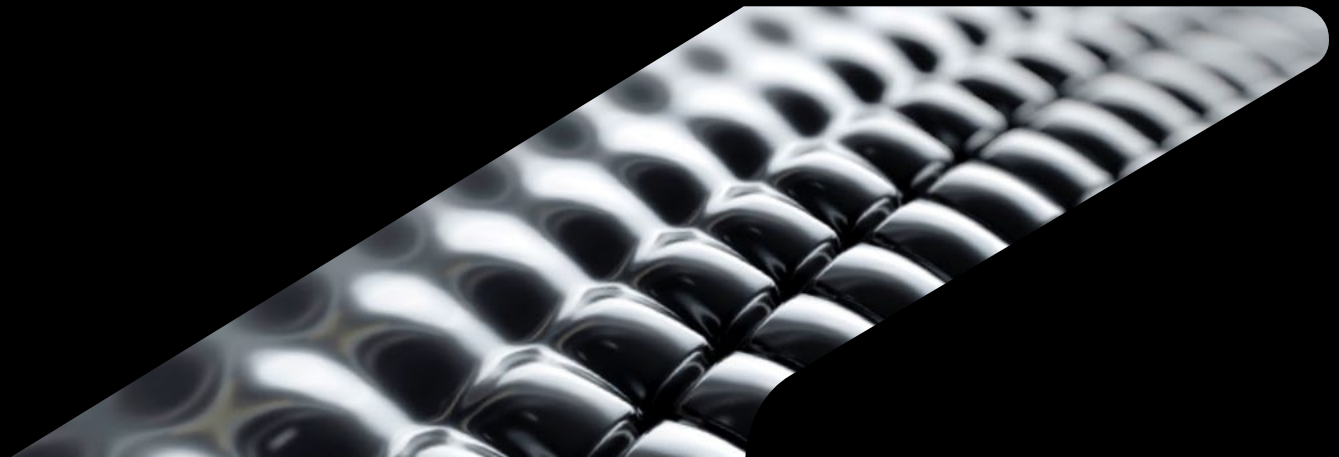
AUTODESK UNIVERSITY

Up and Running with Inventor Nastran Nonlinear Analysis – Real World Examples

Wasim Younis
Simulation Manager – Symetri



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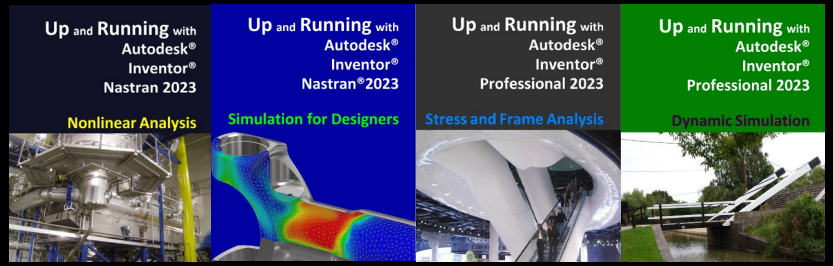
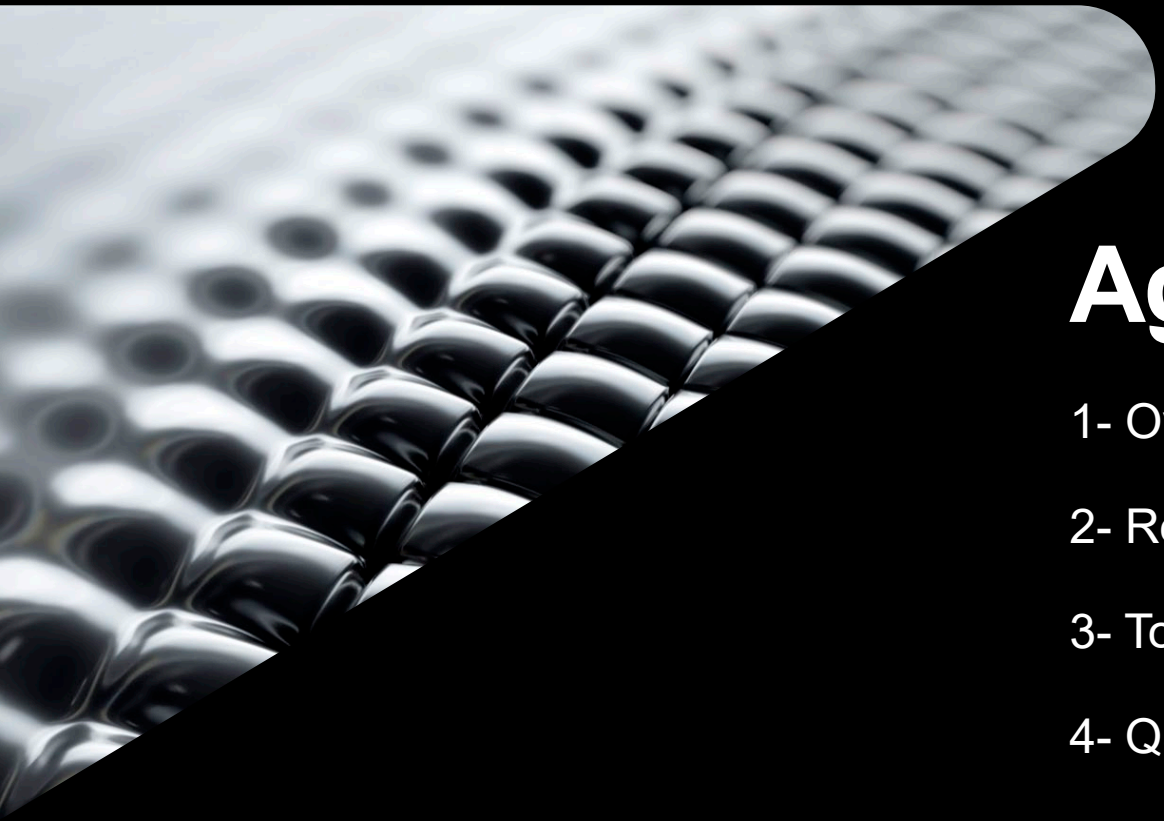
About me

A passionate simulation solutions expert been involved with Autodesk simulation software from when it was first introduced, and is well-known throughout the Autodesk simulation community, worldwide.

Also authored the Up and Running with Autodesk Inventor Professional books. He also manages a dedicated forum for simulation users on LinkedIn – Up and Running with Autodesk Simulation.

Wasim has a bachelor's degree in mechanical engineering from the University of Bradford and a master's degree in computer- aided-engineering from Staffordshire University.





Agenda

1- Overview of Nonlinear Analysis

2- Real world examples

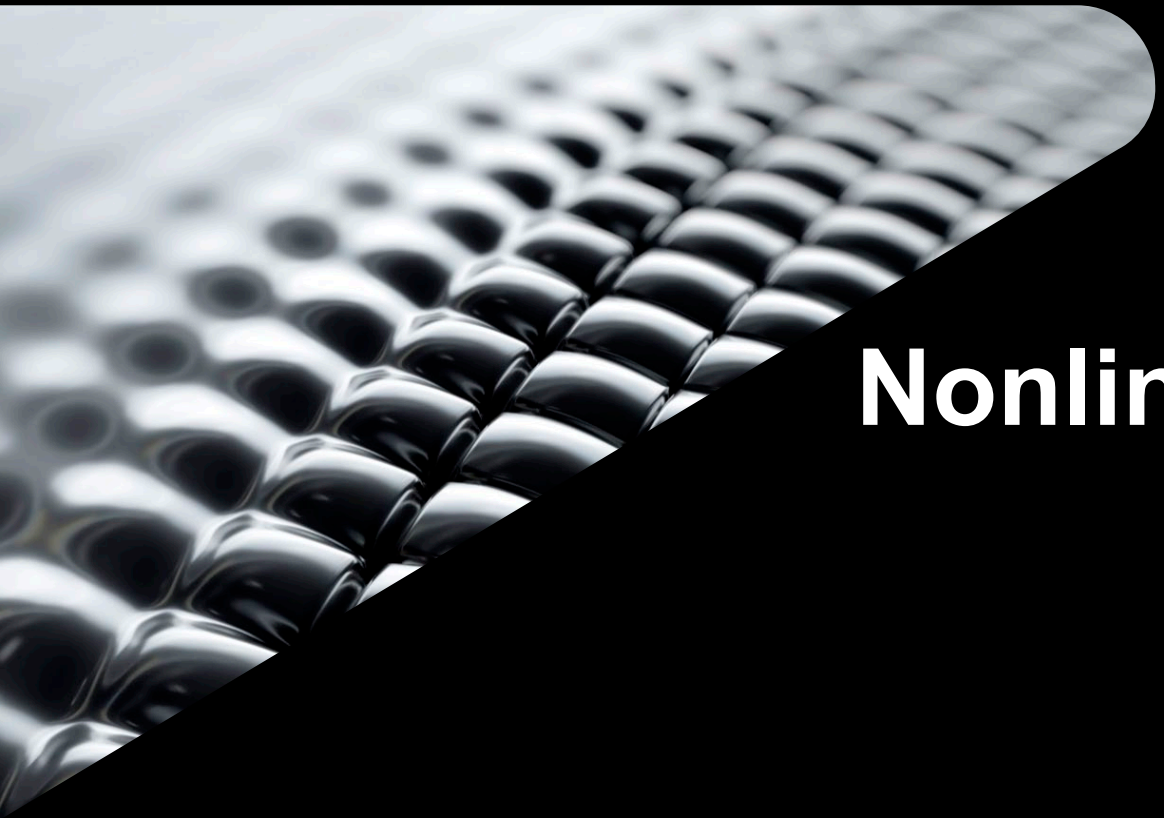
3- Top 10 Tips

4- Q&A

COMPLEX

Masters/PHD?

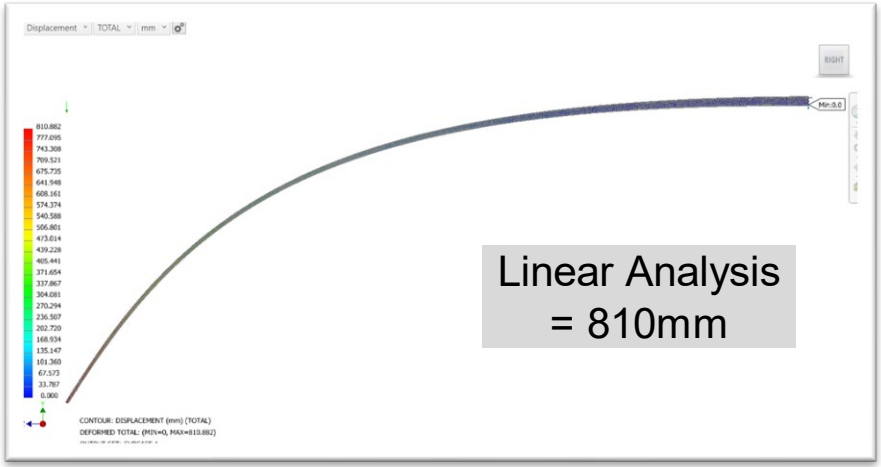

DEMISTIFY NONLINEAR ANALYSIS

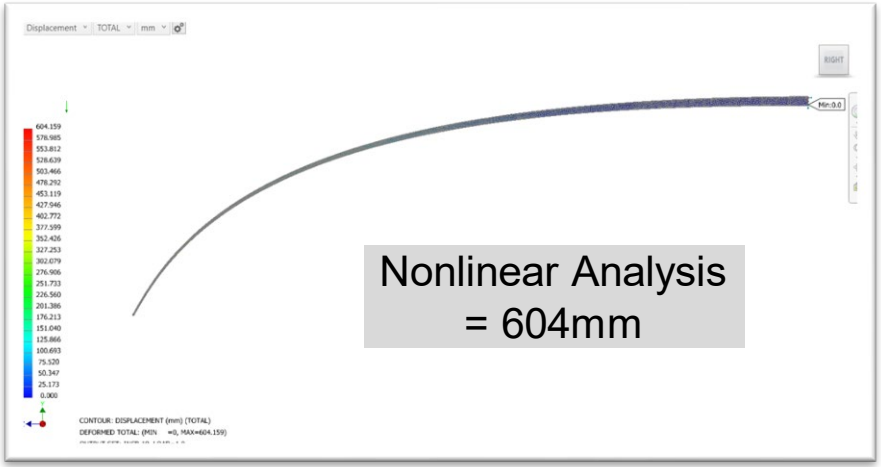
Nonlinear Analysis- An overview

Nonlinear analysis general types

Geometric Nonlinearity



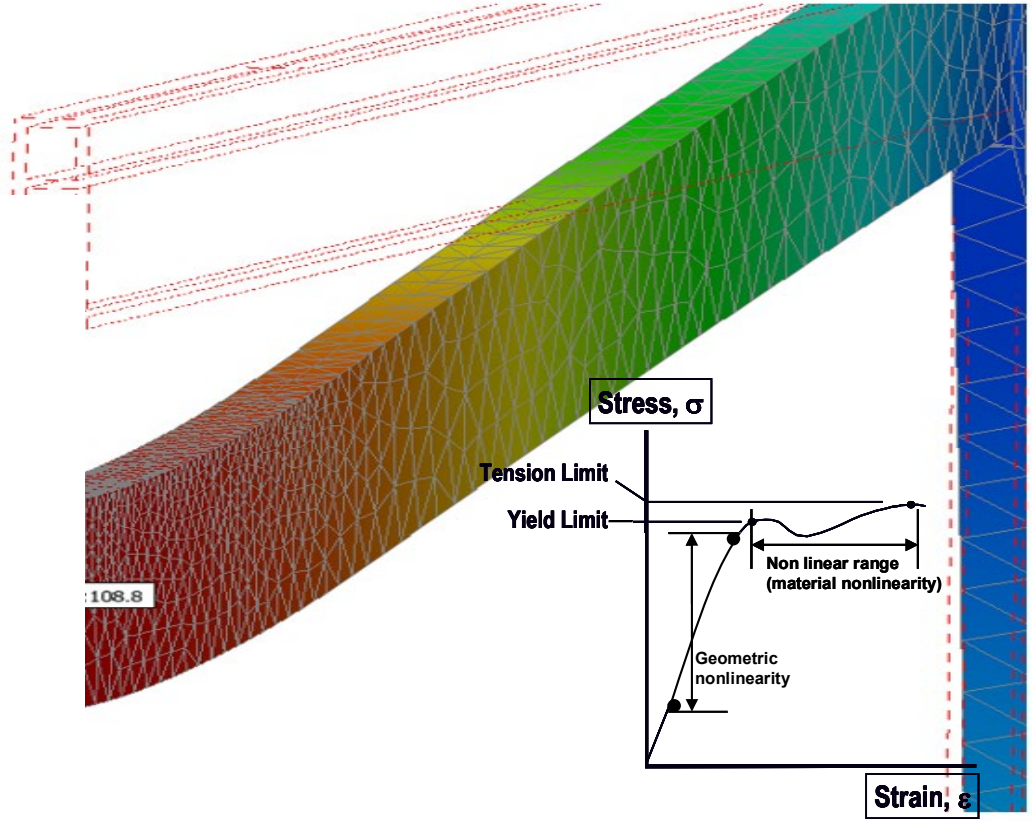
Linear Analysis
= 810mm

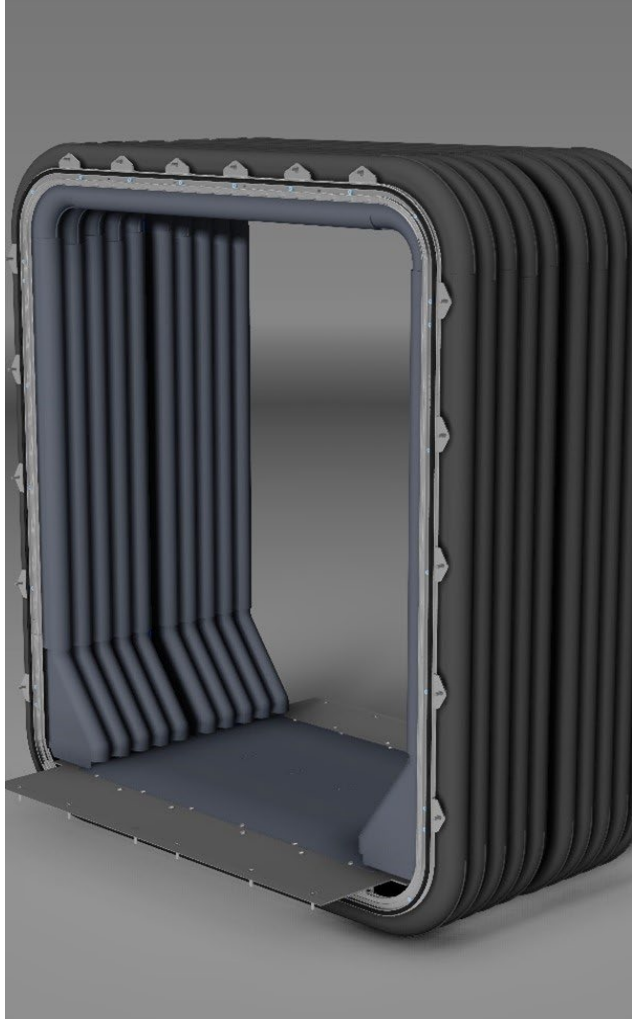


Nonlinear Analysis
= 604mm

Nonlinear analysis general types

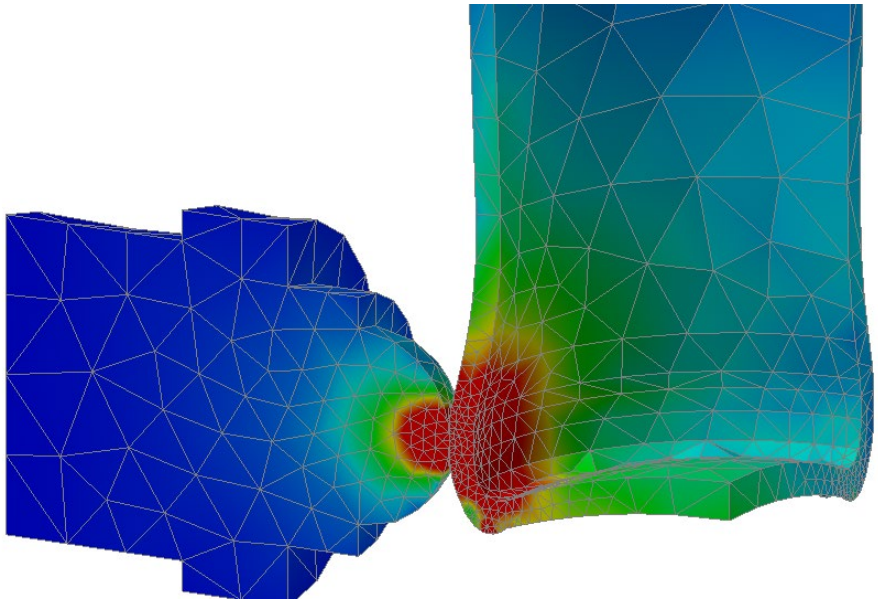
Material Nonlinearity





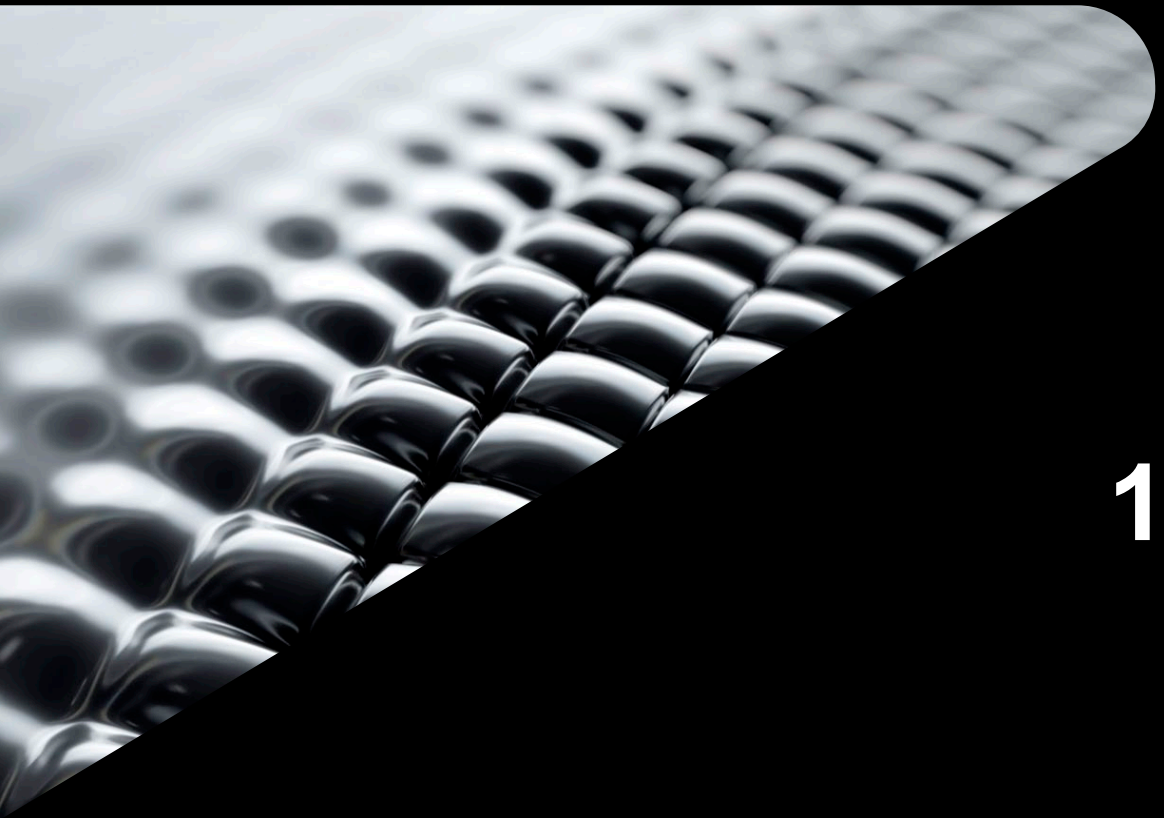
Nonlinear Analysis general types

Contact



Nonlinear Analysis Studies within Nastran

Solver	Application
Nonlinear Static (Implicit)	1 - Critical Load
Nonlinear Transient Response (Implicit)	2 - Drop Test
Explicit Dynamics	3 - Blast Analysis
Nonlinear Buckling (Implicit)	Not covered in this session
Explicit Quasi-Static	
Impact Analysis (Implicit)	



1- Simatek A/S

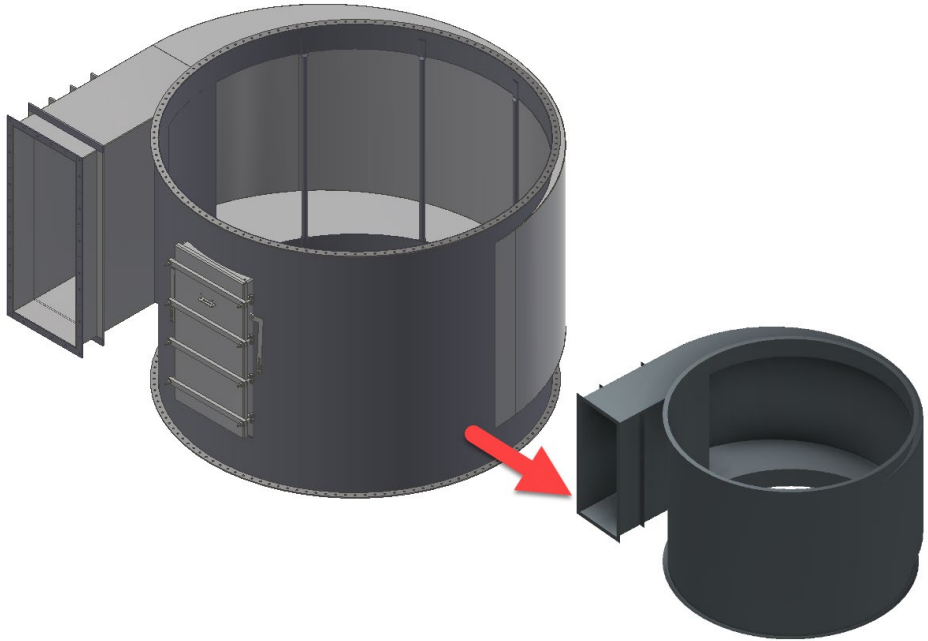
Inlet

- Goal
  - Is to determine maximum permanent deformation at Critical Load.
- Key Information
  - AISI Carbon Steel 304 nonlinear material behavior.
  - Critical (Limit) Load is 0.082MPa
- Limits
  - Permanent Deformation to be less than 10%

Workflow considerations

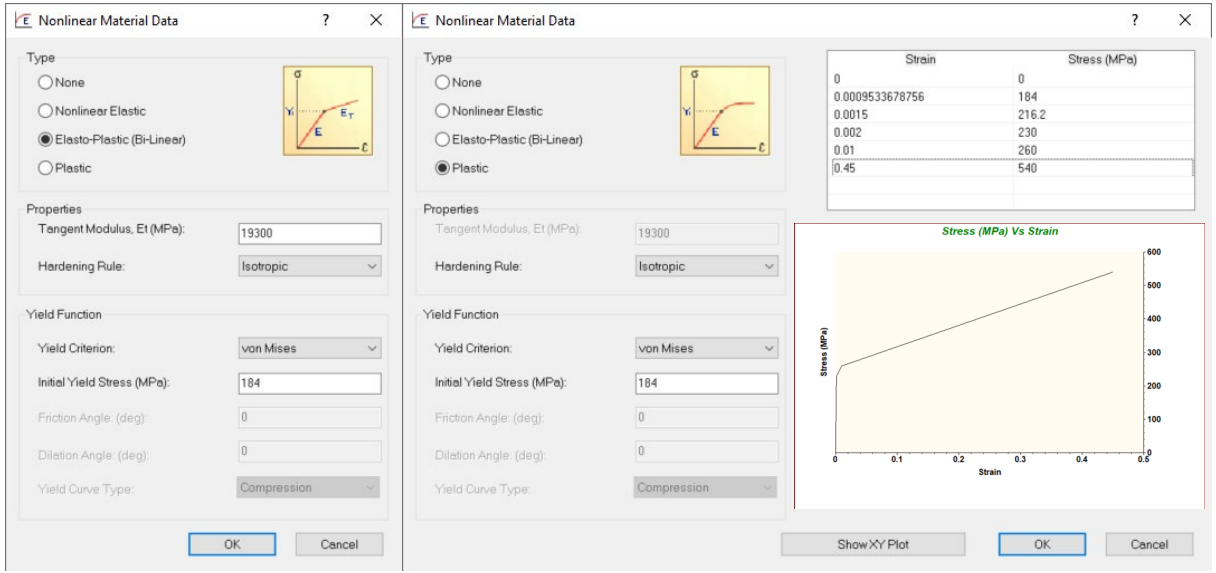
Alternative physical test is not sustainable.

- Geometry
  - Simplification
    - Remove nonstructural components
    - Remove nonstructural features
  - Remodeling
    - A simplified solid assembly
    - A simplified solid model (part)
    - A simplified surface model



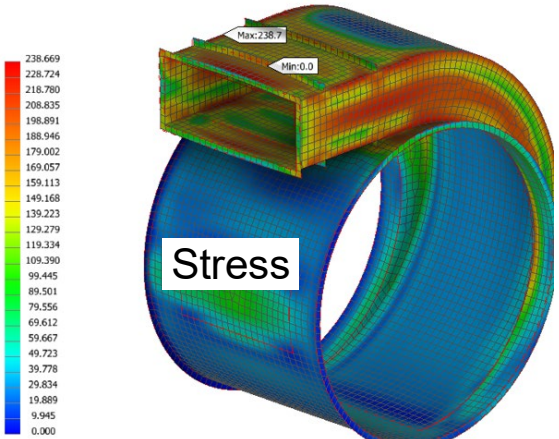
Workflow considerations

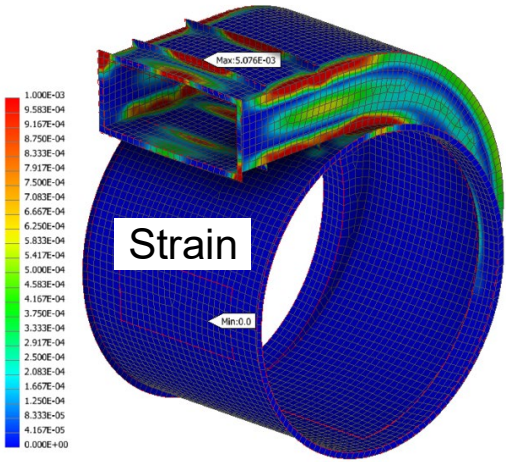
- Material Information (Elastic/Plastic)
  - Bilinear (Approximation)
    - Is an approximation
    - Plastic portion of the curve is typically set to 10%.
  - Plastic (More accurate)
    - More accurate
    - But need to find data and information to define curve

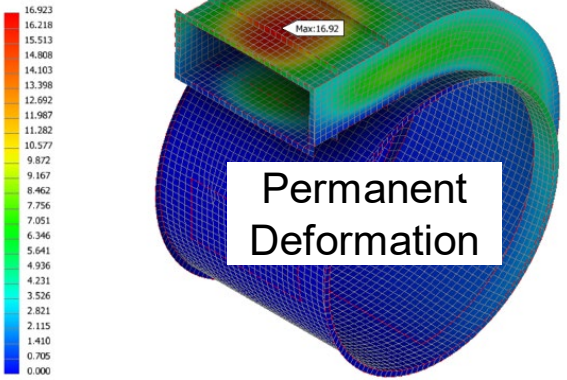


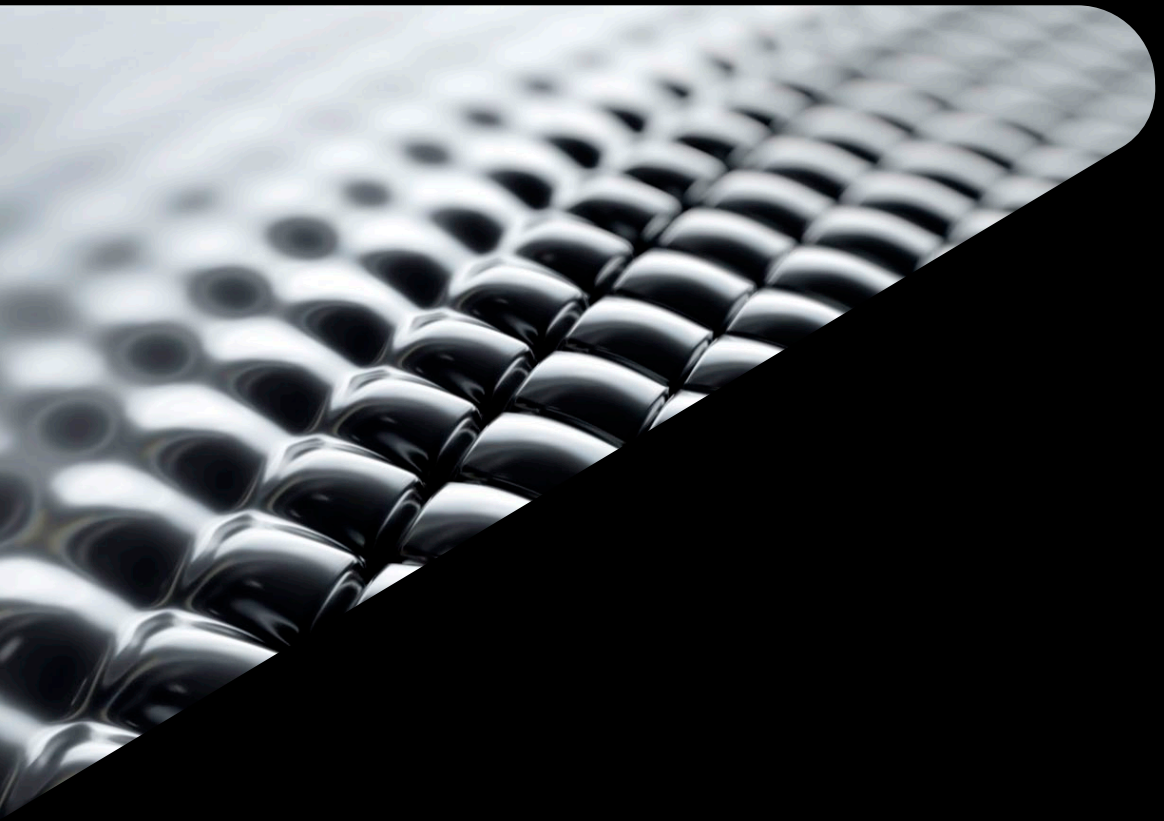
Nastran Demonstration 1

Nastran Nonlinear Static Analysis









2- Dellner

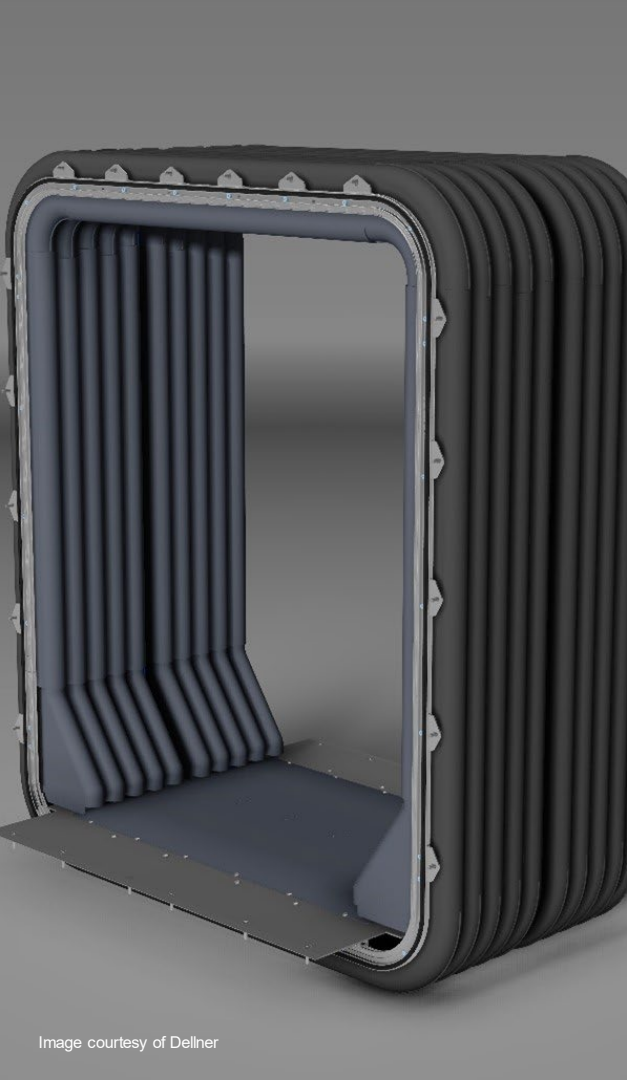


Image courtesy of Dellner

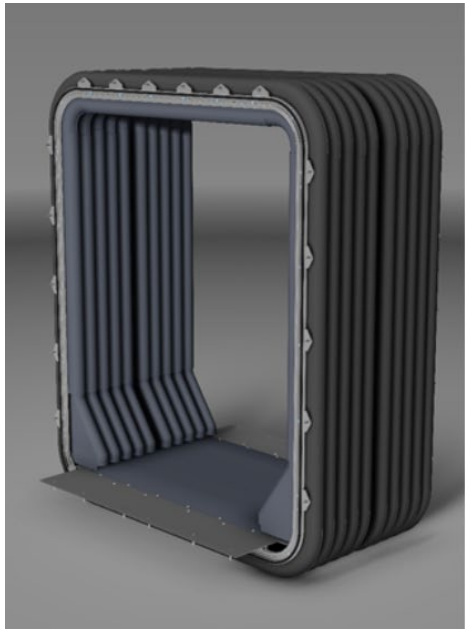
Gangway

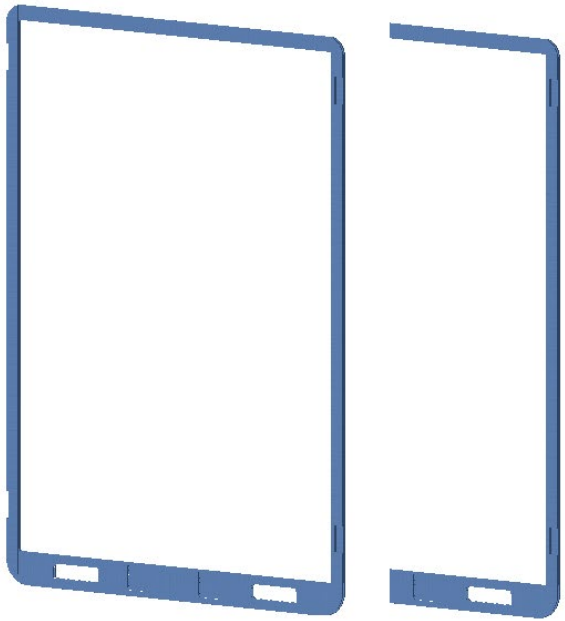
- Goal
  - Is to determine maximum permanent deformation due to a large stone/rock being dropped from a 5m height.
- Key Information
  - Aluminum nonlinear material behavior.
  - Impact Velocity.
  - Time of Impact.
  - Material Damping.

Workflow considerations

Alternative physical test is not sustainable.

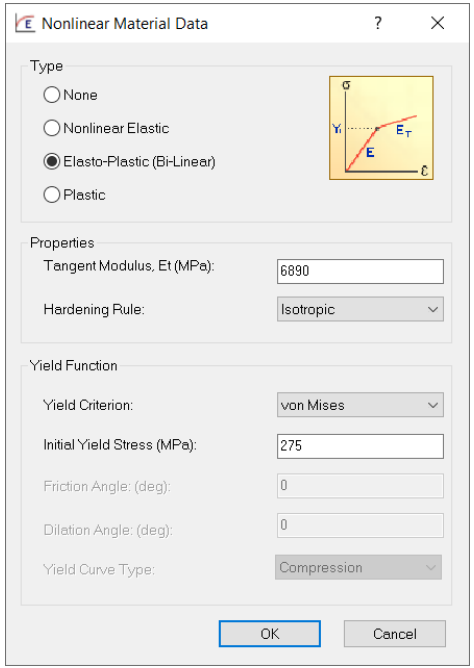
- Geometry
  - Simplification
    - Remove nonstructural components
    - Remove nonstructural features
  - Remodeling
    - A simplified solid assembly (half)
    - A simplified surface/solid assembly (half)





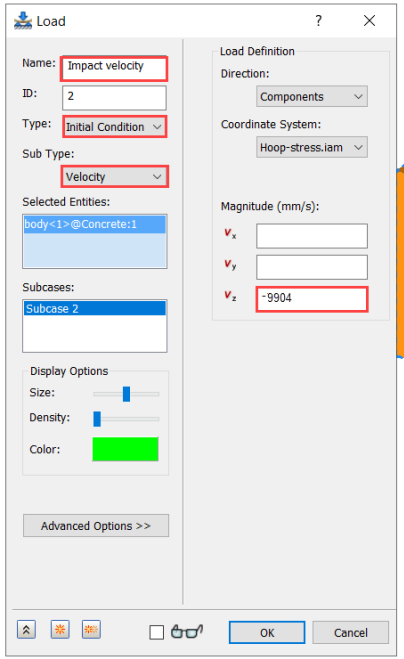
Workflow considerations

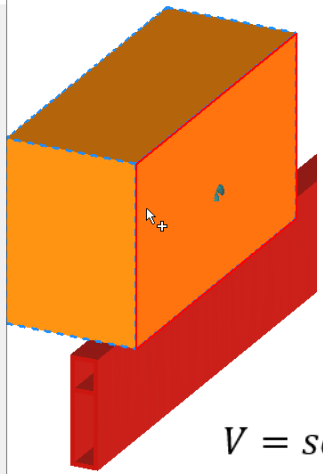
- Material Information (Elastic/Plastic)
  - Bilinear (Approximation)
    - Is an approximation
    - Plastic portion of the curve is typically set to 10%.



Workflow considerations

- Impact Velocity
  - To speed up analysis bring block near target





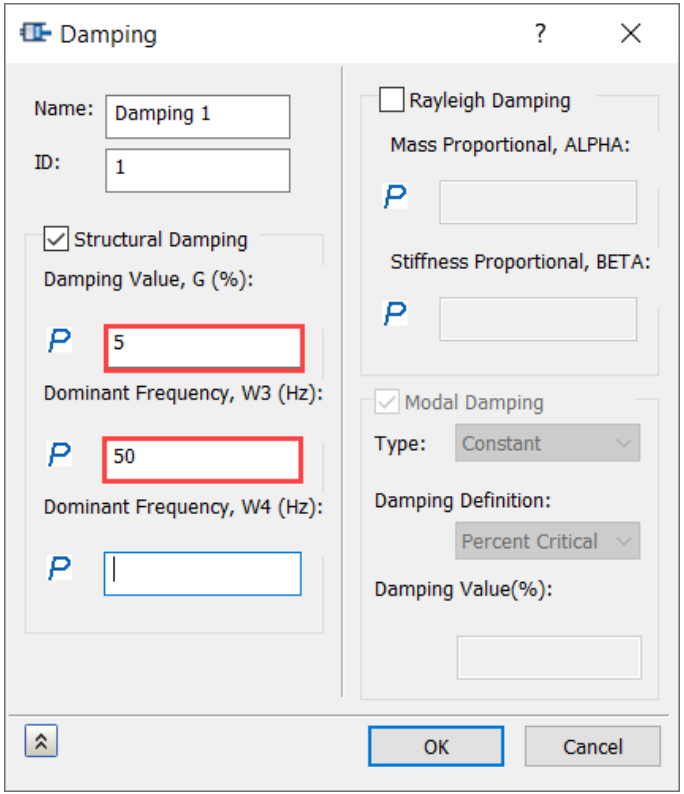
$$V = sqrt\,(2\ x\ g\ x\ d)$$

$$V = sqrt\,(2\ x\ 9810\ x\ 5000)$$

$$V = 9904\ mm/s$$

Workflow considerations

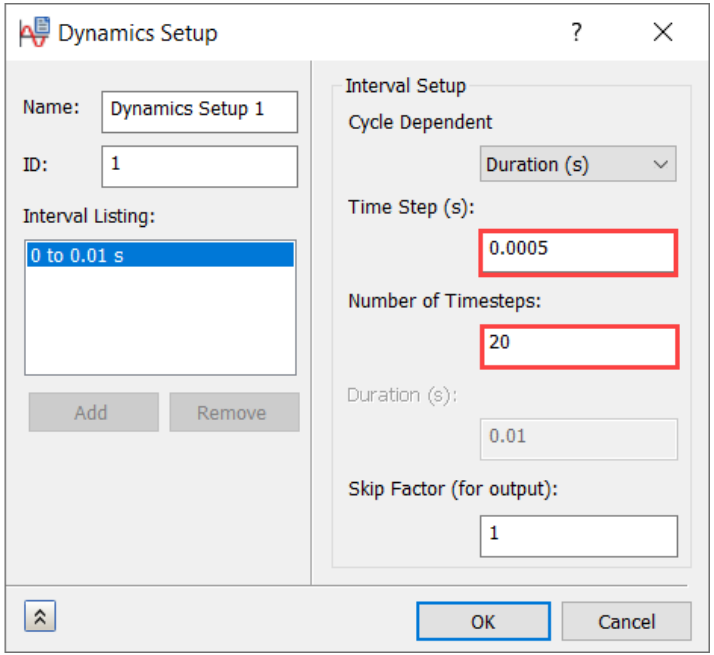
- Damping Data
  - Damping Value
  - Damping Frequency



Workflow considerations

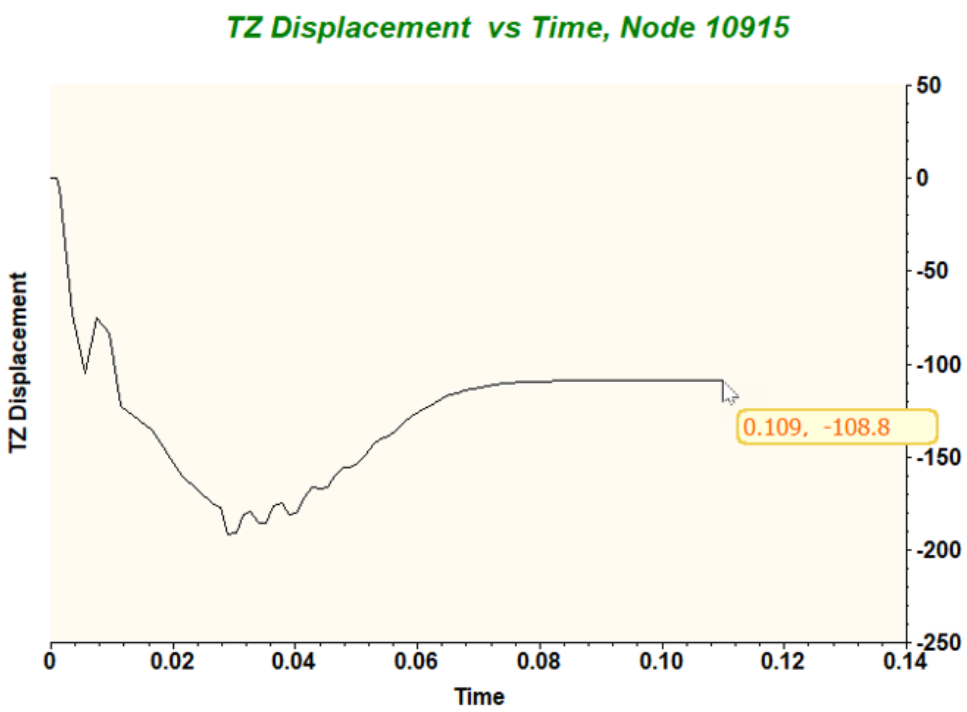
- Dynamic Setup Data (Impact)
  - Time Step
  - Time duration
- Dynamic Setup Data (After Impact)
  - Larger Time Step
  - Longer Time Duration

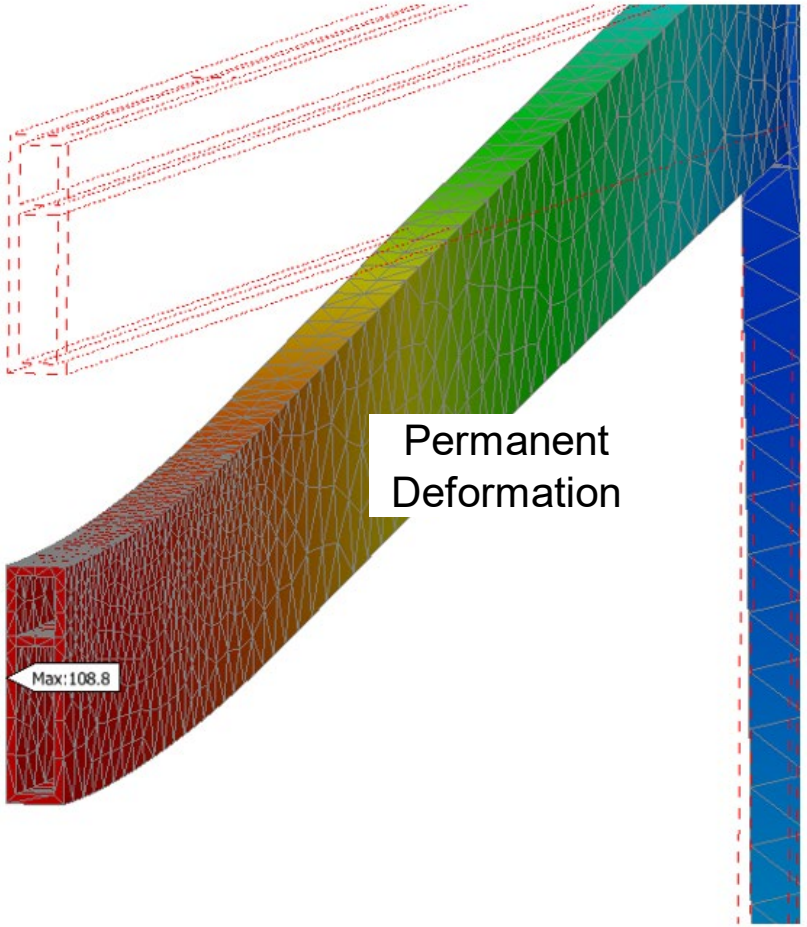
T = D/V = 10/9904 = 0.001



Nastran Demonstration 2

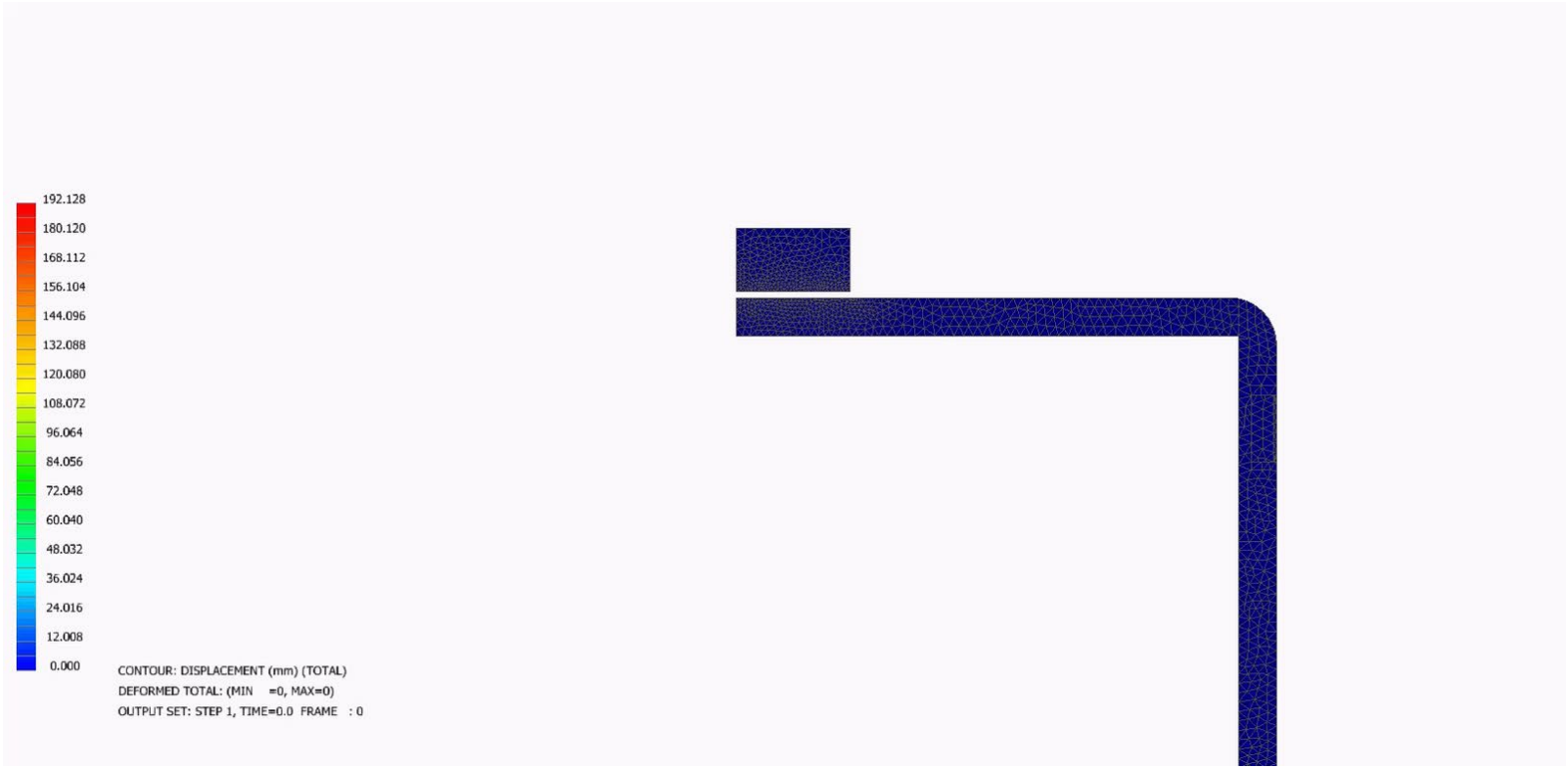
Nastran Nonlinear Transient Response Analysis

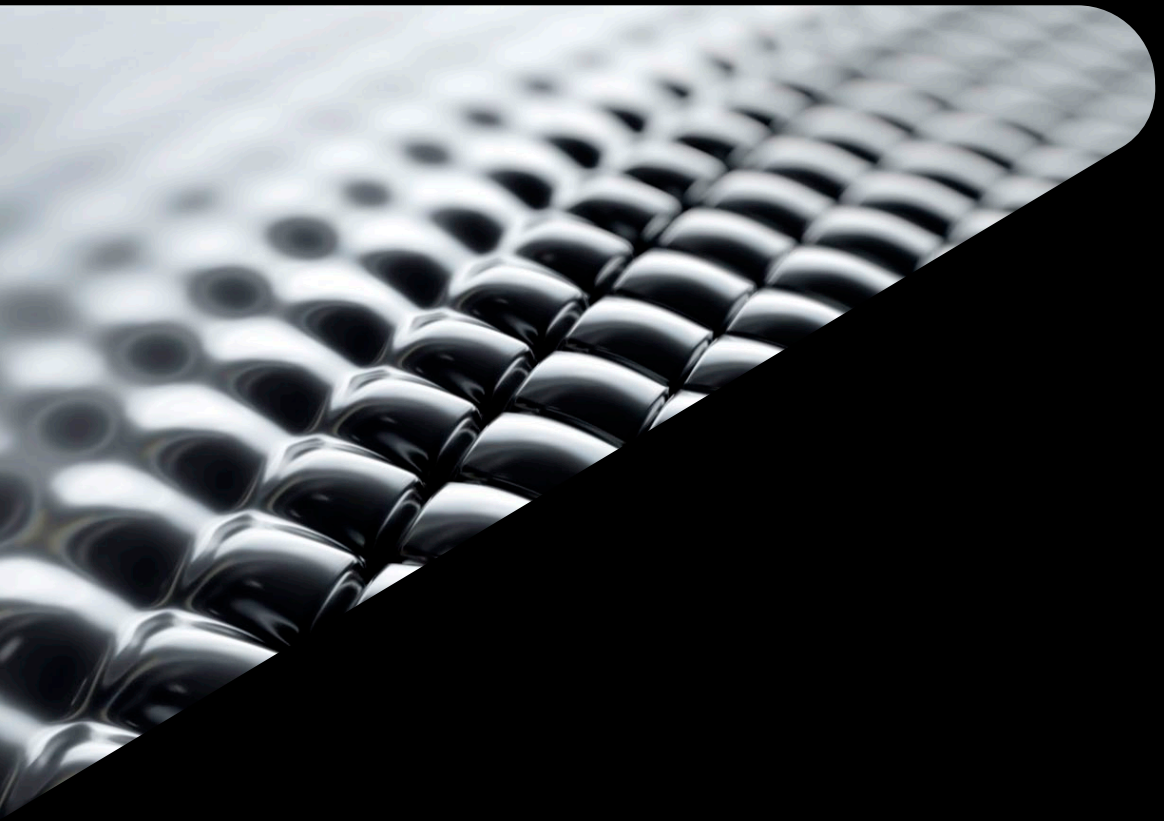




Nastran Demonstration 2

Nastran Nonlinear Transient Response Analysis





3- Euro EMC Products

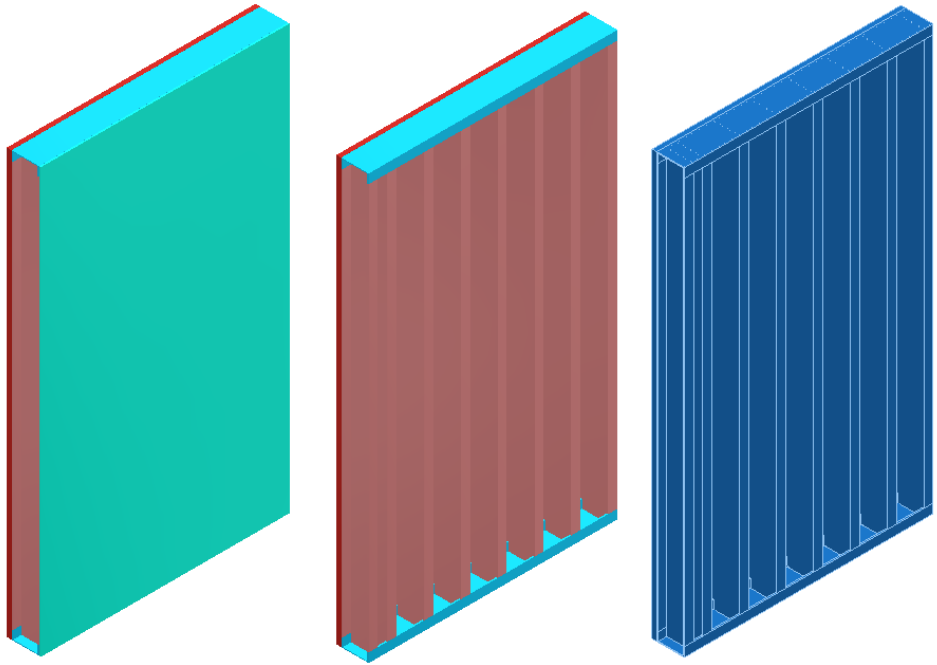
Blast Door

- Goal
  - Is to determine whether the door contains the blast from outside
- Key Information
  - Steel 355 nonlinear material behavior.
  - Blast Load = 200MN of 3ms impulse duration

Workflow considerations

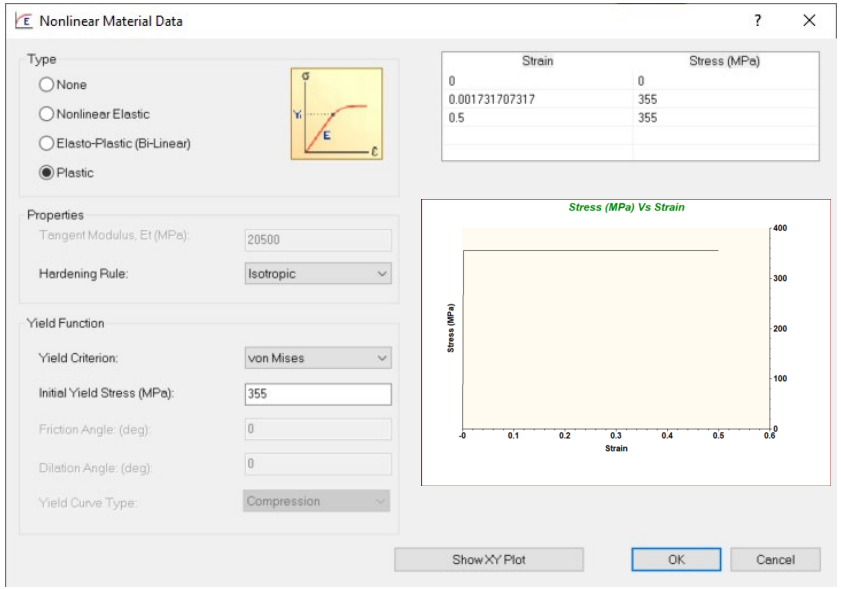
Alternative physical test is not sustainable.

- Geometry
  - Simplification
    - Remove nonstructural components
    - Remove nonstructural features
  - Remodeling
    - A simplified solid assembly
    - A simplified solid model (part)
    - A simplified surface model



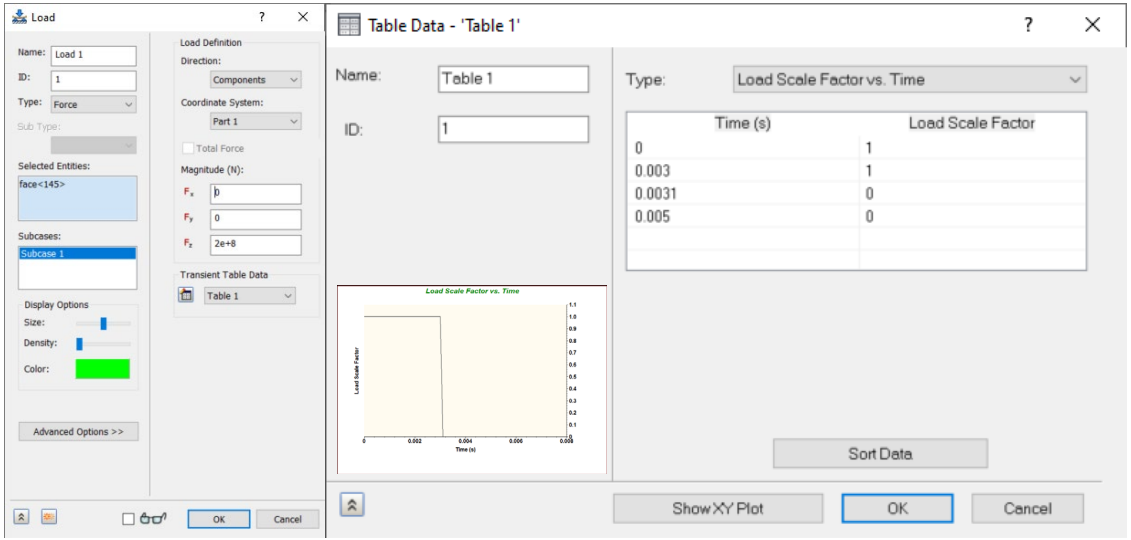
Workflow considerations

- Material Information (Elastic/Plastic)
  - Plastic (100% Plastic)
    - Worst case scenario



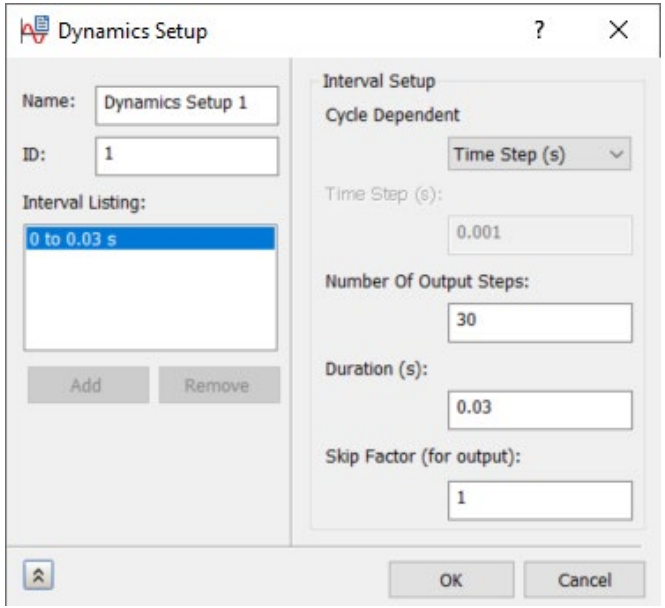
Workflow considerations

- Dynamic Load Information
  - Set up Load duration



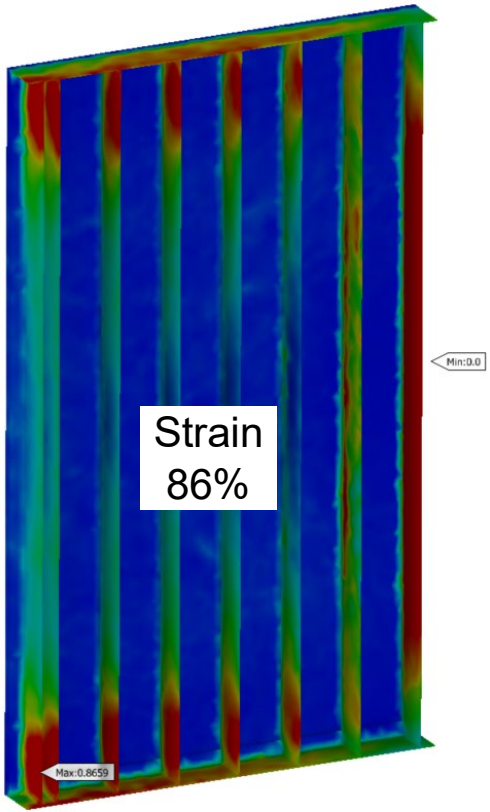
Workflow considerations

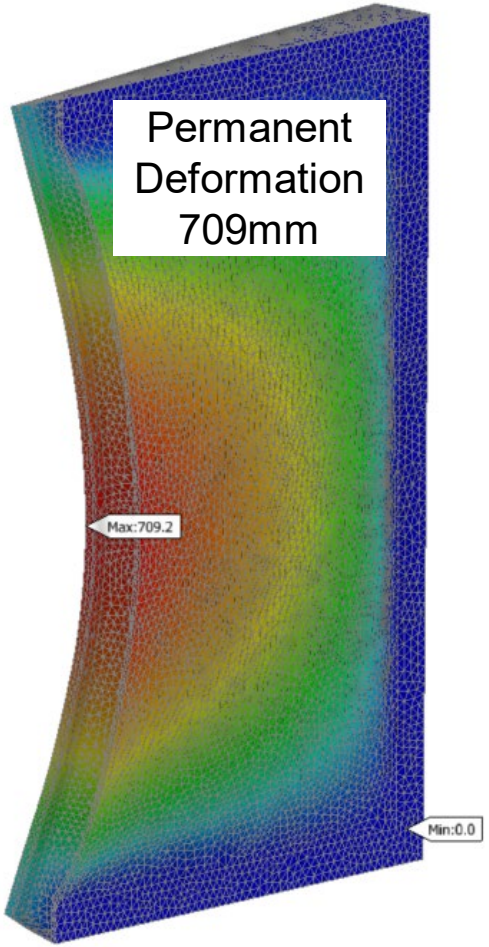
- Dynamic Setup Data
  - Number of Result steps
  - Time duration (maximum deformation achieved)

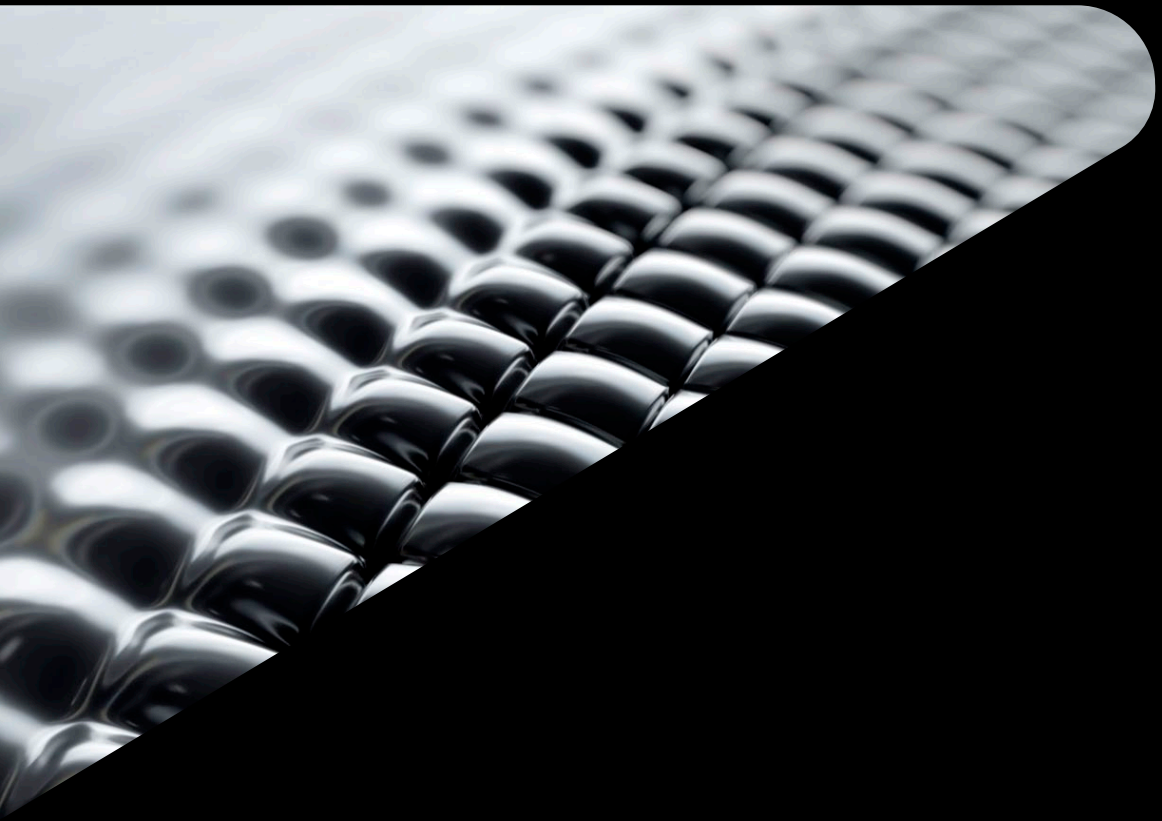


Nastran Demonstration 3

Explicit Dynamics Study



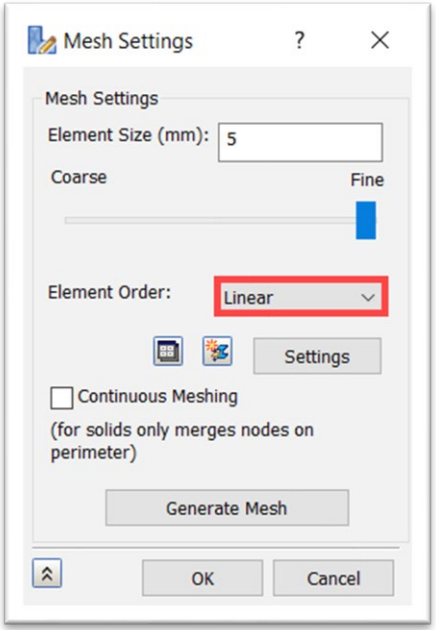




10 TOP TIPS

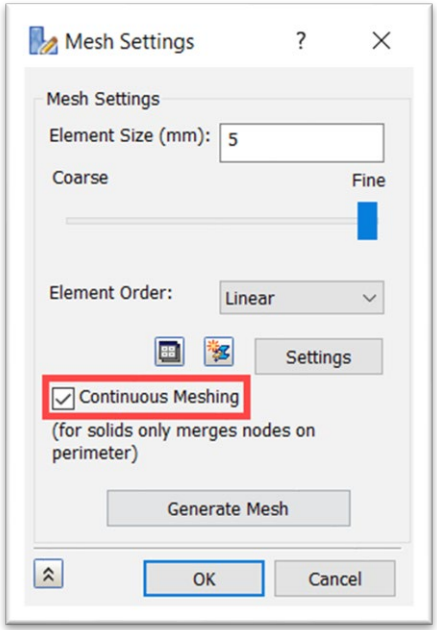
TIP 1

- Use Linear Elements



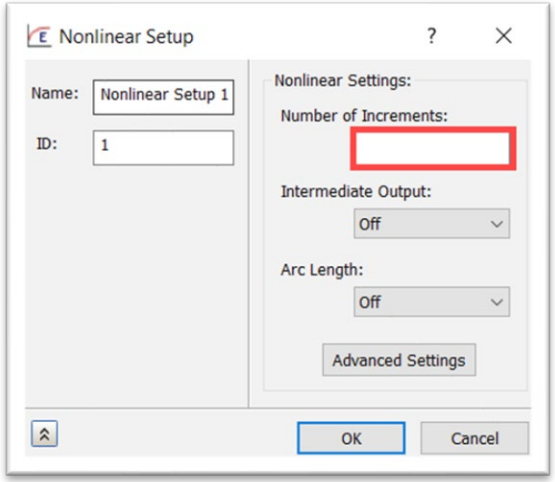
TIP 2

- Use Continuous Meshing for Surface models
  - Surfaces will need to be connected



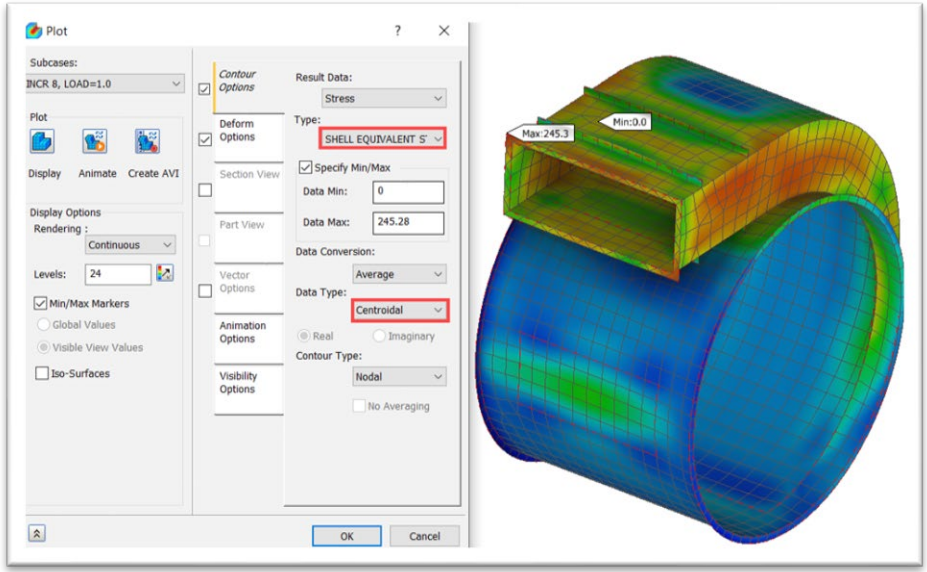
TIP 3

- Leave the Number of Increments field blank



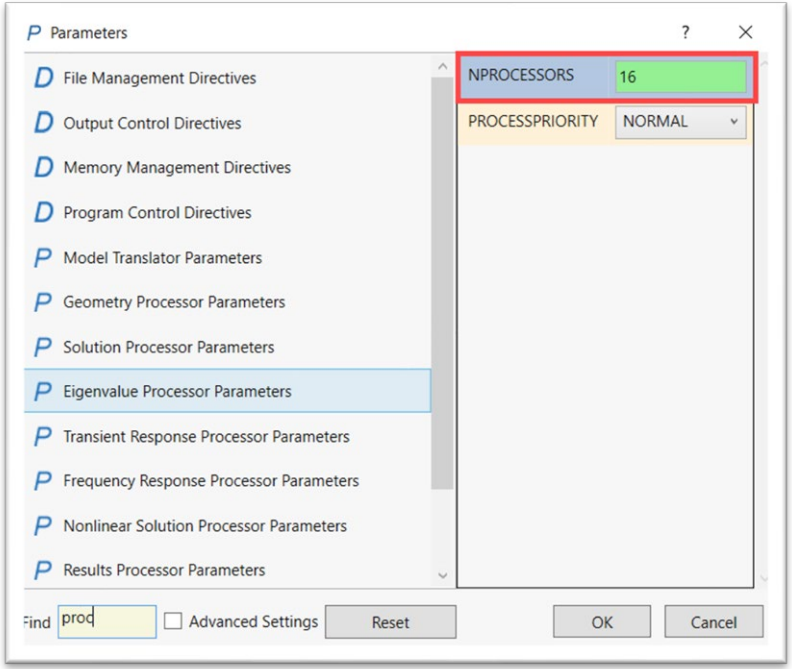
TIP 4

- Use and Display Equivalent Stress Results
  - This stress plot follows the defined stress & strain curve
  - Centroidal Data Type



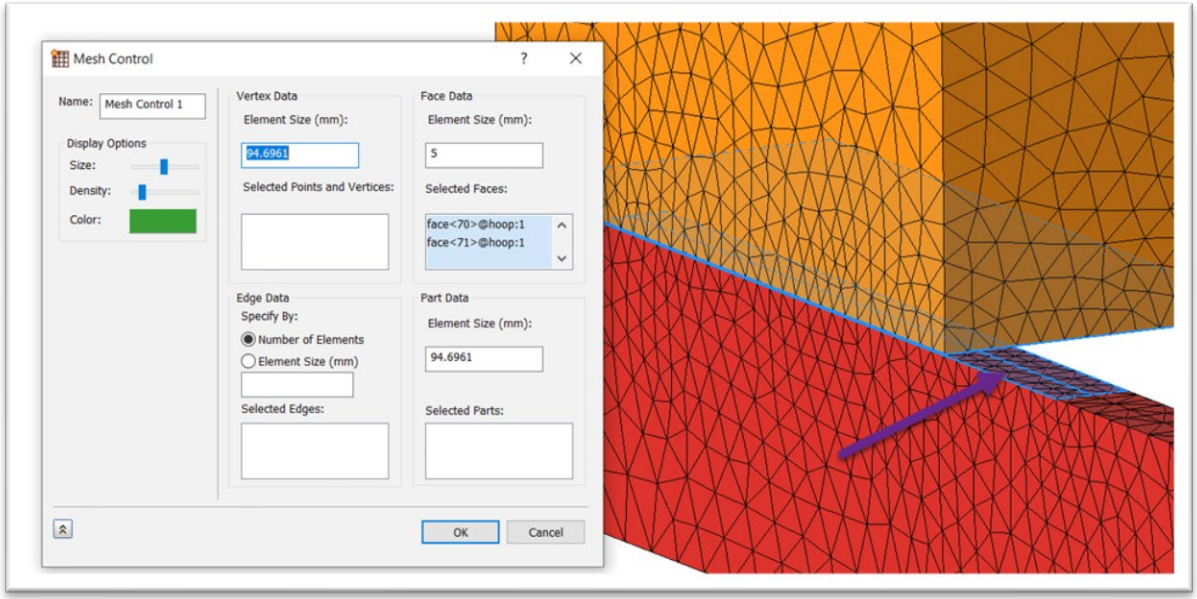
TIP 5

- Use the NPROCESSORS Parameter
  - To enable Nastran to use all cores available



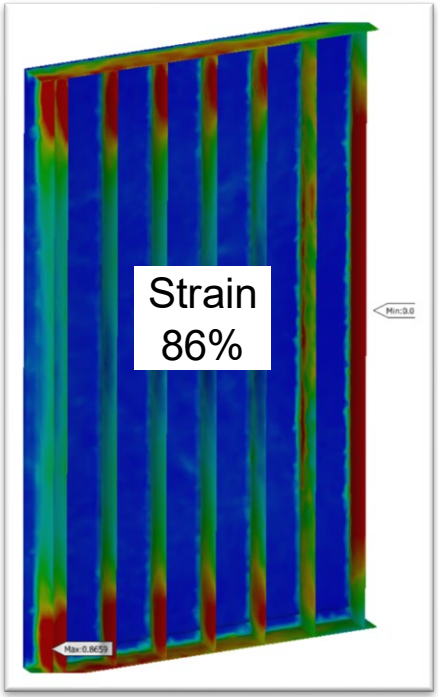
TIP 6

- Use Split faces to reduce mesh size when defining local mesh control



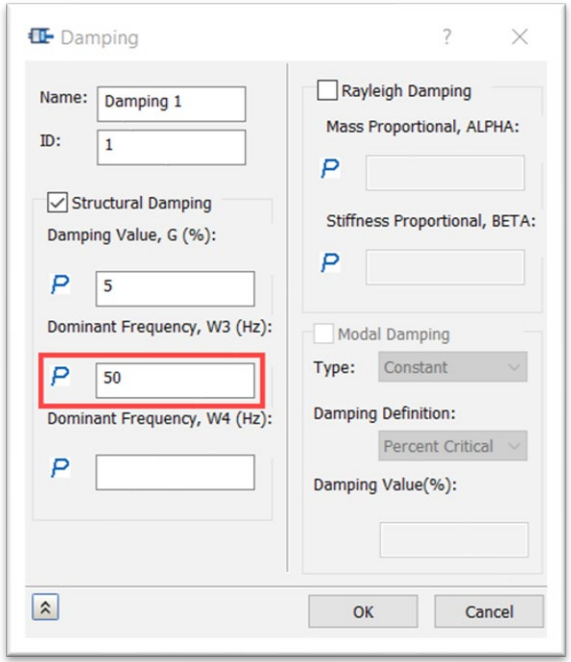
TIP 7

- Use Explicit Solvers when your designs are experiencing high strains



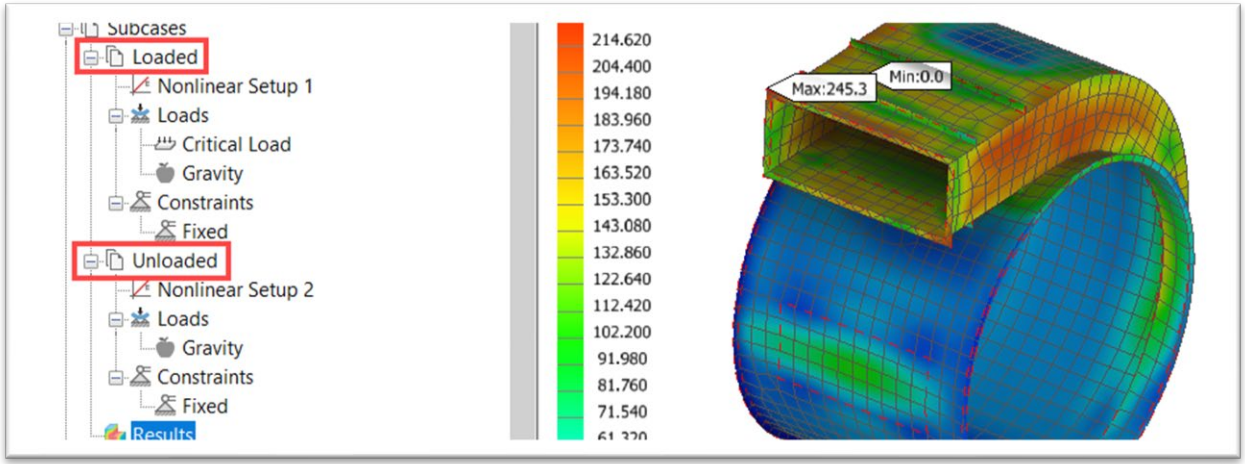
TIP 8

- Run Modal Analysis to determine Dominant Frequency W3



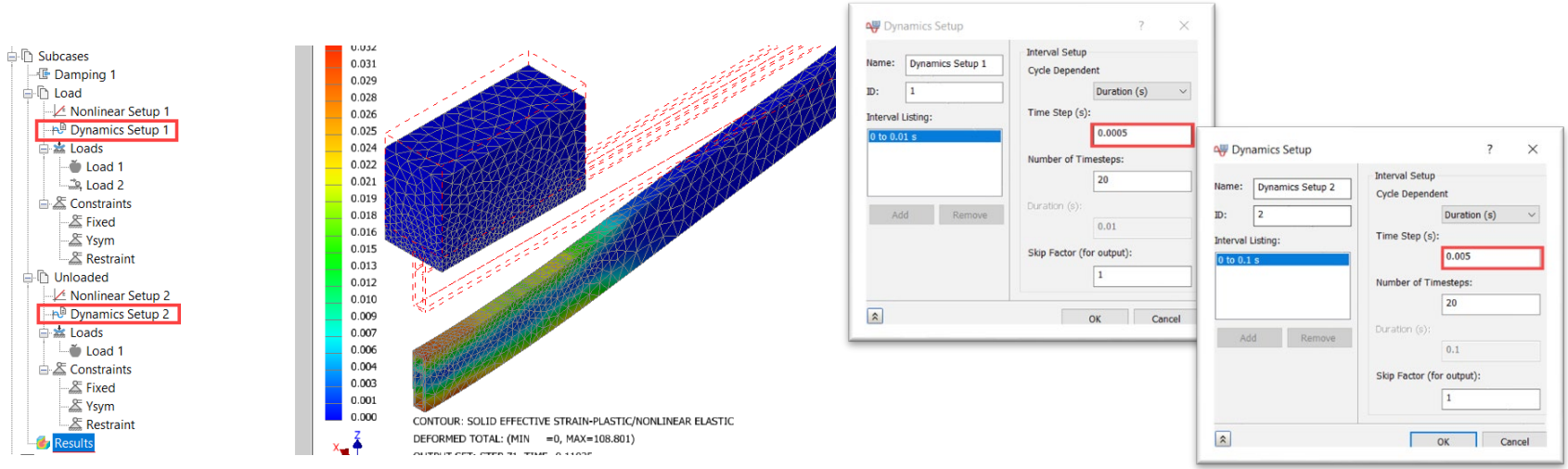
TIP 9

- Use multiple subcases to determine permanent deformations in Nonlinear Static Analysis



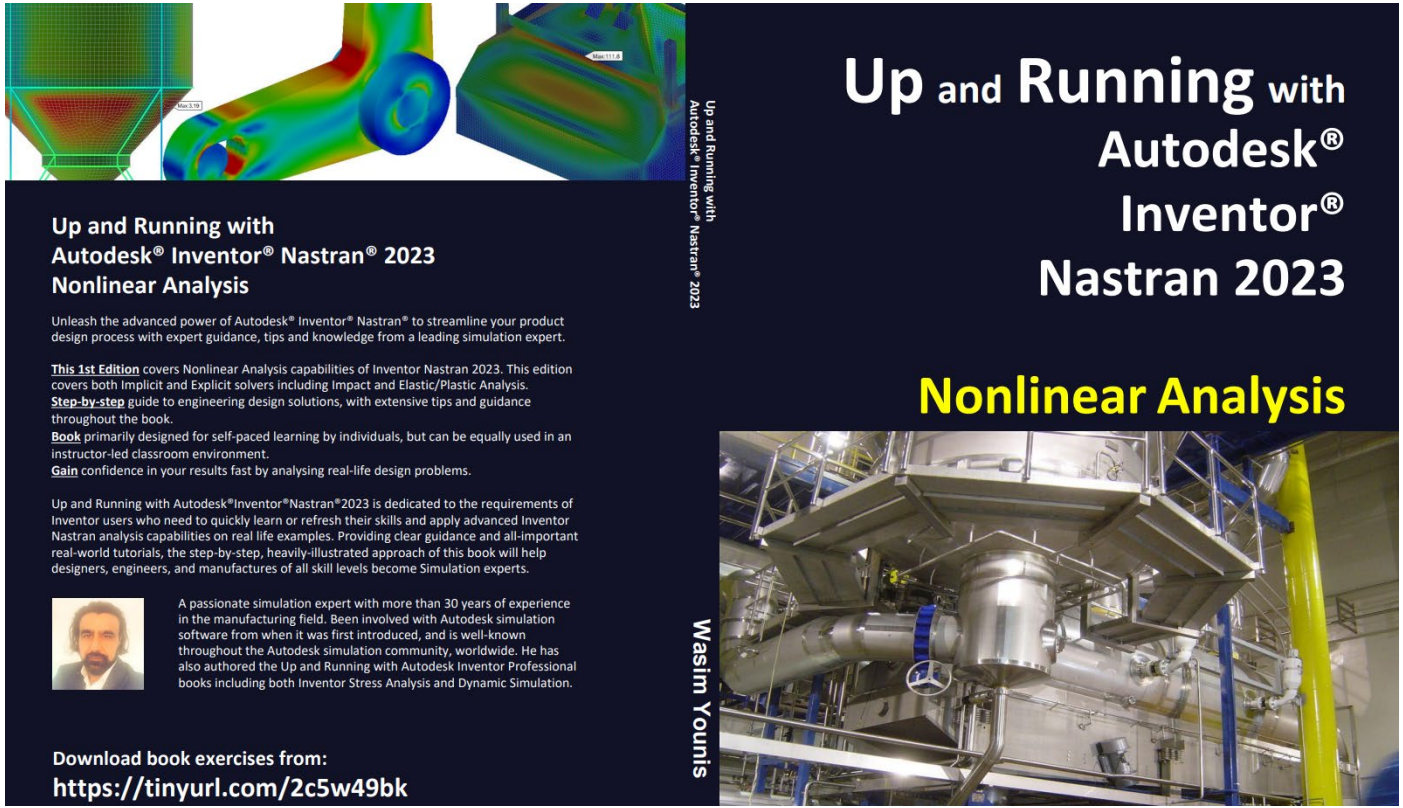
TIP 10

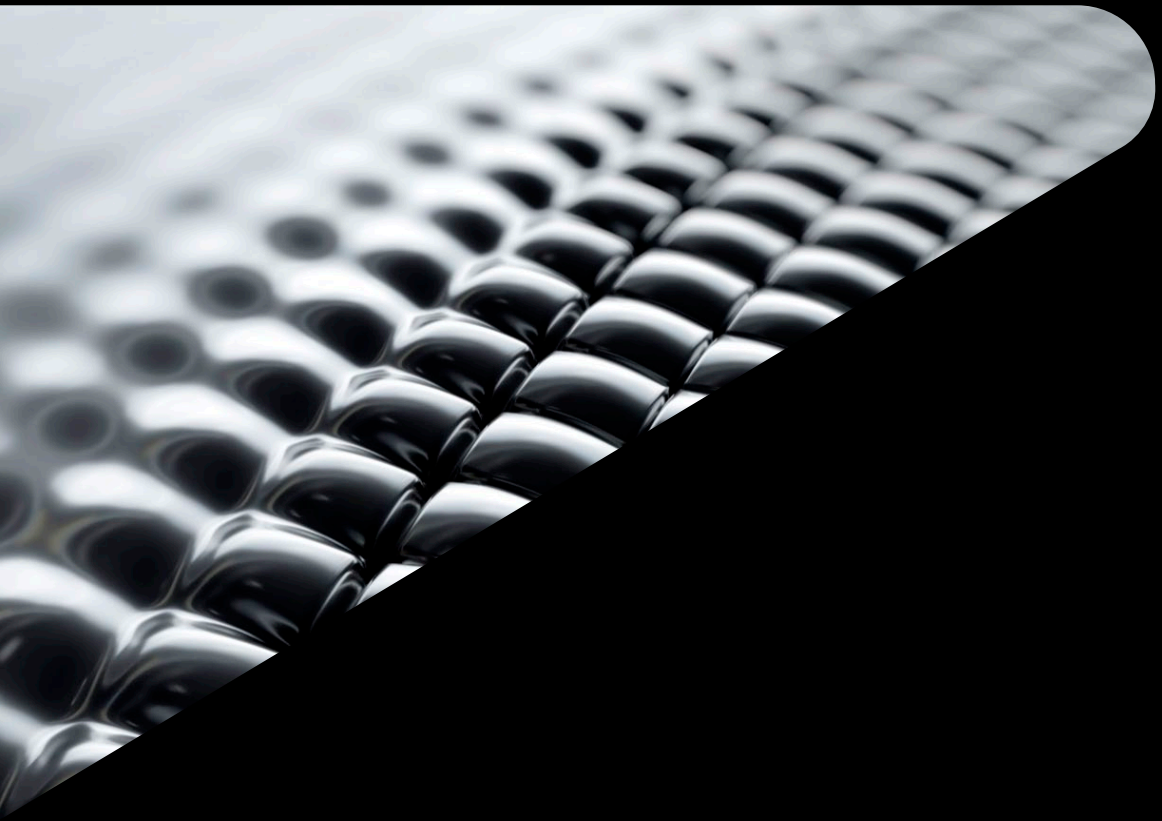
- Use multiple subcases to allow different time steps in Nonlinear Transient Response Analysis



Further learning

Book available from Amazon worldwide.





Q & A