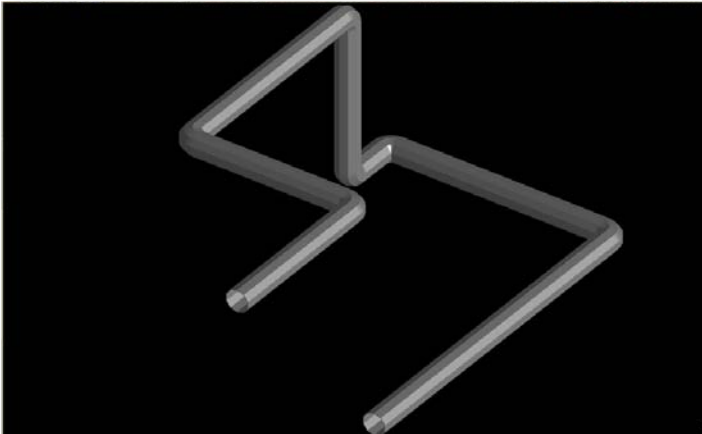
Cold Formed Steel Structure



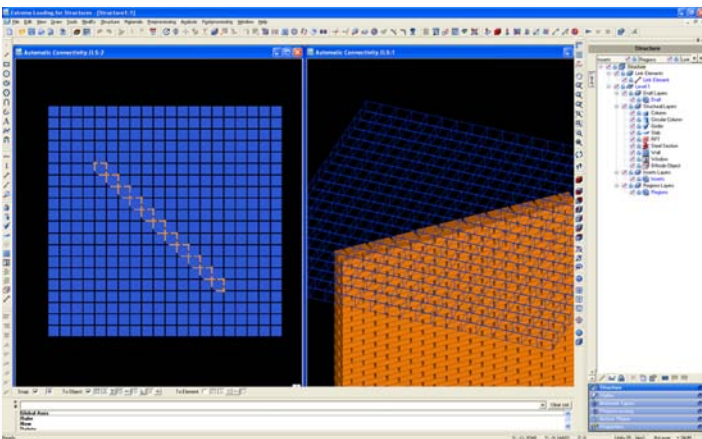
Custom Reinforcement



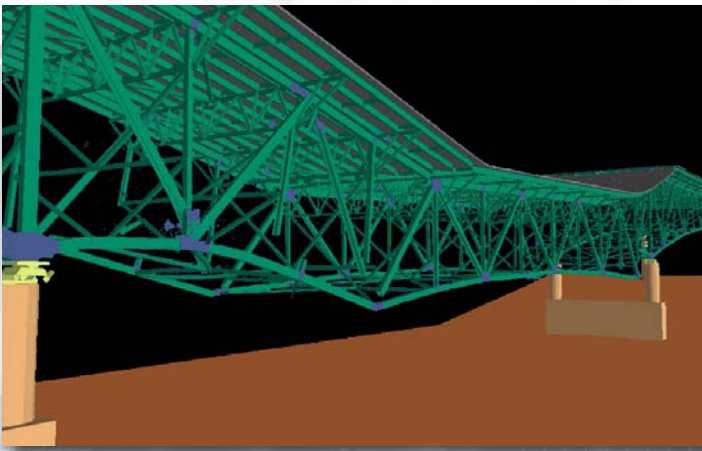
Slab w/ Hole: Before & After Re-meshing



Pipe Created with Follow-Me Option



No Re-Meshing Required for Connectivity



Irregular Ground Boundary - I-35 Minnesota Bridge

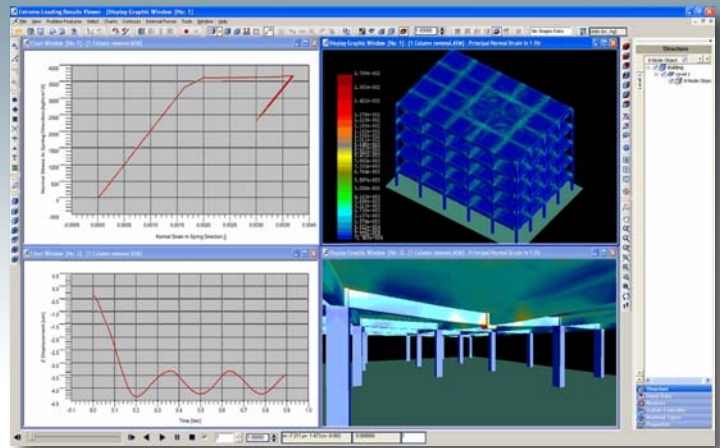
- **Extrusion & Revolution:** create objects using the extrusion or surface of revolution commands.
- **Re-meshing:** re-mesh element selections into square or voronoi (triangle) shaped elements to enhance and optimize element size and shape.
- **Pre-stressing:** apply pre-stressing in concrete and link elements.
- **Cracks & Hole Tool:** pre-define existing cracks or holes in structural components.
- **Follow-me Option:** simply create hollow tubes and pipes using drafting lines and selecting mesh properties.
- **Command Line Settings:** define custom command line shortcuts.
- **Copy Format:** copy structural objects with assigned loads and boundary conditions.
- **Multiple Level Array:** generate multiple copies of levels.
- **Snap Options:** helps you build your model quickly and accurately.
- **Smart recognition of lines and shapes into structural components:** helps the user convert lines and shapes either imported or drawn into the modeling window to three-dimensional structural components.
- **Automatic mesh adjustment & connectivity between elements:** element connectivity is generated automatically by the program without user-intervention. This saves precious time typically lost due to complex connectivity issues.
- **Automatic formation of plastic hinges during both static and dynamic loading:** the user is not required to make assumptions about which areas are prone to failure as this is determined automatically by the program. This saves time typically lost during trial and error processes.

Loading Features

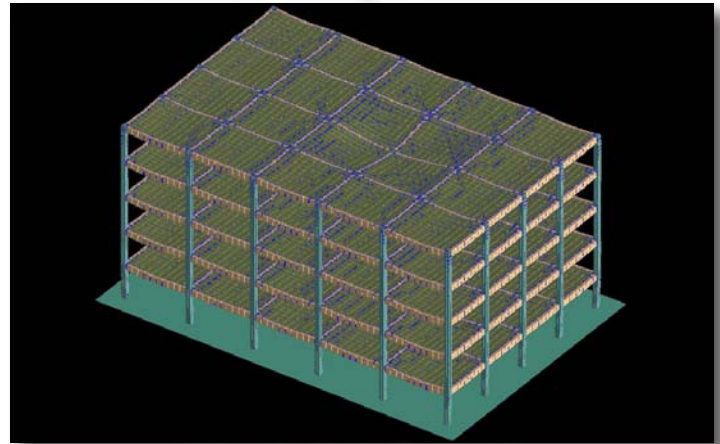
Various loading scenarios can be implemented in The Extreme Loading® for Structures 3.1 utilizing its multi-stage sequential loading:

- **Static Loading:** apply concentrated, uniform pressure, displacement, moving, and hydrostatic pressure loads.
- **Dynamic Loading:** apply concentrated uniform pressure, displacement, moving, seismic, blast, impact, and hydrostatic pressure loads.
- **Staged construction and deconstruction:** add or remove structural components during analysis.
- **Initial velocity and acceleration:** apply velocity and/or acceleration to elements or structural component.
- **Corrosion Loading:** consider the effects of corrosion on all types of objects and materials to determine the failure capacity of corroded structures as well as failure capacity after retrofitting.
- **Irregular Boundaries:** creates irregular boundary conditions to model natural terrain as set by the user.
- **Rigid Body Regions:** easily apply rigid body constraints to any elements inside a specific region in

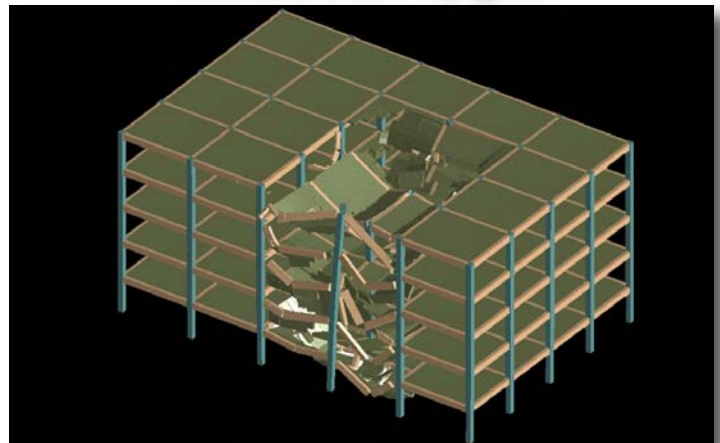
- space even if the elements are not yet created.
- **Spring Controller:** gives users control over the material properties of springs enclosed in any specified region.
- **Loading Regions:** apply loads to all elements enclosed in a specifically defined region.
- **Linear & Nonlinear Materials Models:** for concrete, steel, aluminum, brick, glass, tension only, and elastic
- **Material Regions:** edit the material of all elements enclosed in a certain region.
- **Kill Boundaries:** eliminates unwanted debris and decreases simulation time based on “killing” boundary conditions set by the user.
- **Physical Data Conflict Dialogue:** automatically detects conflicts in loads and boundary conditions, allowing the user to remove them.
- **Custom Run:** run the analysis for specific parts of the structure or the whole structure.
- **Automatic Backups:** automatically creates multiple backups of the results during analysis as set by the user. Analysis can be resumed from any of the backup files.
- **Solver Controller:** pause and resume analysis as well as adjust some features of the model during the analysis based on the output.



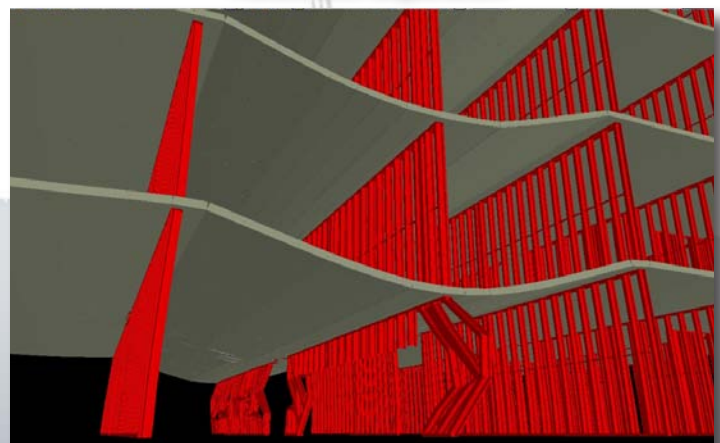
Automatic Yielding of Reinforcement



Automatic Crack Propagation



Automatic Separation



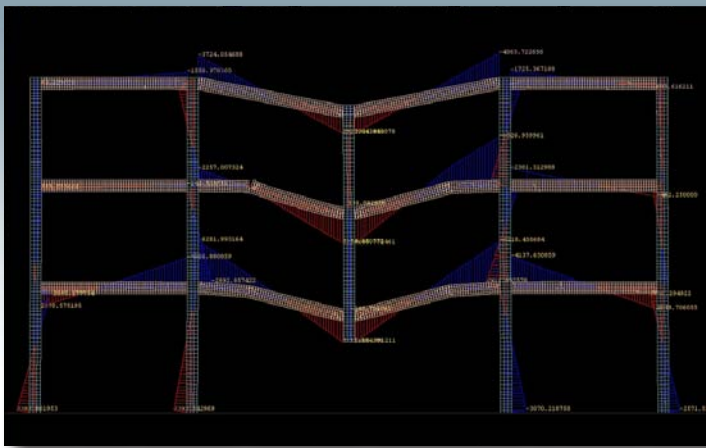
Automatic Membrane Action & P-Δ Effect

Analysis Features

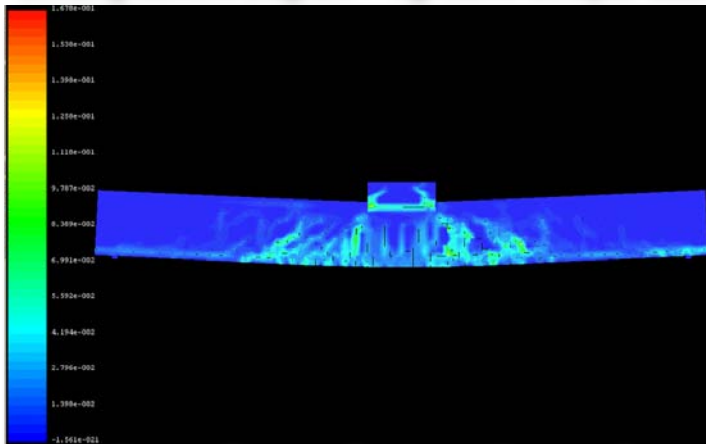
The Applied Element Method (AEM) based solver in Extreme Loading® for Structures 3.1 is a derivative of the Finite Element Method (FEM) and the Discrete Element Method (DEM). AEM is capable of performing both linear and nonlinear analysis that follows the behavior of structures through separation, collision and collapse while **automatically** taking into consideration:

- **Yielding of Reinforcement:** automatically calculates material strain from elastic to plastic deformation.
- **Plastic Hinge Formation:** automatically places plastic hinges.
- **Buckling and Post-buckling:** automatically calculates elastic and plastic bending under compressive loads.
- **Crack Propagation:** automatically calculates the location and propagation of cracks.
- **Membrane Action & P-Delta Effect(P-Δ):** automatically calculates the dynamic force and displacement caused by Membrane Action and the P-Delta Effect.
- **Separation of Elements:** automatically separates elements based on nonlinear material properties.
- **Collision and Collapse:** automatically calculates the collision and collapse of separated elements.

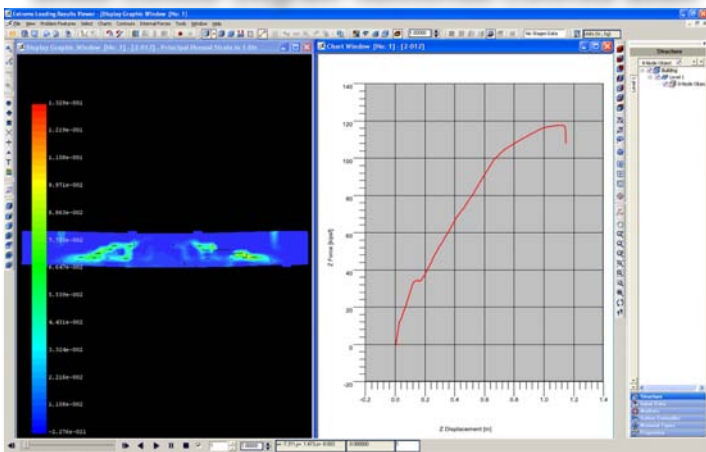
For Structural Engineers, this means assumptions typically required for analysis are eliminated. Defining plastic hinges is not necessary. Cracking, separation and collisions will occur automatically.



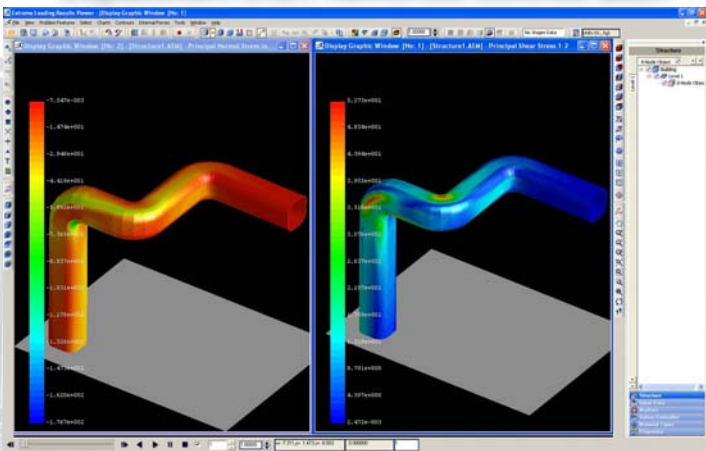
Bending Moment Diagram: Progressive Collapse Case



Stress Contour Diagram: Reinforced Concrete Beam



Displacement Chart: Reinforced Concrete Beam



Stress Contours: Seismic Analysis of Piping System

Output Viewer Features

The frame by frame Extreme Loading® for Structures: Results Viewer allows the user to view, analyze and export presentation materials from the following options:

- **Problem Features:** gives users several viewing options for interpreting results.
 - Velocity vectors
 - Contact points
 - Blast wave
 - Blast surfaces
 - Crack locations
- **Enhanced Display Controls:** allow users more control over output display and selection of elements, springs, sections, components, or levels.
- **Enhanced Filters:** display objects by material or component type.
- **Eigen modes:** view animated periods and frequencies for all mode shapes of the model.
- **Custom Internal Force Diagrams:** create animated internal force diagrams for components, levels, or the whole structure taking into consideration cracks, rebar, yielding and other phenomena that occur during loading.
 - Bending moment
 - Shear
 - Normal
 - Torsion
- **Contour Diagrams:** create animated stress, strain, and kinematics contour diagrams for components, levels, or the whole structure filtered by the component type or material type.
- **Charts:** allow users more control over all aspects of charts and the ability to animate charts to follow the steps of the analysis.
 - Load
 - Displacement
 - Stress
 - Strain
 - Time
 - Velocity
 - Acceleration
- **Movie Generation:** add text and markers to *.avi and *.bmp.

Minimum System Requirements:

Microsoft® Windows 2000 Professional SP4
 Intel® Pentium® III or higher
 512 MB RAM
 Hardware-Accelerated OpenGL® graphics card
 150 MB of hard disk space

Recommended System Requirements:

Microsoft® Windows XP, Vista, or 7
 Core 2 Quad processor
 4 GB RAM
 Hardware-Accelerated OpenGL® graphics card
 80 GB of hard disk space

Updated Samples

Samples are problems solved using ELS that discuss static, dynamic, blast, and progressive collapse cases. Most cases document a comparison of analysis performed using ELS with experimental results or analytical solution using other analysis methods or tools. Documentation and an ELS file are available explaining each case. You can use the ELS file to run the sample and view its output.

Updated Tutorials

Included with ELS are more than 20 video tutorials that take users through all of the steps required to create and analyze various models and analysis cases. These video tutorials are updated and added to on a regular basis and as new features are added.

ELS User Portal

From the new ELS User Portal, Licensed ELS Users have 24-7 access to Software Updates, Tutorials, Quick Start Guide, Modeler Manual, Viewer Manual, Theoretical Manual, Technical Reference Manual and Marketing Materials.

Additional Information or Purchase

For more information or a quote for Extreme Loading® for Structures software visit <http://www.extremeloading.com/RequestAQuote.aspx> or call us at 1-919-645-2090.

ELS Certified Training

In addition to the startup materials that come with each license of Extreme Loading® for Structures Software (ELS), users will benefit from completing the Extreme Loading® for Structures Certification program. Training modules include:

- Structural Vulnerability Assessment
- Blast Analysis
- Progressive Collapse Analysis
- Seismic Analysis
- Forensic Engineering
- Performance Based Design

For more information on pricing and the availability of ELS Certified Training visit www.extremeloading.com/Training.aspx

Project Support

ASI offers ELS users various levels of project support. From modeling assistance to running a model to full project consultation services. Fill out the Request a Quote Form at <http://www.extremeloading.com/RequestAQuote.aspx> for more information.

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