SE2382: Autodesk® Simulation Mechanical for the Construction Industry

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Simulation Evangelist

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Class Summary

- During this class, you will learn the how Autodesk Simulation Mechanical software can be used for construction industry applications. Autodesk Simulation Mechanical will be used to create a global model with fine local details, such as a bolted connection in a steel structure. We will also cover critical effects such as pre-stress of bolts, contact between parts, plastic deformation, and dynamic behavior that captures real behavior. Additional common applications such as erection construction, optimization and fatigue will also be explored.

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Learning Objectives

At the end of this class, you will be able to:

- Get an insight into the structural performance of an assembly
- Study the effect of pre-stressed bolts on your assemblies
- Simulate structure failures to understand why they failed
- Set up a global model with critical local detail
- Understand how to setup an fabrication construction
- Run design optimization and fatigue analyses

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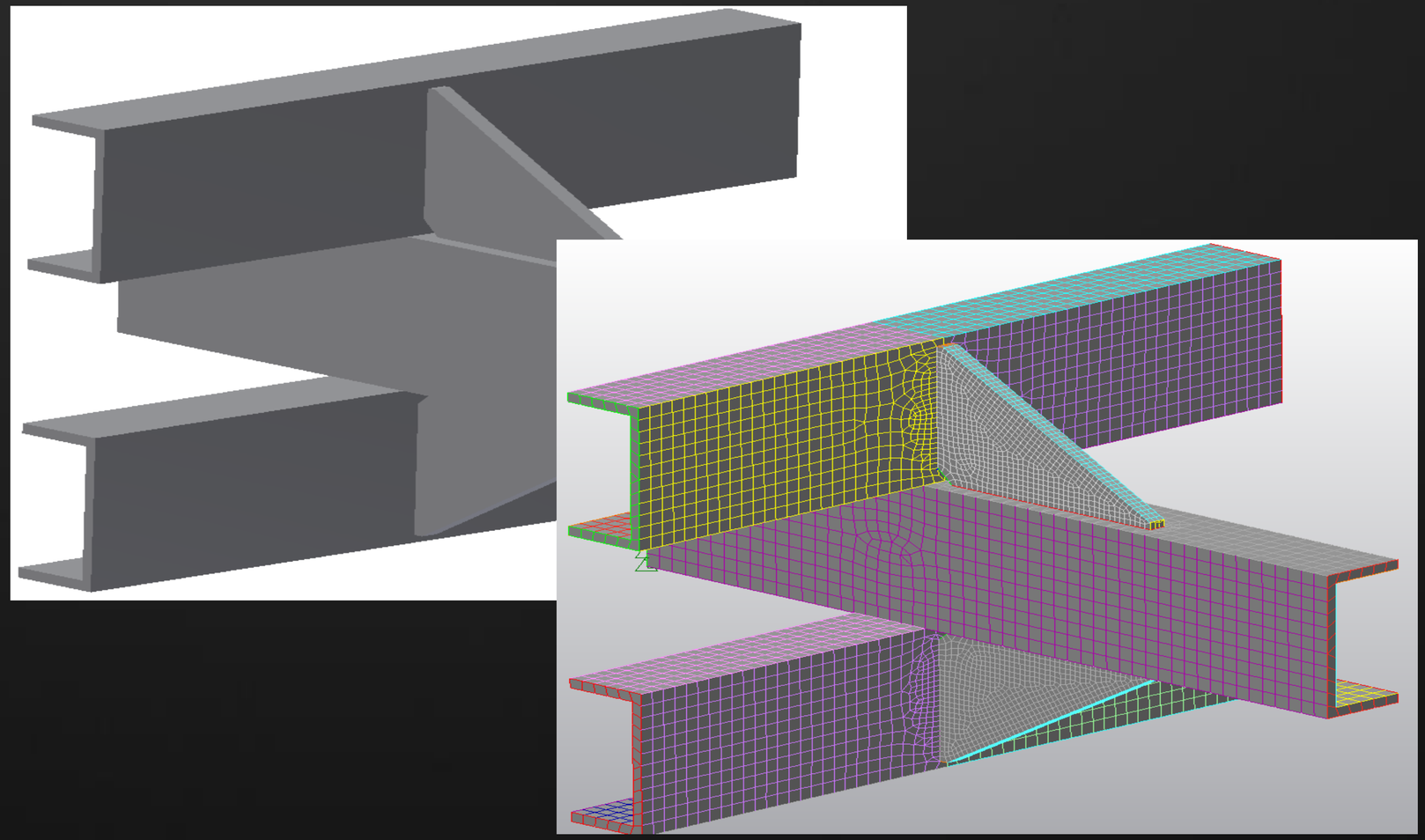
Hexa-Dominent Solid Mesher

Solid Meshing Options:

- Bricks and Tetrahedra
- All Tetrahedra
- Tetrahedra and wedges
- Bricks and wedges



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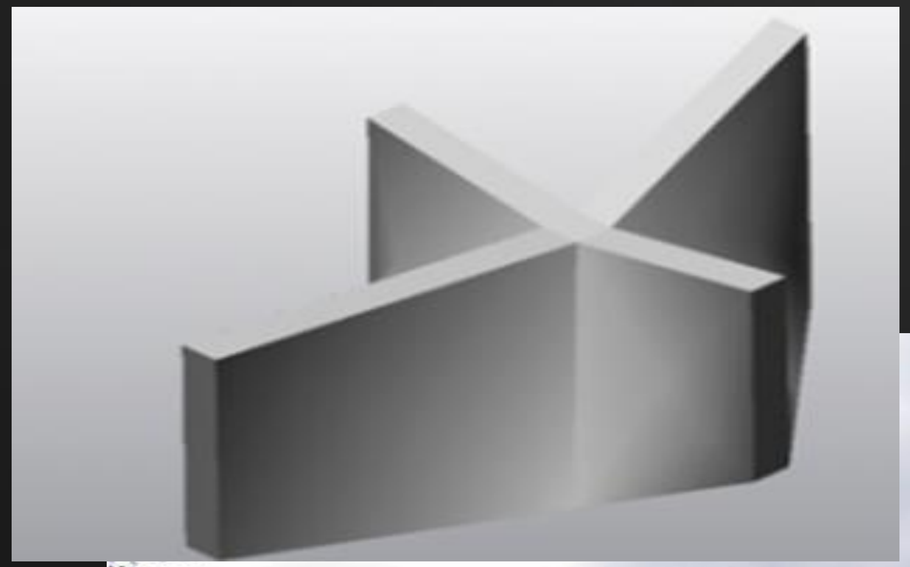
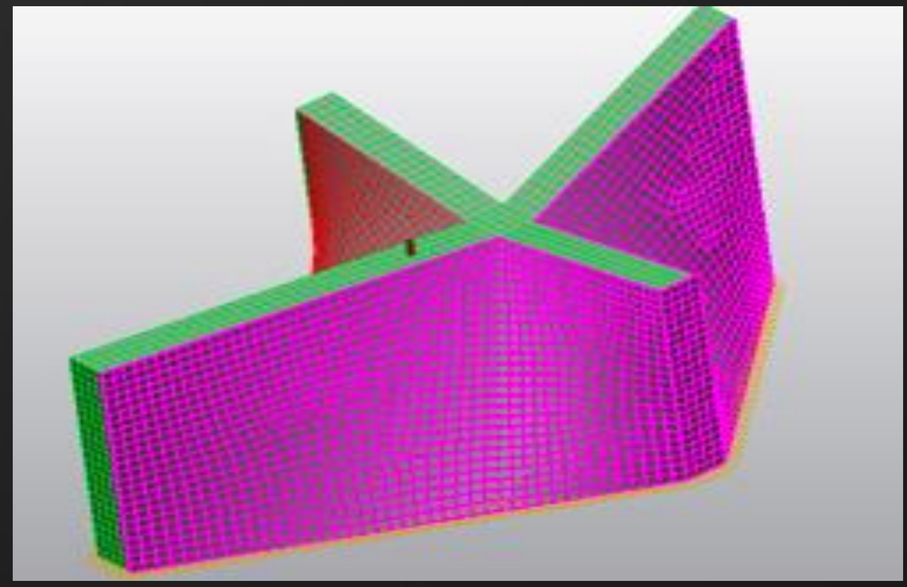
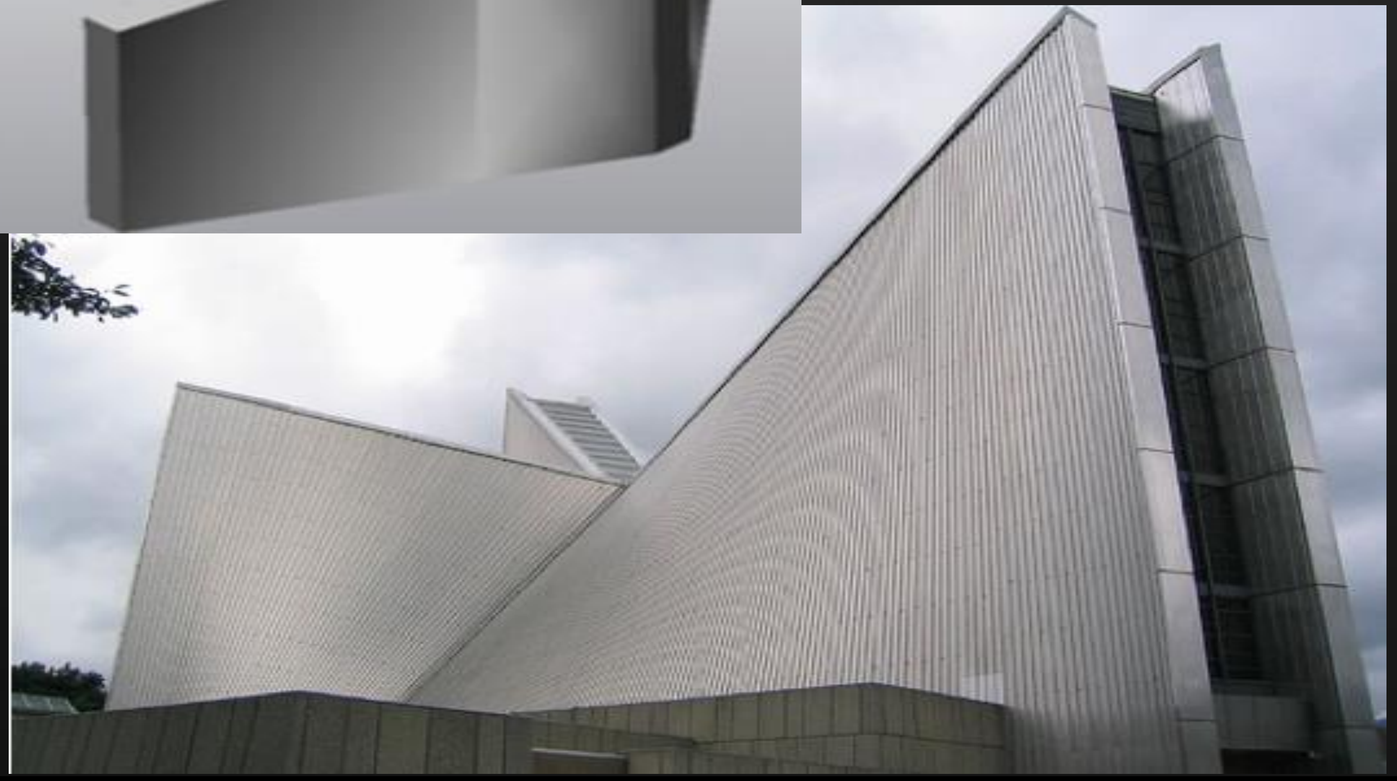
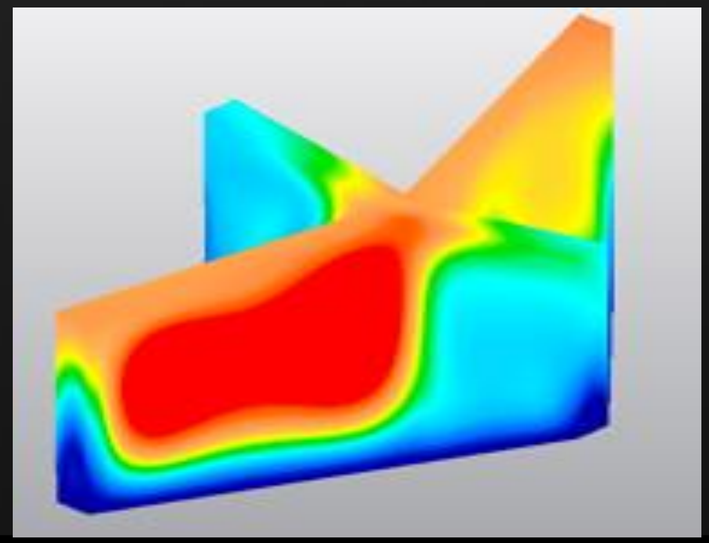
Powerful Shell and Solid Mesher









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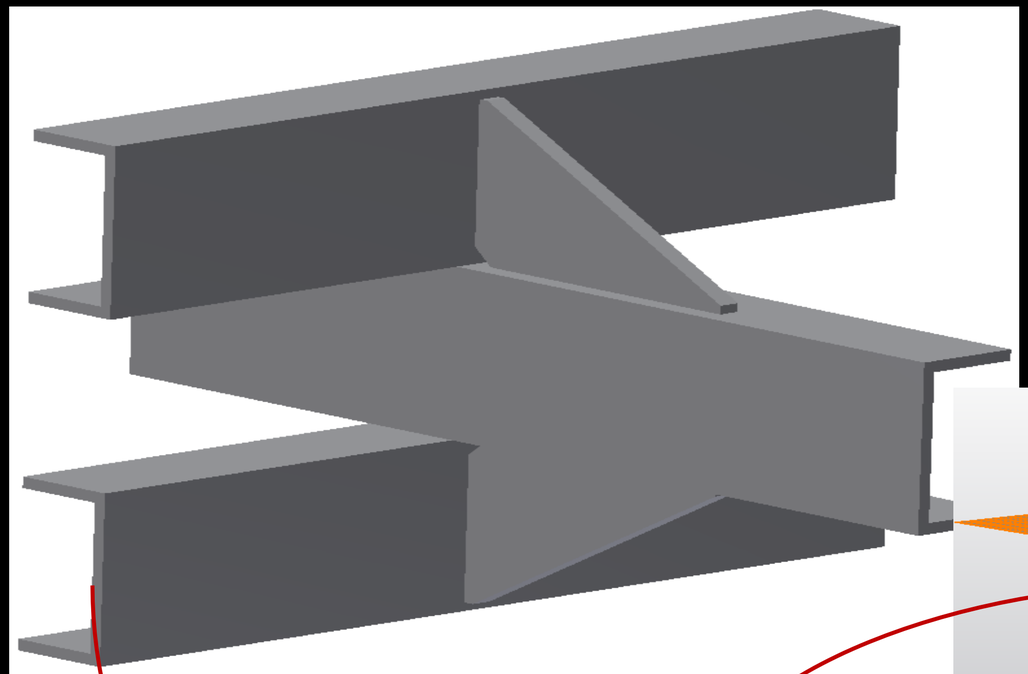
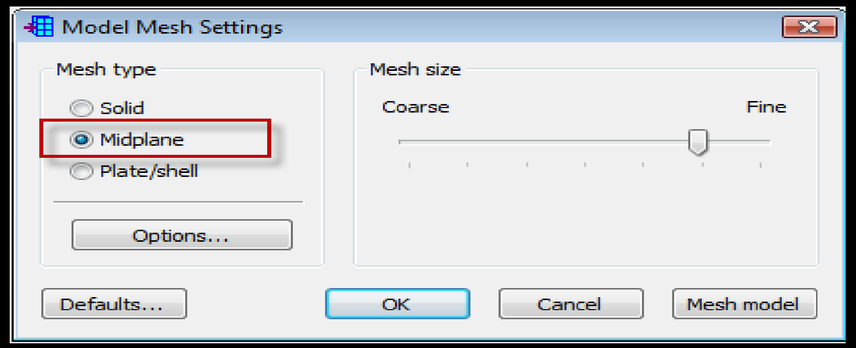
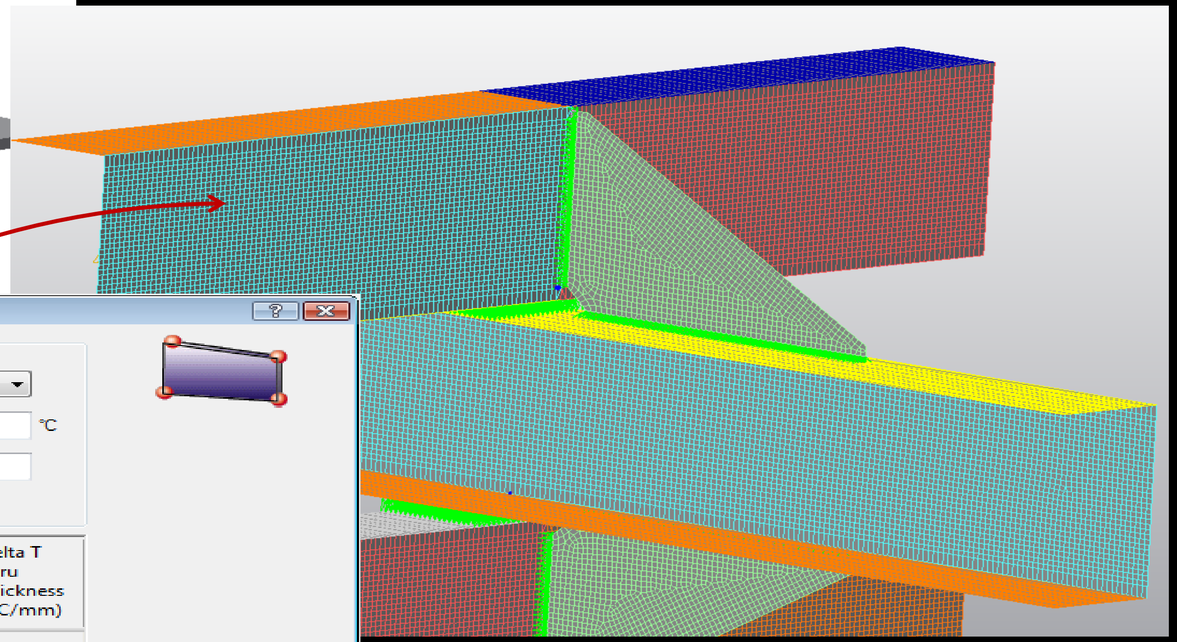
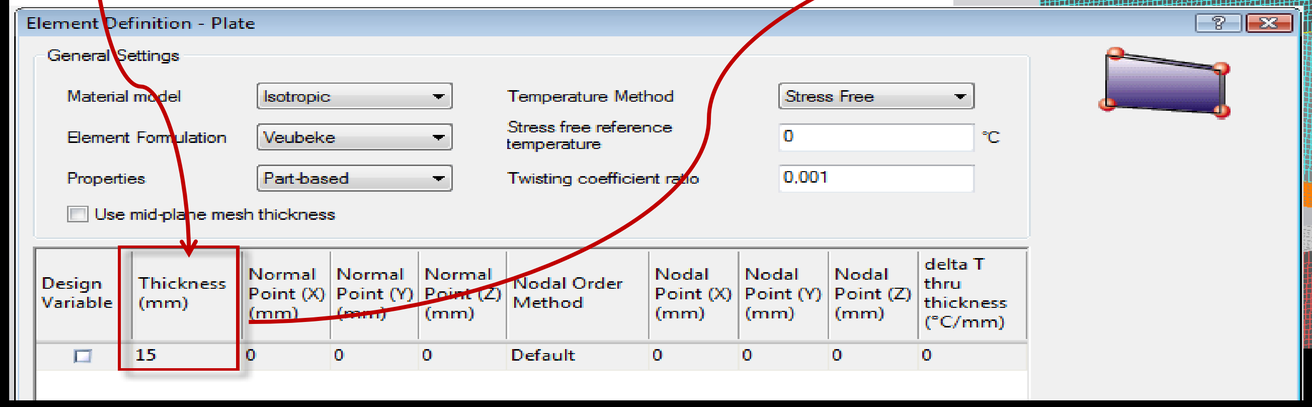
Automatic Shell Meshing for Thin Solids









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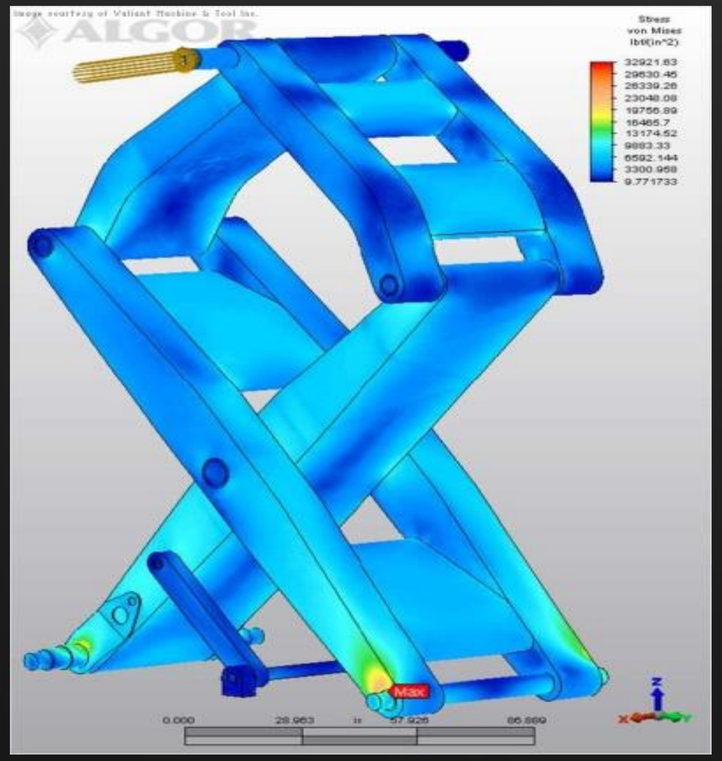
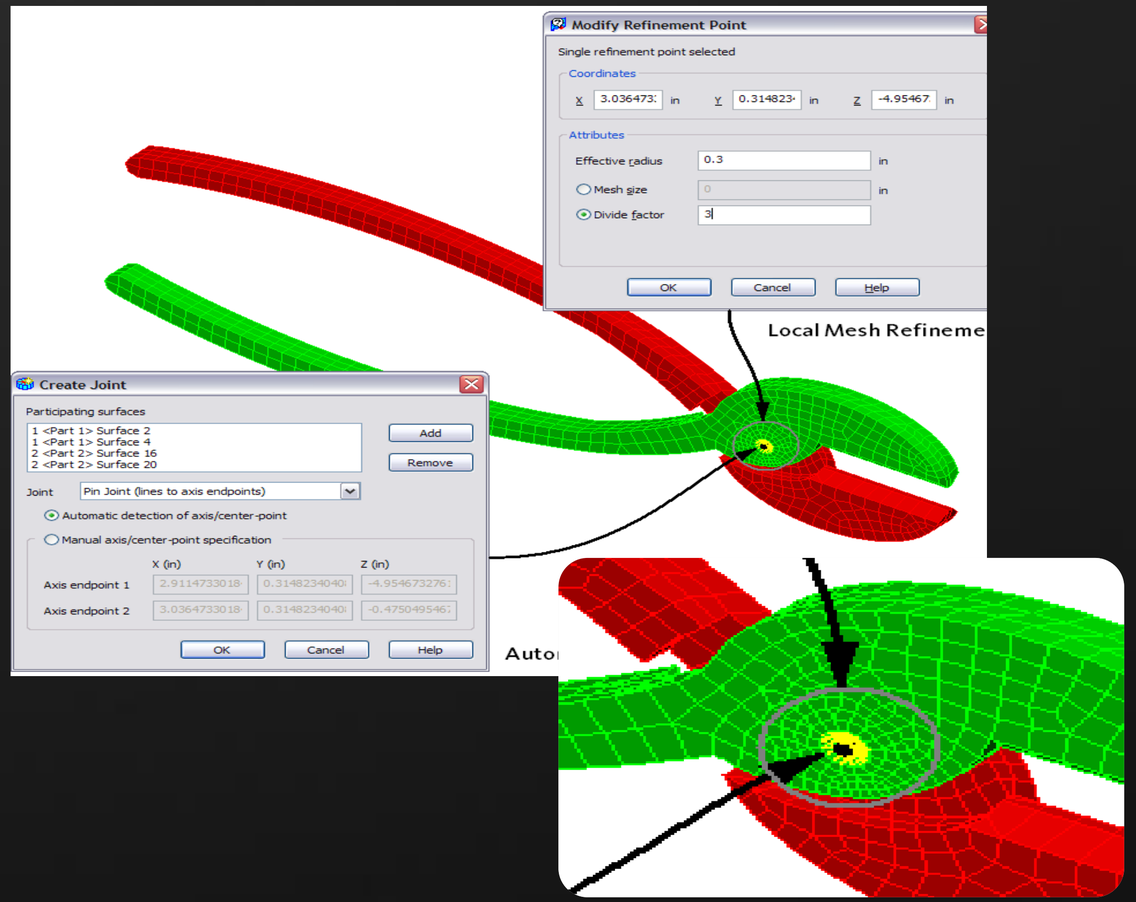
Wizard for Joints Representation

Two Types of Joints:

- Pin Joint
- Universal Joint





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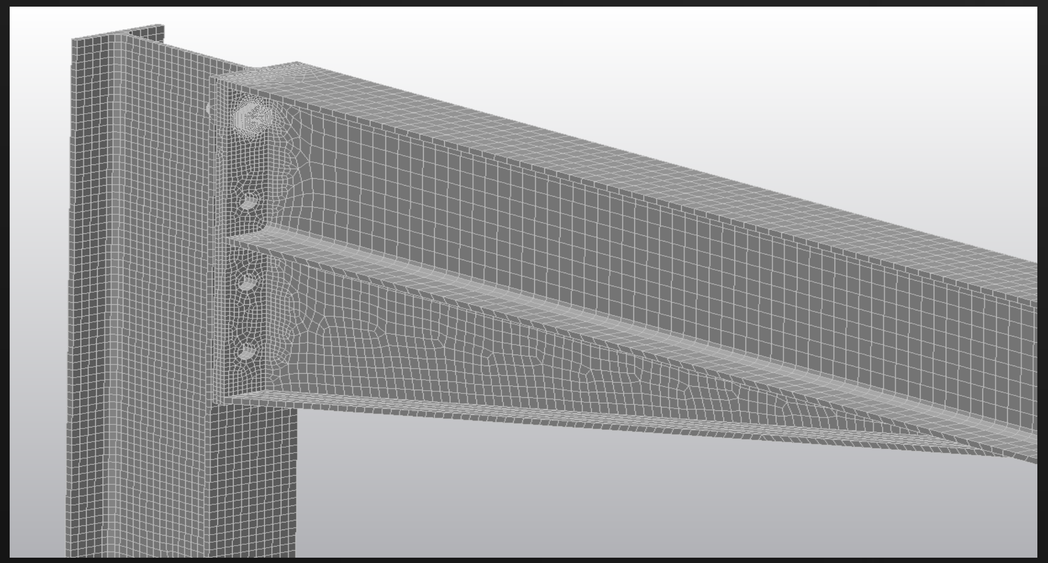
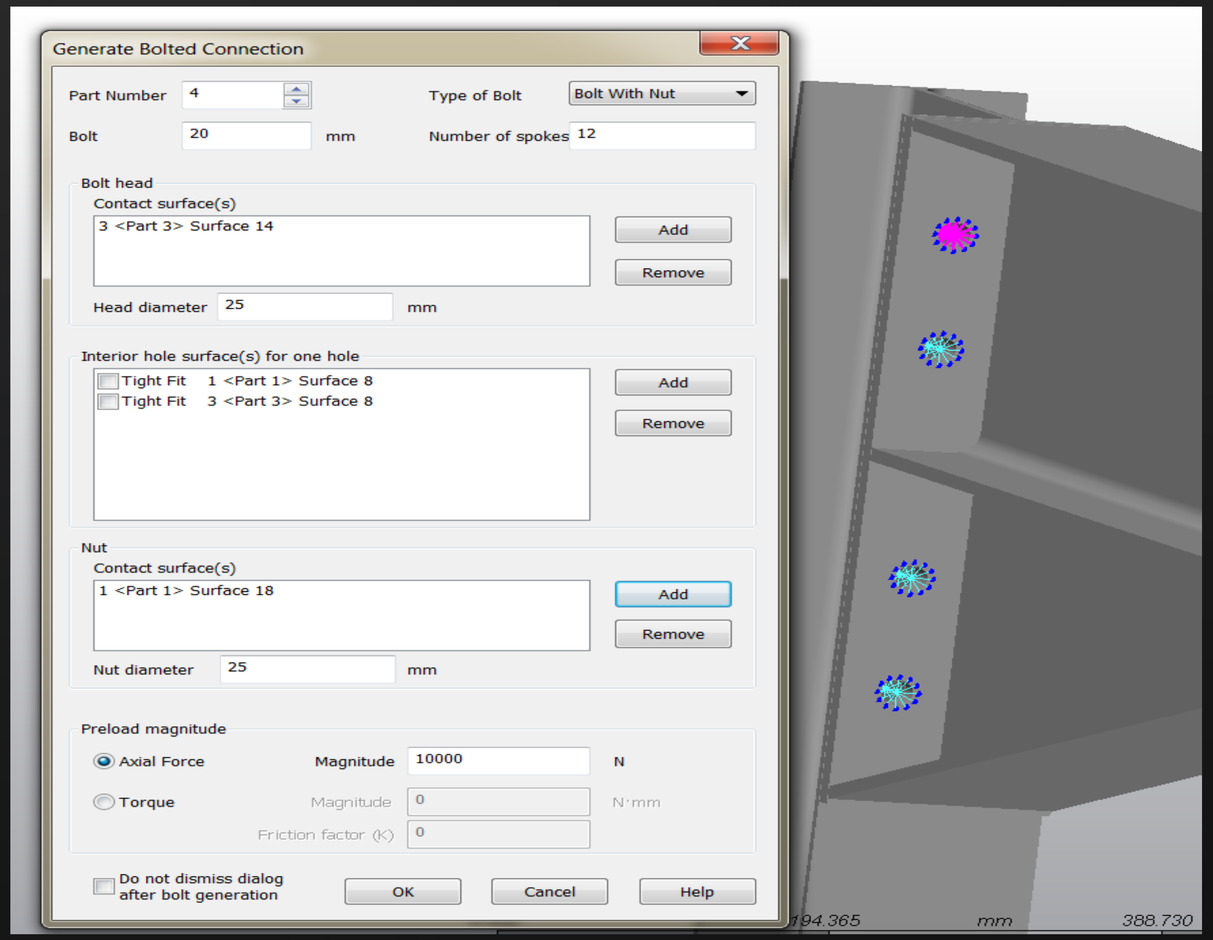
Wizard for Bolts Representation

Simple and efficient modeling for bolts WITH PRESTRESS





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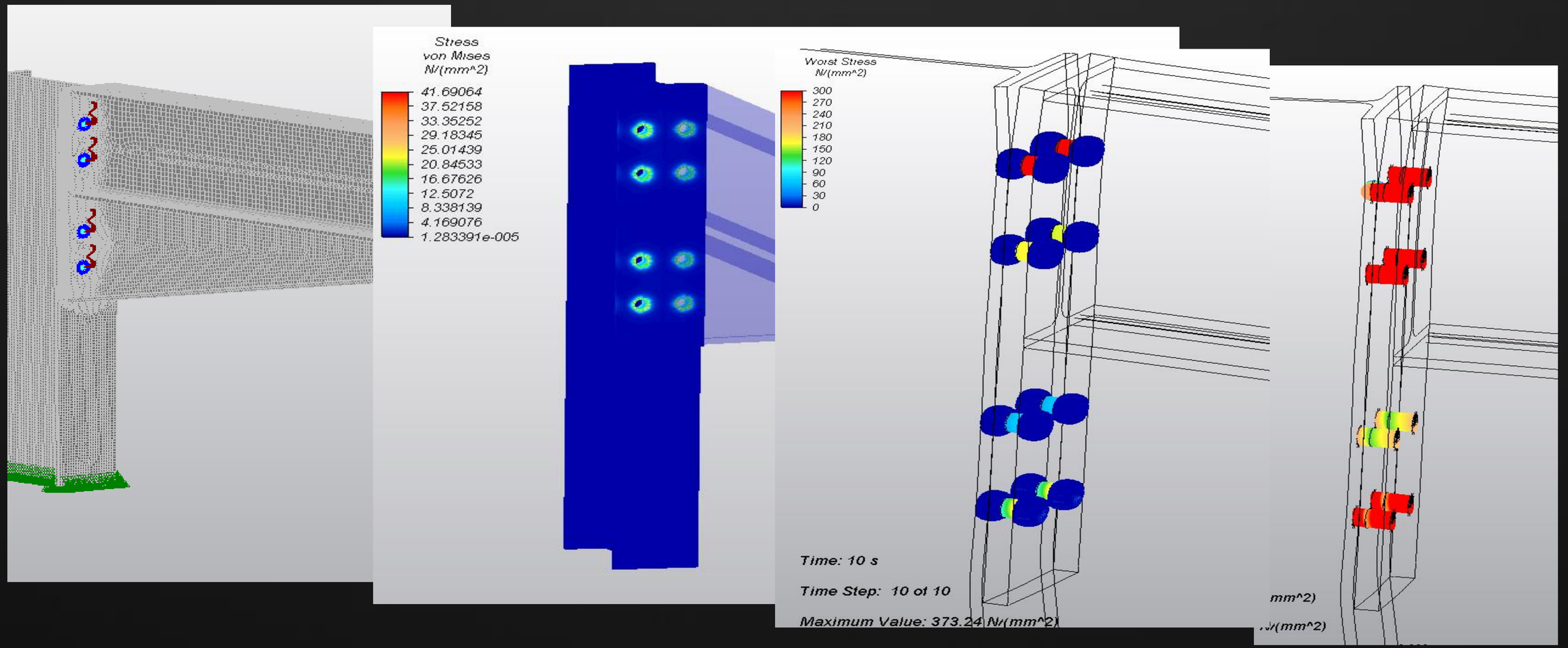
Wizard for Bolts Representation

Detailed post-processing of bolted connection



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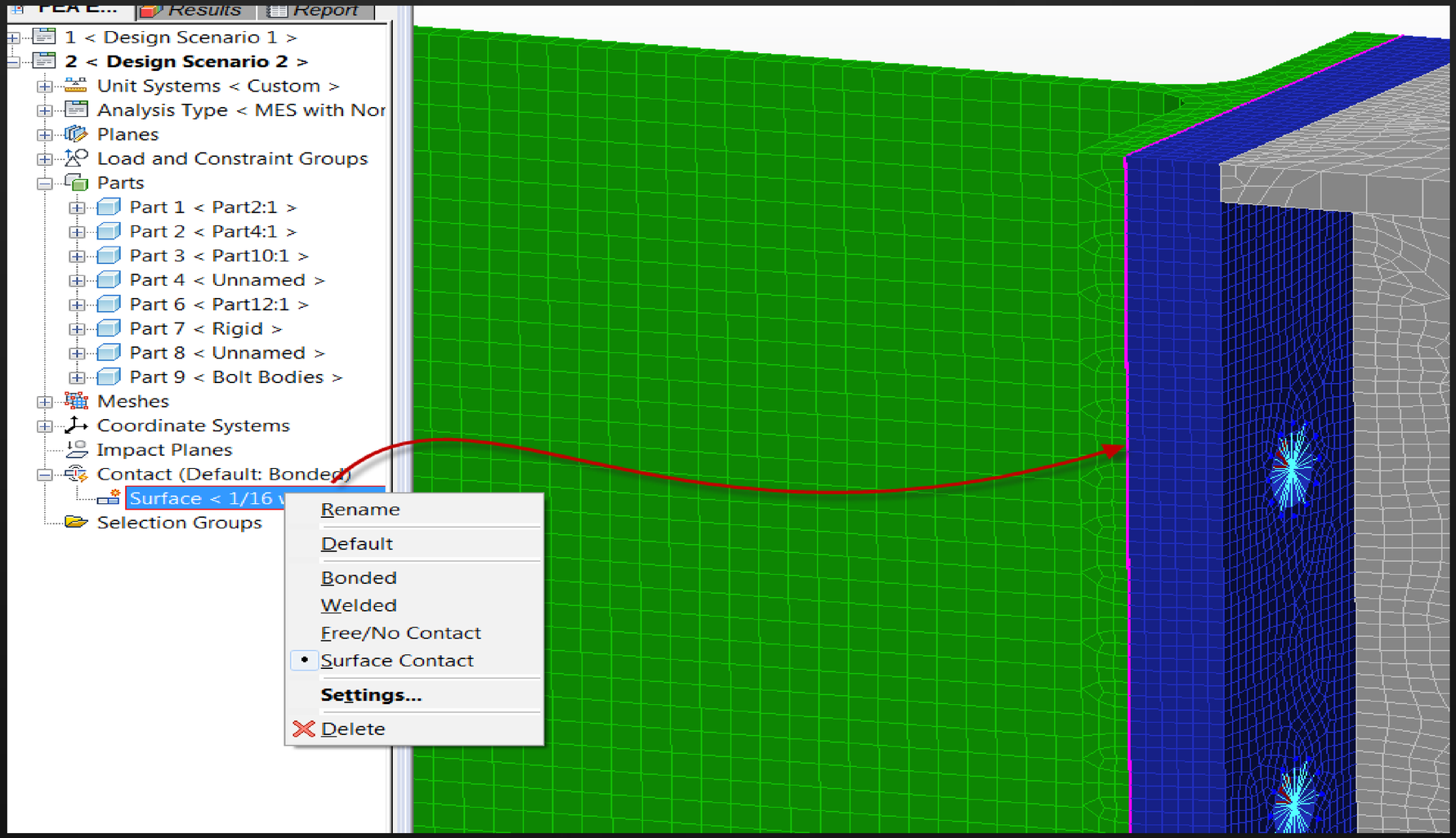
Non-linear Contact



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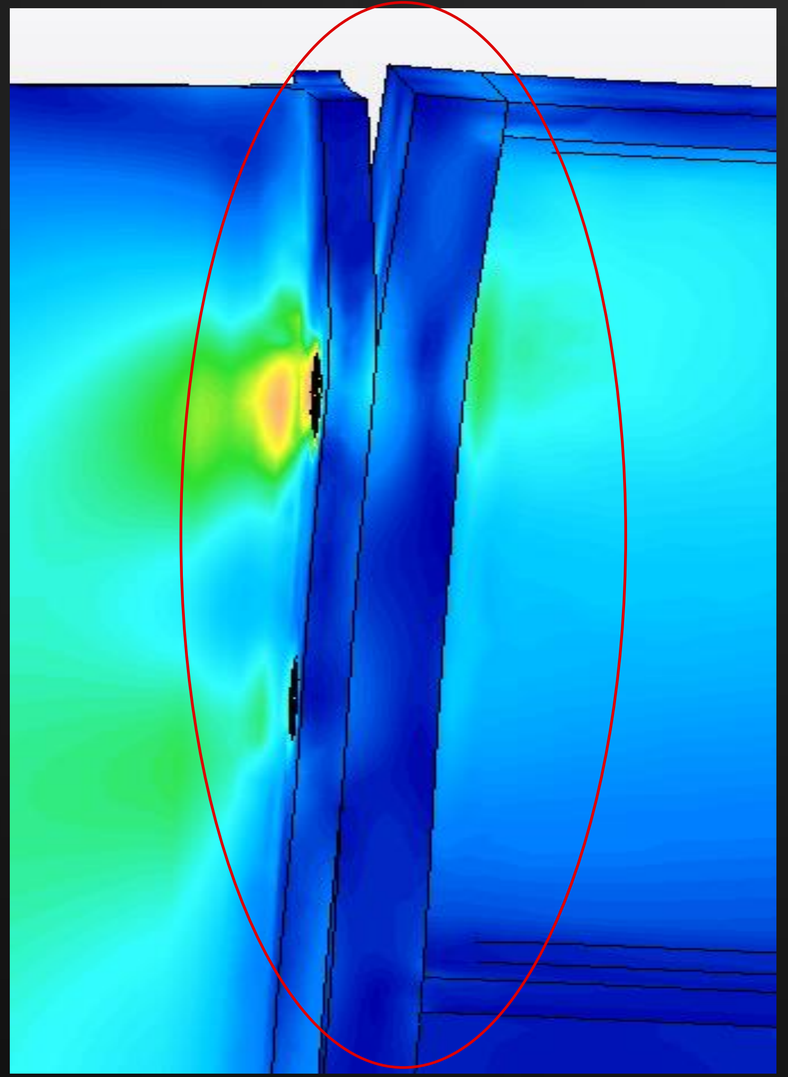
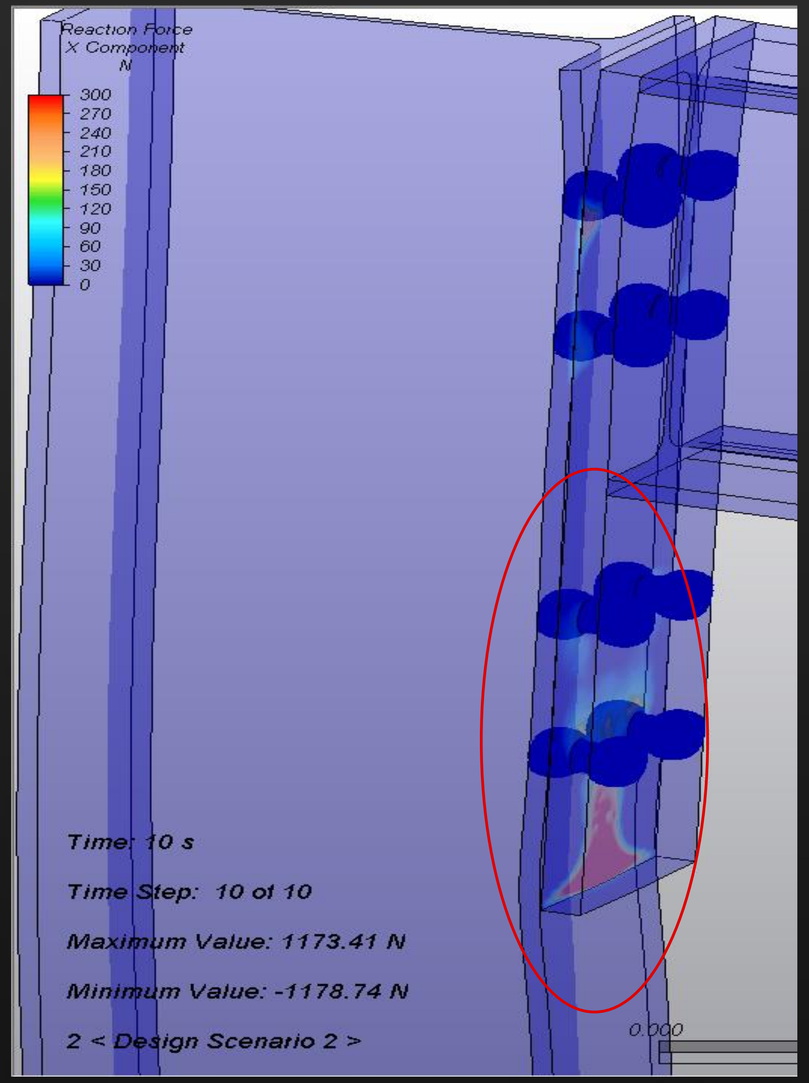
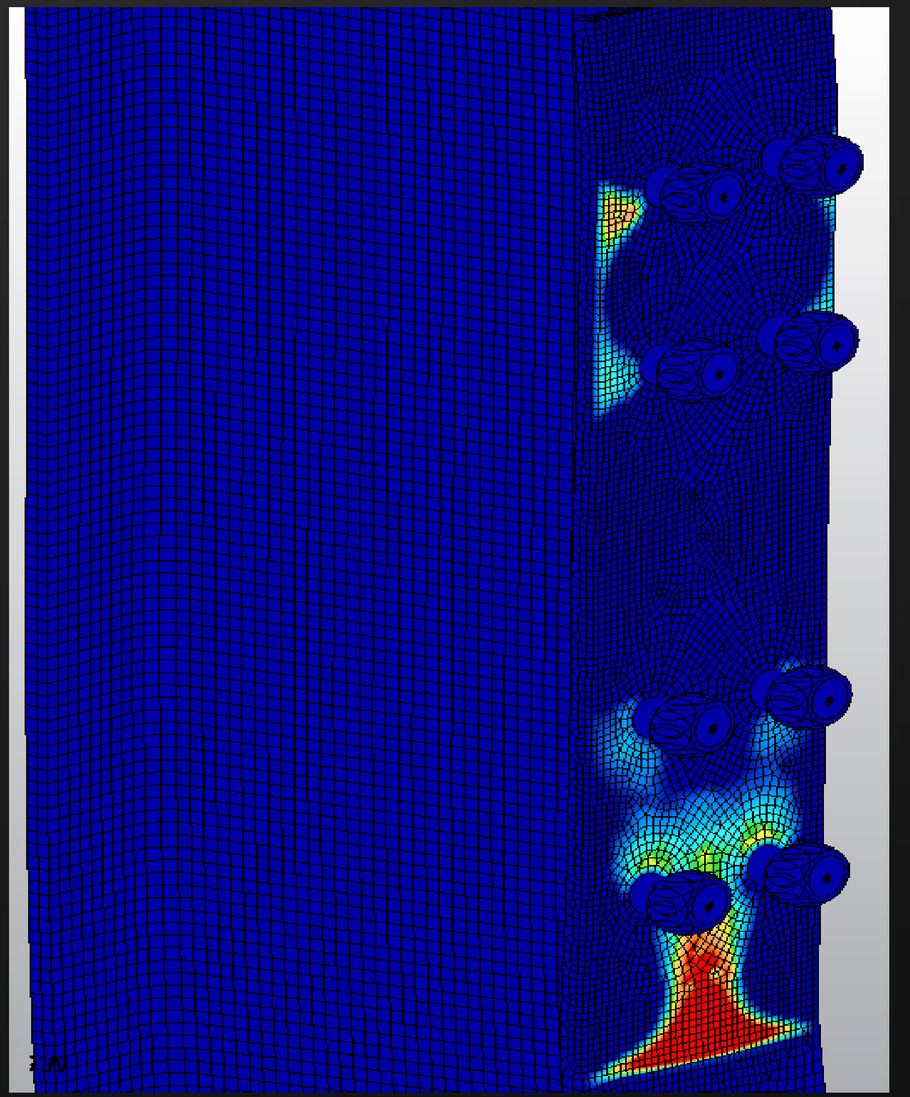
Non-linear Contact







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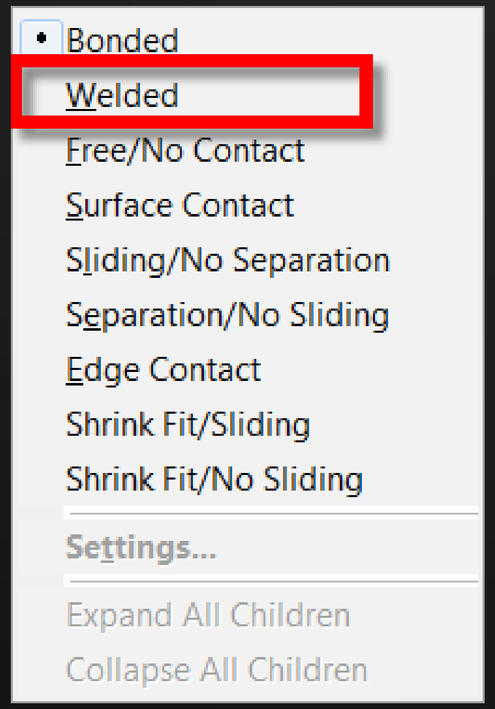
Modeling Welds in Your Models

Option 1



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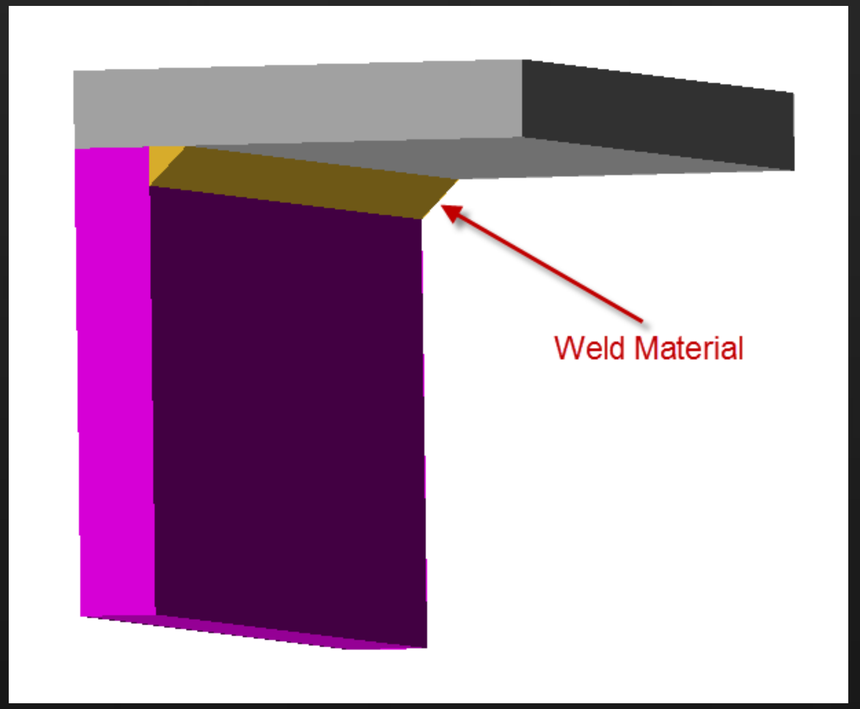

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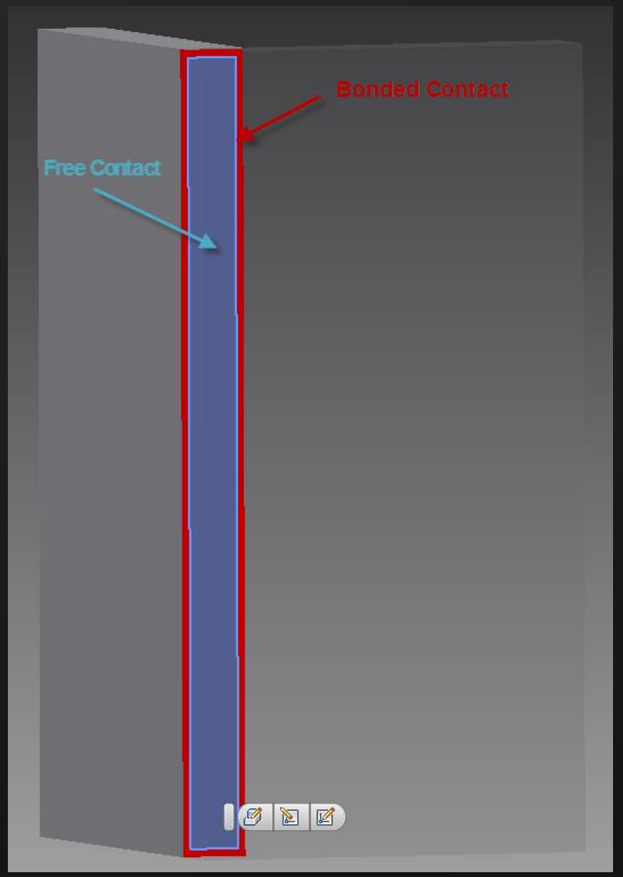

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Demonstration 1

General Construction Analysis Techniques

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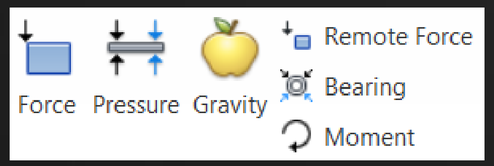
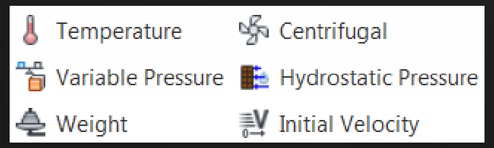
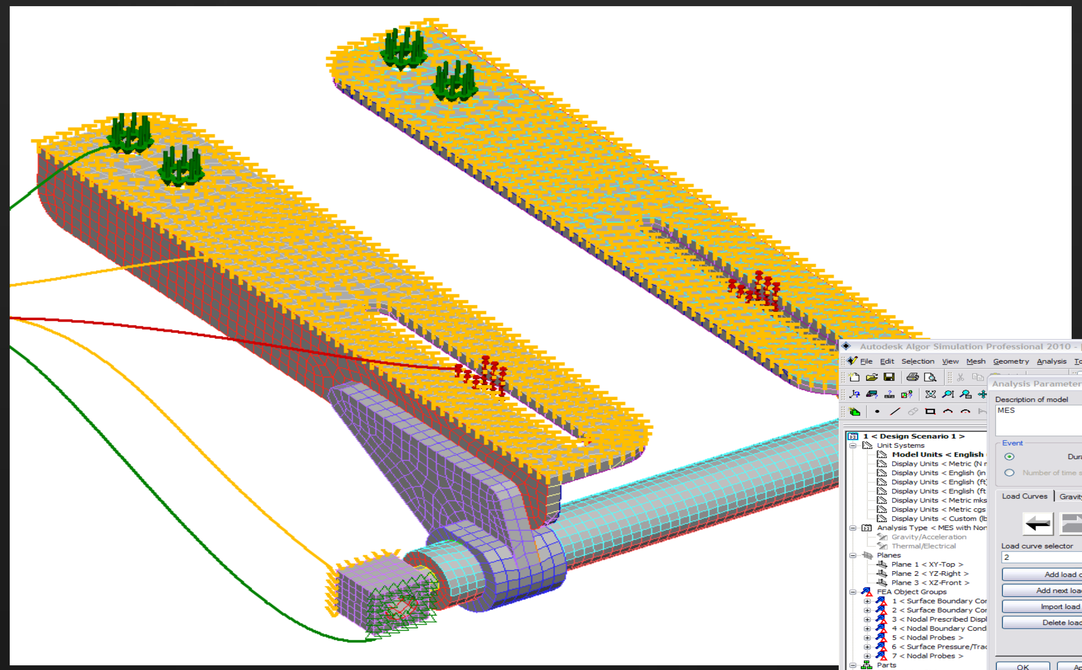
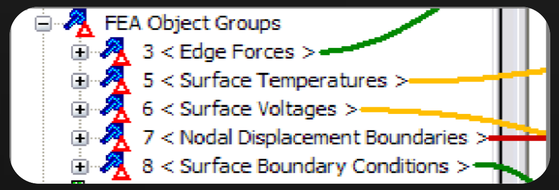
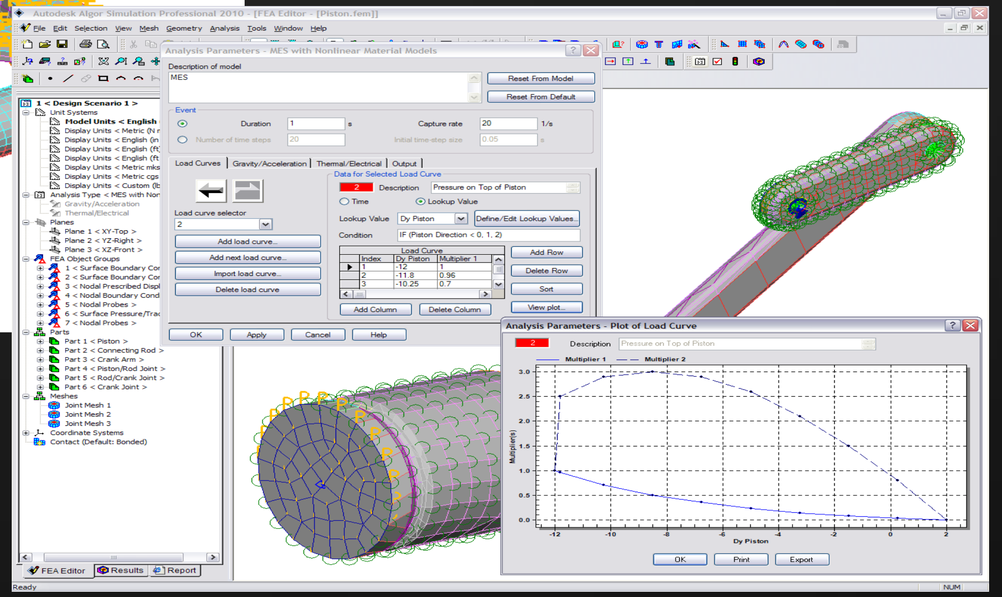
Wide Variety of Support and Loads











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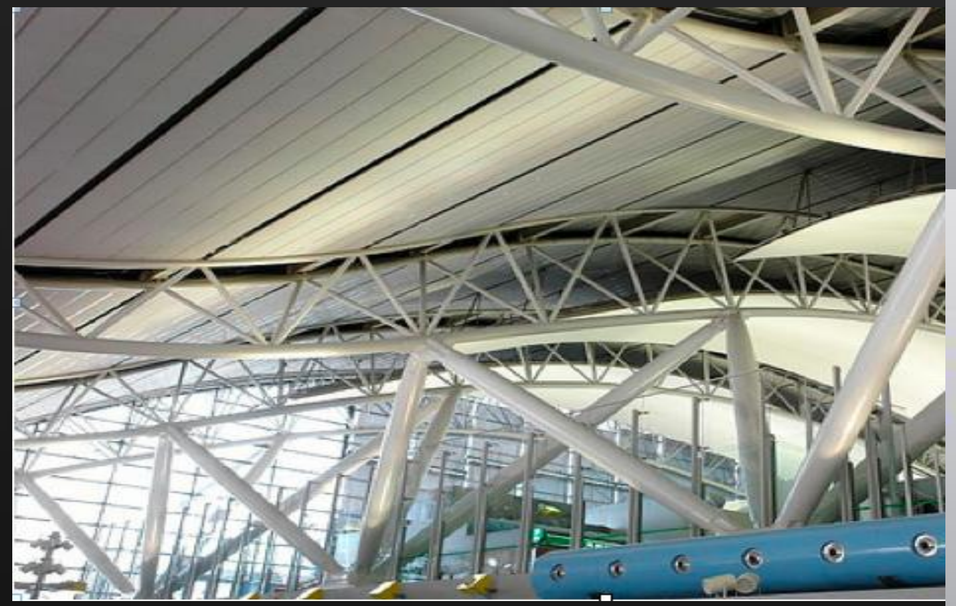
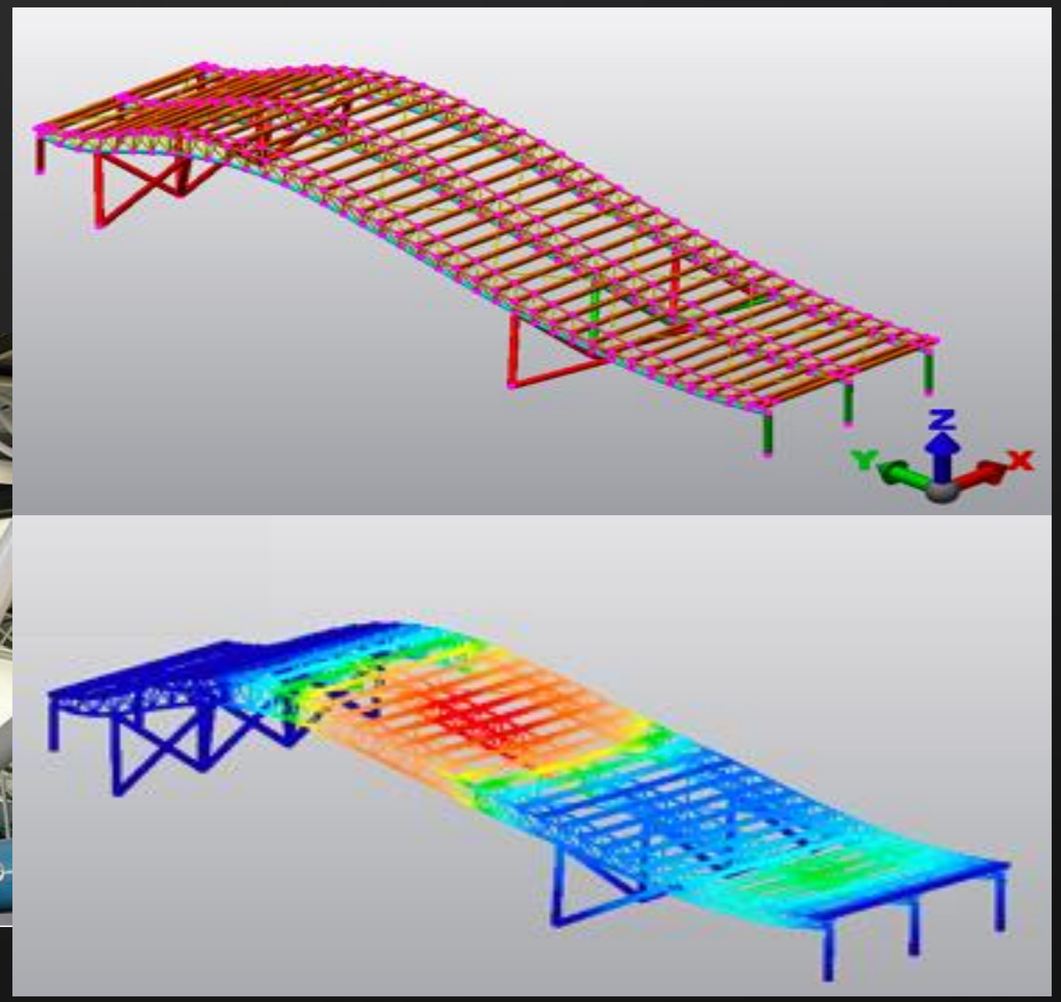
Direct AutoCAD Import

Importing for:

- Construction Objects
- Beams
- Trusses
- 2-D models





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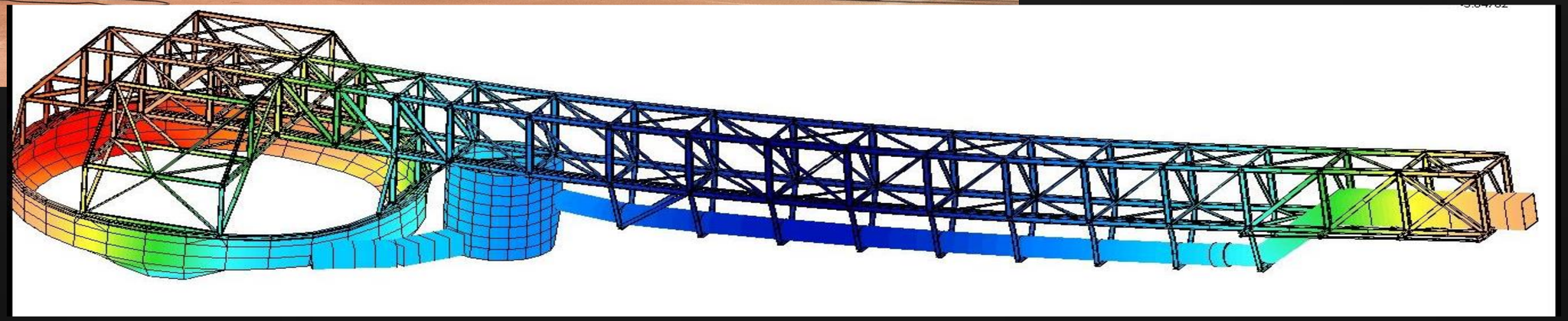
Mixed Element Modeling



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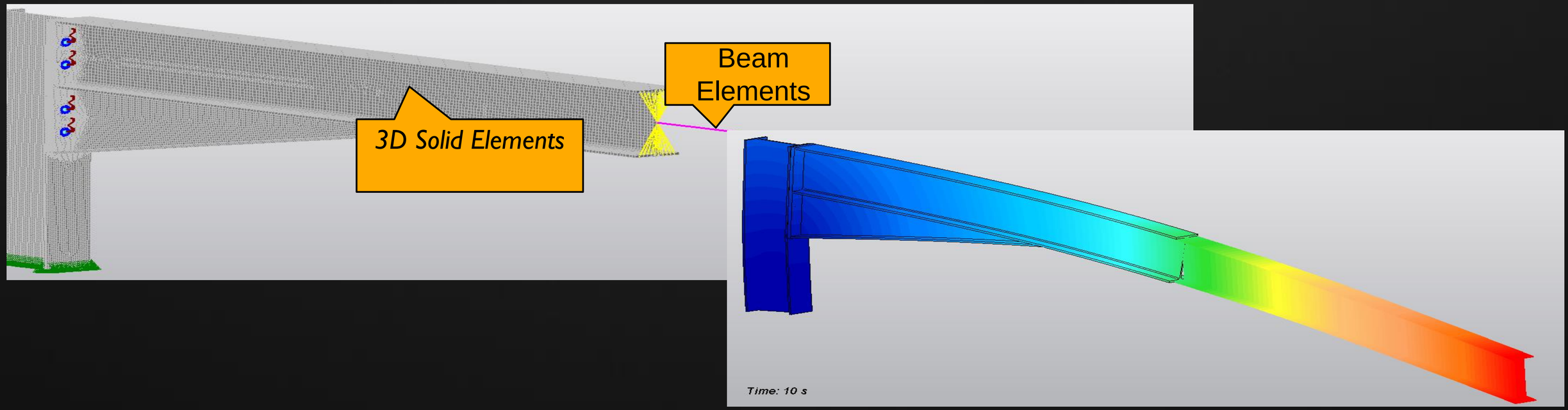
Mixed Element Meshing

BENEFITS:

- Captures the detailed behavior of the critical zone
- Includes the effect/stiffness of surrounding structure
- Allows modeling connections like bolts, rivets, welds



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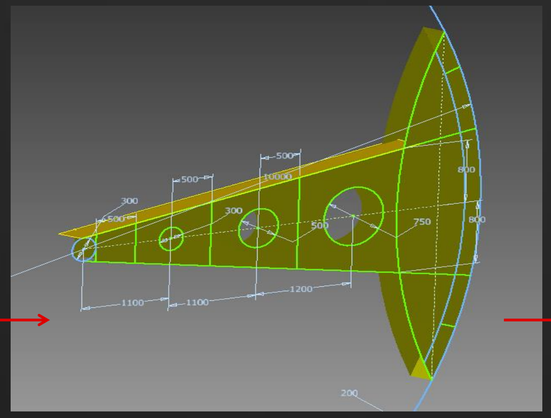
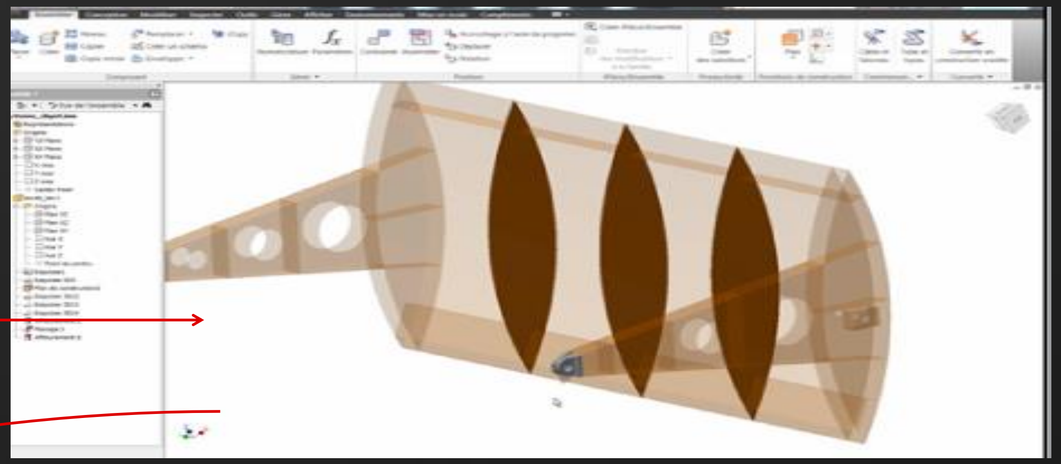
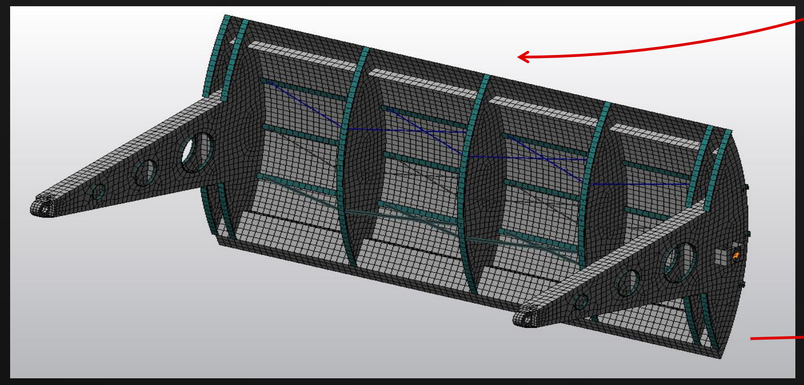
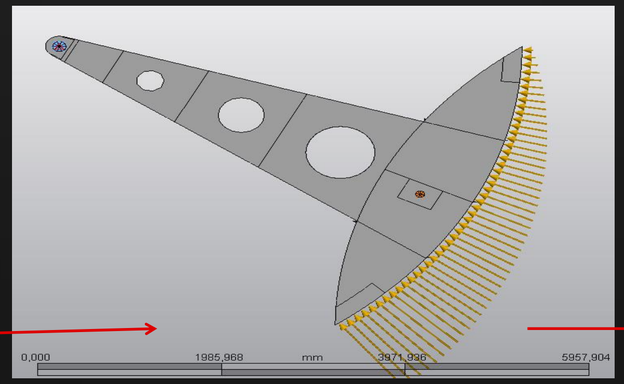
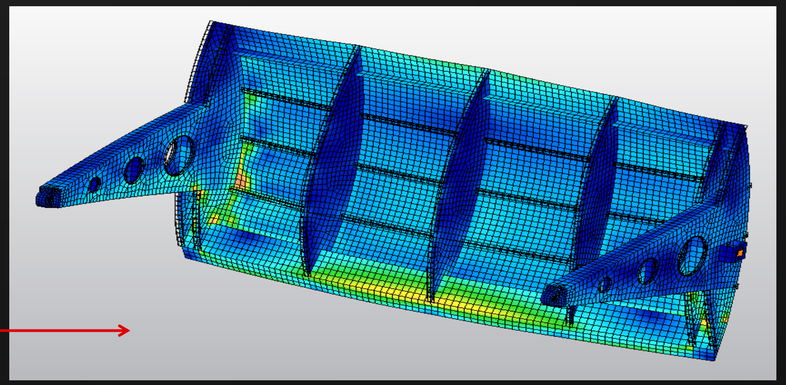
Static Stress Analysis – Design Process











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Mixed Element Meshing

Line Elements

Beam Elements

Gap Elements

Rigid Elements

Spring Elements

Truss Elements

Solid Elements

Brick Elements

Tetrahedral Elements

Hydrodynamic Elements

Surface Elements

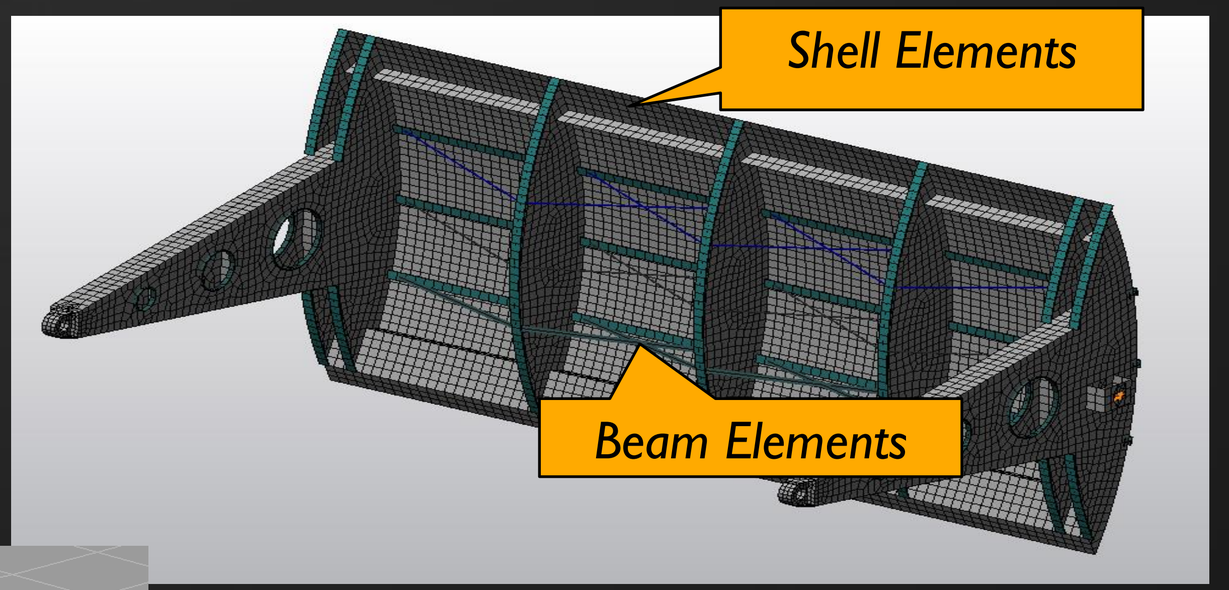
2-D Elements

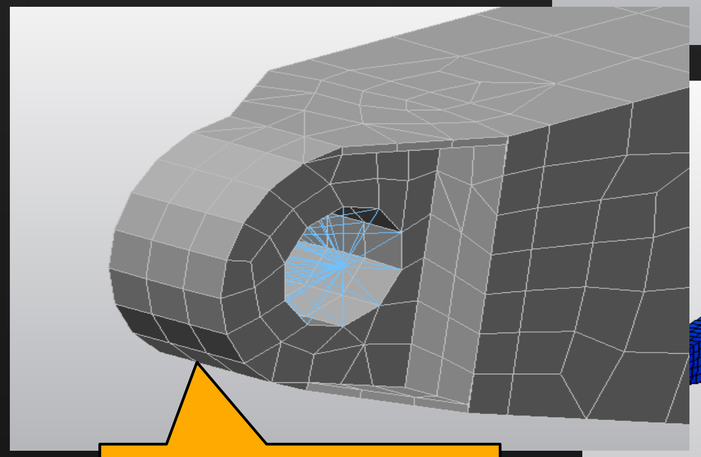
Membrane Elements

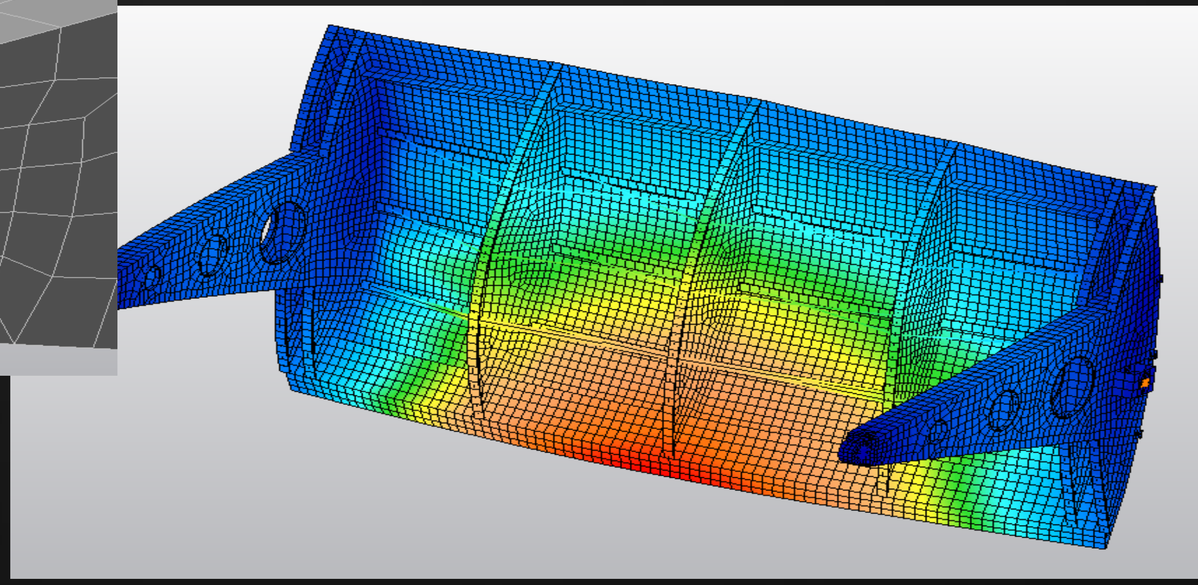
Plate Elements

Thick Composite Elements

Thin Composite Elements







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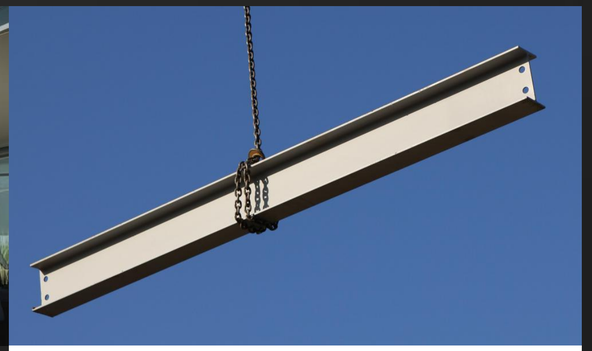
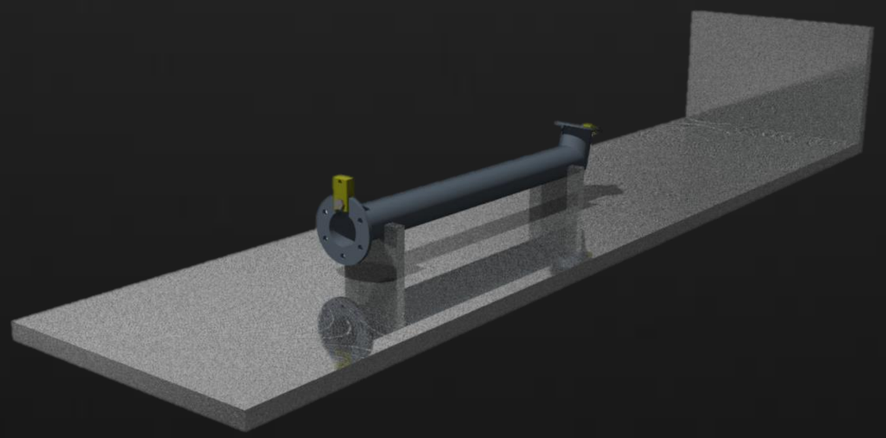
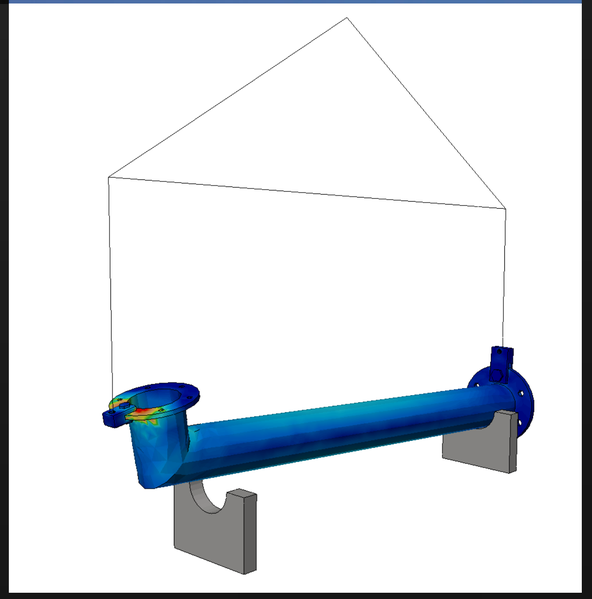
ERECTION ENGINEERING

Advantages of Performing a Structure Lifting Simulation:

- Nonlinear material considerations
- Stress & deformation vs. time and position
- What-if scenarios
  - Impact or drop test







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Demonstration 2

Structure Erection Analysis

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Large Choice of Material Models

- Elastic
- Plastic
- Variable tangent
- Curve description
- Curve description with cutoff tension
- Drucker-Prager
- von Mises with isotropic hardening
- von Mises with kinematic hardening
- von Mises curve with isotropic hardening
- von Mises curve with kinematic hardening
- Temperature-dependent orthotropic
- Thermoelastic
- Thermoplastic
- Viscoelastic (thermal-creep)
- Viscoplastic (thermal-creep)
- Mooney-Rivlin (2, 5 and 9 constants)
- Ogden (1st - 6th order)
- Blatz-Ko (thermal and finite-strain viscoelastic)
- Hyperfoam (1st - 6th order)
- Linear elastic isotropic
- Linear elastic orthotropic
- Linear temperature-dependent isotropic
- Linear temperature-dependent orthotropic
- Gasket (geometrically linear and nonlinear)
- Piezoelectric
- General piezoelectric
- General piezoelectric temperature-dependent anisotropic
- Anisotropic
- Temperature-dependent composite
- Composite laminate

Arruda-Boyce (thermal and finite-strain Viscoelastic)

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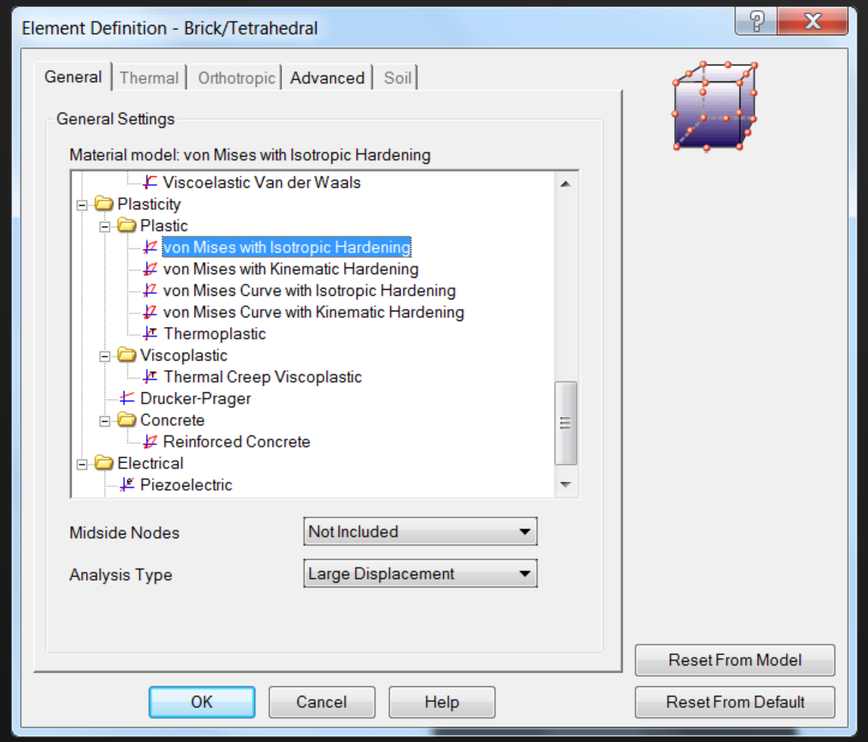
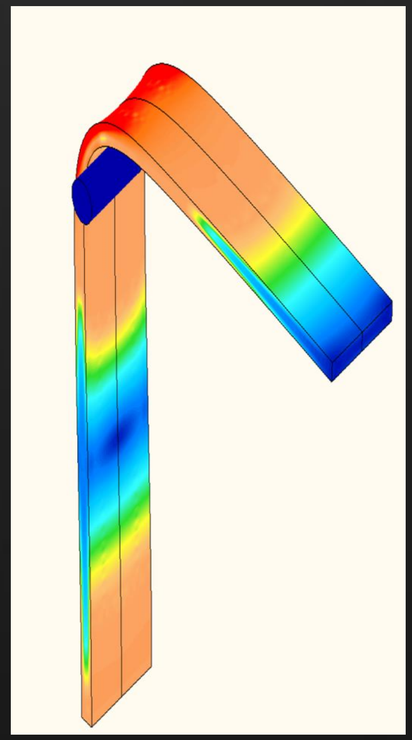
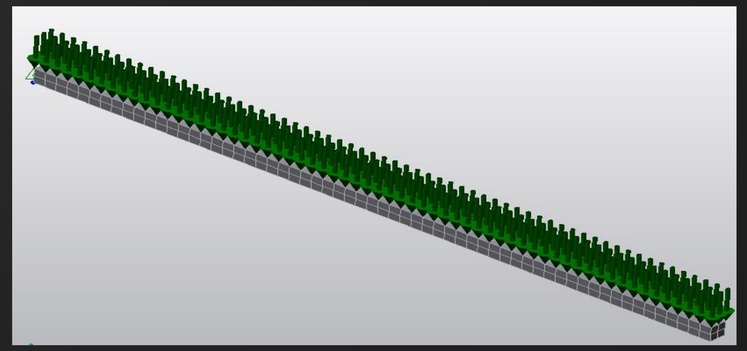
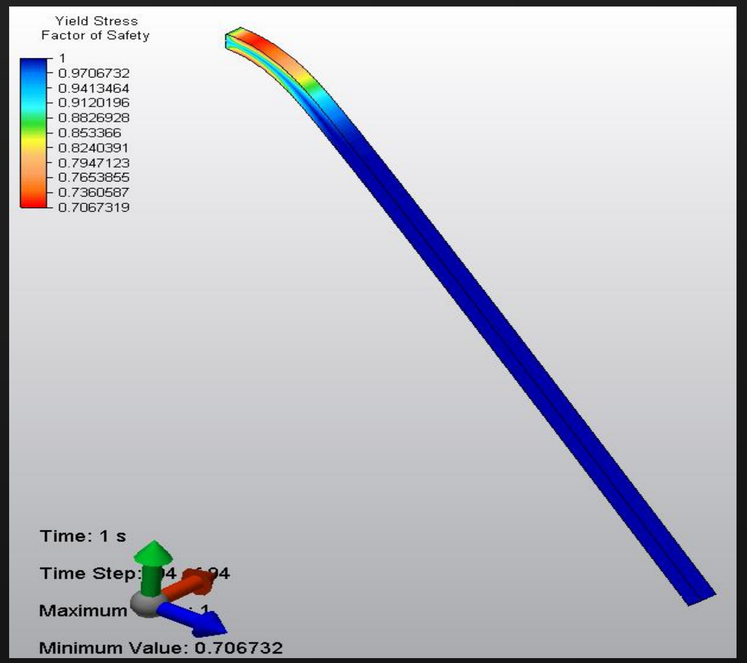
Non-linear: Elasto-plastic Analysis









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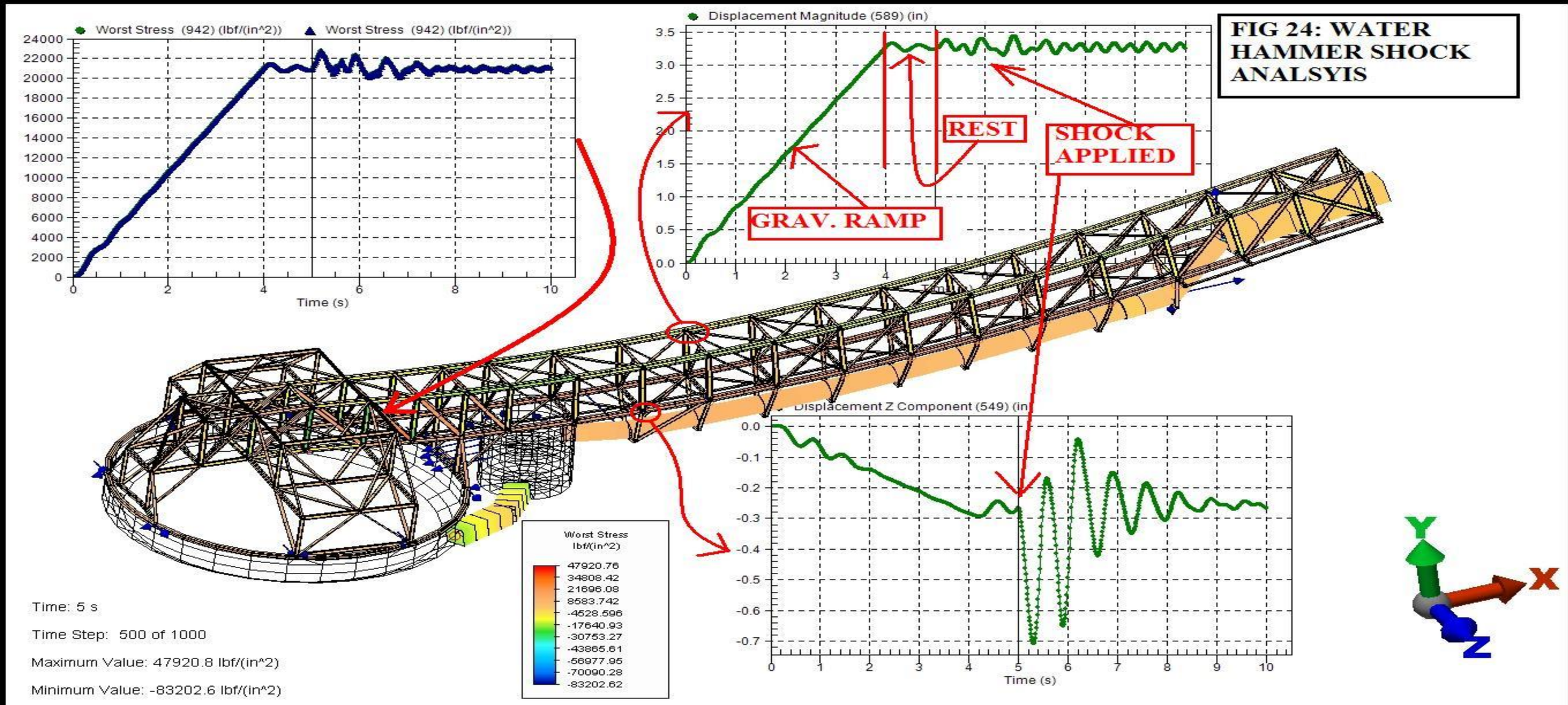
Dynamic Analysis Examples



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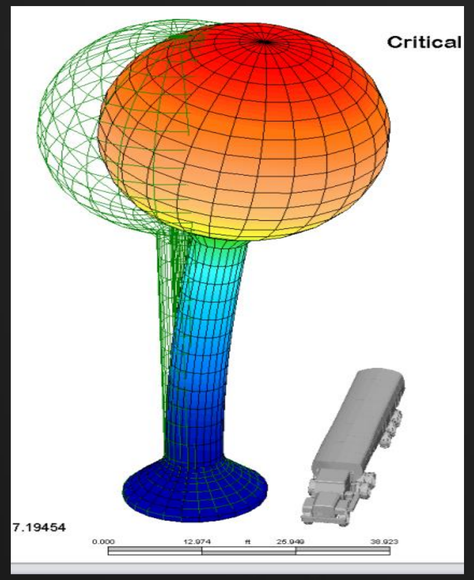
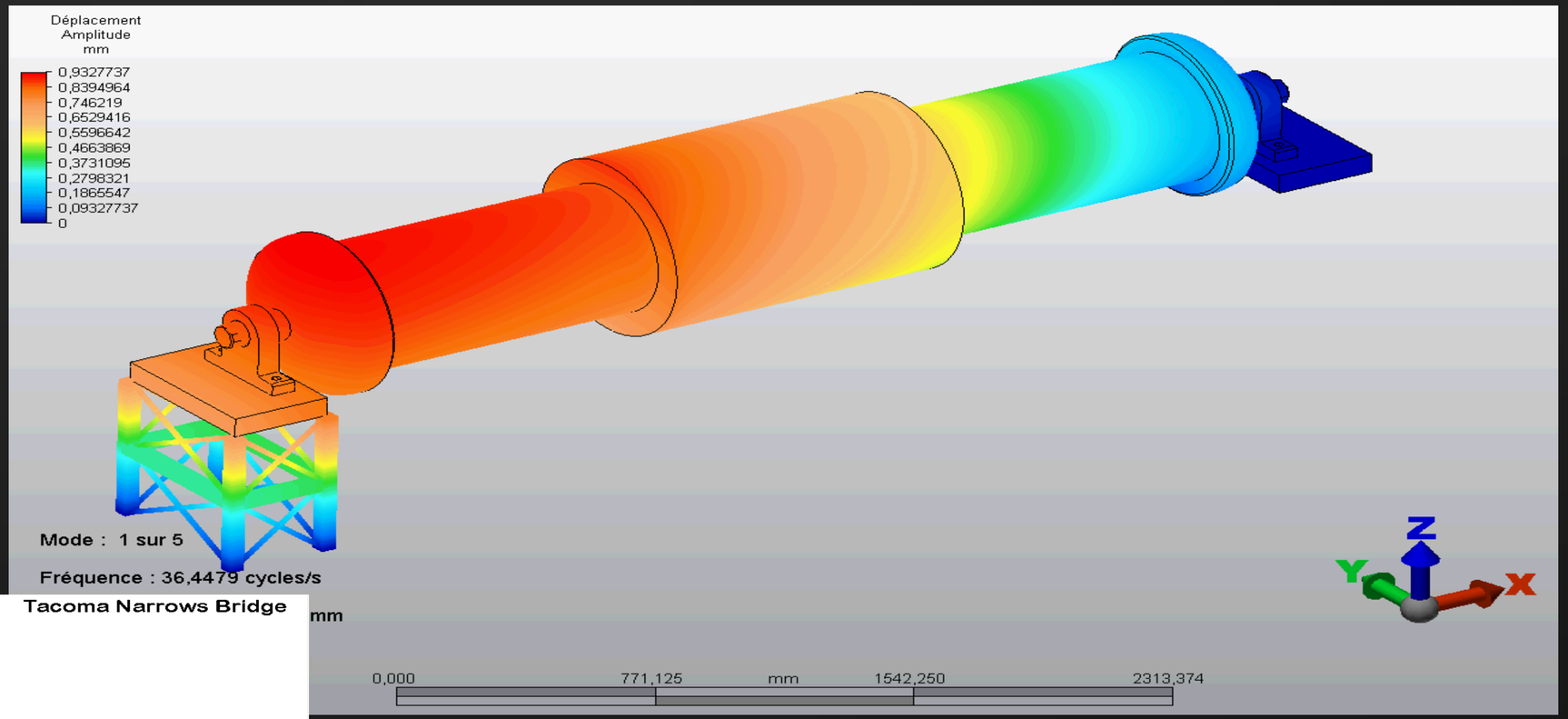
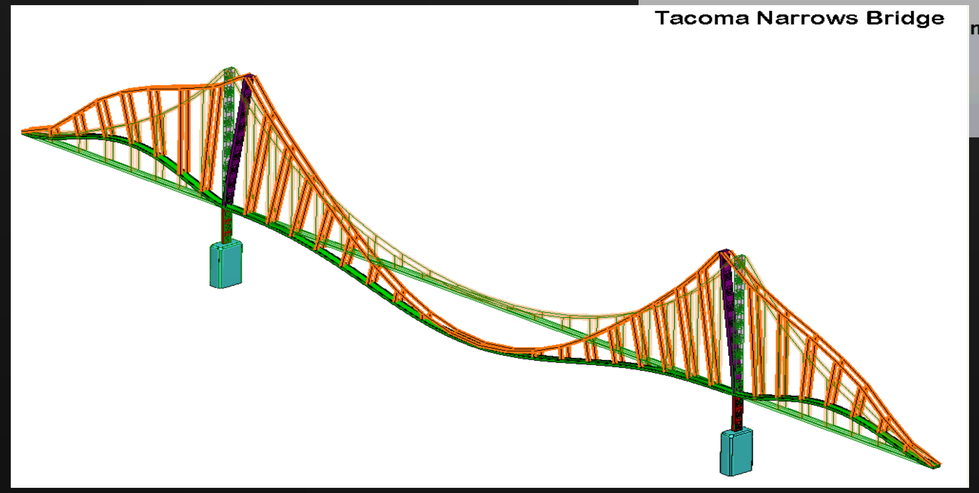
Dynamic Analysis Examples







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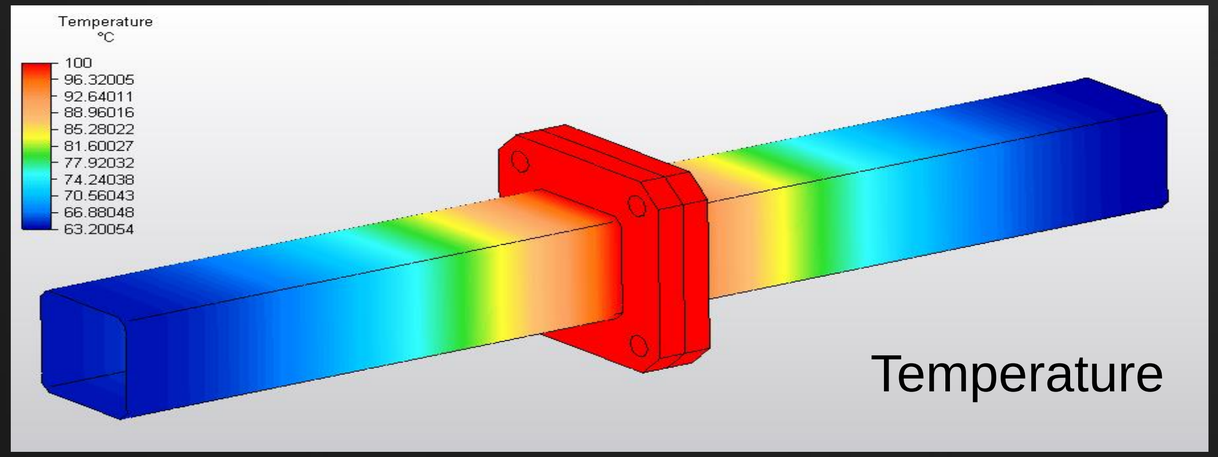
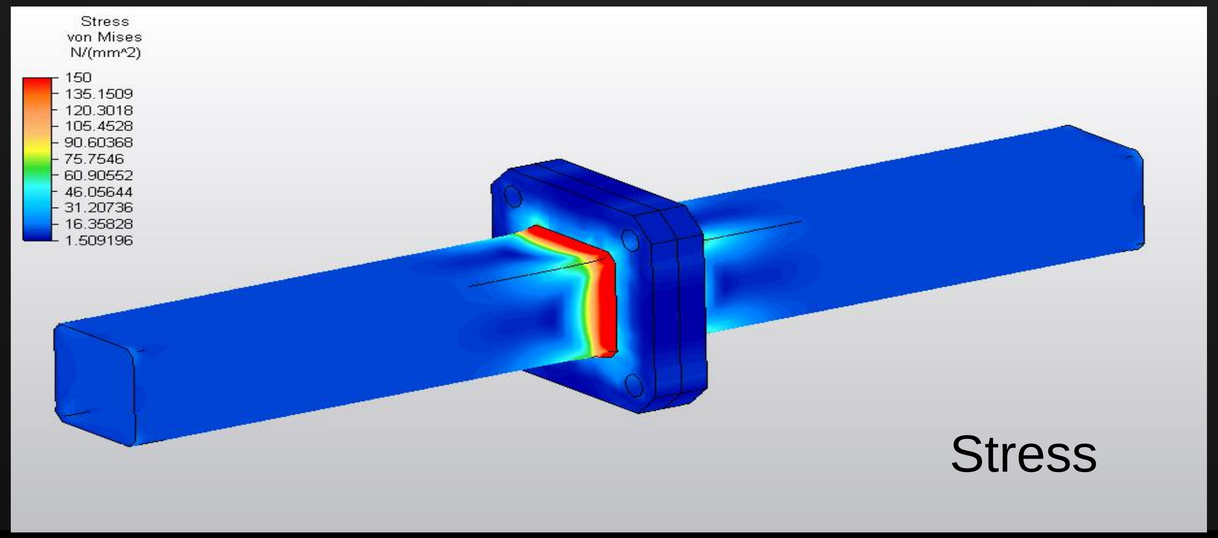
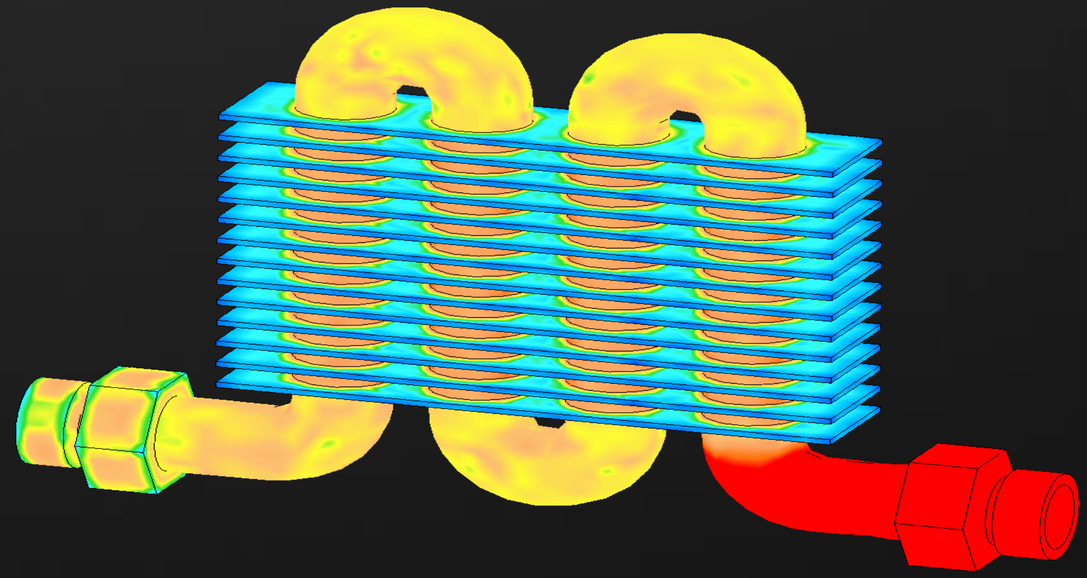
Thermal Analysis

Study thermal temperature distribution and its effect on the stress







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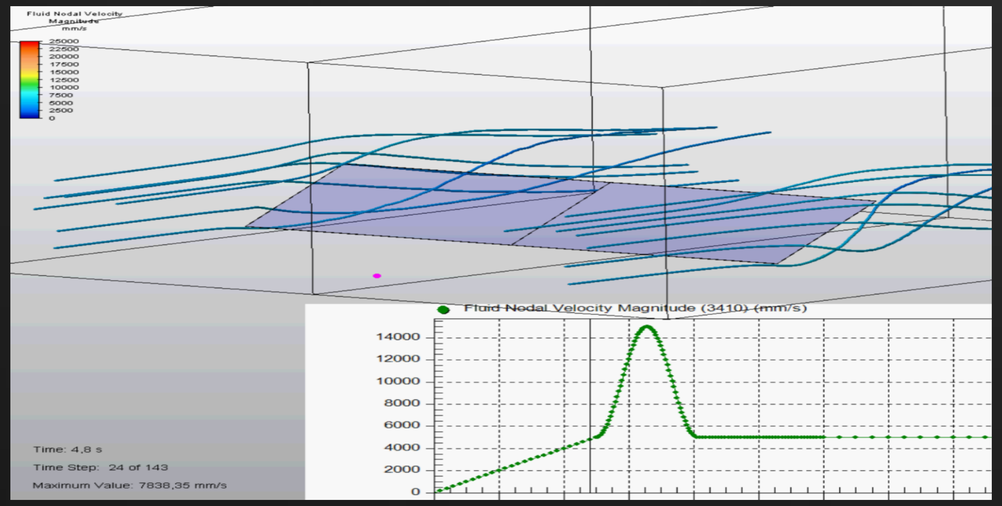
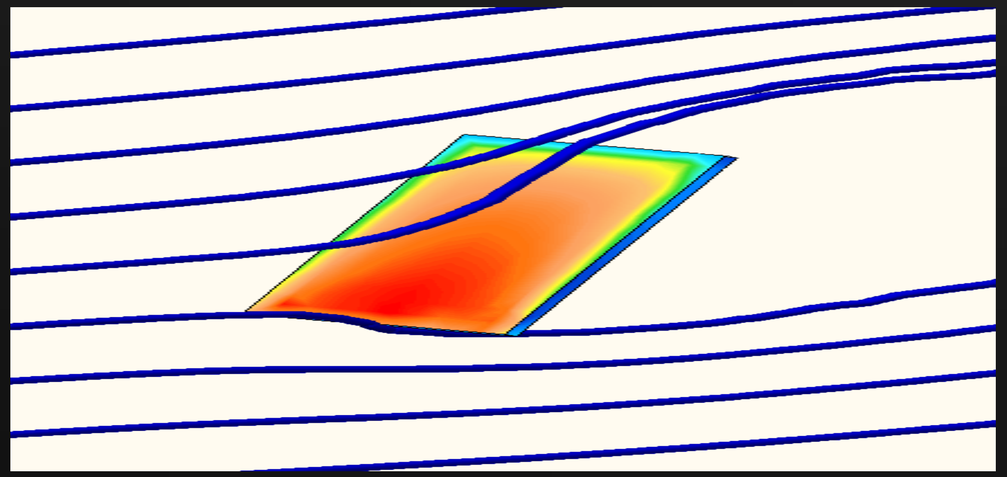
Fluid-Structure Interaction



- Representation of fluid pressure for structural analysis
- Check out Project Hydra on Autodesk Labs!!!



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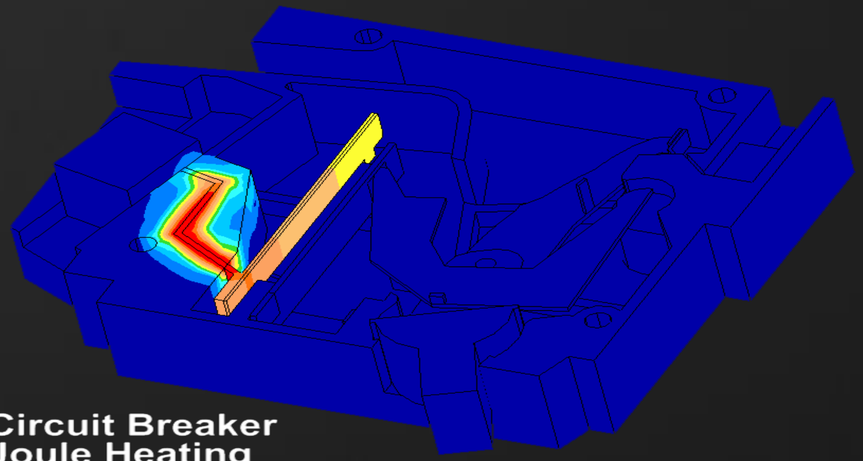
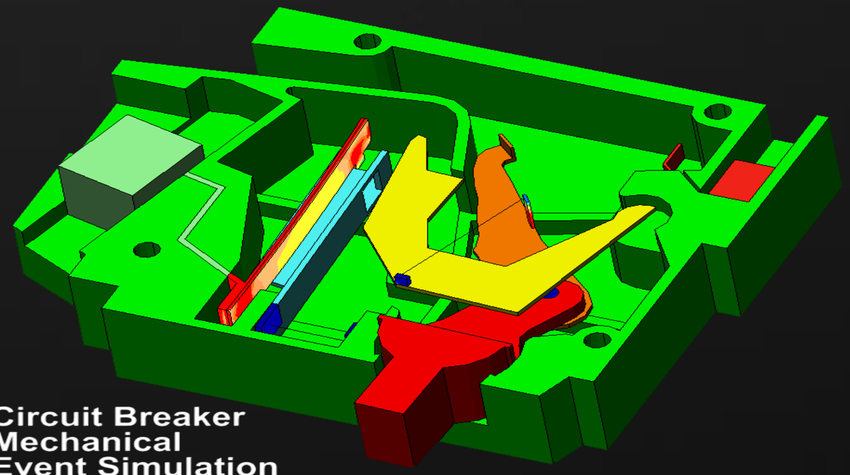
Multiphysics Analyses

Study the effect of multiple physics on the structure:

- Thermal stress analysis
- Fluid and thermal analysis
- Fluid and structural analysis
- Electrostatic analysis
- Joule heating analysis
- Electromechanical analysis



Circuit Breaker
Joule Heating
Time: 5 secs.



Circuit Breaker
Mechanical
Event Simulation
Time: 6.528 secs.

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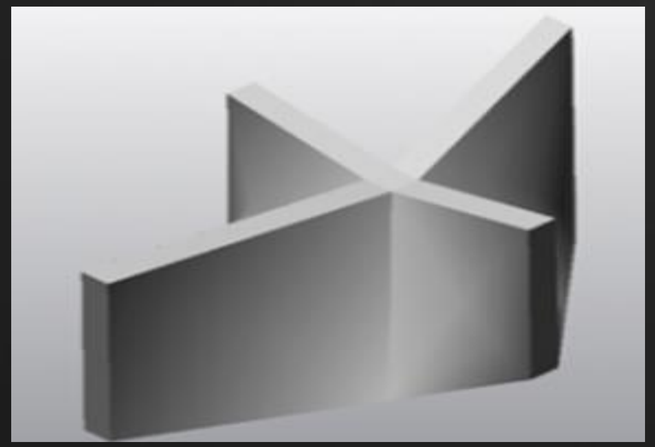
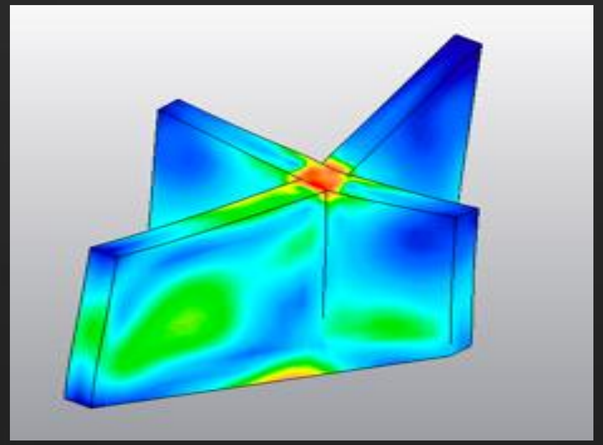
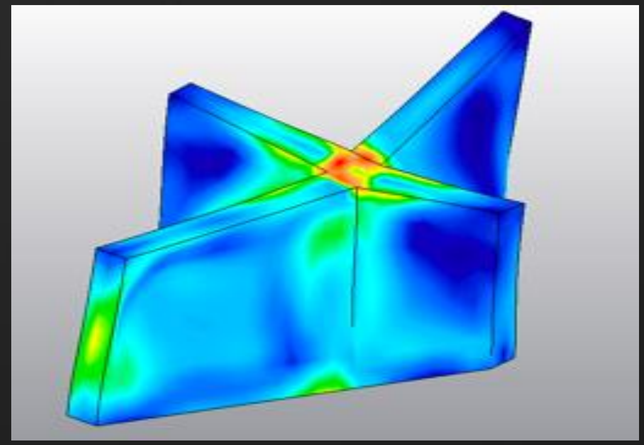
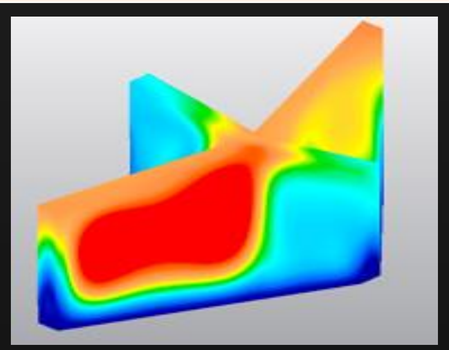
Design Optimization

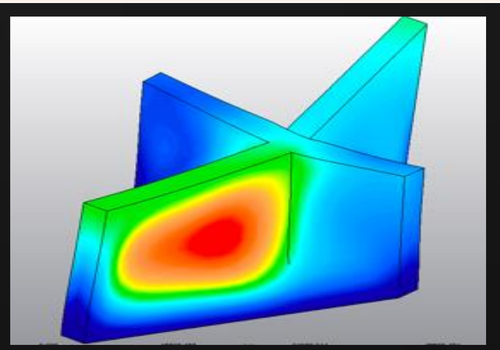






Thickness	500mm	100mm
Stress	3.82MPa	13.46 MPa
Deformation	11.282 mm	11.282 mm





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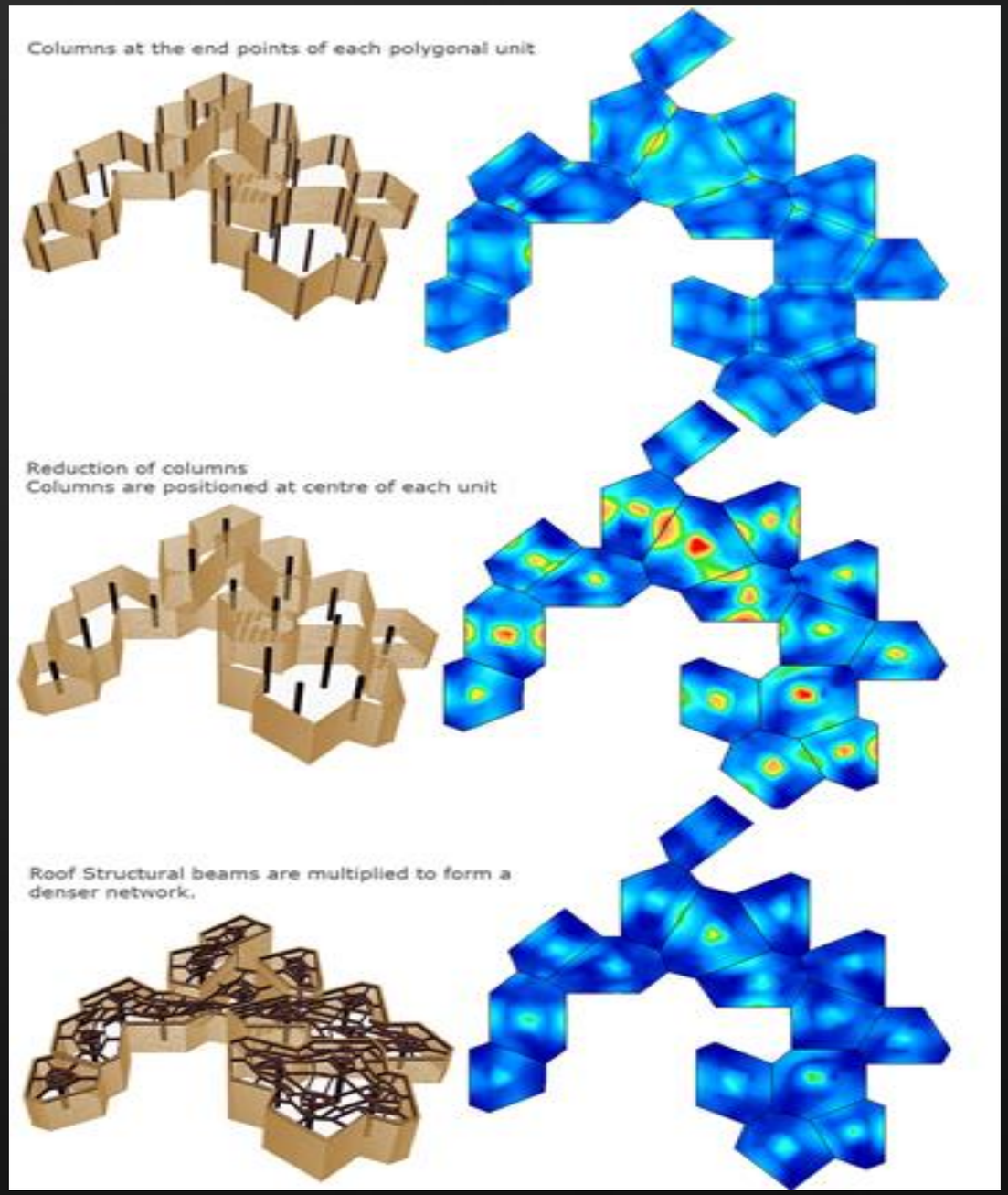

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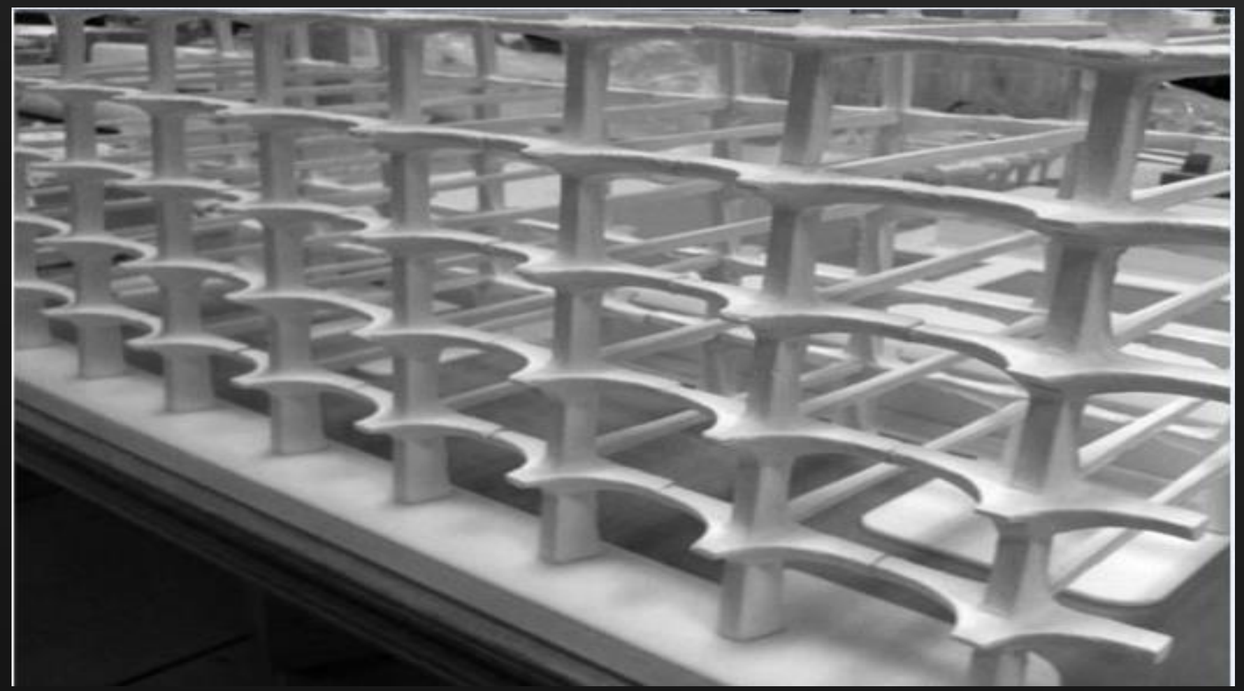

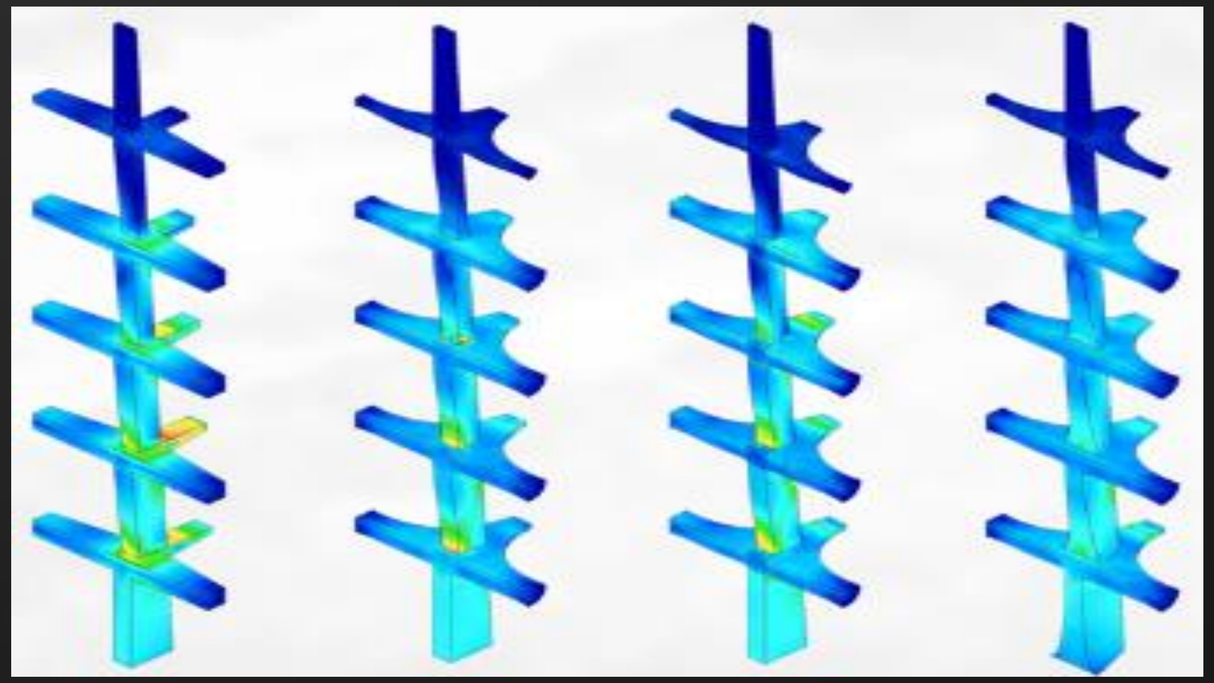

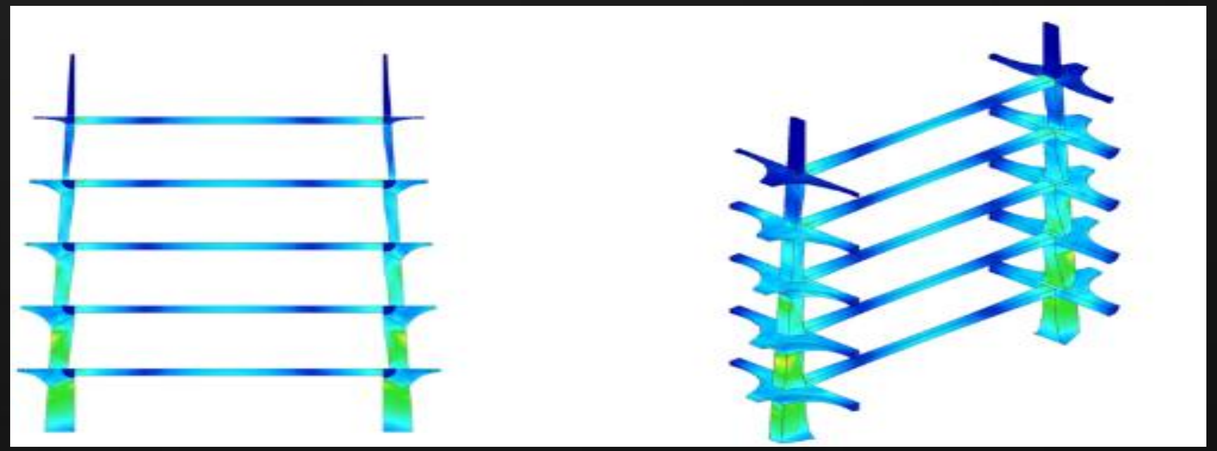

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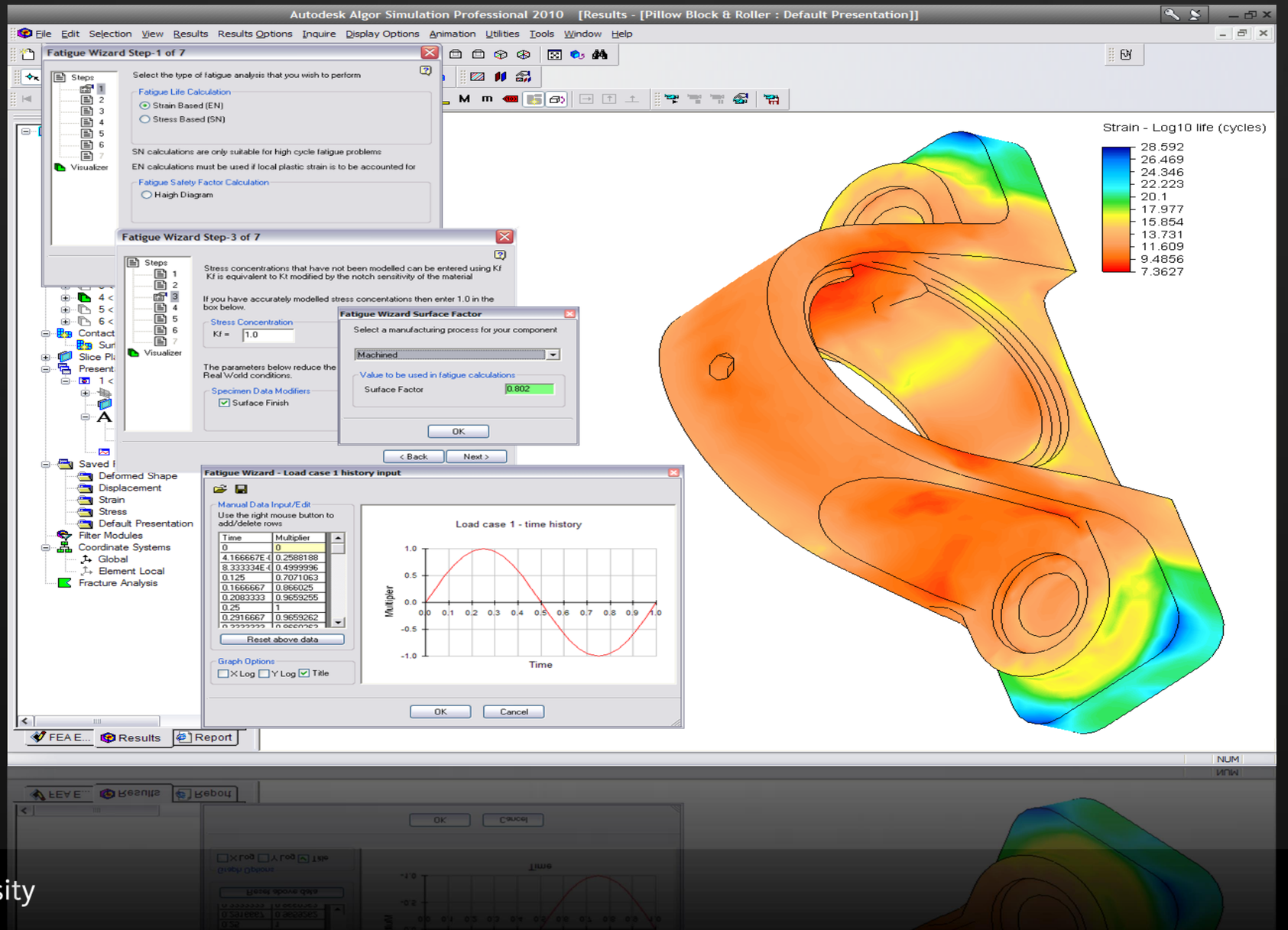
Fatigue Analysis



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Demonstration 3

Design Optimization, Fatigue and Environmental Loading

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Summary

- Construction Analysis Techniques
  - Detailed models with part simplification
  - Bolt wizard
  - Welding
- Structure Erection Analysis with Mechanical Event Simulation
  - Mixed modeling
  - Prescribed displacements
  - 360 solving power
- Optimization and Fatigue
  - Project Hydra
  - Stress vs. strain fatigue

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Questions? I have Answers!

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