Simulation for Designers-
Take your Inventor analysis to the next level

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Class summary

Are you a veteran Inventor Simulation software user? Are you limited to what you can do with Inventor Simulation software? If the answer is Yes, this class is for you. This class will also be beneficial for designers with little knowledge of Inventor Simulation software. The session will start by demonstrating the powerful functionalities of Autodesk Nastran In-CAD software, followed by showcasing how designers like you around the world have made great designs by utilizing the powerful functionalities of Autodesk Nastran In-CAD software. This session features Nastran In-CAD.

Key learning objectives

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

- Learn how to set up designs in Autodesk Nastran In-CAD
- Learn how to analyse and interpret designs in Autodesk Nastran In-CAD
- Learn how other designers have successfully utilized Autodesk Nastran In-CAD within their design processes
- Learn how to apply best practices

Agenda

Introduction:	Wasim	(2 mins)
Nastran In-CAD – An Intro :	Wasim	(3 mins)
Nastran In-CAD – Next Level:	David	(20 mins)
Customer Examples:	Wasim	(10 mins)
Best Practices:	David	(10 mins)
More Info:	Wasim	(10 mins)
Q & A:	Wasim/David	(5 mins)

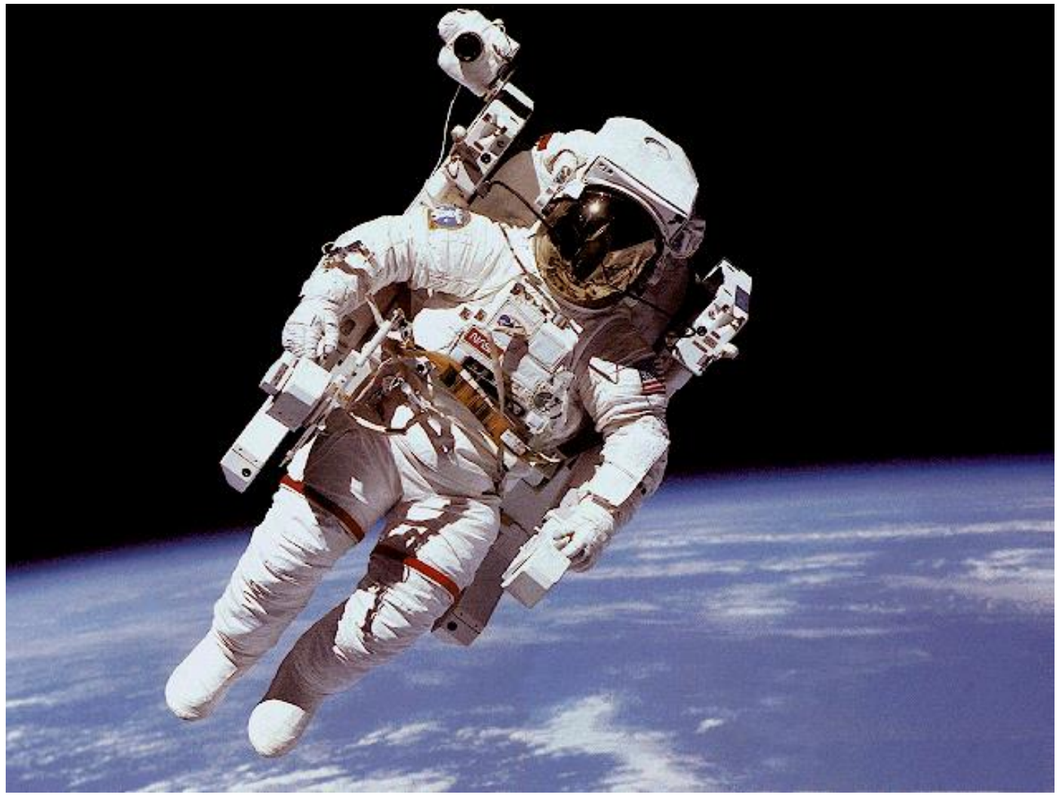
Nastran In-CAD – An Intro

Nastran In-CAD - What is Nastran?

- Nastran was developed by NASA:

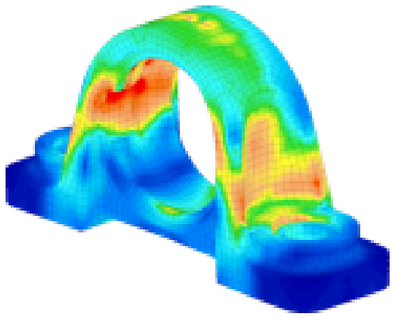
  NASA **STR**uctural **AN**alysis

- It's the industry standard for more than 40 years

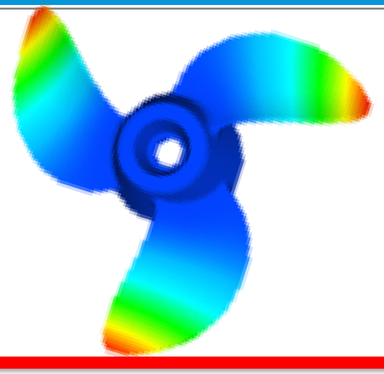


Nastran In-CAD - Capabilities

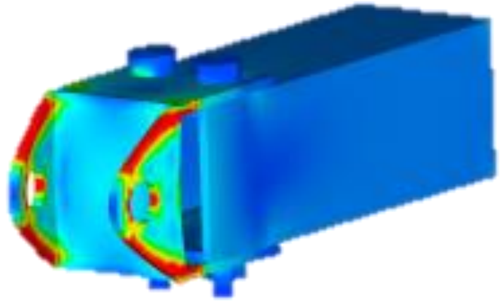
Linear Statics



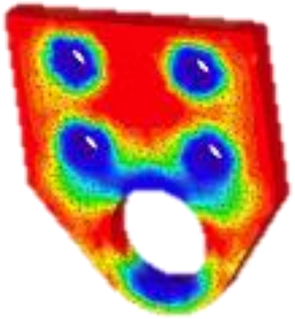
Normal Modes



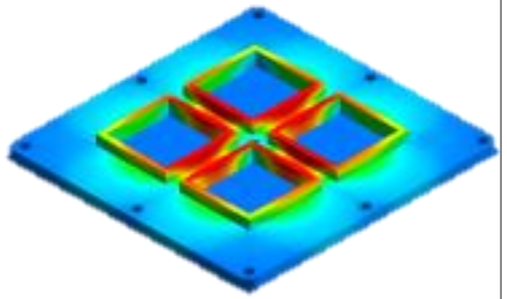
Assembly Modeling with Contact – No friction



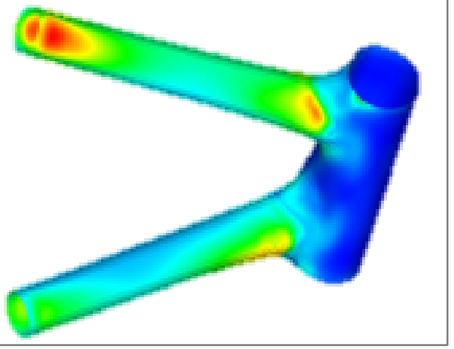
Pre-stress Static and Normal Modes



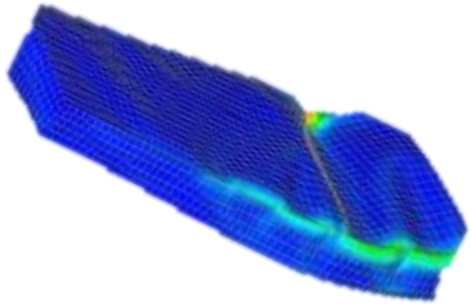
Linear Steady State Heat Transfer



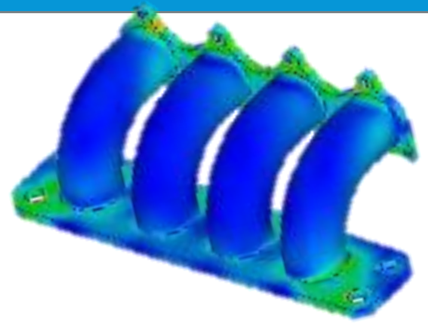
Composites



Buckling

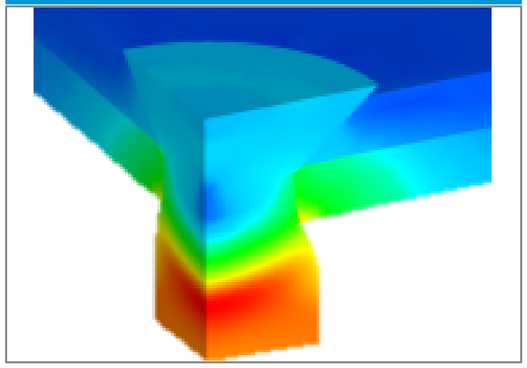


Thermal Stress

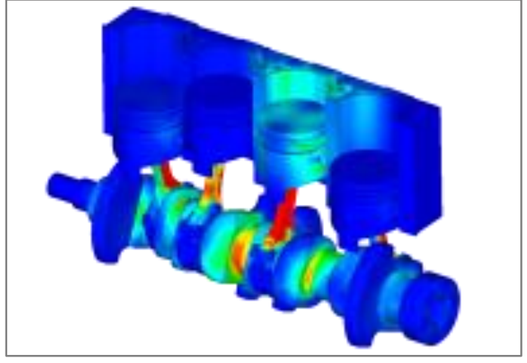


Nastran In-CAD - Capabilities

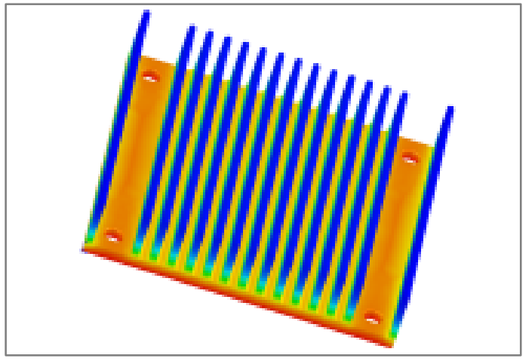
Nonlinear Statics



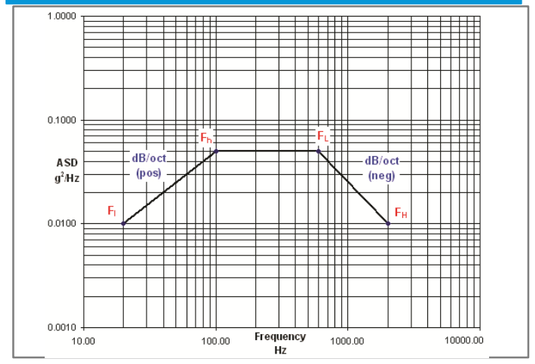
Nonlinear Transient Heat Transfer



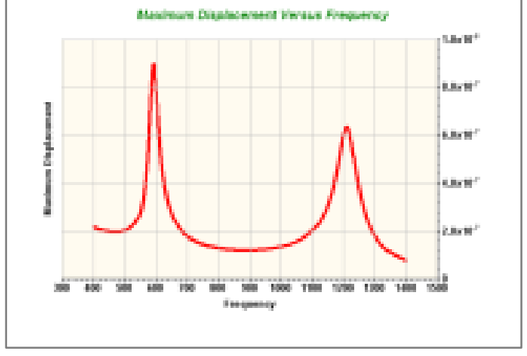
Nonlinear Steady State Heat Transfer



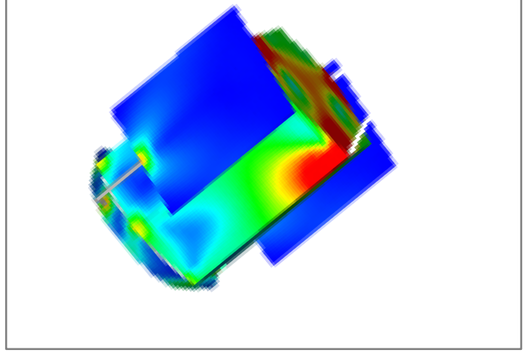
Random Response



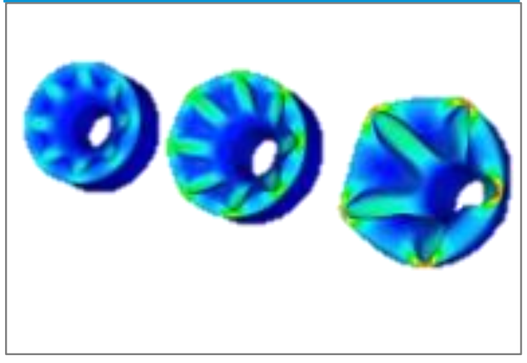
Frequency Response



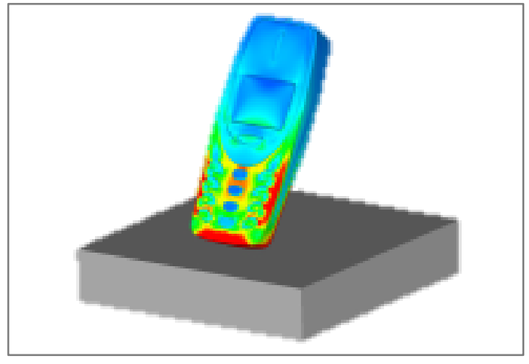
Linear and Nonlinear Transient Response



Advanced Nonlinear and Hyperelastic Materials

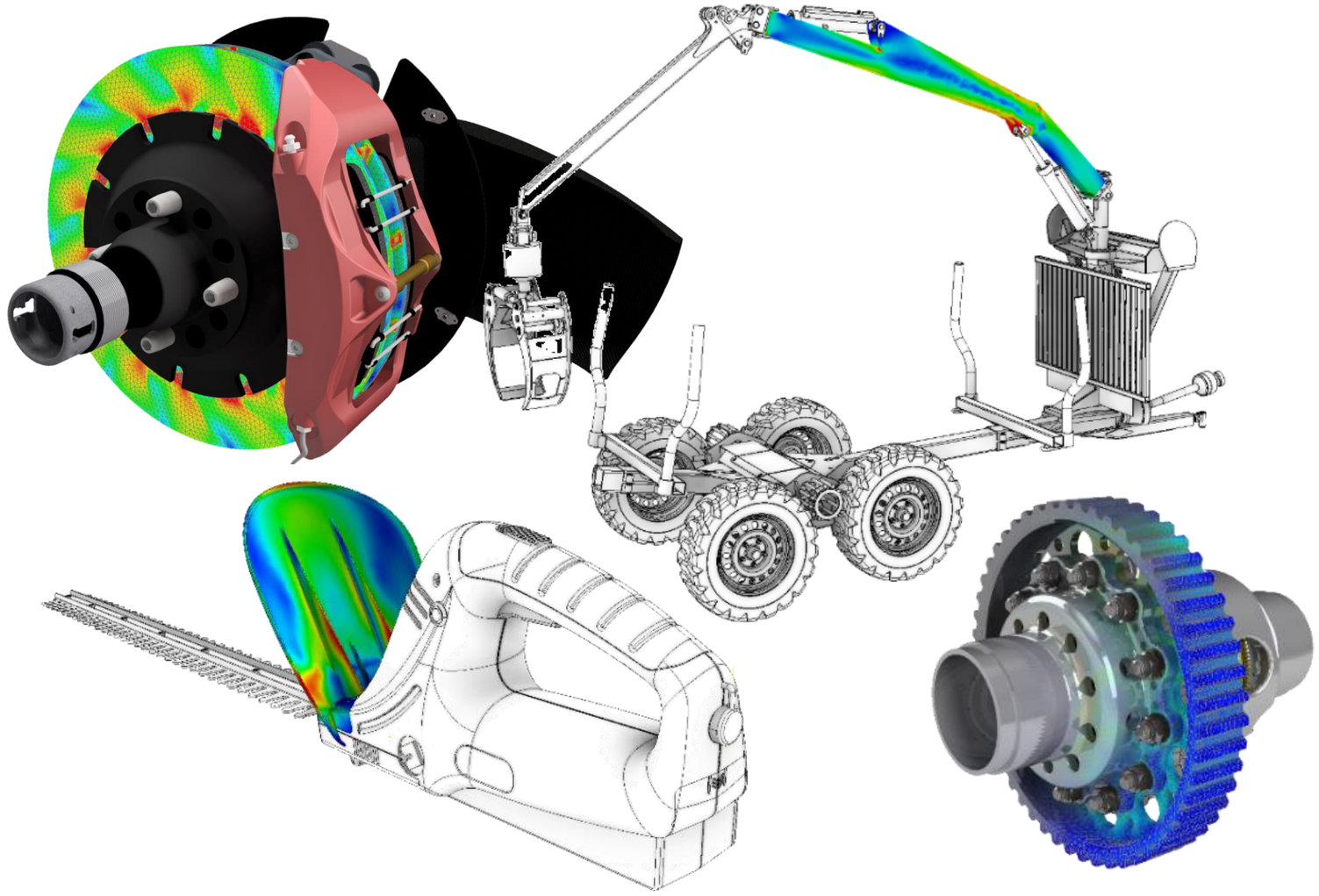


Automated Impact Analysis (AIA) and Drop Test



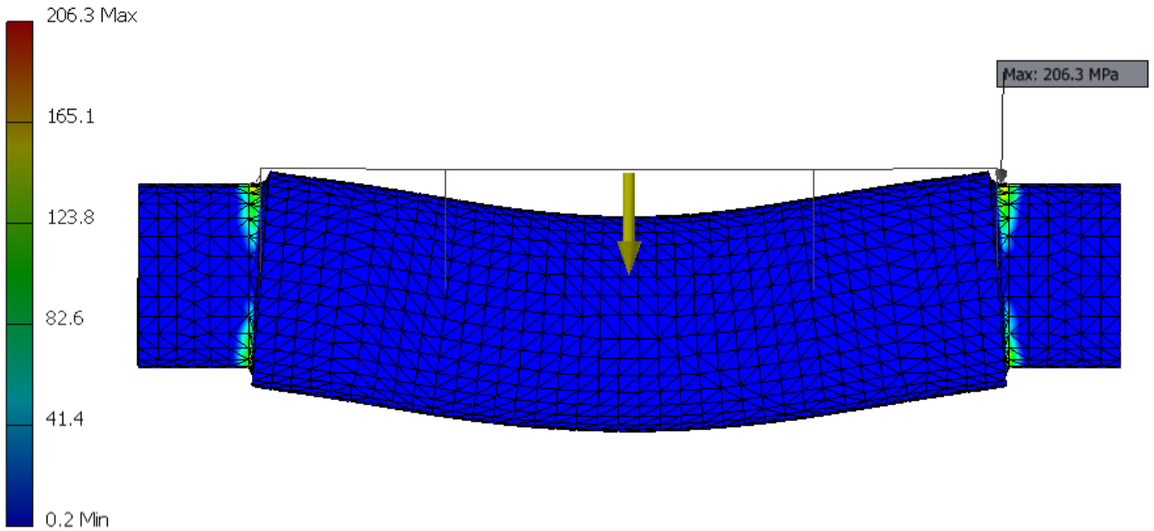
Nastran In-CAD – Overcomes Inventor Analysis limitations

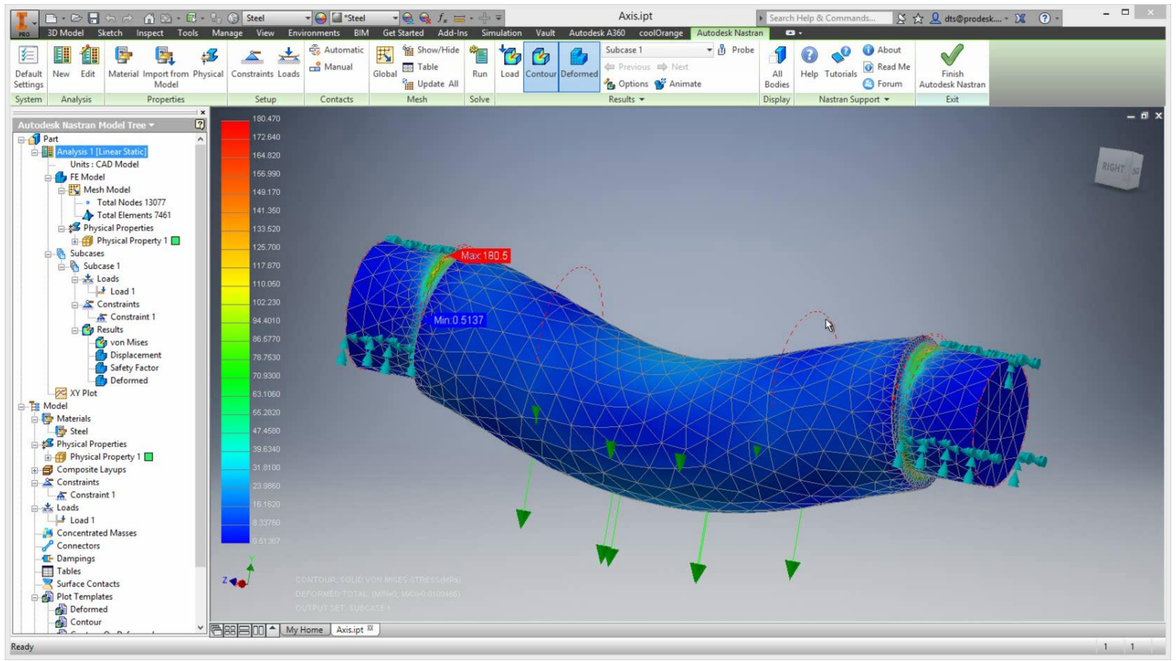
- Bolted Connections
- Buckling
- Thermal Stress
- Fatigue
- Drop-test
- Non-Linear –
  - Beyond Yield Limit
  - Large Displacement
- Frequency response
- And more……



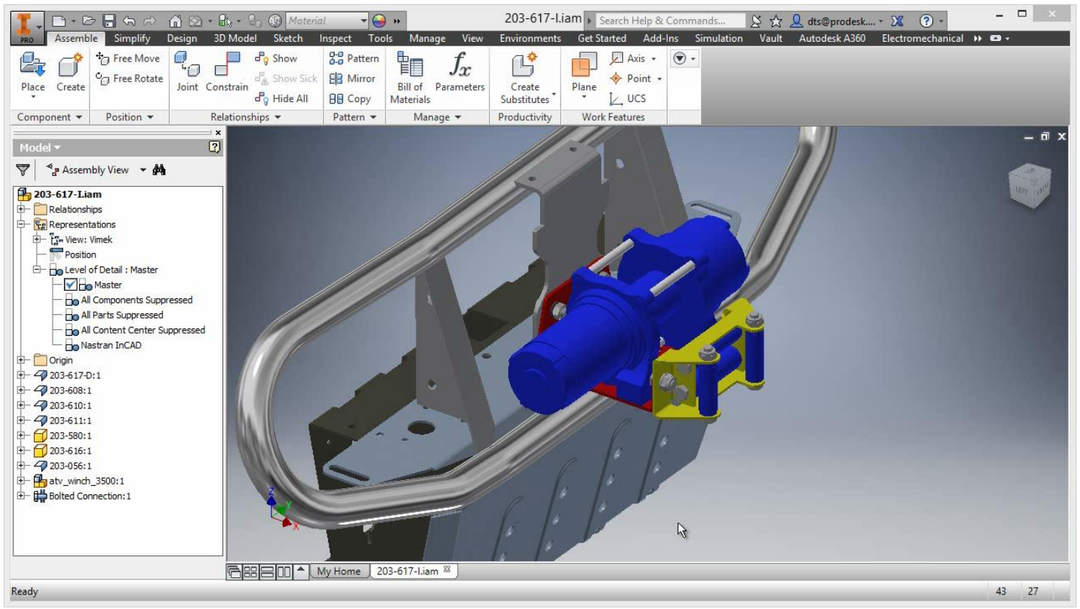
Nastran In-CAD –
Take Inventor Analysis to next level

Nastran In-CAD – Take analysis to next level
Simply support pin

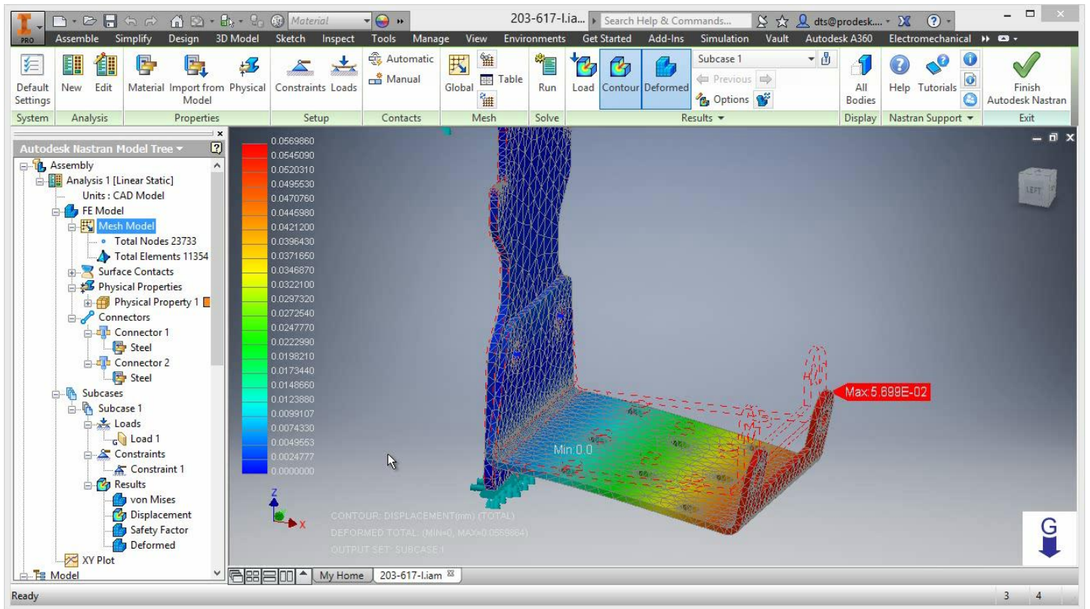




Nastran In-CAD – Take analysis to next level Winch example

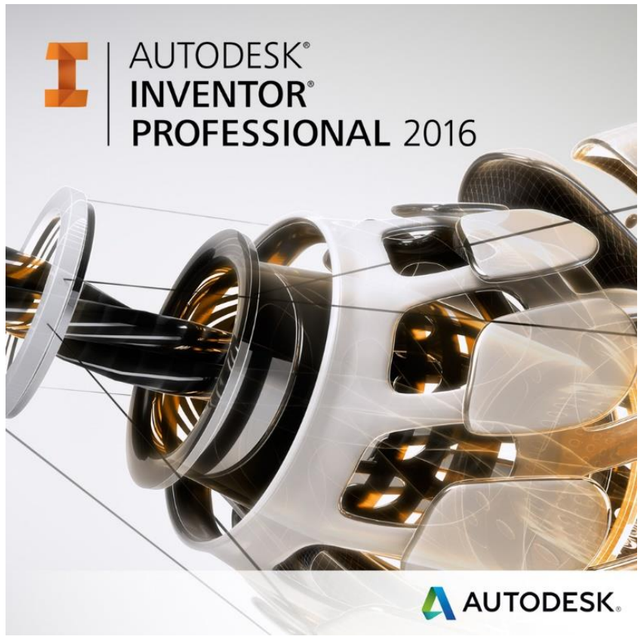


- Assembly analysis including **BOLT PRELOADS** to simulate realistic behaviour of assembly interaction.
- Cannot be done with Inventor Stress Analysis

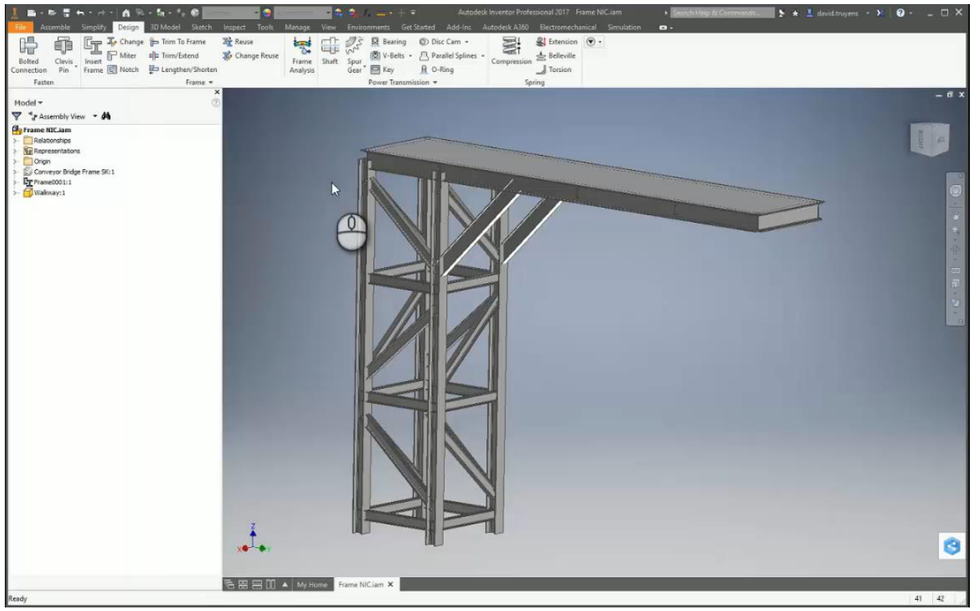


- Assembly analysis using **CONCENTRATED MASS**
- This helps to simplify the model and thus the analysis.
- In Inventor Stress Analysis all of the geometry will need to be included.

Nastran In-CAD – Take analysis to next level Structural Frame

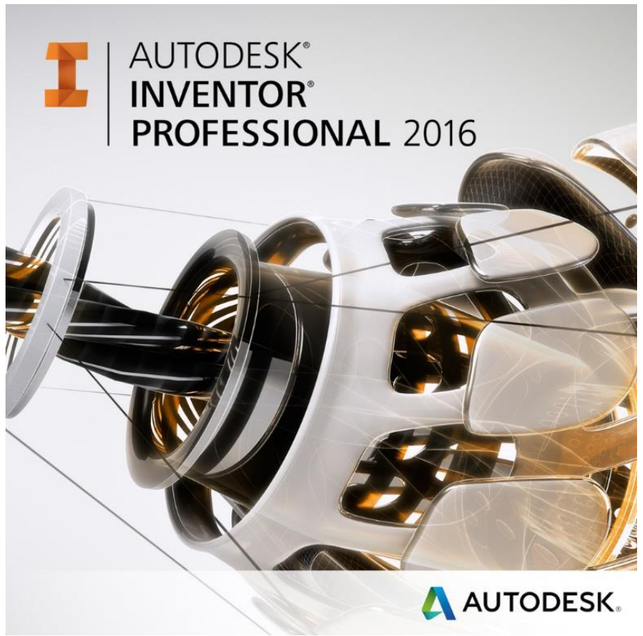


- Cannot combine beam and shell elements within Inventor Stress analysis

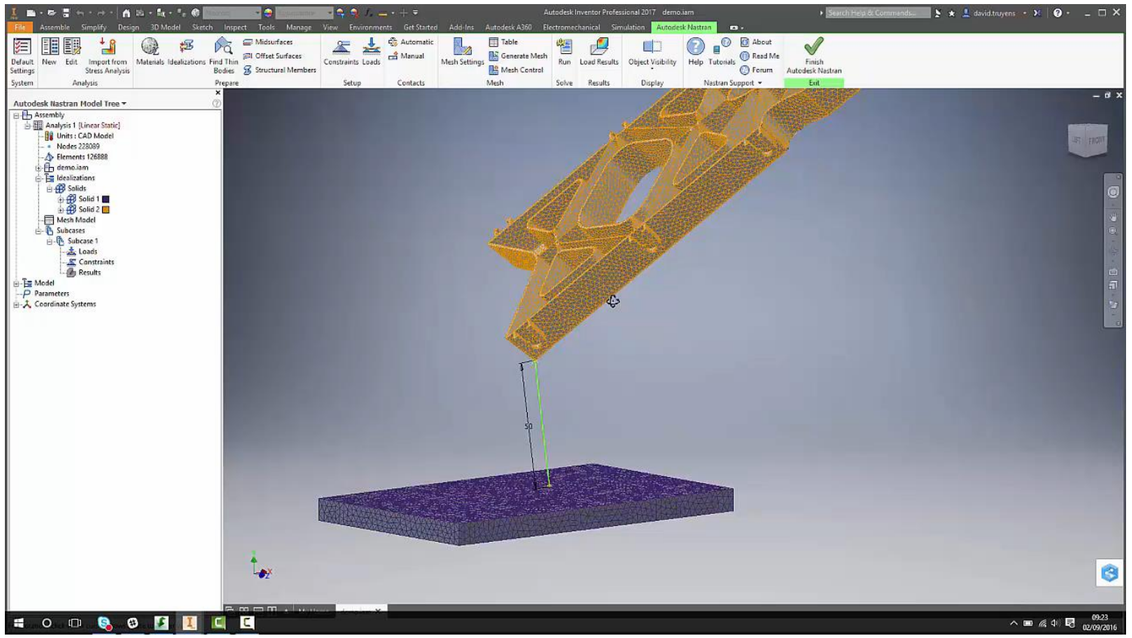


- Nastran In-CAD allows to combine beam and shell elements (plus solid elements)
- Nastran In-CAD makes use of content centre and converts to beam elements

Nastran In-CAD – Take analysis to next level
Drop Test

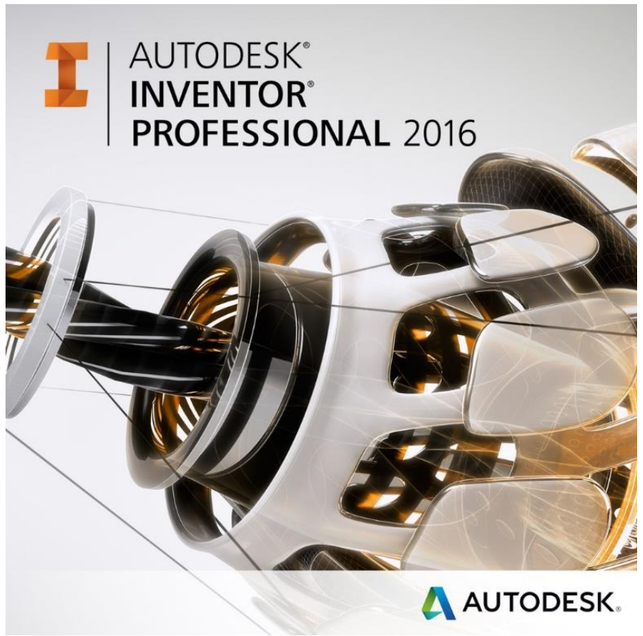


- Cannot be analysed within Inventor Stress Analysis

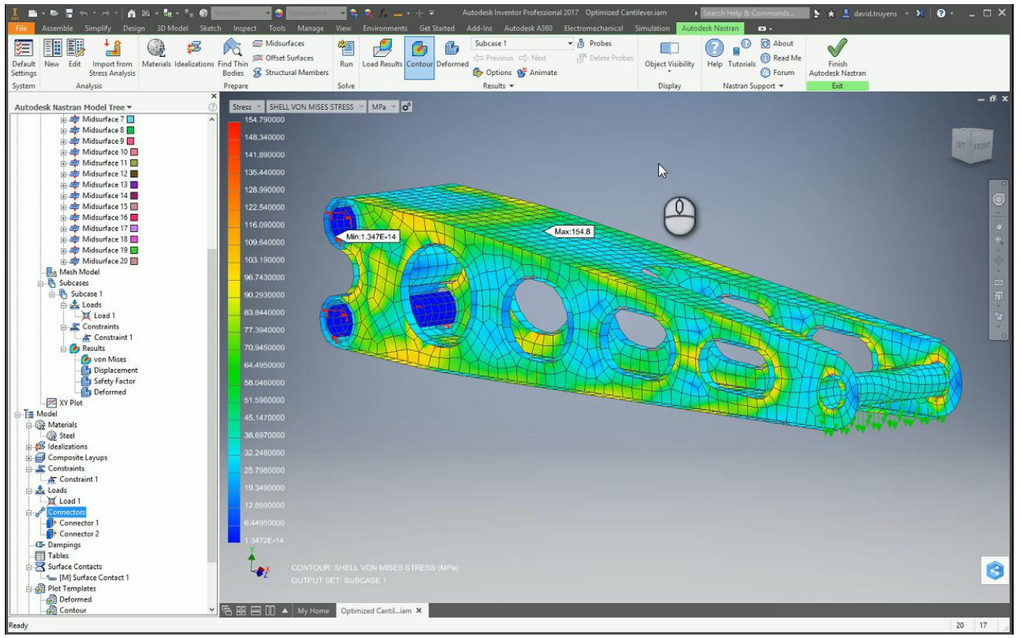


- Nastran In-CAD allows to very easily setup a drop test

Nastran In-CAD – Take analysis to next level Structural Frame



- Cannot perform buckling analysis

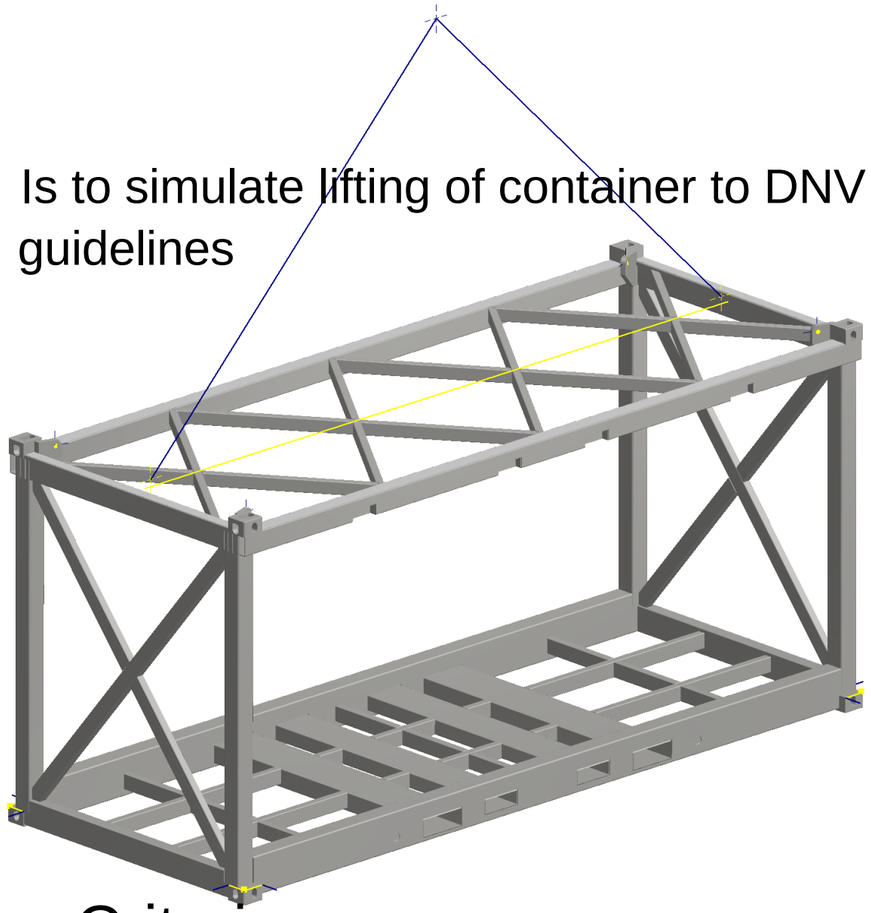


- Nastran In-CAD allows you to perform linear and non-linear buckling.

Customer Examples

Swire Oilfield Services Ltd

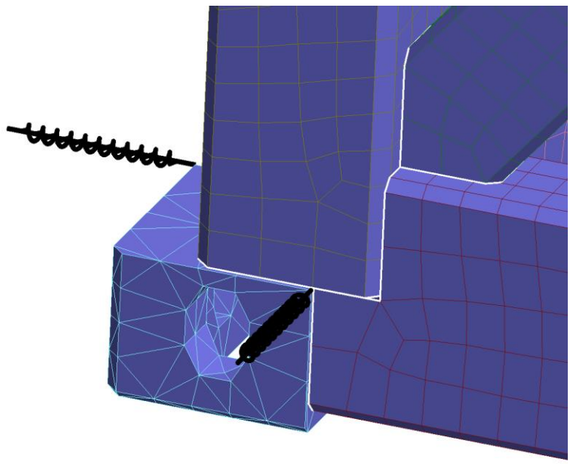
Goal: Is to simulate lifting of container to DNV guidelines

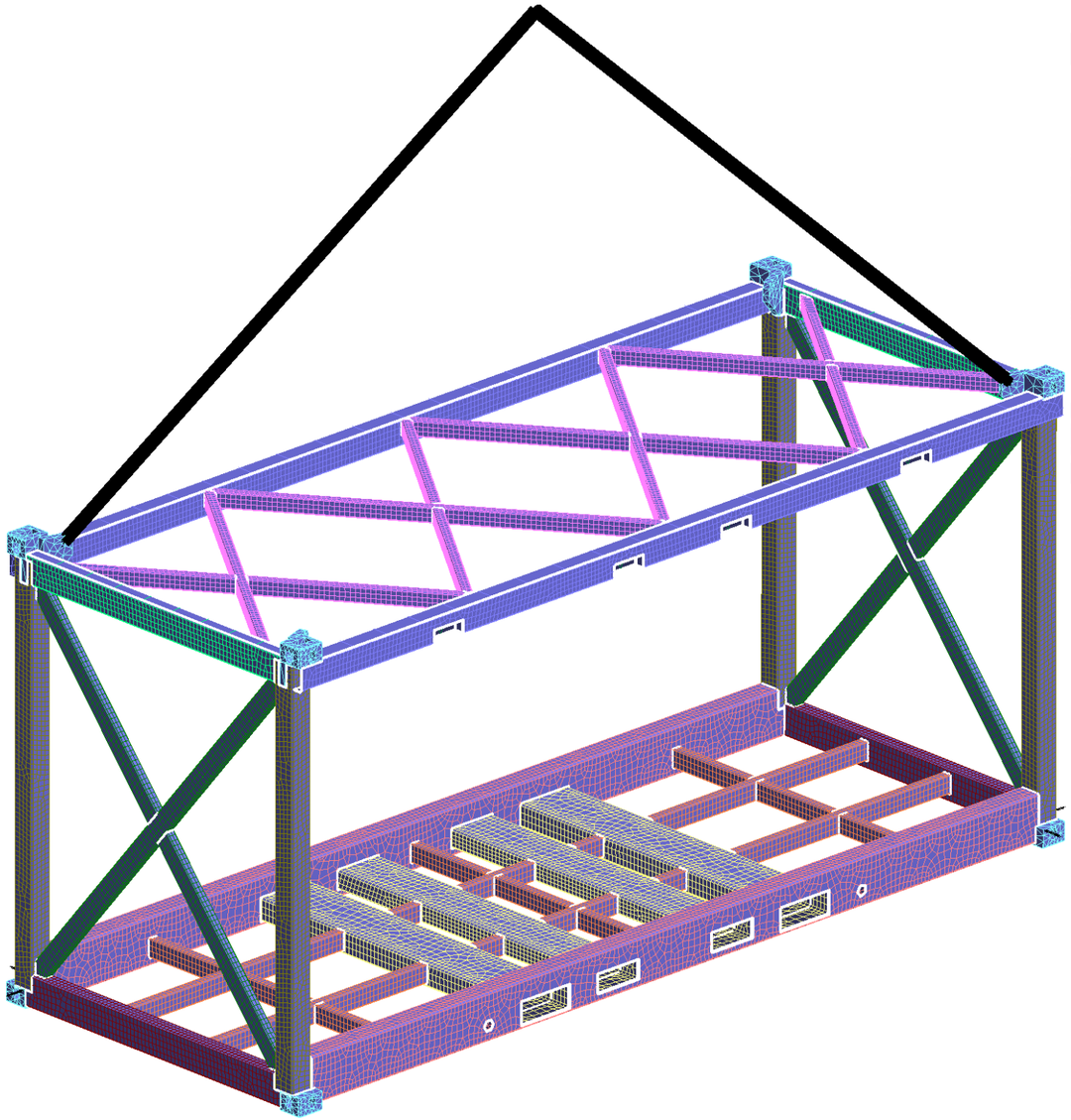


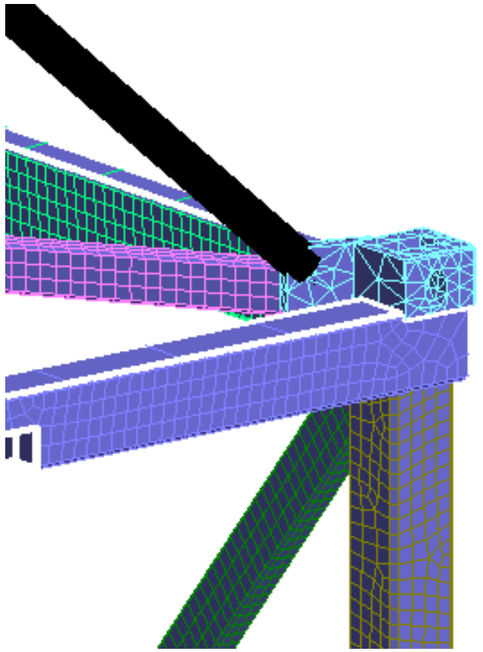
Design Criteria

- Stress is below yield limit

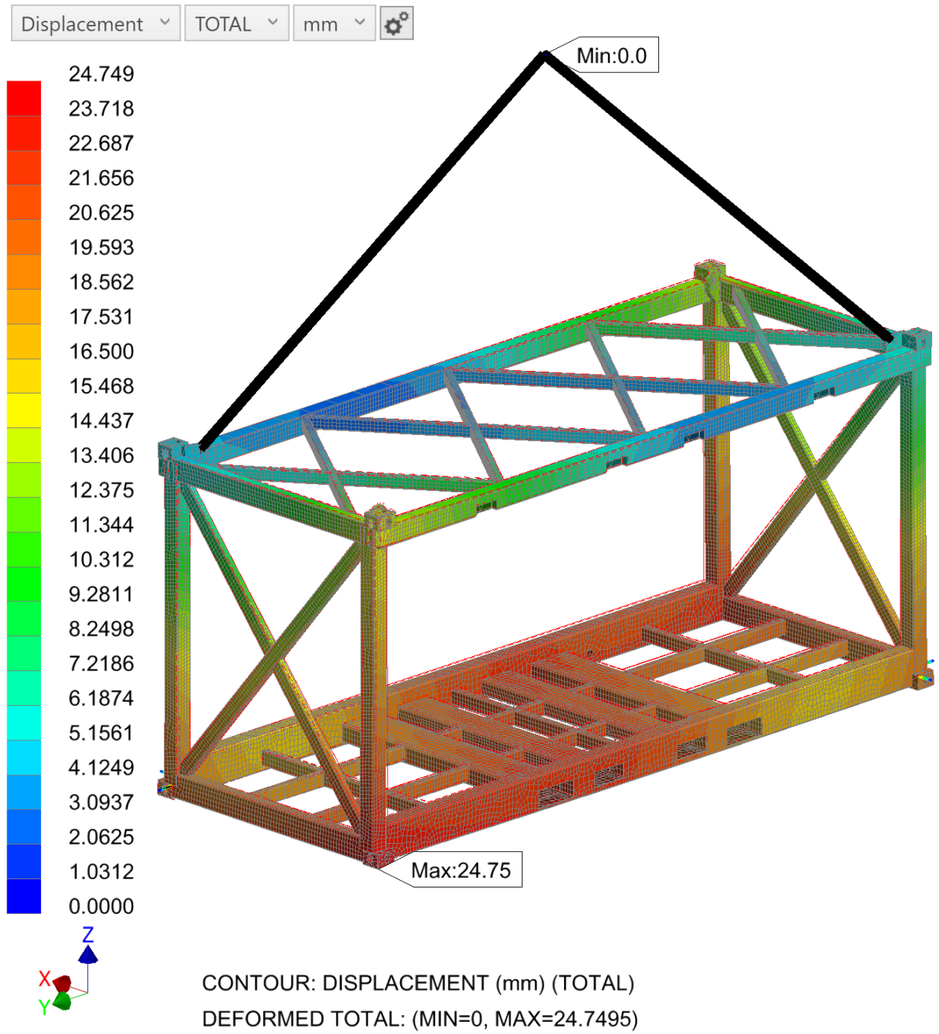
Swire Oilfield Services Ltd

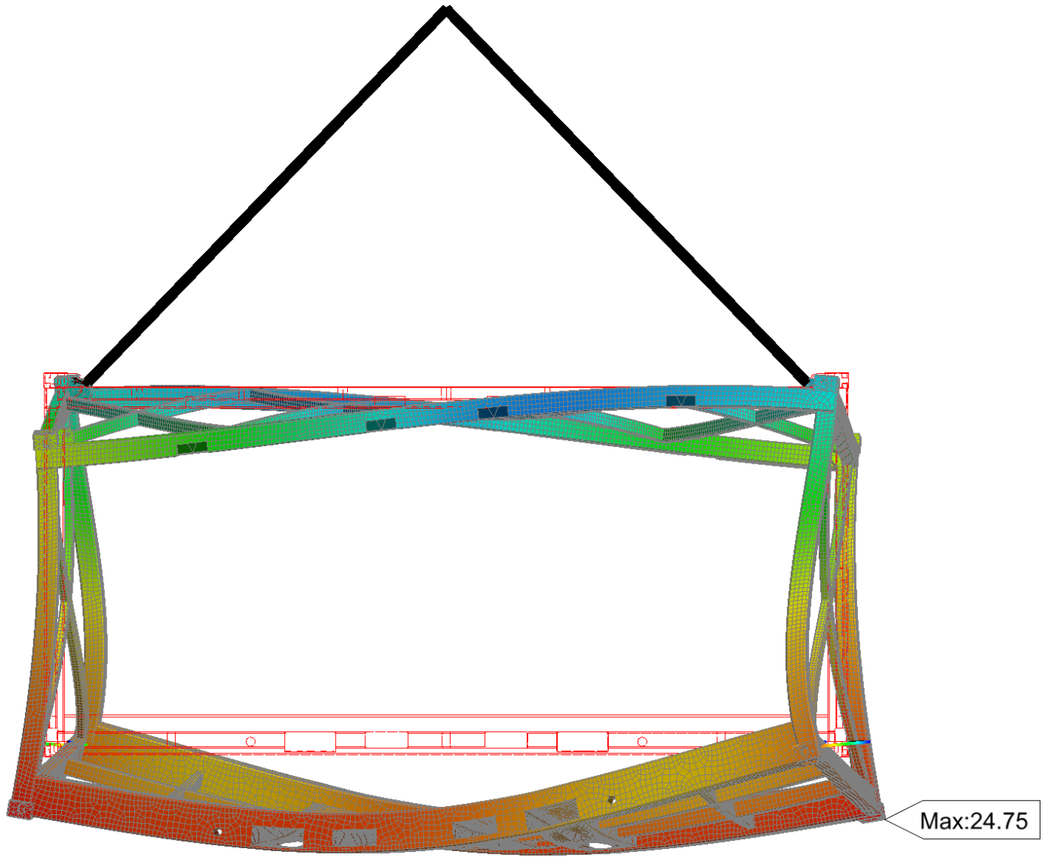






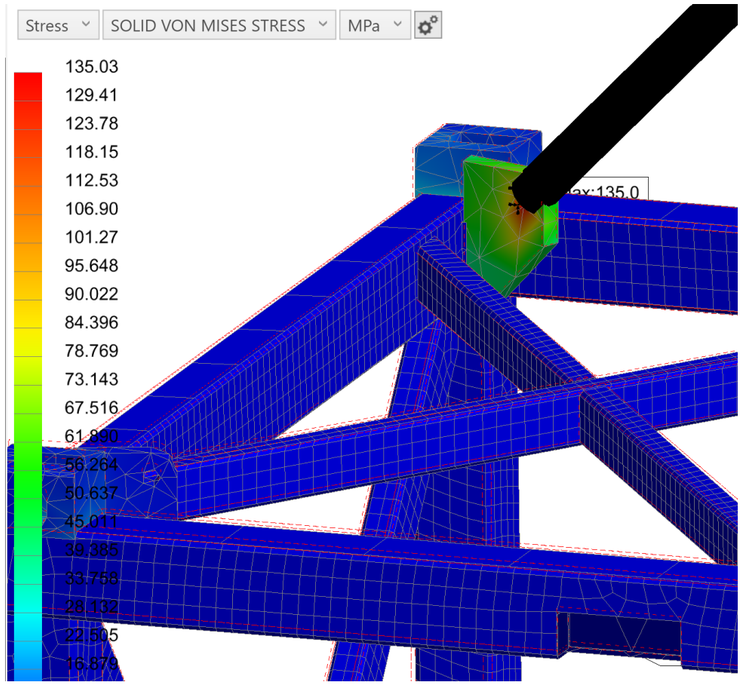
Swire Oilfield Services Ltd

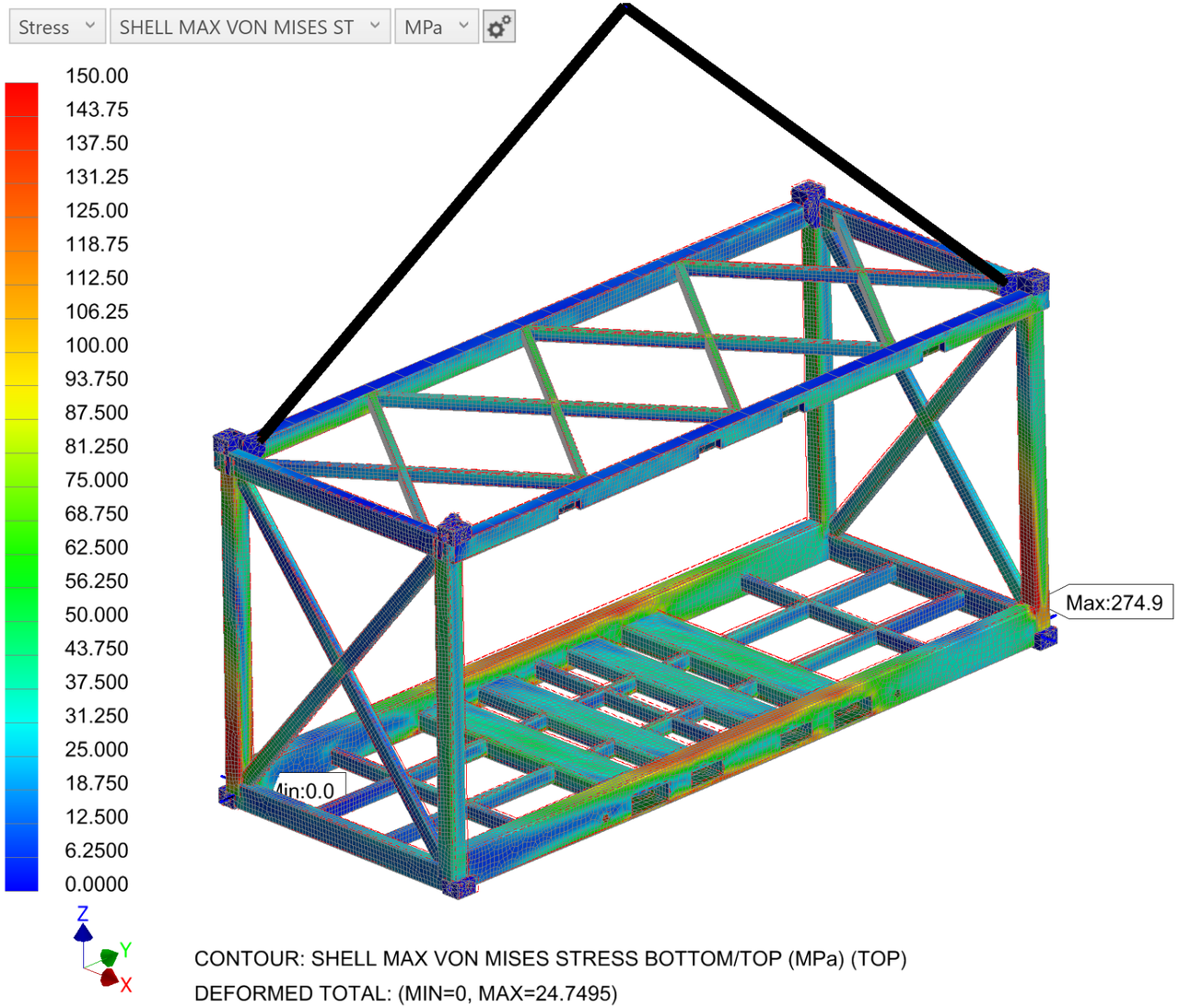




CONTOUR: DISPLACEMENT (mm) (TOTAL)
DEFORMED TOTAL: (MIN=0, MAX=24.7495)
OUTPUT SET: SUBCASE 1

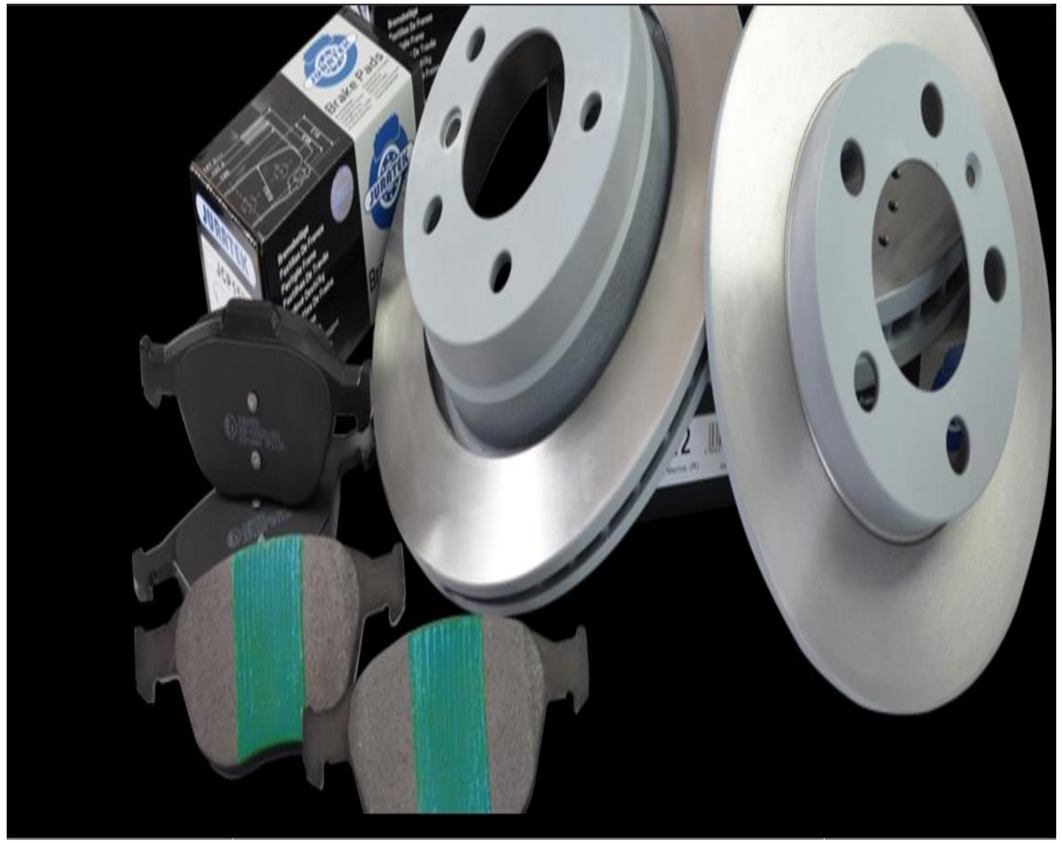
Swire Oilfield Services Ltd



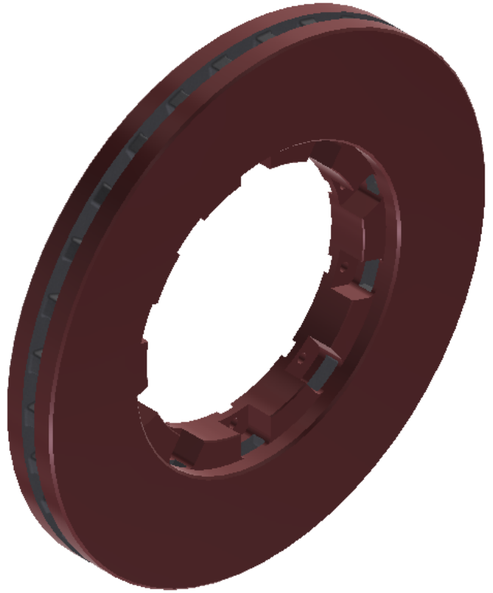


CONTOUR: SHELL MAX VON MISES STRESS BOTTOM/TOP (MPa) (TOP)
DEFORMED TOTAL: (MIN=0, MAX=24.7495)
OUTPUT SET: SUBCASE 1

Juratek



Goal: Is to determine stresses due to braking

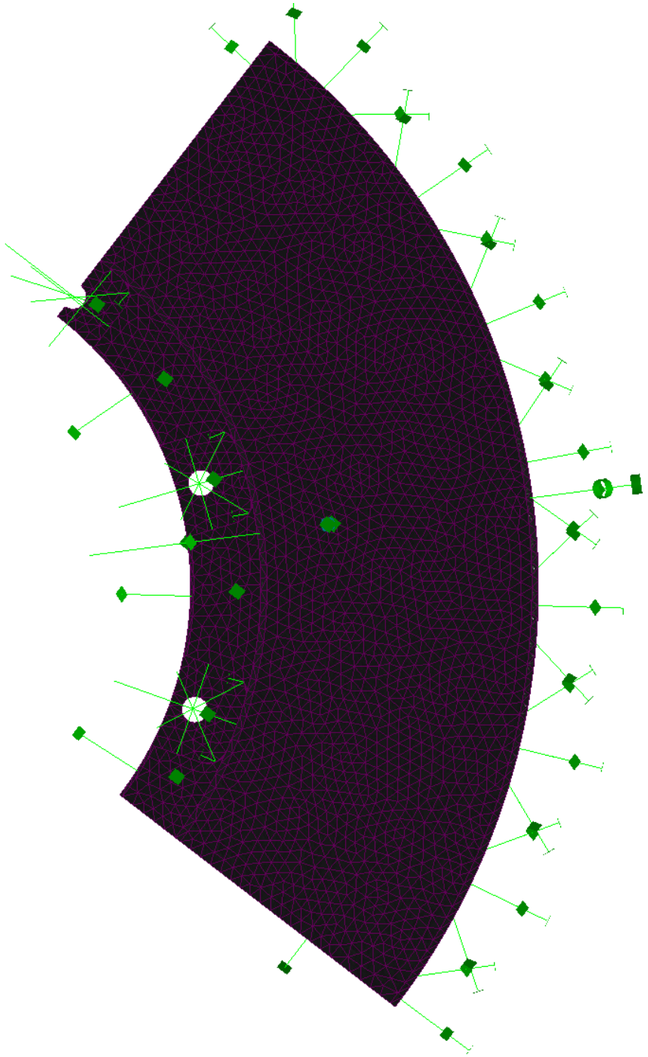


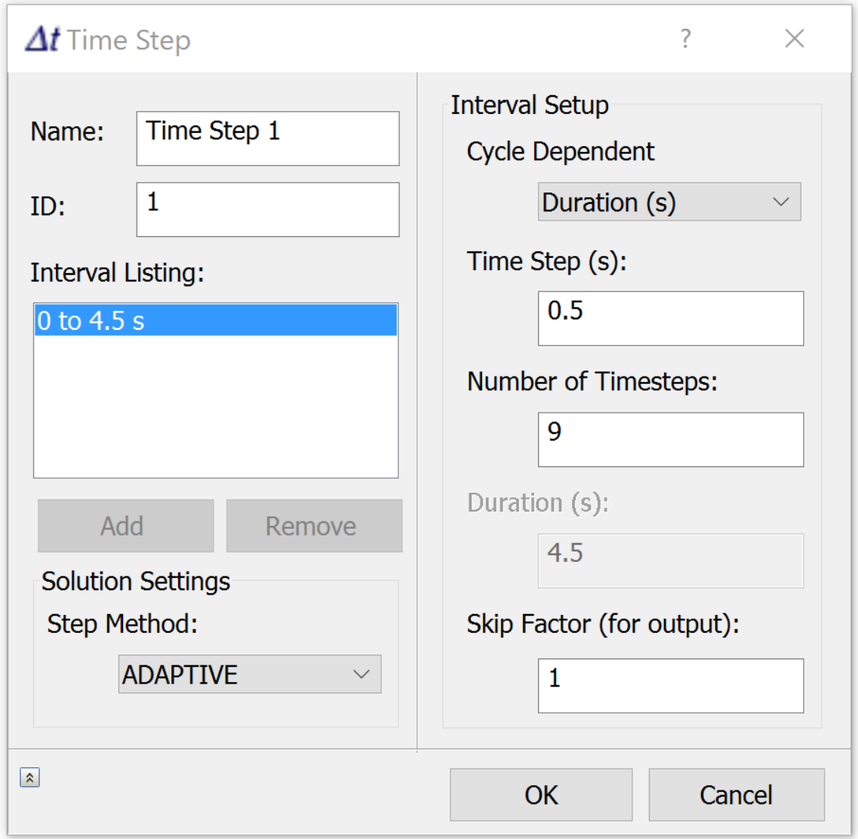
Design Criteria

- Stress is below yield limit

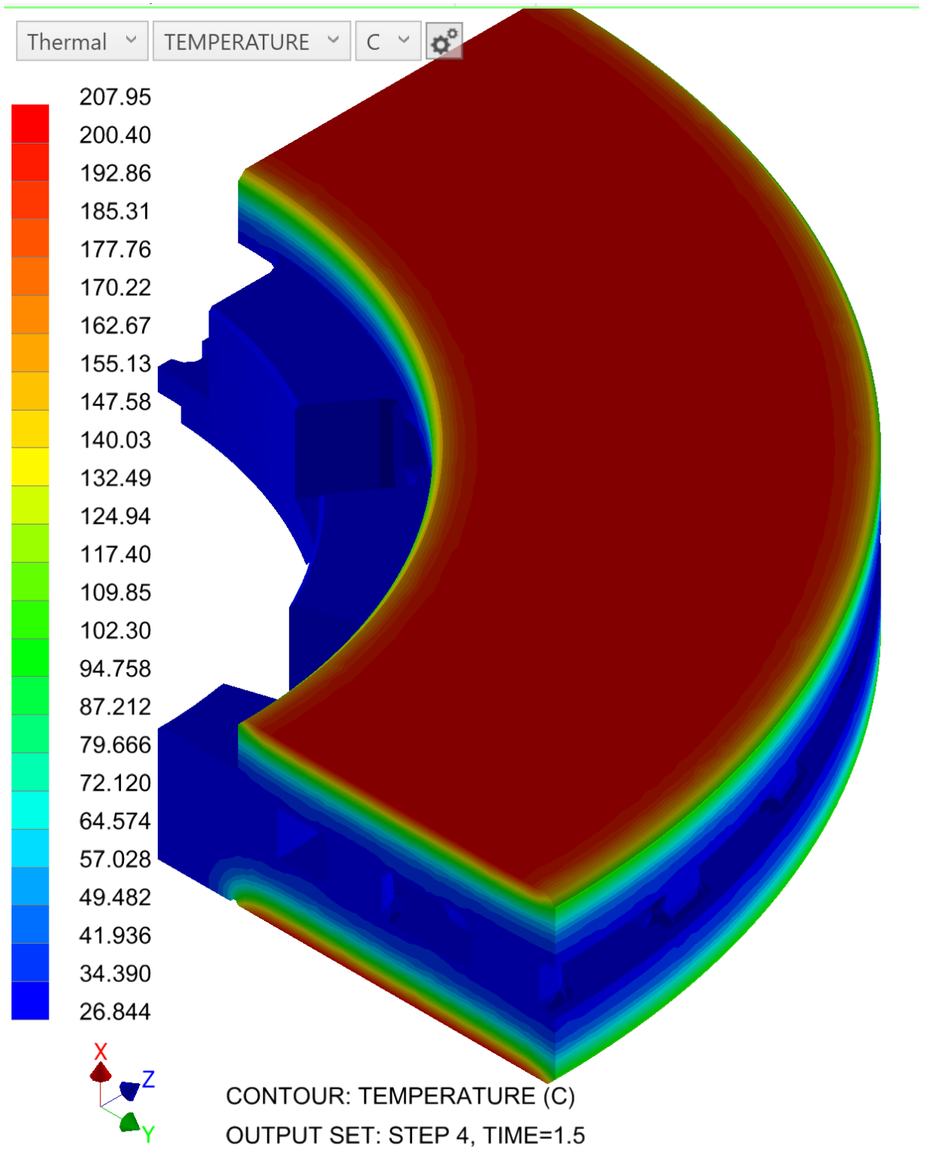
Juratek

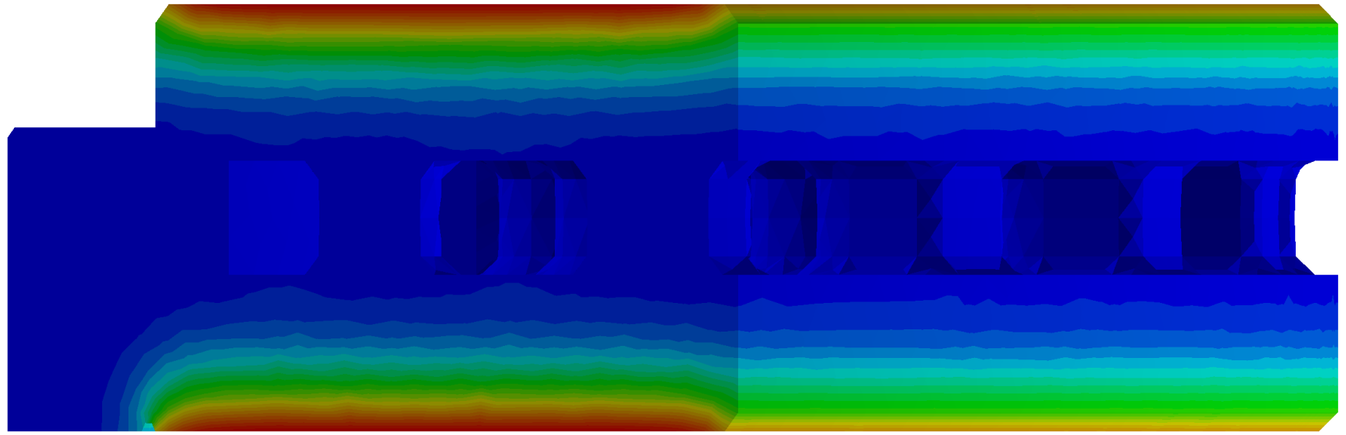
- Part
  - Analysis 1 [Nonlinear Transient Heat Transfer]
    - Units : CAD Model
    - Nodes 325766
    - Elements 227050
    - Part 1
    - Idealizations
      - Solids
        - Solid 1
    - Mesh Model
    - Subcases
      - Subcase 1
        - Loads
          - Heat Flux
          - Convection
          - Radiation
          - Initial Temp
        - Constraints
        - Time Step 1
        - Results
  - Analysis 1 - Copy [Linear Static]
- Model
- Parameters
- Coordinate Systems



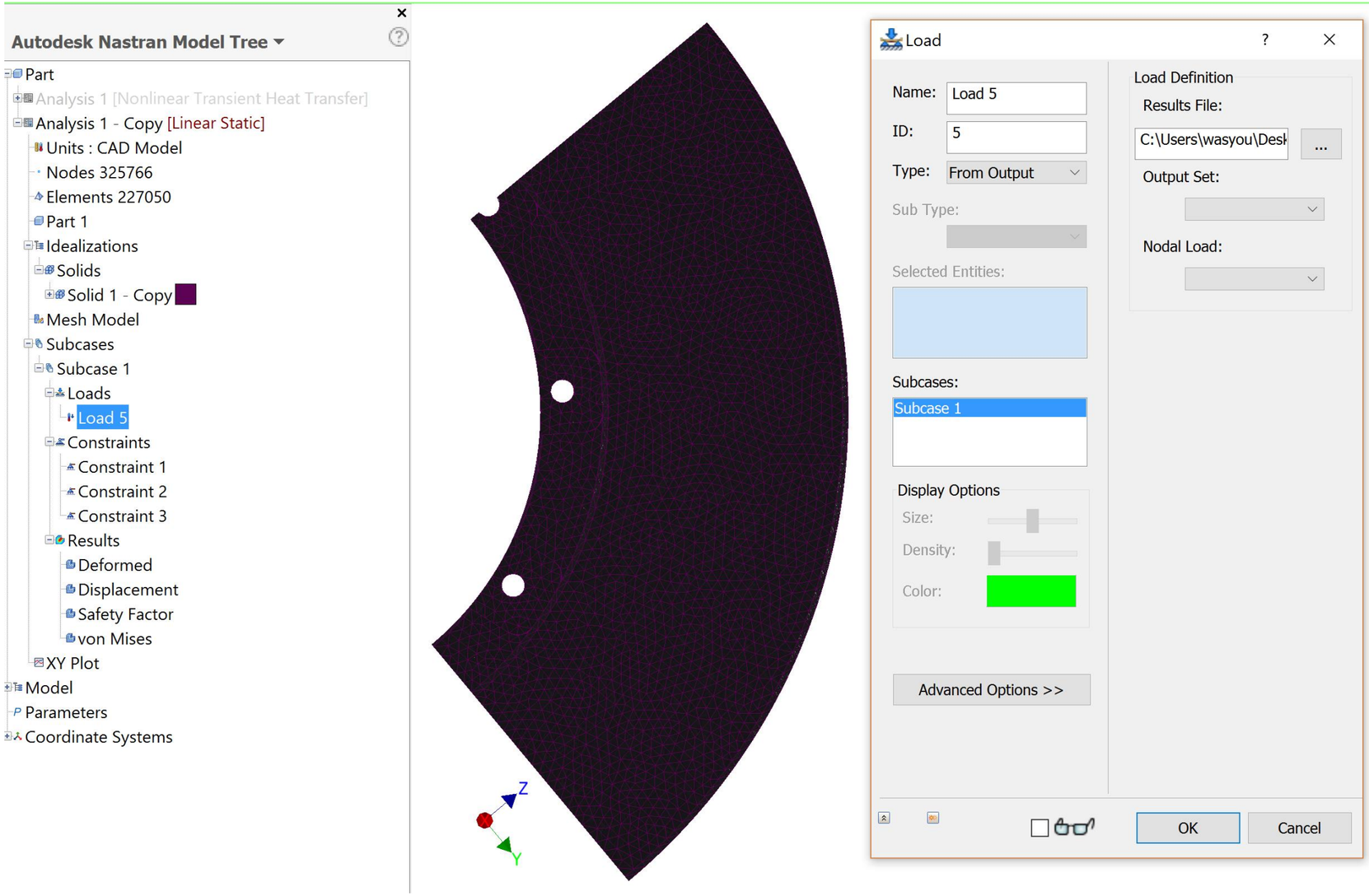


Juratek


Thermal
TEMPERATURE
C
207.95
200.40
192.86
185.31
177.76
170.22
162.67
155.13
147.58
140.03
132.49
124.94
117.40
109.85
102.30
94.758
87.212
79.666
72.120
64.574
57.028
49.482
41.936
34.390
26.844
X
Z
Y
CONTOUR: TEMPERATURE (C)
OUTPUT SET: STEP 4, TIME=1.5

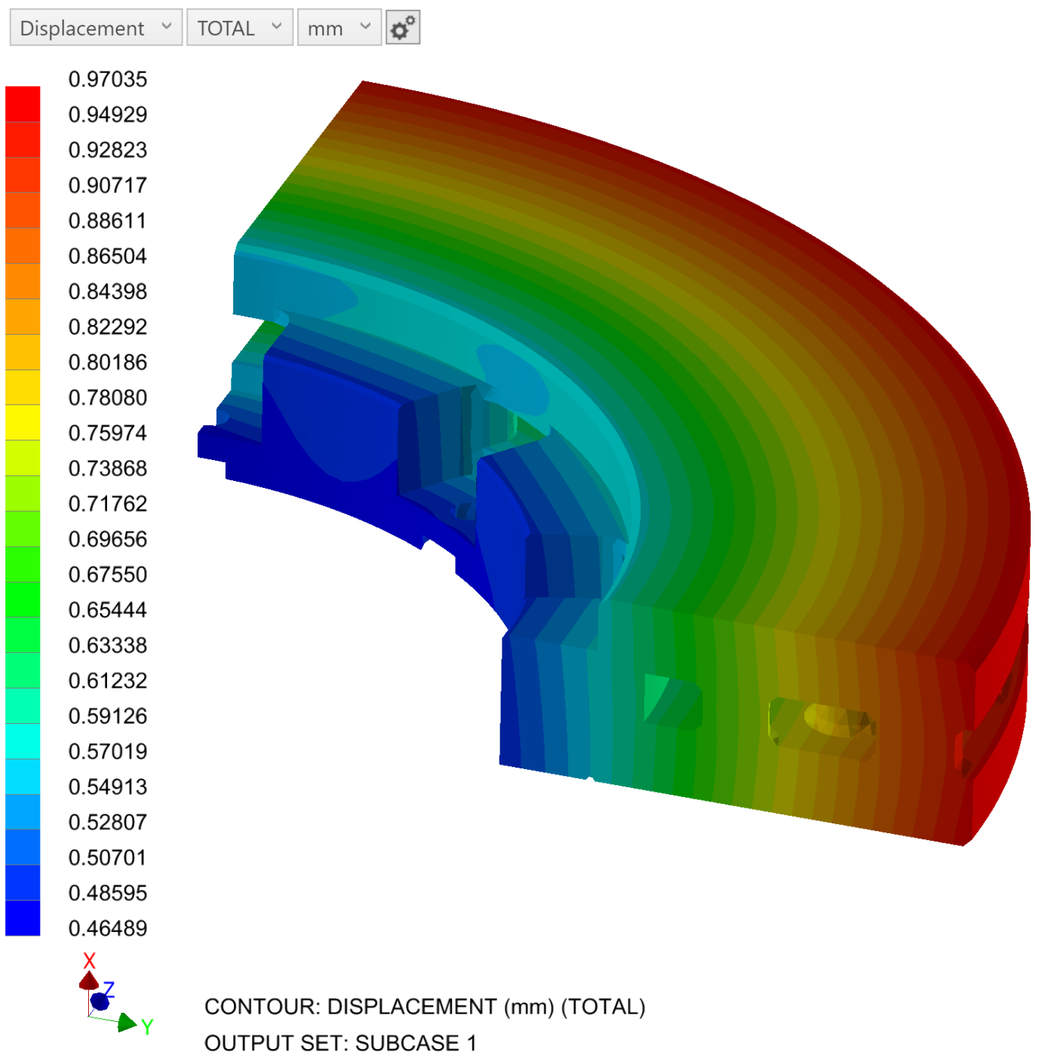


Juratek

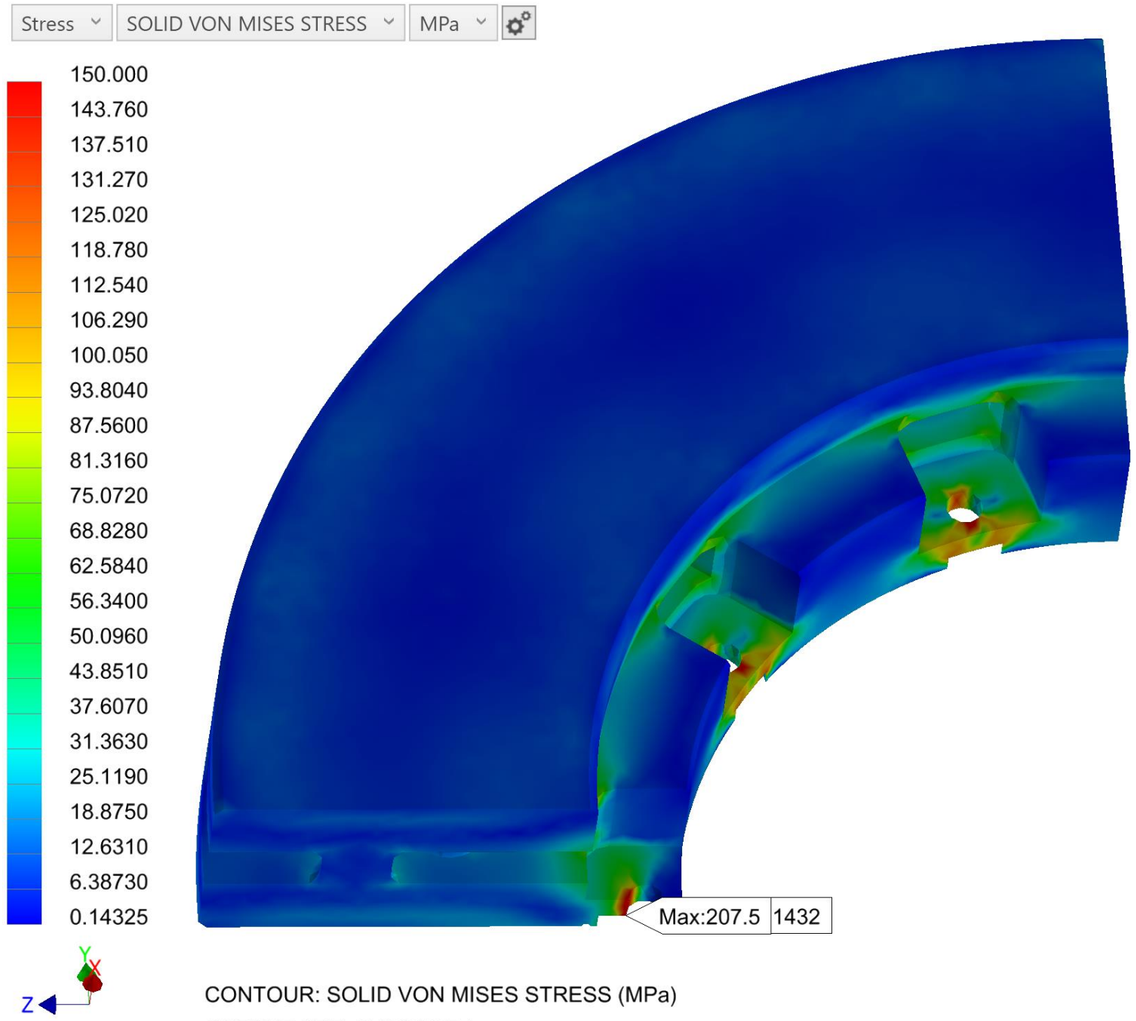

Autodesk Nastran Model Tree
Part
Analysis 1 [Nonlinear Transient Heat Transfer]
Analysis 1 - Copy [Linear Static]
Units : CAD Model
Nodes 325766
Elements 227050
Part 1
Idealizations
Solids
Solid 1 - Copy
Mesh Model
Subcases
Subcase 1
Loads
Load 5
Constraints
Constraint 1
Constraint 2
Constraint 3
Results
Deformed
Displacement
Safety Factor
von Mises
XY Plot
Model
Parameters
Coordinate Systems
Z
Y

Load
Name:
Load 5
ID:
5
Type:
From Output
Sub Type:
Selected Entities:
Subcases:
Subcase 1
Display Options
Size:
Density:
Color:
Advanced Options >>
Load Definition
Results File:
C:\Users\wasyou\Desk
...
Output Set:
Nodal Load:
OK
Cancel

Juratek



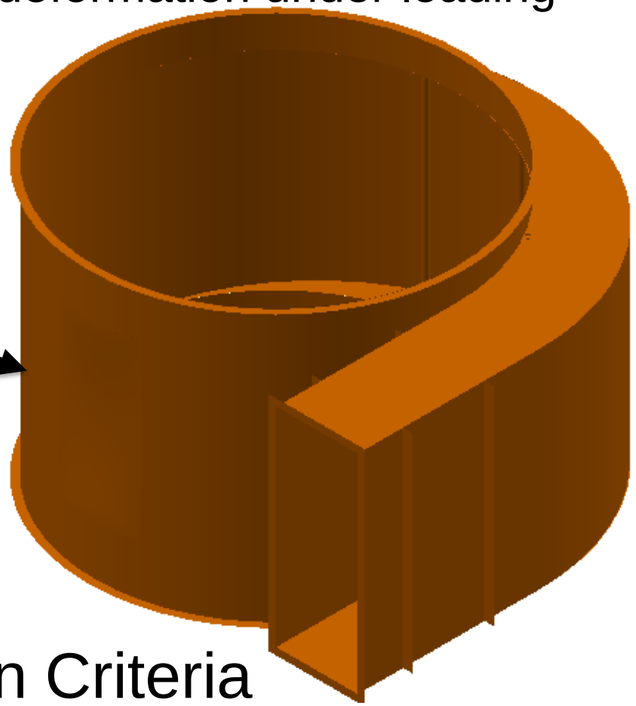
CONTOUR: DISPLACEMENT (mm) (TOTAL)
OUTPUT SET: SUBCASE 1



CONTOUR: SOLID VON MISES STRESS (MPa)
OUTPUT SET: SUBCASE 1

Simatek Ltd

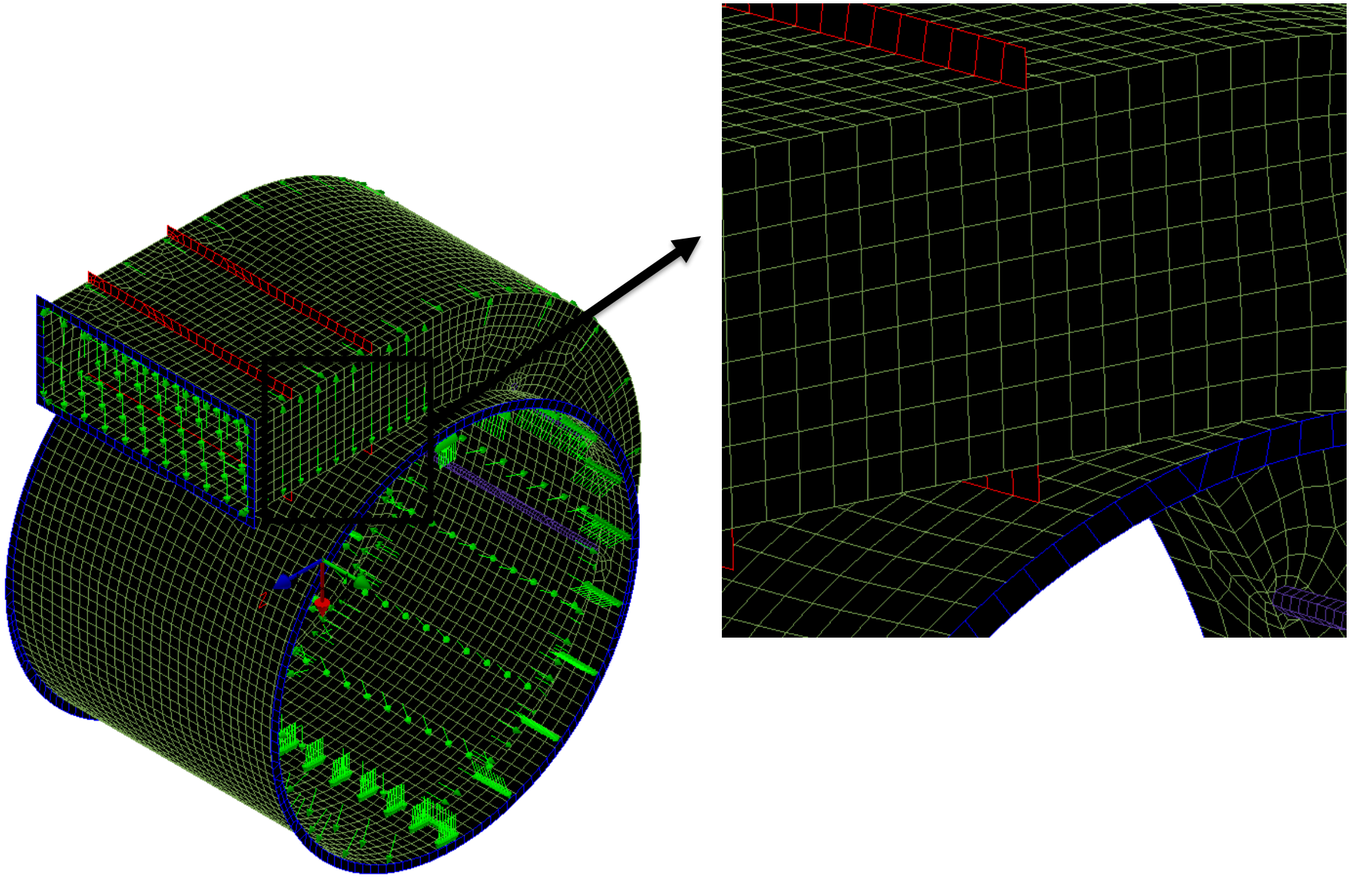
Goal: Is to determine amount of permanent deformation under loading



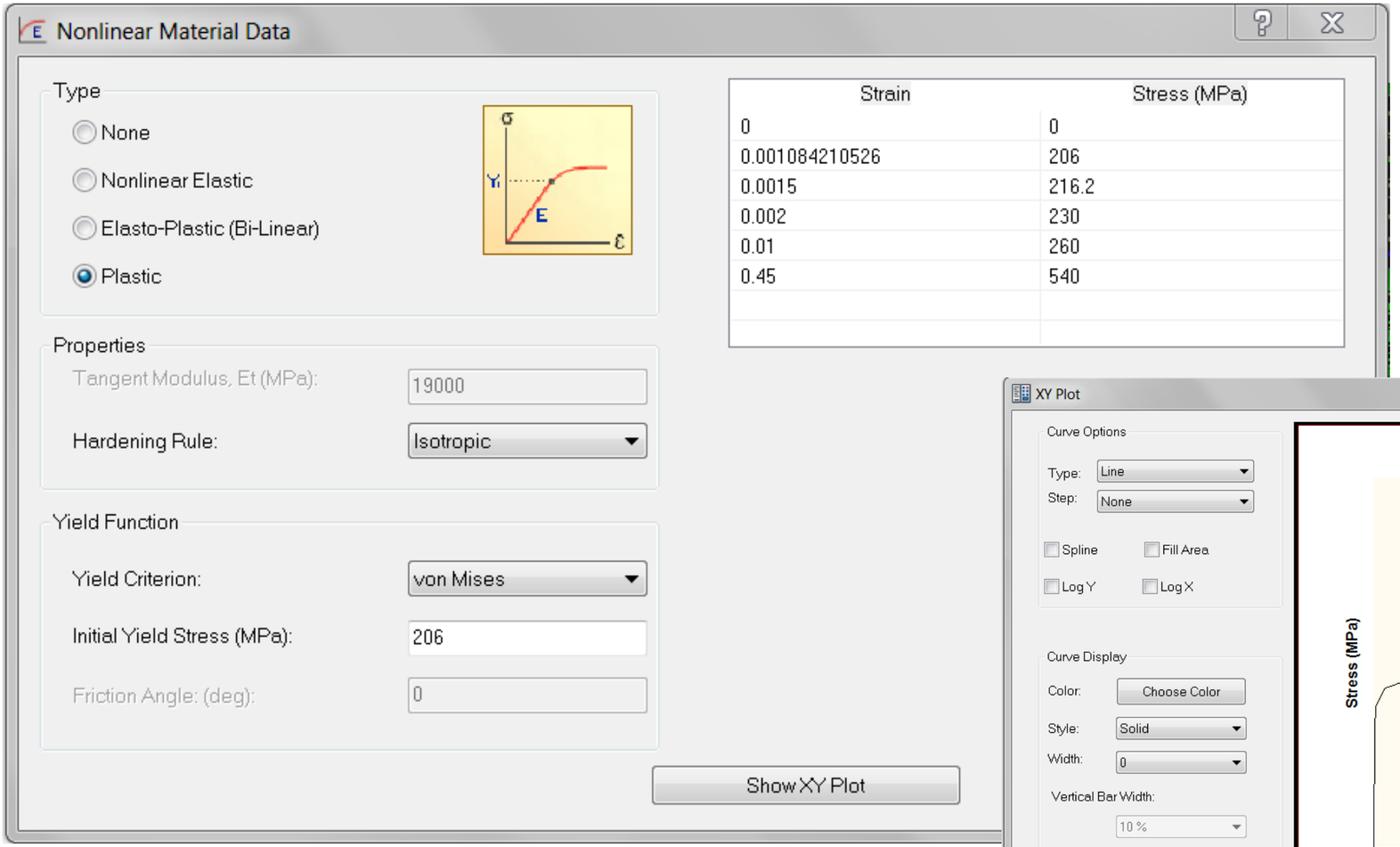
Design Criteria

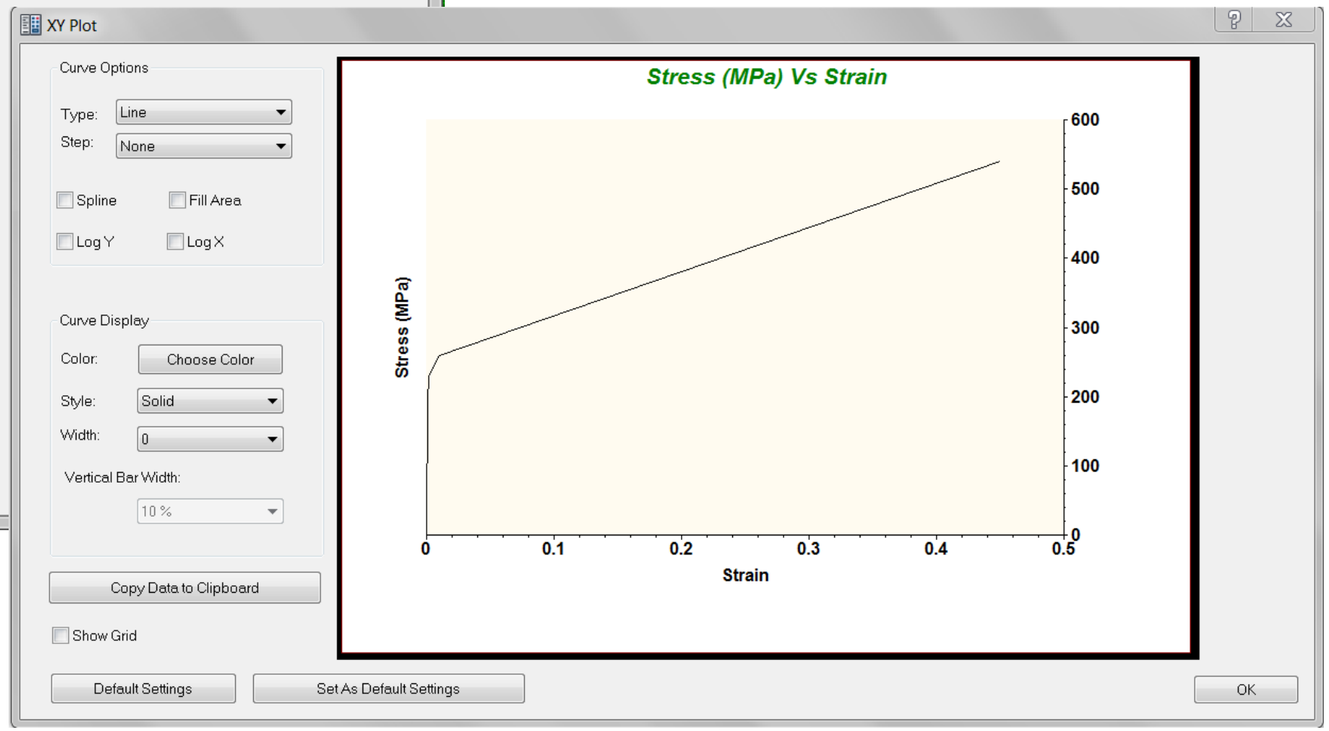
- Predefined Stress/Strain Material data
- Pressure 90 MPa

Simatek Ltd



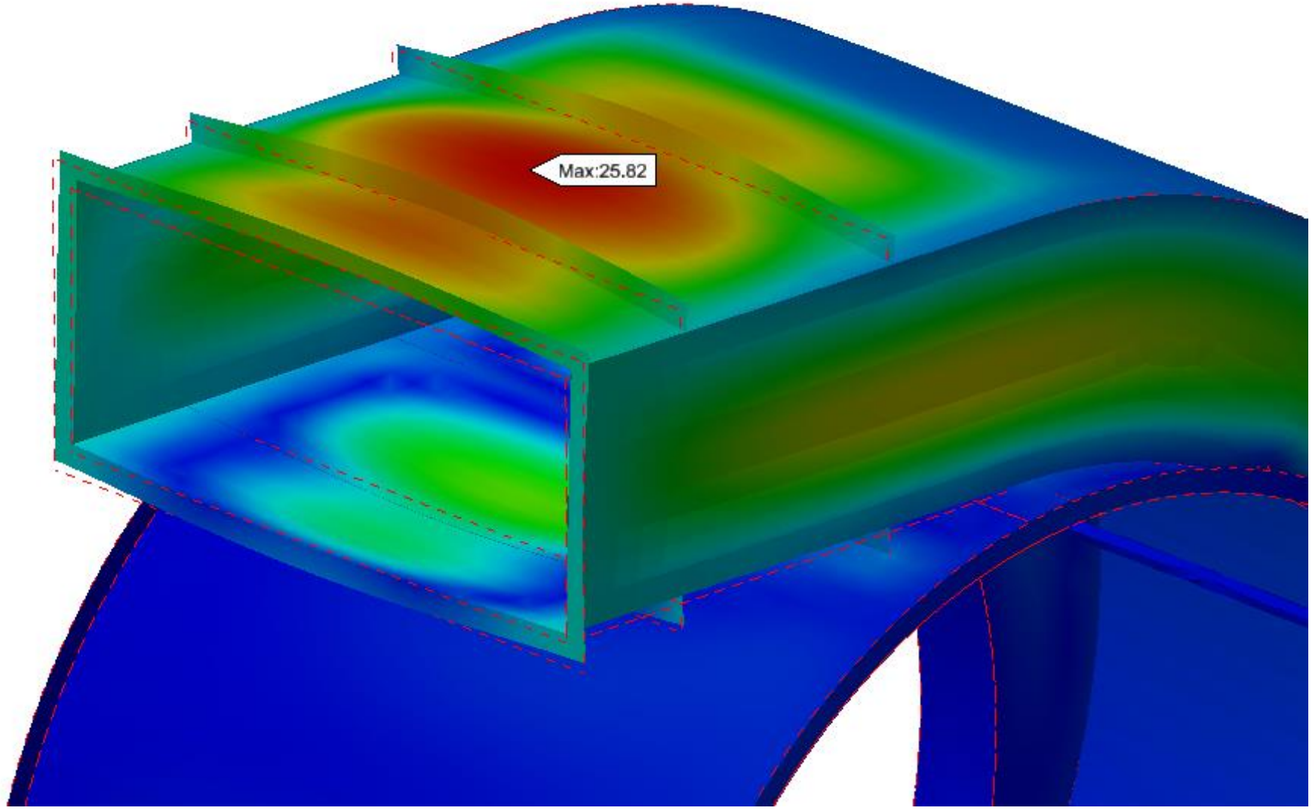
Simatek Ltd


Nonlinear Material Data
Type
None
Nonlinear Elastic
Elasto-Plastic (Bi-Linear)
Plastic
σ
Yi
E
ε
Strain
Stress (MPa)
0
0
0.001084210526
206
0.0015
216.2
0.002
230
0.01
260
0.45
540
Properties
Tangent Modulus, Et (MPa):
19000
Hardening Rule:
Isotropic
Yield Function
Yield Criterion:
von Mises
Initial Yield Stress (MPa):
206
Friction Angle: (deg):
0
Show XY Plot

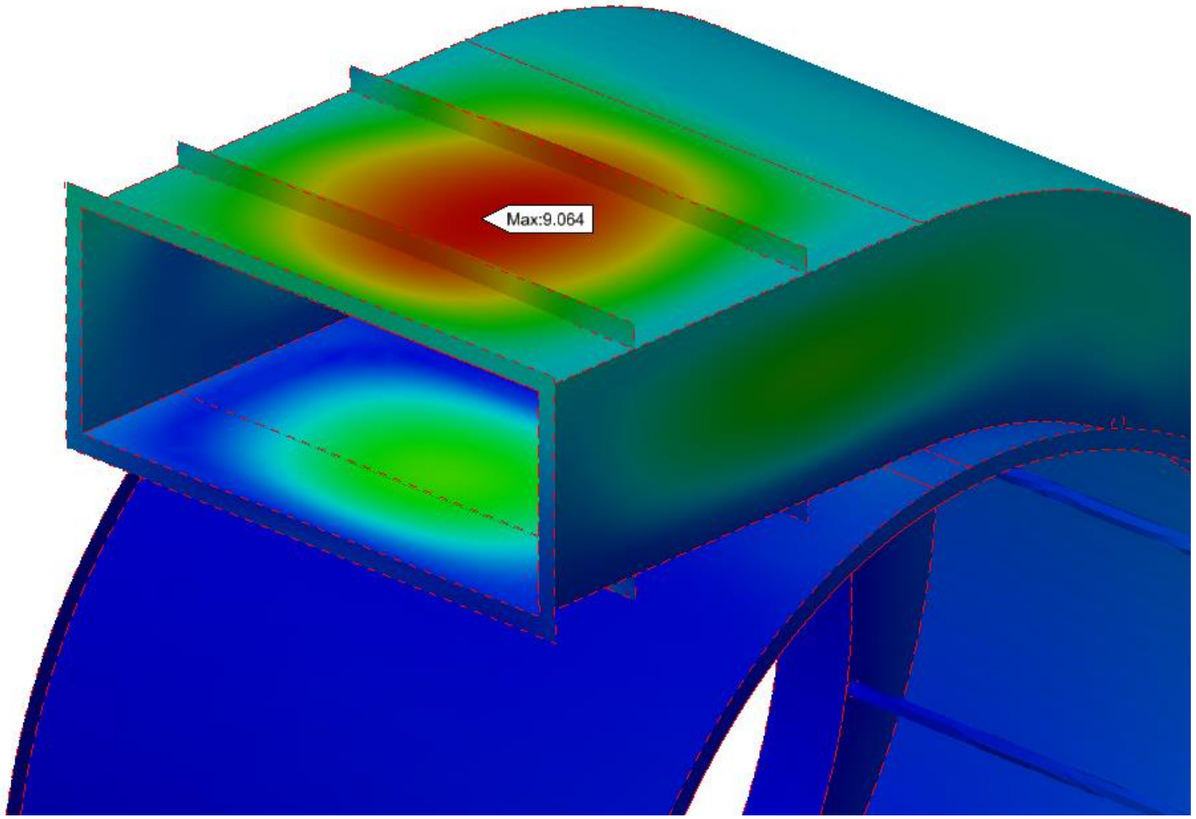

XY Plot
Curve Options
Type:
Line
Step:
None
Spline
Fill Area
Log Y
Log X
Curve Display
Color:
Choose Color
Style:
Solid
Width:
0
Vertical Bar Width:
10 %
Copy Data to Clipboard
Show Grid
Default Settings
Set As Default Settings
OK
Stress (MPa) Vs Strain
Stress (MPa)
Strain
600
500
400
300
200
100
0
0
0.1
0.2
0.3
0.4
0.5

Simatek Ltd

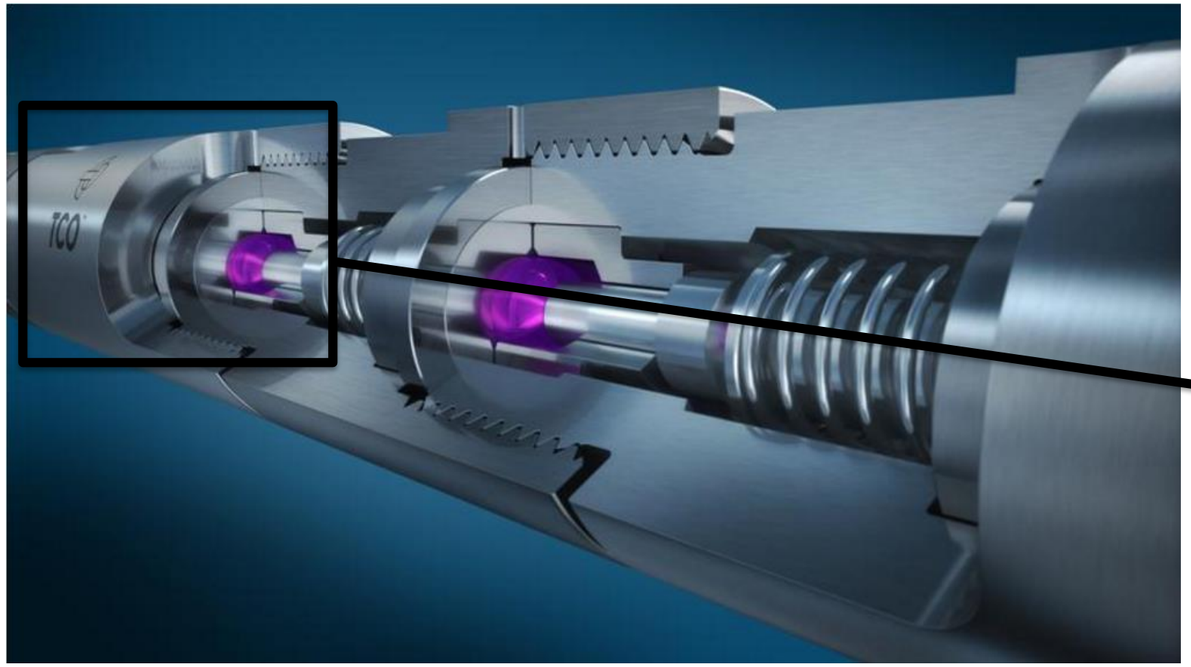
Deformation under loading



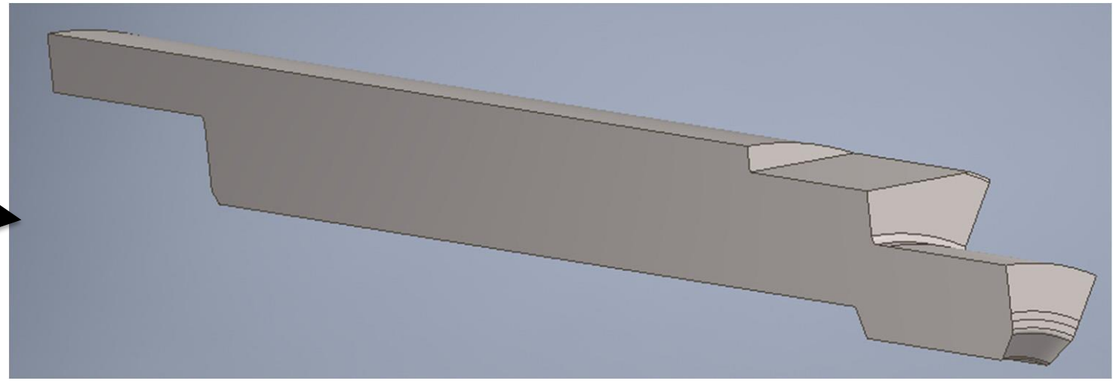
Permanent Deformation when unloaded



TCO



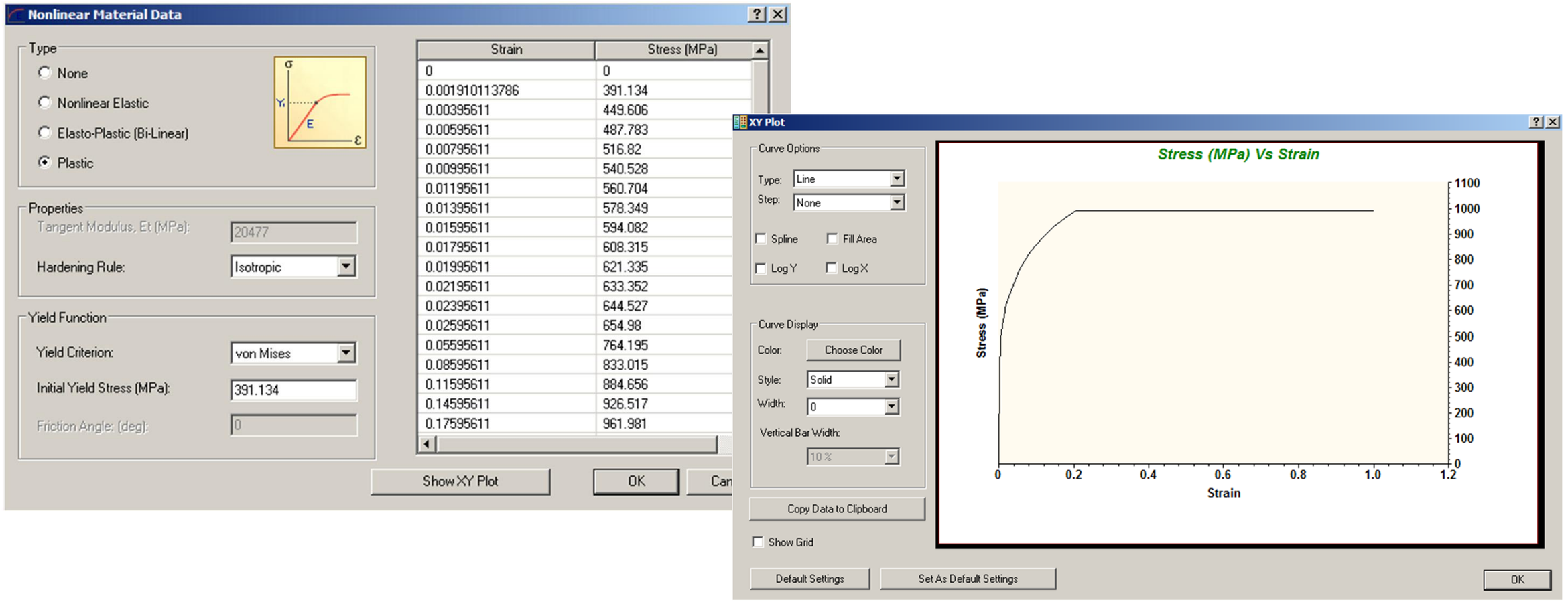
Goal: Is to determine whether component retain blast pressures



Design Criteria

- Predefined Stress/Strain data
- Multiple Load cases

TCO



If solution diverges the part is considered to be unsuitable

NB: As loads are multiplied by a safety factor of 3.5

TCO

4.4 Review of plastic strain

4.4.1 01-SetupMeshCheck (Linear Static)

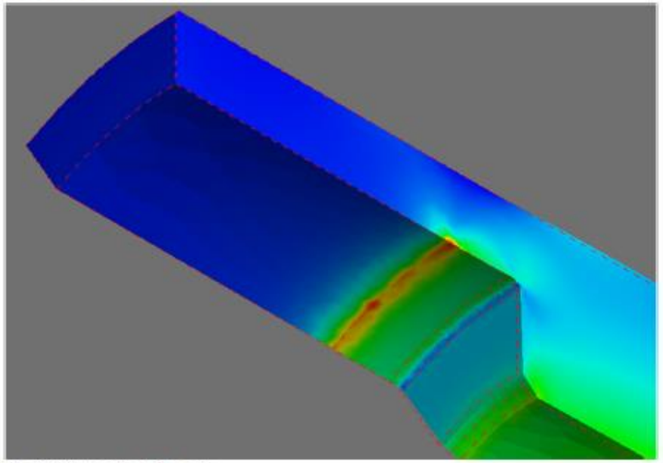
The scale was normalised to min and max value:

Side:

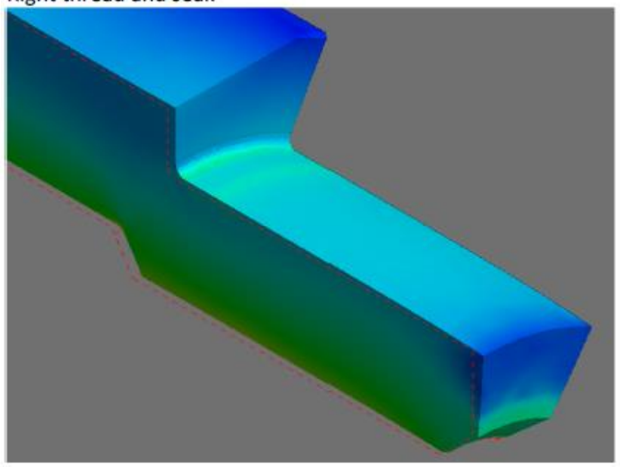
Top:

Bottom:

Left thread and seal:



Right thread and seal:



CUE DEE

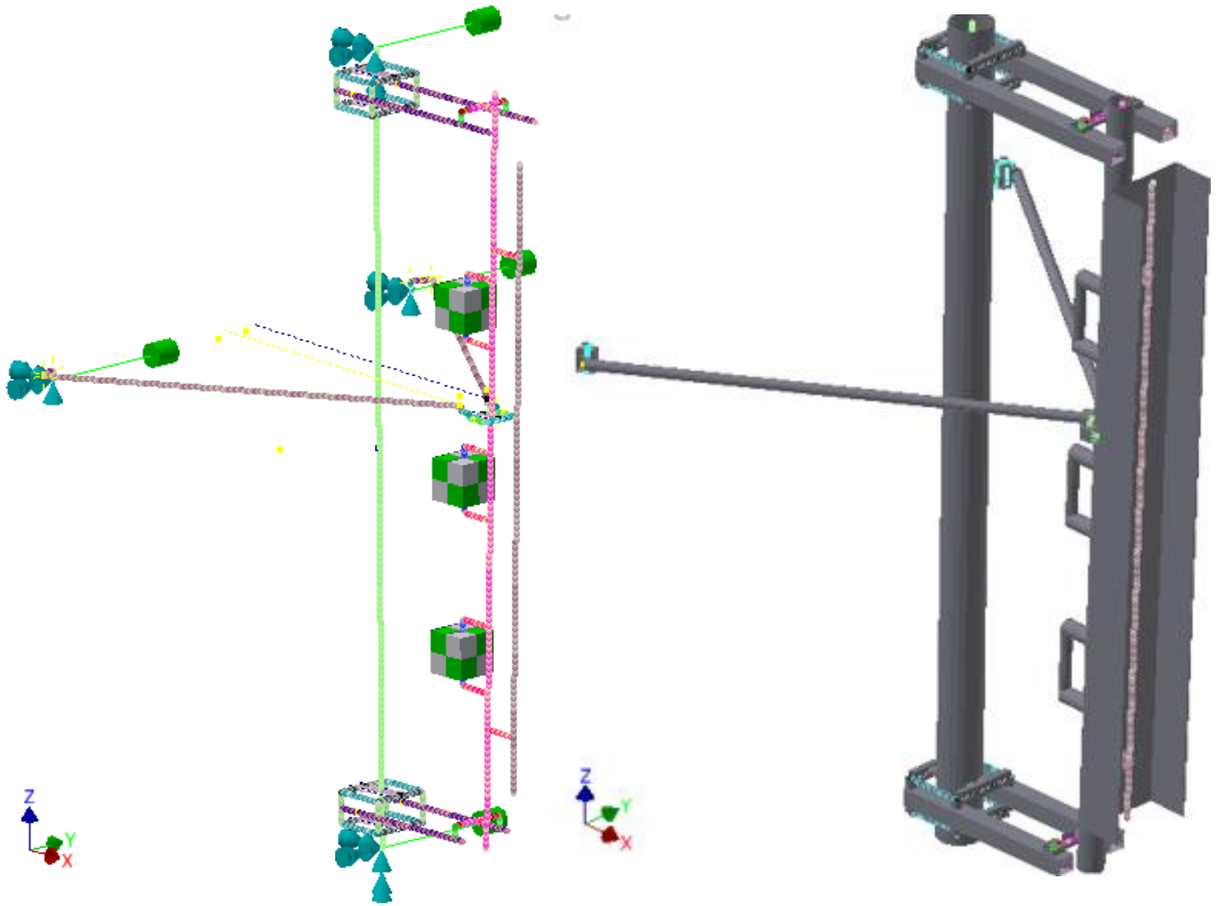
Goal: Is to verify structural integrity from vibration/shaking loading.

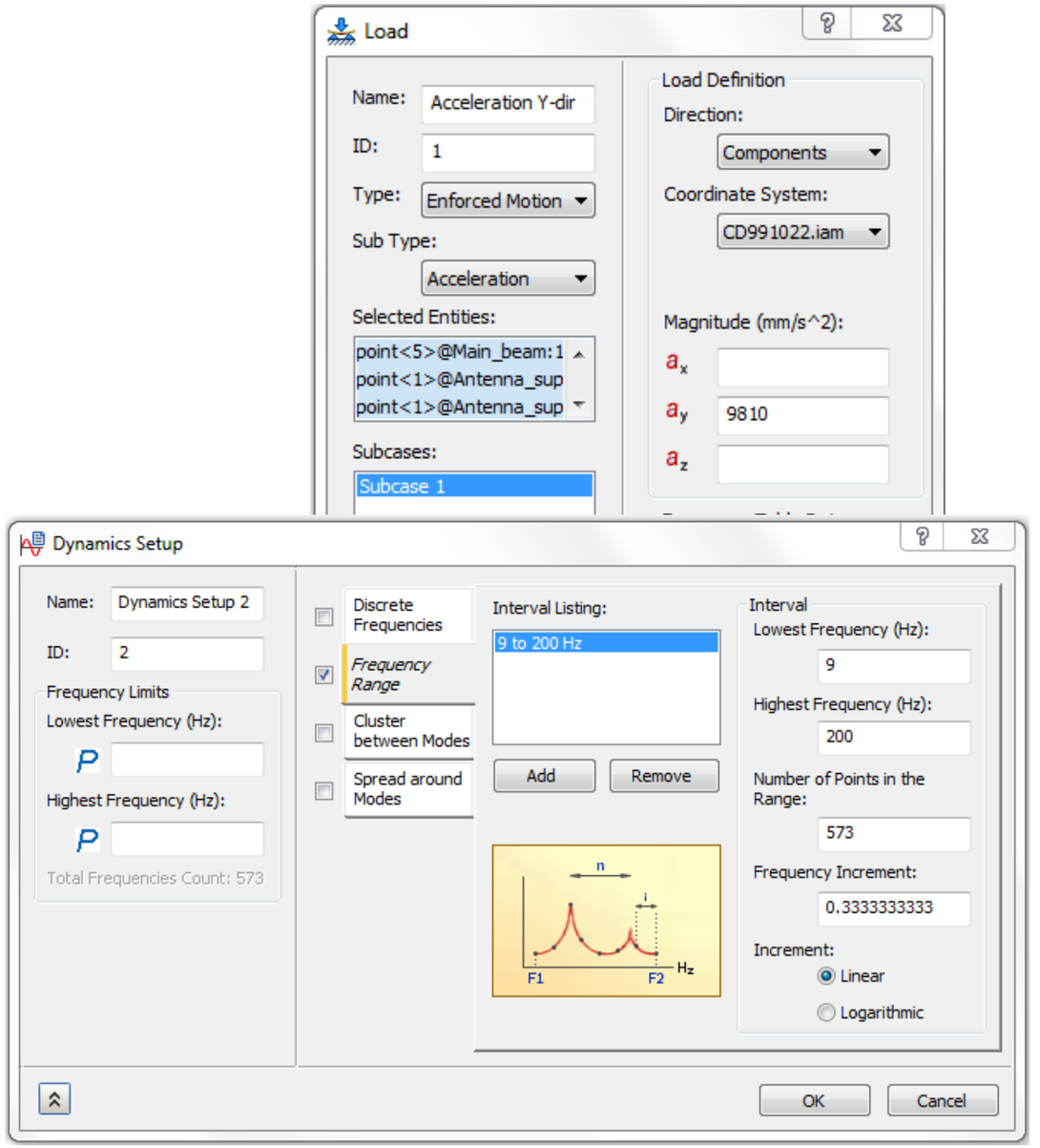
Design Criteria

- Predefined displacements/acceleration within a specific frequency interval (according to standard testing procedures)
  - 2-9Hz: 3mm displacements
  - 9-200Hz: 1g acceleration
  - All directions

CUE DEE

Beam elements 3D visualisation





CUE DEE

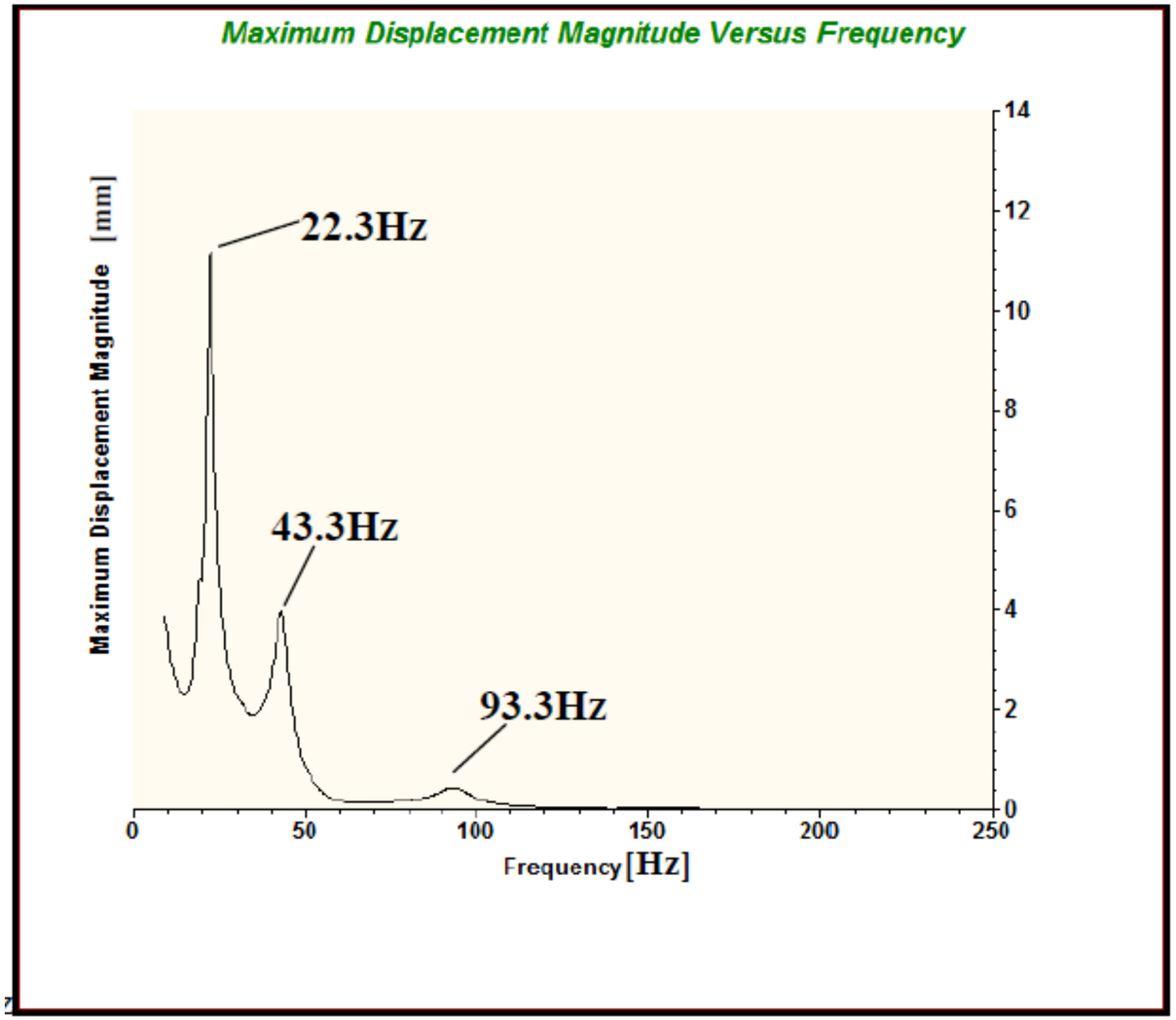
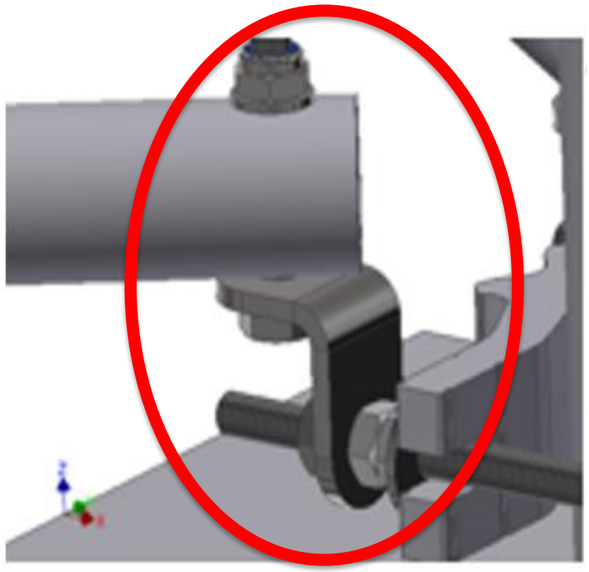
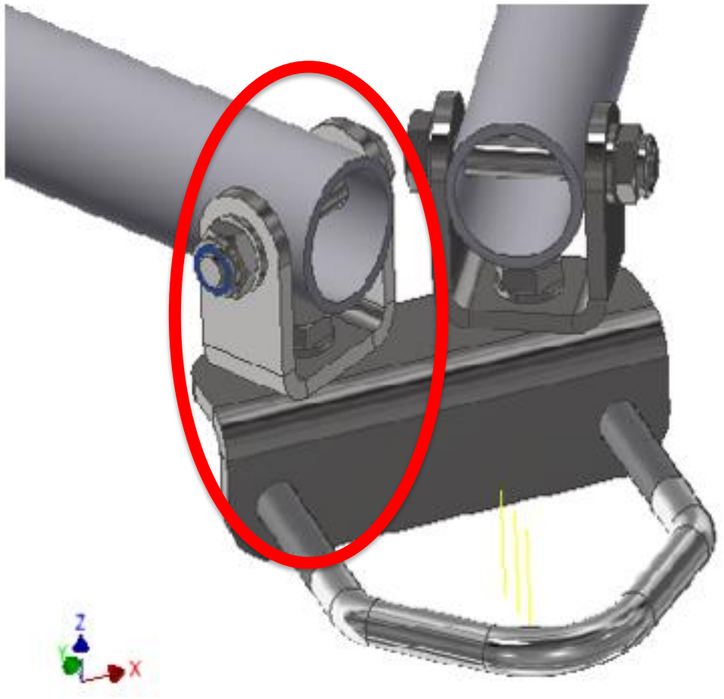


Figure 7 Max displacement vs frequency, x-direction.

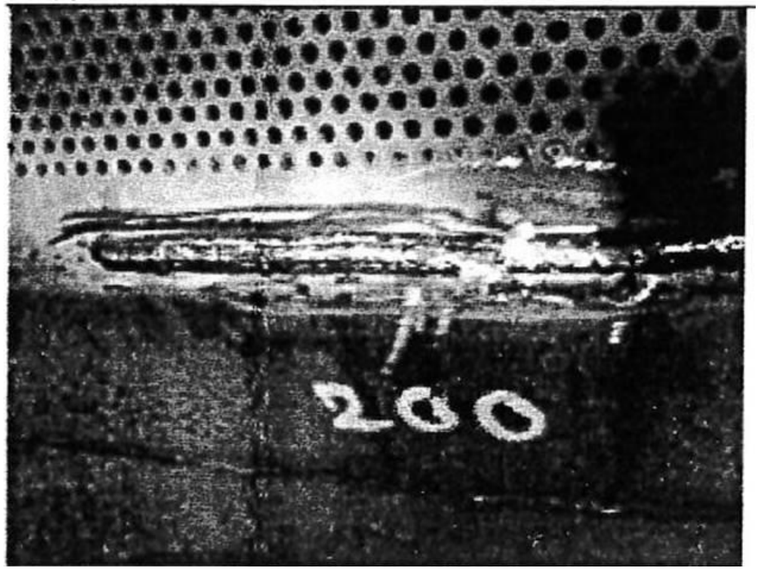
CUE DEE





Relitor

Goal: New design and optimization of a screen plate in a paper making machines

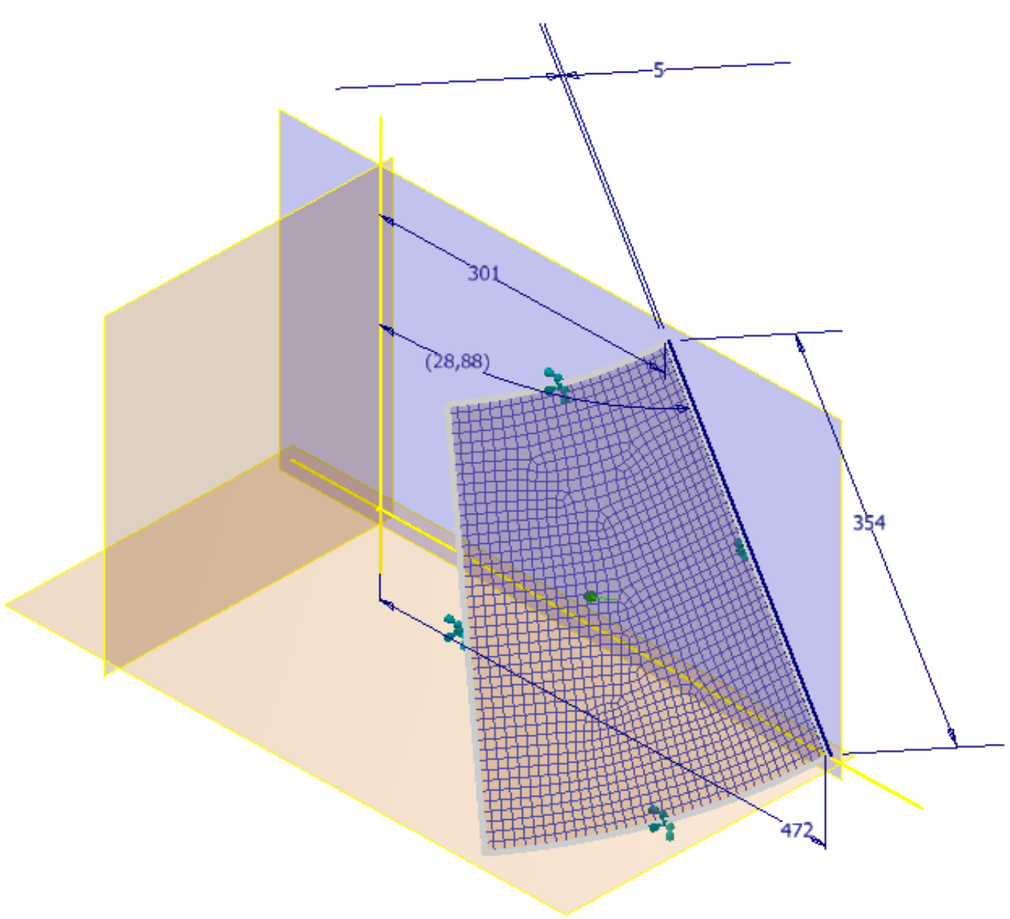


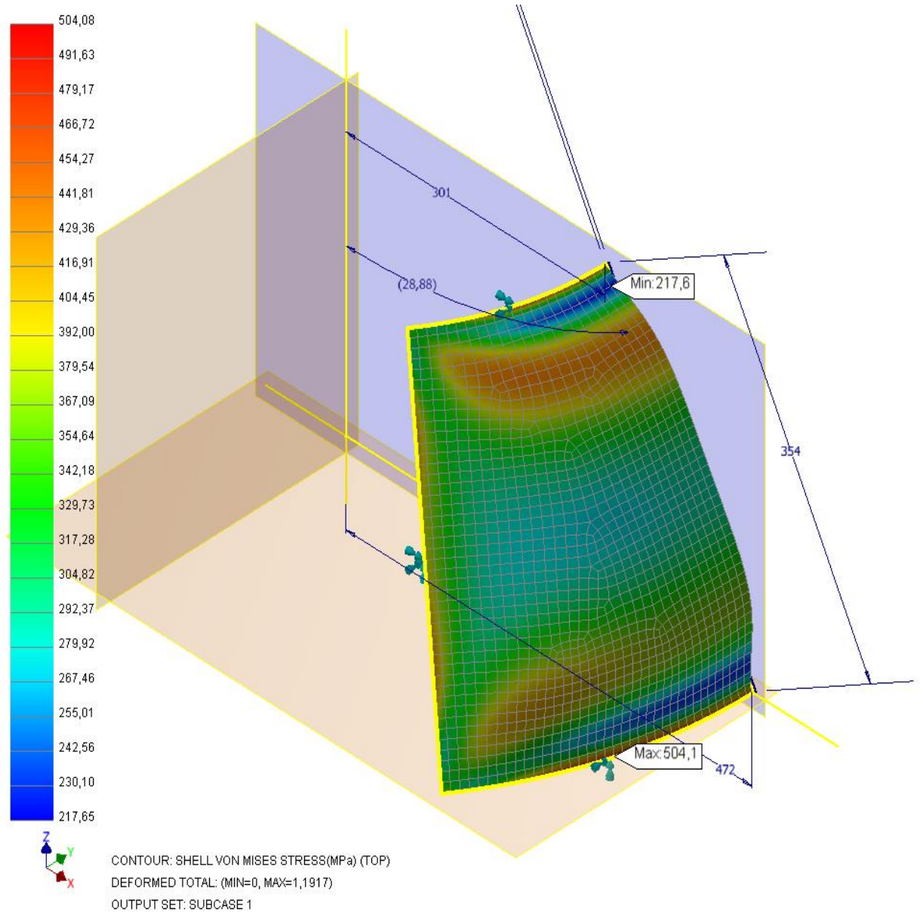
Design Criteria

- Temperature increase of 100ºC
- Solve issue of cracking from high stress

Relitor

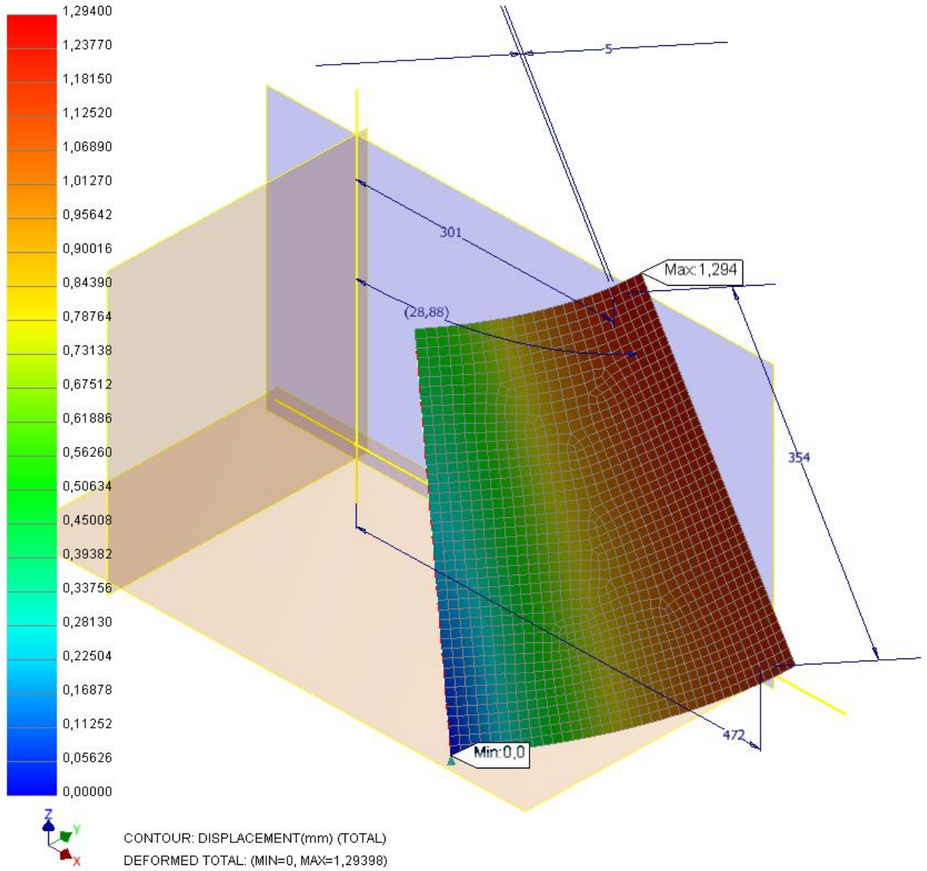
Original design – high stresses

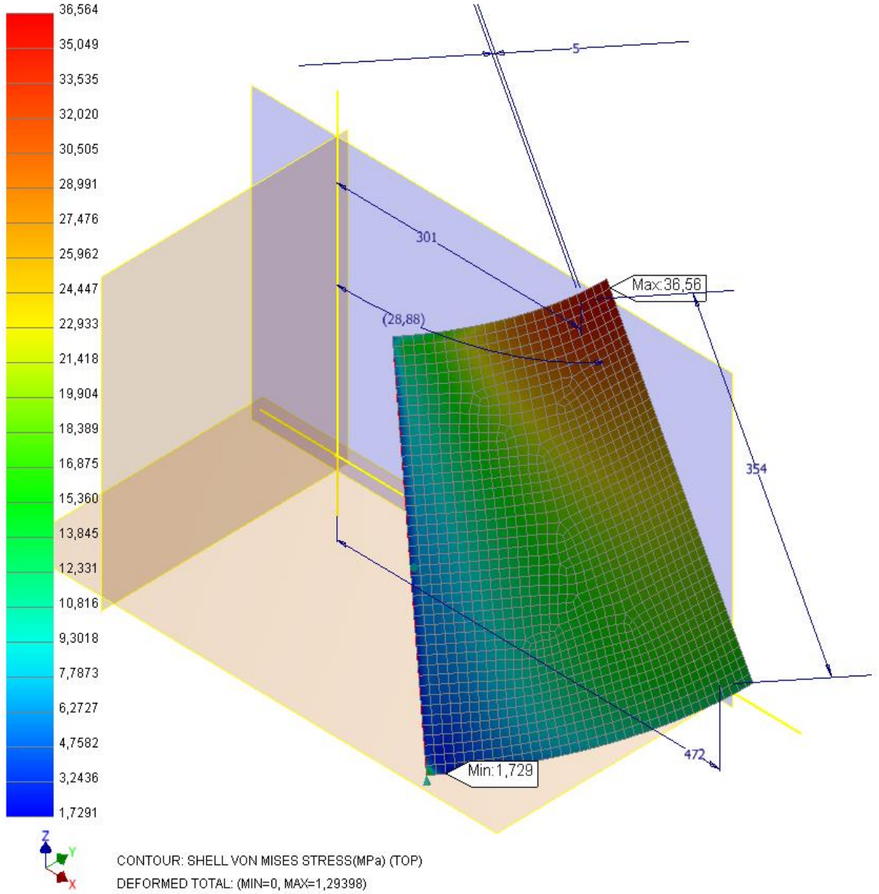




Relitor

Modified design suggestions – much lower stresses



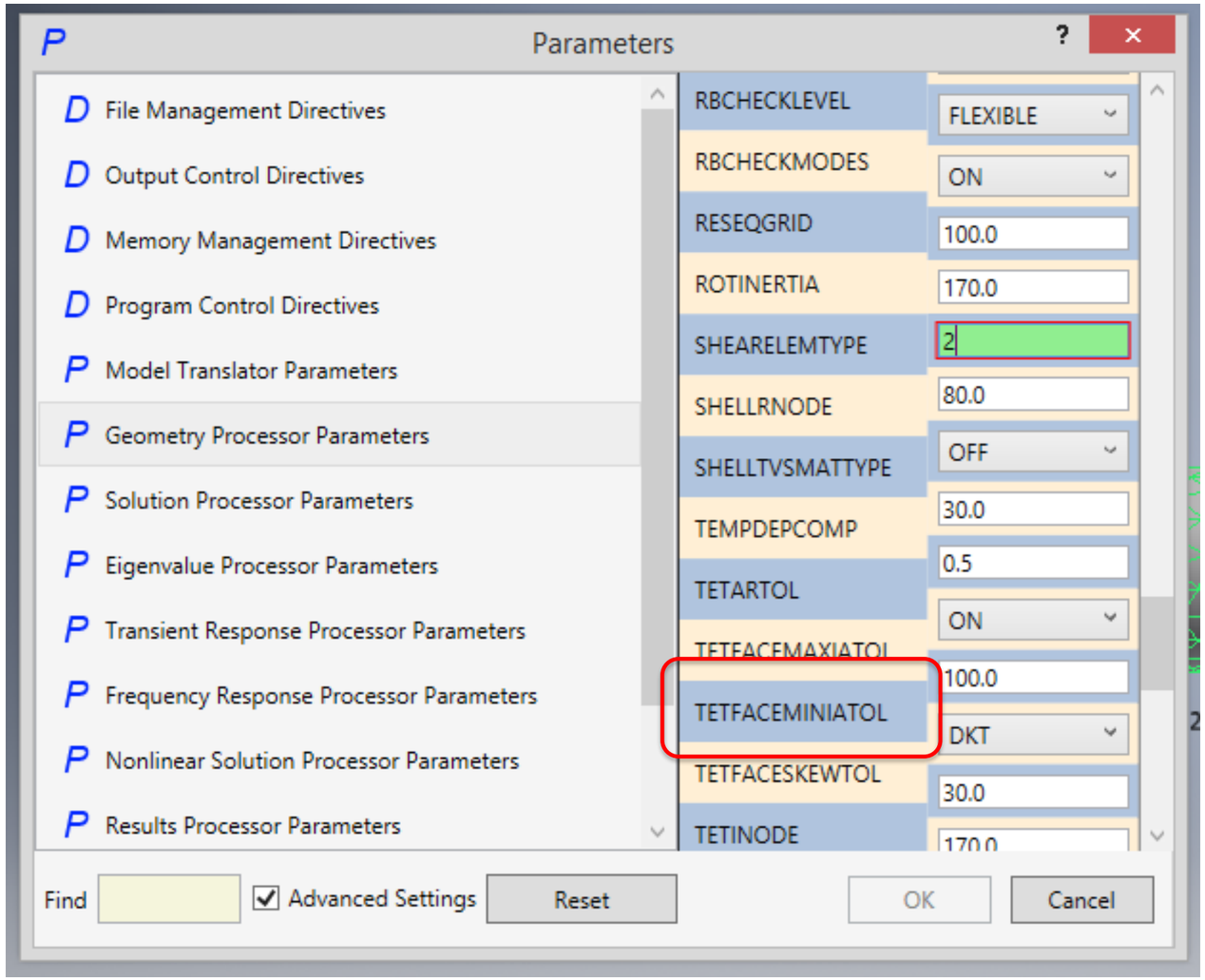


Best Practices

Some guidelines to get you started.

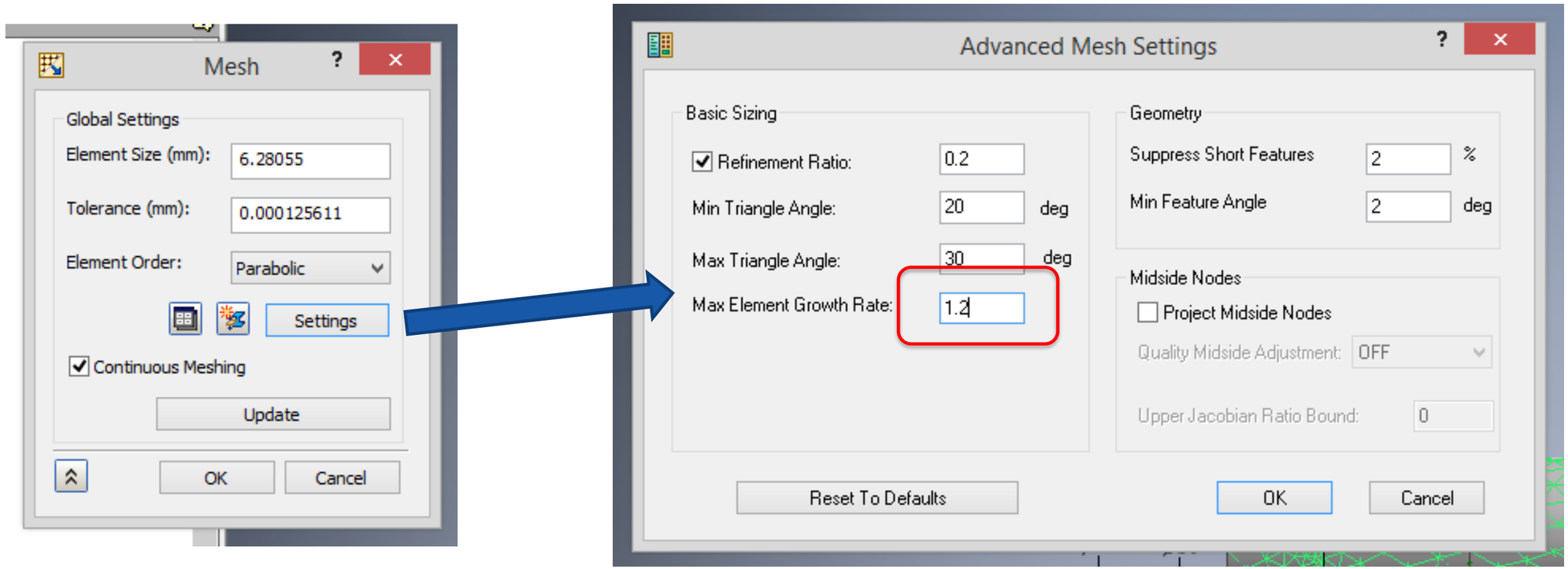
- Get rid of the Warning

```
WARNING G3015: TET ELEMENT 1806 HAS AN INTERIOR ANGLE LESS THAN 10.0

OPERATION RESUMED
PERCENT COMPLETE:    30

WARNING G3015: TET ELEMENT 2372 HAS AN INTERIOR ANGLE LESS THAN 10.0

OPERATION RESUMED
PERCENT COMPLETE:    30

WARNING G3015: TET ELEMENT 2555 HAS AN INTERIOR ANGLE LESS THAN 10.0

OPERATION RESUMED
PERCENT COMPLETE:    30
```



Some guidelines to get you started.

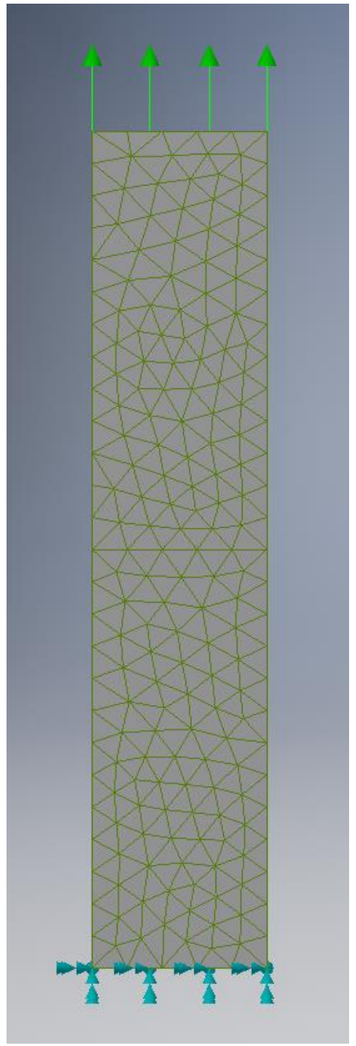
- Or just make a good mesh:

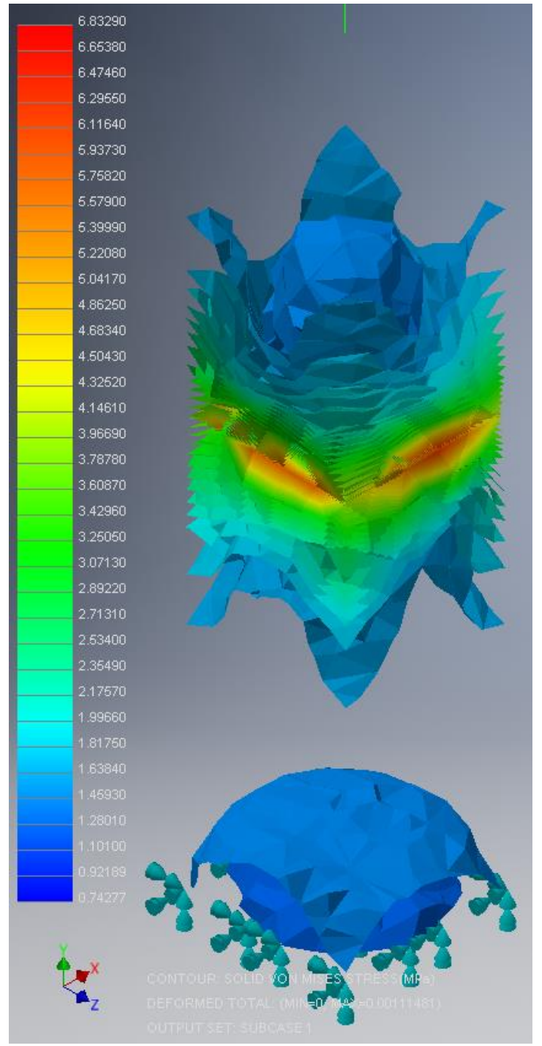


Some guidelines to get you started.

Connecting Solids - Default

- Continuous mesh – standard
- Edges are connected
- Surfaces will never be connected
- Section view
- Iso surfaces view

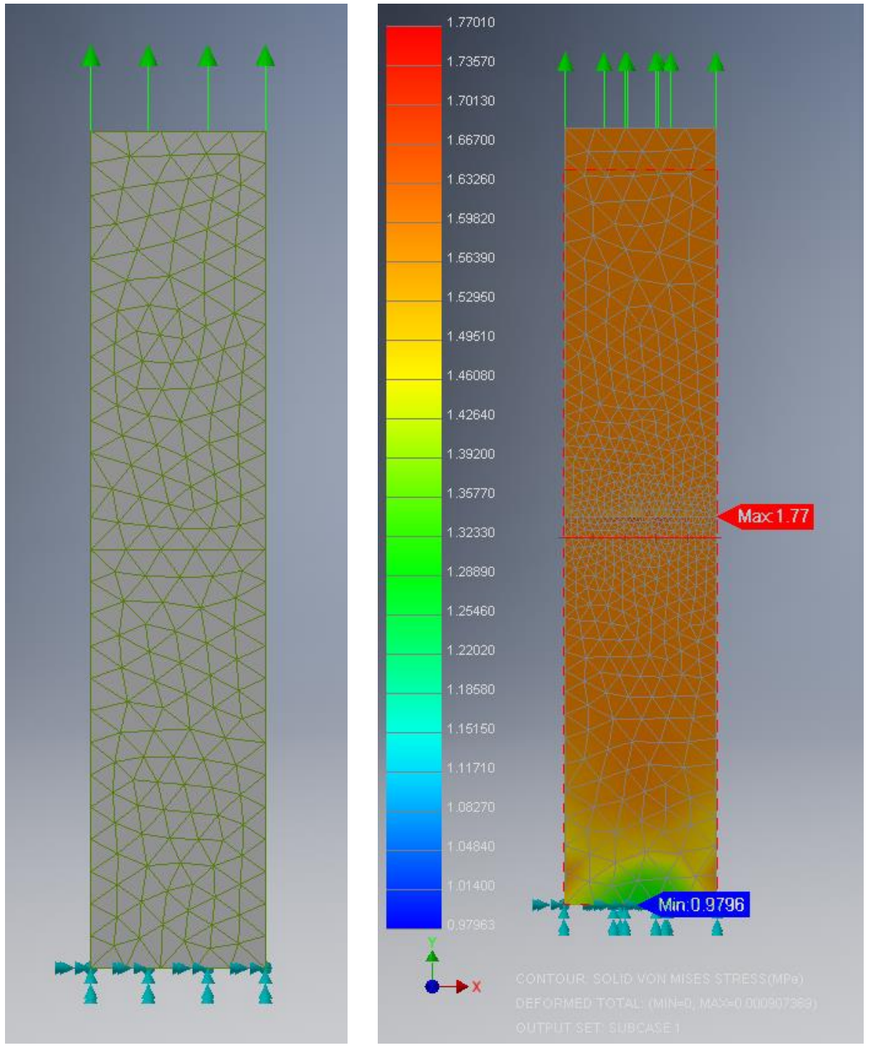




Some guidelines to get you started.

Connecting Solids – With Contacts

- Run automatic contacts
- Contacts are sensitive to the mesh size
- Add a refinement region



Some guidelines to get you started.

Contacts vs Connections

- When nodes touch they become one. So no contact is needed. This is very powerful for shell elements.
- Nodes never touch between two faces. So you'll always need a contact there.

More Information

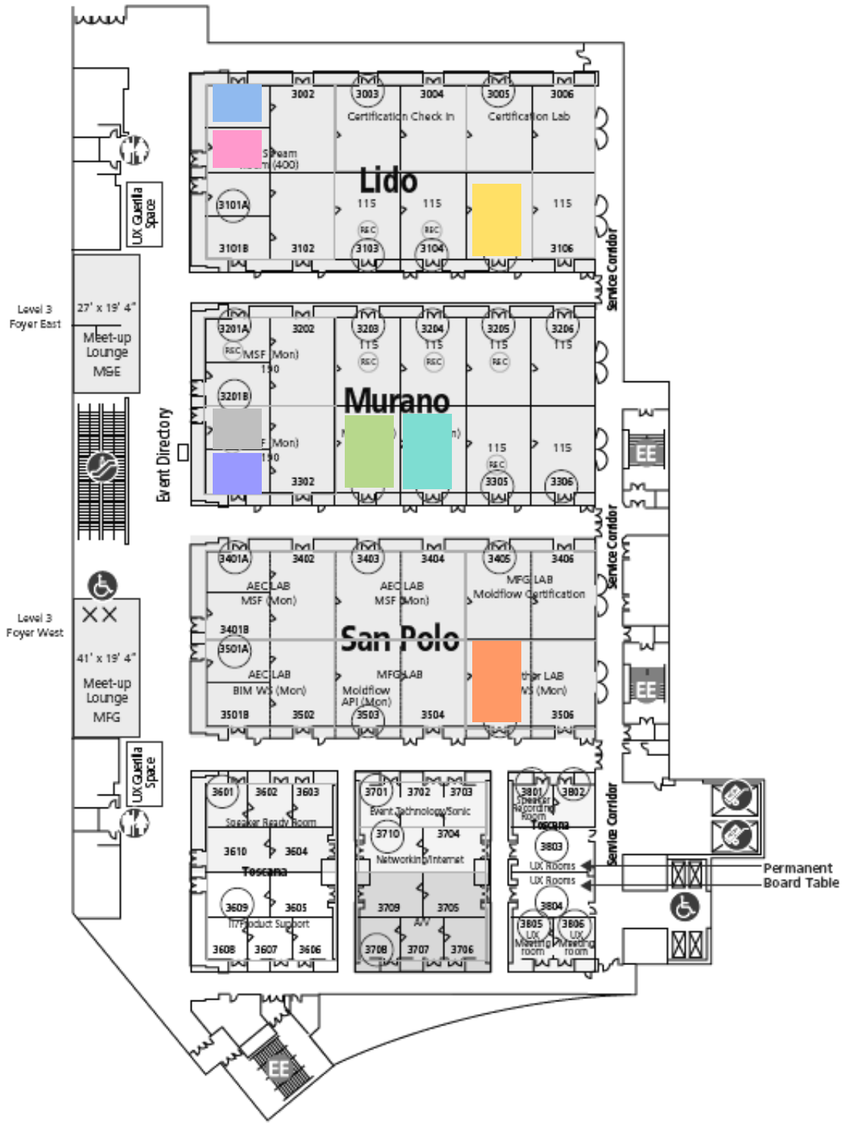
Nastran In-CAD –
Have a go and find out it’s powerful capabilities

SIM21006 - L – Hands On FEA: Test your Simulation Intuition
Tuesday 3 – 4.30 pm – Lab

- Introduction to Nastran In-CAD
- Introduce to more advanced pre/post processing
  - Volume Mesh
  - Section results
  - And more
- More analysis
  - Buckling
  - Drop test

Other Classes You May Be Interested In

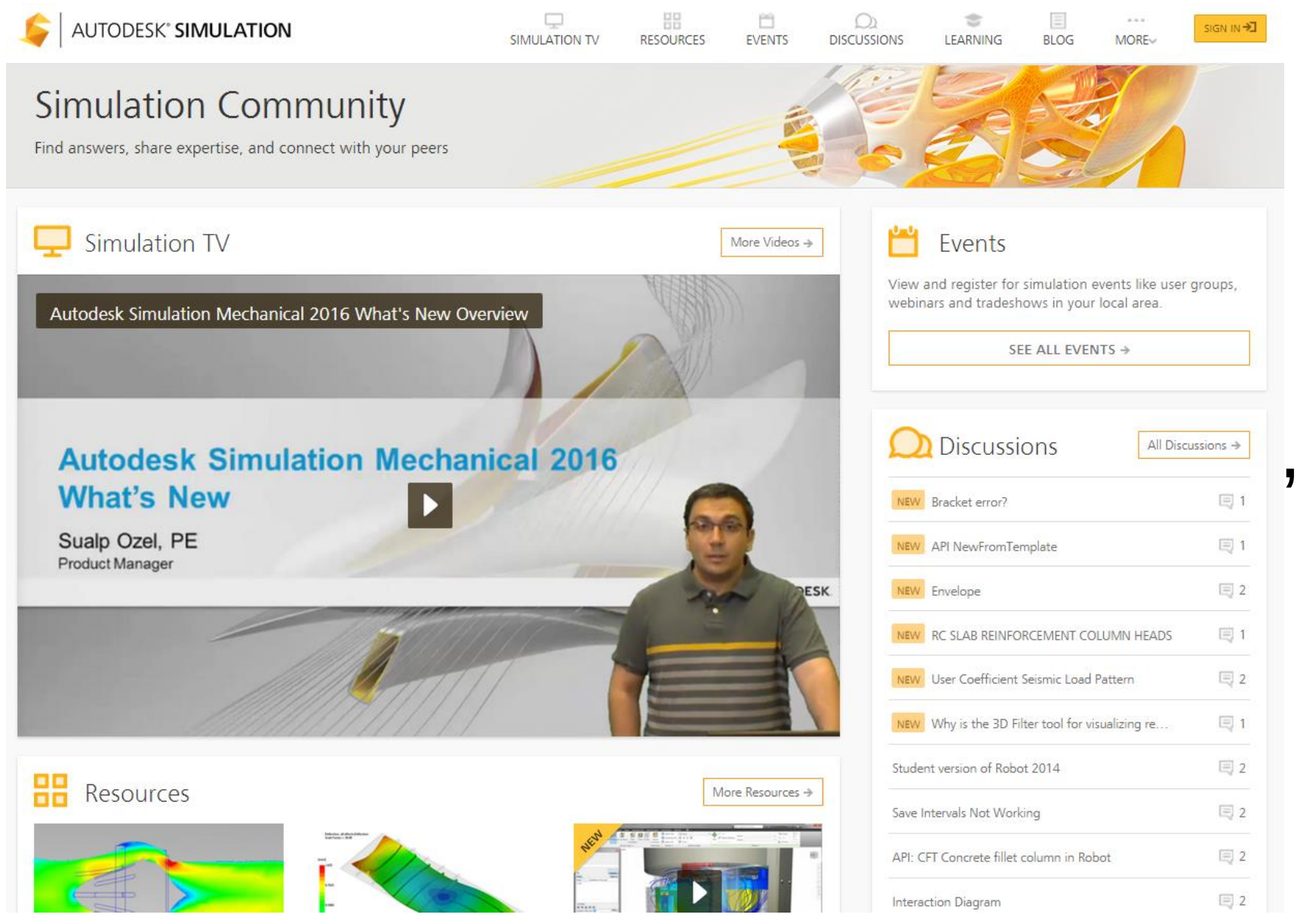
	Tues - 15	Wed - 16	Thurs - 17
8:00	**Class 1: Manager's Guide to Making Simulation Effective in Product Development** - *Vince Adams, John Cichy*	**Class 5: Making Models Ready for Analysis - An Introduction to SimStudio Tools** - *Jim Swain*	**Class 8: Generative Design with Nastran Topology Optimization** - *David Weinberg, Michael Smell*
9:00			
10:00	**Opening Session Keynote**	**General Session (No Classes)**	**Closing (No Classes)**
11:00			
12:00			
1:00	**Class 2: Simulation For Designers – Take your Inventor analysis to the next level** - *Wasim Younis, David Truyens*	**Class 6: Can't touch this; how and when to use contact in FEA** - *David Cordova, Mitch Muncy*	**Class 9: How to Perform Failure Analysis and Test Correlation** - *Nick Duff*
2:00			
3:00	**Class 3: Hands On FEA: Test your Simulation Intuition** - *Vince Adams, David Truyens*	**Class 7: Durability 101: Don't get tired of fatigue** - *John Holtz*	**Class 10: Let's get together: Using Connectors in FEA** - *Andrew Sartorelli, David Truyens*
4:00			
5:00	**Class 4: Upfront Simulation for Optimized Design** - *James Herzing, Mike Smell, Vaclav Prchlik*	**From digitally-scanned DWG geometry to CFD model: A workflow for a real case study** - *Gilberto Fernandez*	



Resources – SimHub

simhub.autodesk.com

Simulation TV	Feature demos and What's New videos
Resources	White papers and validation documents
Discussions / Idea Station	Ask questions, share your knowledge and ideas
Blog	Feature stories, tips and tricks, latest news
Learning	Archive of AU-online presentations



→ Ask a question of the SimSquad

Questions

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Symetri
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Simulation Specialist
Autodesk
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How did I do?

- Your class feedback is critical. Fill out a **class survey** now.
- Use the AU mobile app or fill out a class survey online.
- Give feedback after each session.
- AU speakers will get feedback in real-time.
- **Your feedback results in better classes and a better AU experience.**

Thank you
for attending