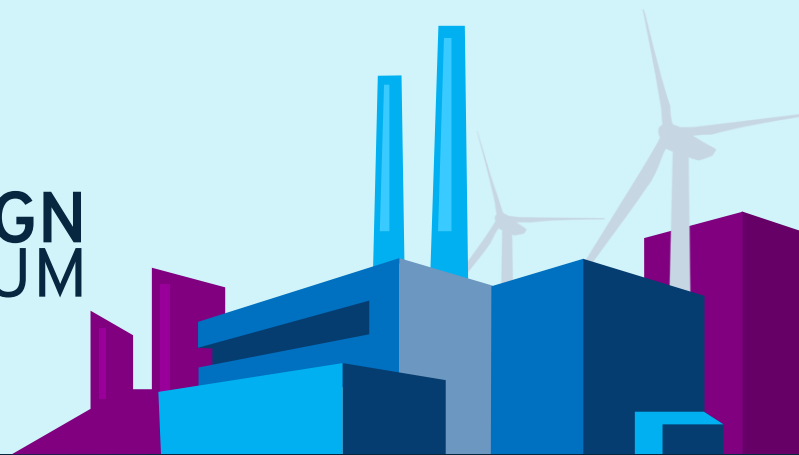




2022  
INDUSTRI&DESIGN  
FORUM



# Gennemgang af simuleringer af nogle eksempler fra hydraulik industrien.

*SPOR 5*

# SPOR 5

13:00 – 13:50

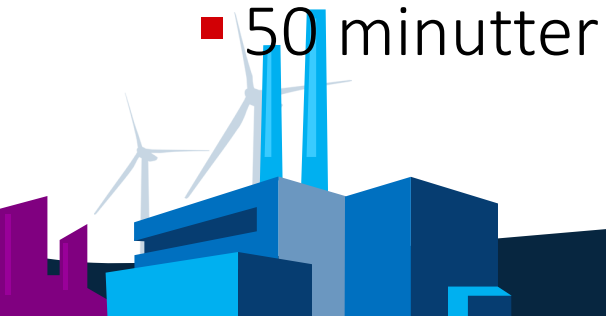
- *Af Arne Kjær*  
*CEO, PTFE Engineering*

Oplev hvordan du udnytter Inventor Nastran til at vurdere forskellige materialevalg og effekten af forskellige designforslag. Der vil blive vist eksempler fra pneumatik- og hydraulikindustrien, hvor forskellige funktionsparametre simuleres ved at benytte forskellige funktioner, der er til rådighed i Inventor Nastran 2023. Du vil også få vist forskellige muligheder for at måle og benytte sig af data fra plastindustrien.



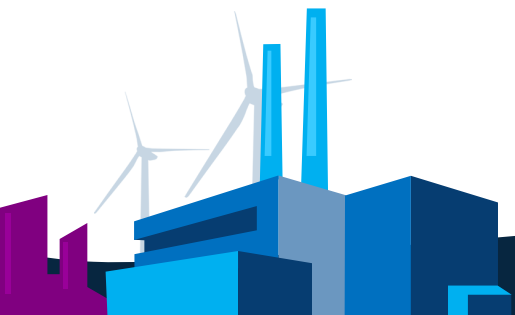
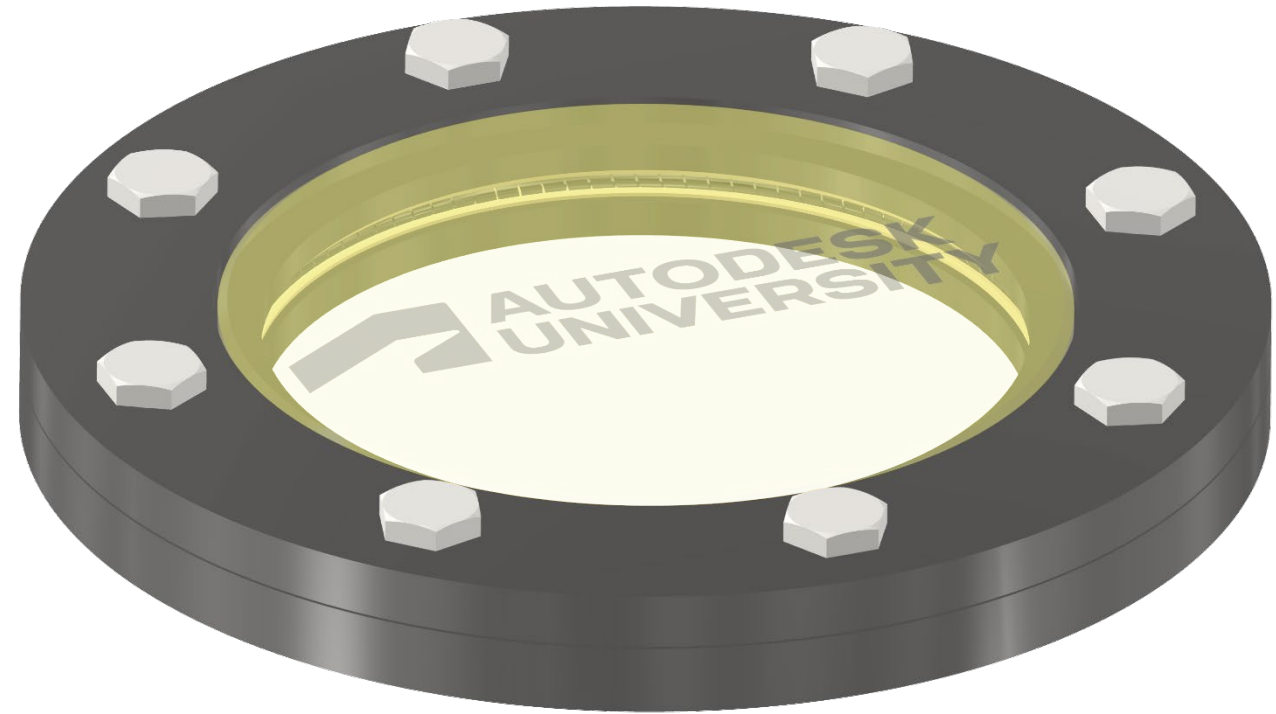
# Gennemgang af simuleringer af nogle eksempler fra hydraulik industrien.

- Gennemgang af et par eksempler hvor der lægges fokus på hvordan man udnytter Inventor Nastran 2023 til at vurdere forskellige materiale valg og effekten af forskellige design forslag.
- Der vil blive vist eksempler fra pneumatik og hydraulik industrien hvor forskellige funktions parametre simuleres ved at benytte forskellige funktioner der er til rådighed i Inventor Nastran 2023.
- Vi vil gennemgå forskellige muligheder for at måle og benytte sig af data fra plast industrien.
- 50 minutter



# Inspektions luge med overtryk

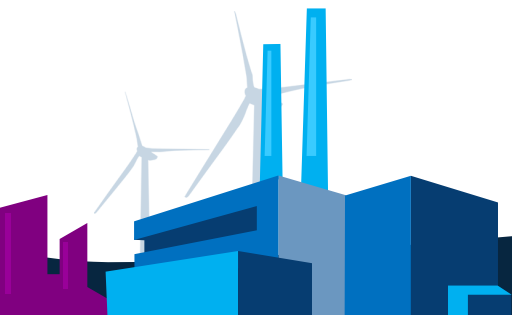
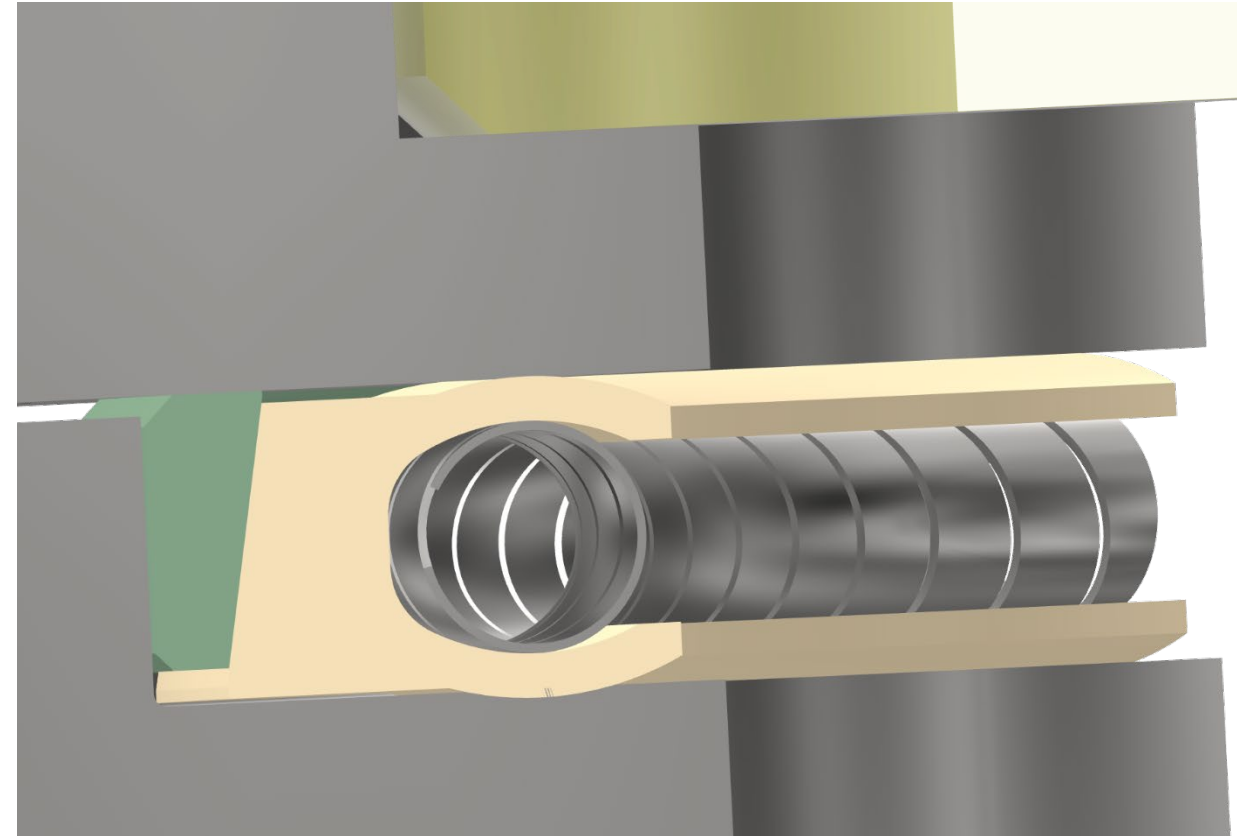
- I en maskine med højt tryk skal der installeres en inspektions luge.
- Det skal vurderes hvilket af to tætnings materialer der er bedst egnet ved at simulere opgaven i Inventor Nastran 2023.



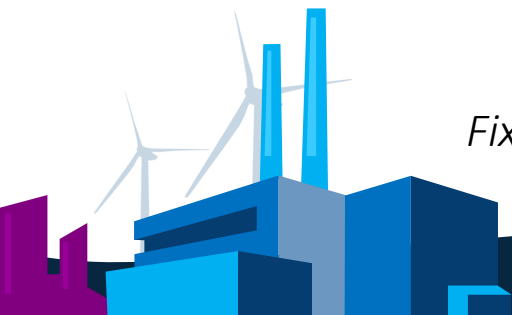
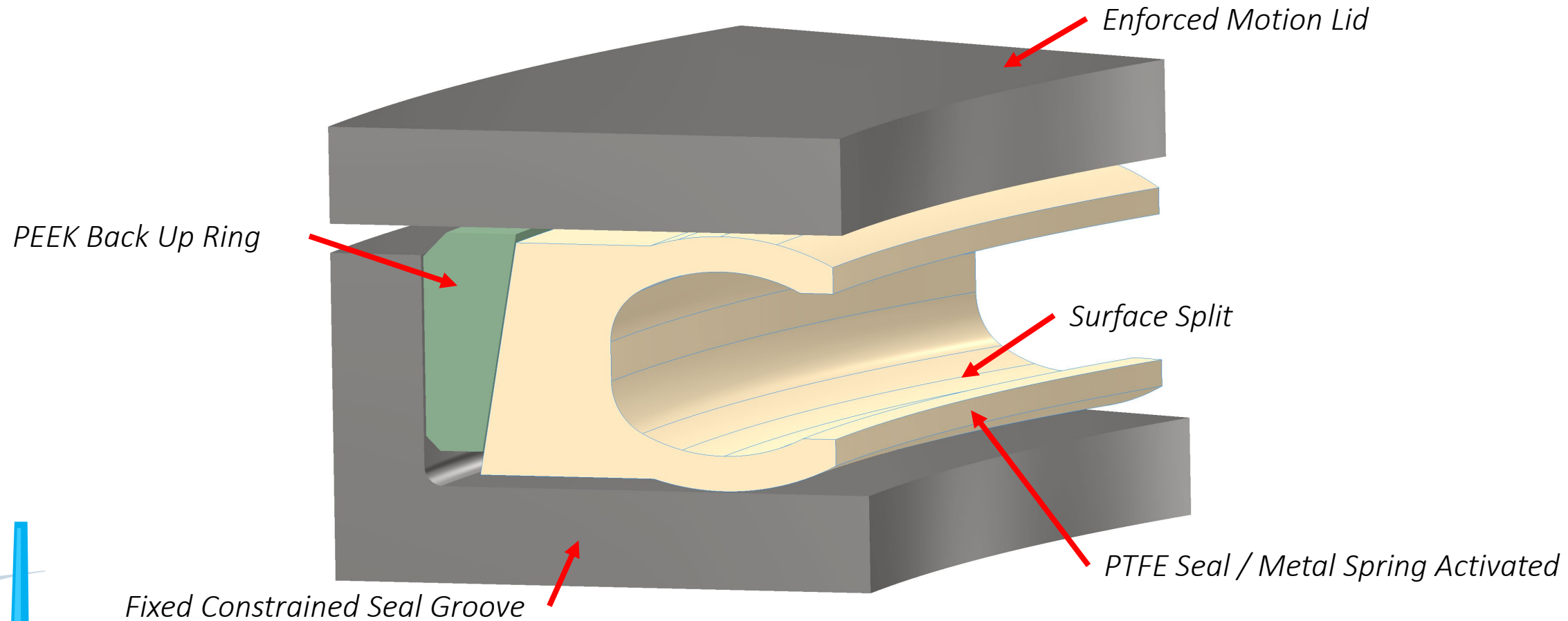


# Inspektions luge med overtryk

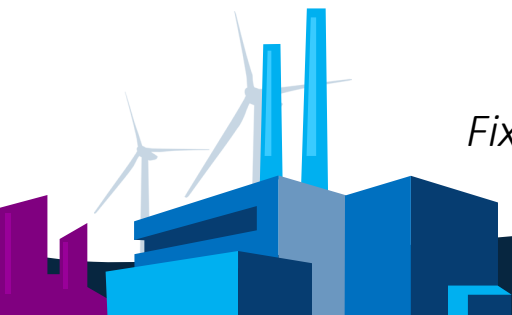
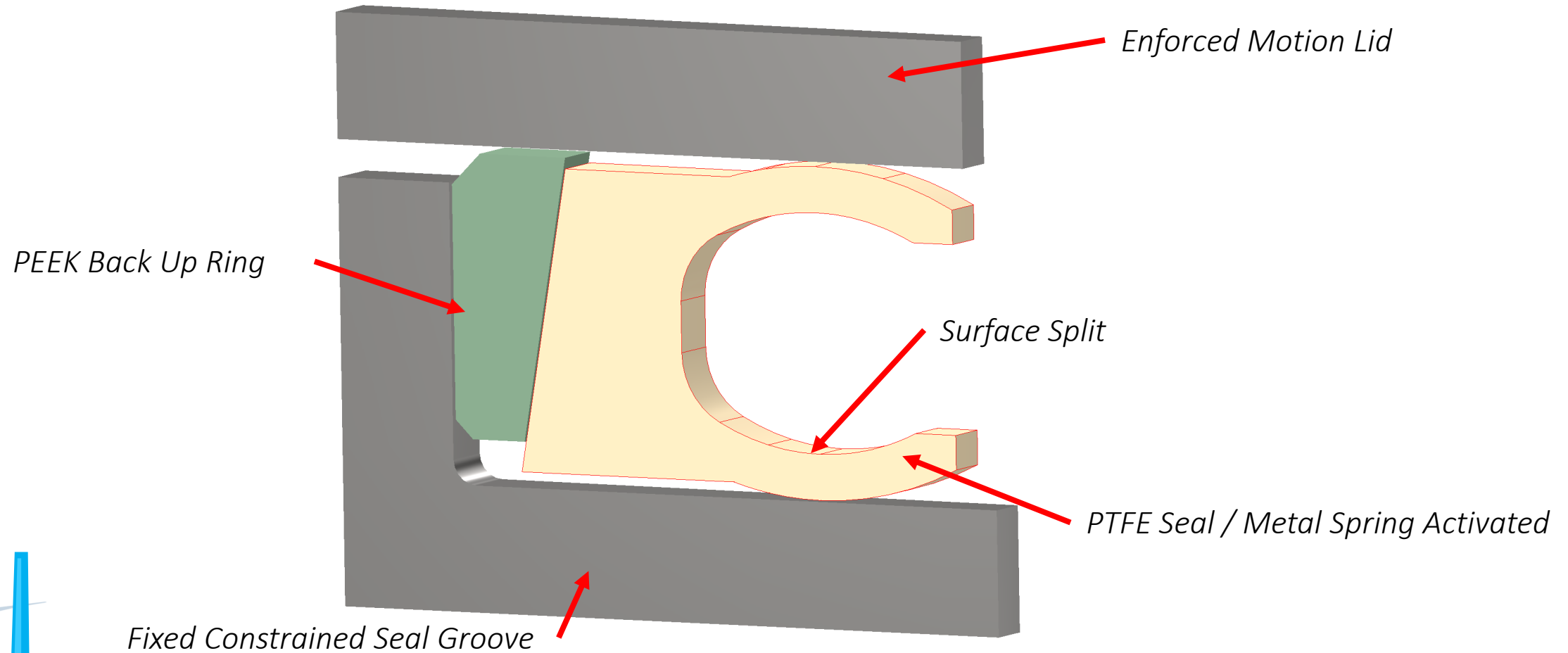
- Tætningen består af en PTFE baseret fjederaktiveret tætning støttet op af 1 Support ring fremstillet i PEEK.
- Simuleringen skal vise hvordan tætningen tilpasser sig ind i sporet under montagen.
- Efterfølgende skal tætningen vurderes efter at have modstået 10 MPa i indvendigt tryk.



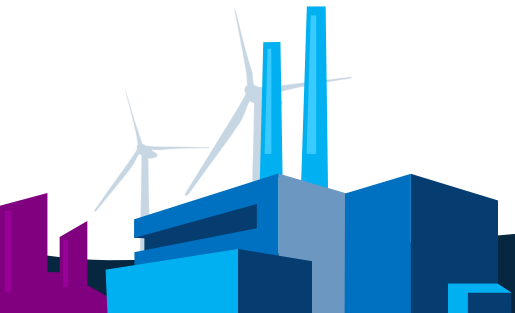
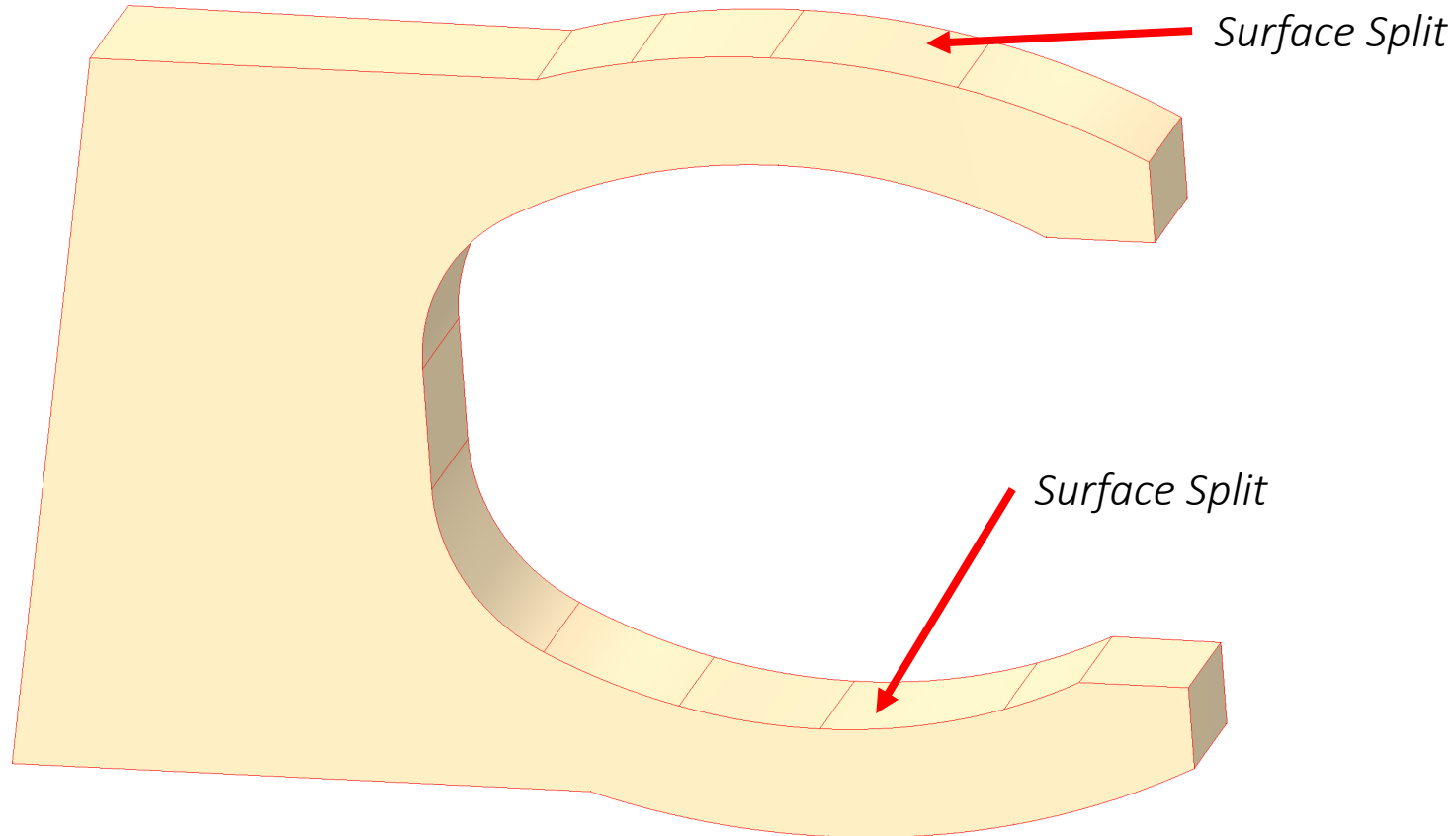
# Autodesk Inventor Nastran 2023 Assembly

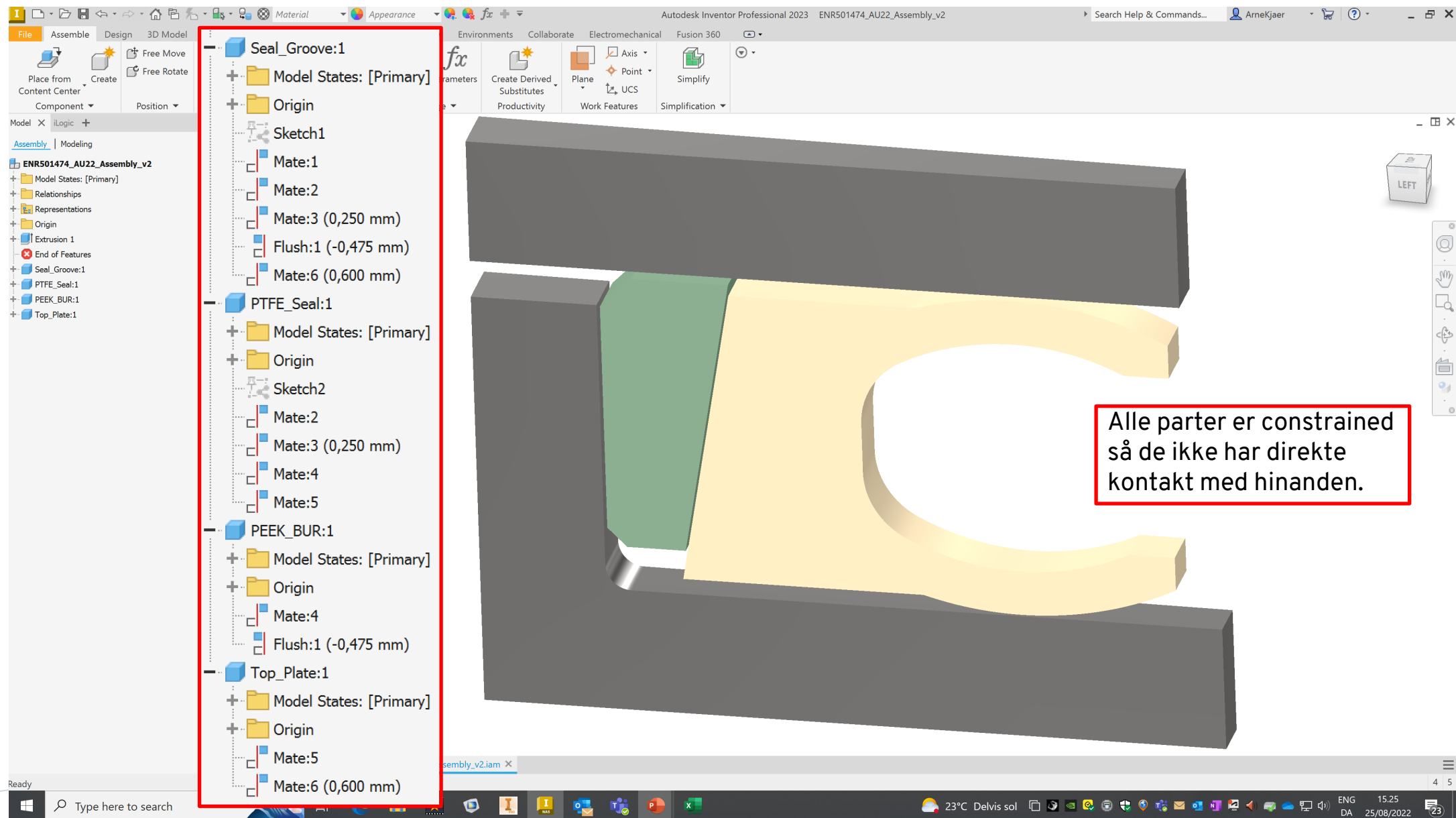


# Autodesk Inventor Nastran 2023 Assembly



# Autodesk Inventor Nastran 2023 Assembly





Alle parter er constrained  
så de ikke har direkte  
kontakt med hinanden.

Autodesk Inventor Professional 2023 ENR501474\_AU22\_Assembly.v2

File Assemble Design 3D Model Sketch Annotate Inspect Tools Manage View Environments Collaborate Electromechanical Fusion 360 Autodesk Inventor Nastran

Default Settings System New Edit Import from Stress Analysis Materials Idealizations Connectors Offset Surfaces Structural Members Constraints Loads Mesh Settings Table Generate Mesh Mesh Control Convergence Settings Run Load Results Object Visibility Help Tutorials About Read Me Forum Autodesk Inventor Nastran Finish Exit

Model iLogic Nastran... X Nastran Out... Nastran File +

Assembly Analysis 1 [Linear Static] Model Parameters Coordinate Systems

Analysis ? X

Name: Analysis 1 Title:

Type: Linear Static Units: Select Units

Output C

Nodal

☒ Linear Static

☐ Normal Modes

☐ Linear Buckling

☒ Prestress Static

☐ Prestress Normal Modes

☒ Nonlinear Static

☐ Nonlinear Buckling

-----

☐ Direct Transient Response

Modal Transient Response

Impact Analysis

Nonlinear Transient Response

Output

Direct Frequency Response

Modal Frequency Response

Random Response

Shock/Response Spectrum

-----

Multi-Axial Fatigue

Vibration Fatigue

-----

Linear Steady State Heat Transfer

Nonlinear Steady State Heat Transfer

Nonlinear Transient Heat Transfer

-----

Explicit Dynamics

Explicit Quasi-Static

Plot

Cancel

LEFT

Home ENR501474\_AU22\_Assembly.v2.iam X

For Help, press F1

Type here to search

23°C Delvis sol ENG 15.29 DA 25/08/2022

Autodesk Inventor Professional 2023 ENR501474\_AU22\_Assembly\_v2

File Assemble Design 3D Model Sketch Annotate Inspect Tools Manage View Environments Collaborate Electromechanical Fusion 360 Autodesk Inventor Nastran

Default Settings New Edit Import from Stress Analysis Materials Idealizations Connectors Offset Surfaces Structural Members Constraints Loads Auto Manual Mesh Settings Table Generate Mesh Mesh Control Convergence Settings Run Load Results Object Visibility Help Tutorials About Read Me Forum Finish Autodesk Inventor Nastran Exit

Model iLogic Nastran... X Nastran Out... Nastran File +

Assembly  
Analysis 1 [Nonlinear Static]  
Model  
Parameters  
Coordinate Systems  
ENR501474\_AU22\_Assembly\_v2  
PEEK\_BUR:1  
PTFE\_Seal:1  
Seal\_Groove:1  
Top\_Plate:1  
Cylindrical 5

Coordinate System

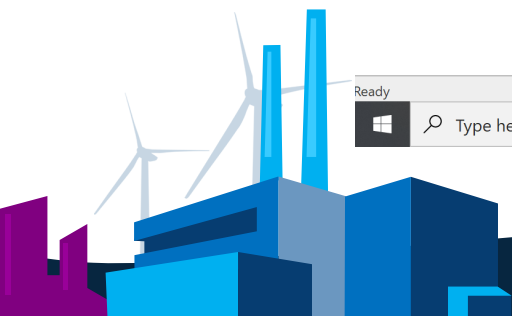
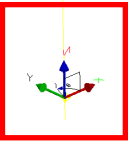
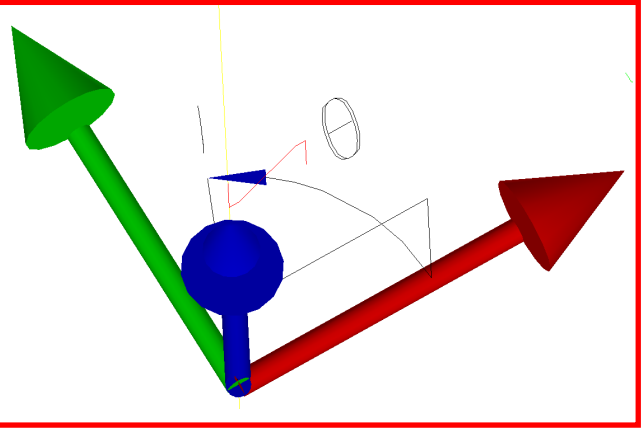
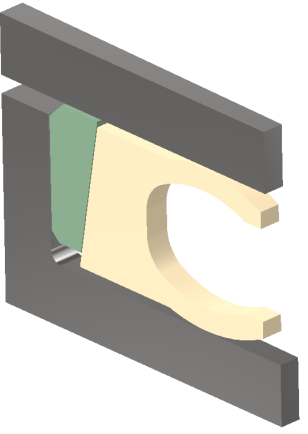
Name: Cylindrical 5  
ID: 5  
Type: Cylindrical  
Reference To: ENR501474\_AU22  
☒ Display

Origin  
☒  
Defined: Global  
X: 0  
Y: 0  
Z: 0

Point on XZ Plane  
☒  
Defined: Global  
X: 50  
Y: 0  
Z: 0

Point on Z Axis  
☒  
Defined: Global  
X: 0  
Y: 50  
Z: 0

OK Cancel



Autodesk Inventor Professional 2023 ENR501474\_AU22\_Assembly\_v2

File Assemble Design 3D Model Sketch Annotate Inspect Tools Manage View Environments Collaborate Electromechanical Fusion 360 Autodesk Inventor Nastran

Default Settings New Edit Import from Stress Analysis Materials Idealizations Connectors Offset Surfaces Structural Members Constraints Loads Auto Manual Mesh Settings Table Generate Mesh Convergence Settings Run Load Results Object Visibility Help Tutorials Read Me About Finish Autodesk Inventor Nastran Exit

Model iLogic Nastran... X Nastran Out... Nastran File +

Assembly  
Analysis 1 [Nonlinear Static]  
Model  
Materials  
Stainless Steel AISI 301  
PTFE Aromatic polyester  
PEEK Special Comp  
Idealizations  
Solids  
PEEK 3  
PEEK Special Comp  
Stainless Steel 1  
Solid 2  
Shells  
Beams  
Concentrated Masses  
Composite Layups  
Constraints  
Loads  
Connectors  
Dampings  
Tables  
Surface Contacts  
Plot Templates  
Groups  
Parameters  
Coordinate Systems  
ENR501474\_AU22\_Assembly\_v2  
PEEK\_BUR:1  
PTFE\_Seal:1  
Seal\_Groove:1  
Top\_Plate:1  
Cylindrical 5

Material

Select Material

Name: Victrex PEEK 450 G  
ID: 3  
Type: Isotropic  
Sub Type: Neo-Hookean  
Idealizations: Stainless Steel 1 Solid 2 PEEK 3  
Save New Material  
Analysis Specific Data  
Nonlinear  
Fatigue  
PPFA

General  
P 1,3e-9  
GE 0  
T 296,15

Allowables  
S<sub>y</sub> 106,8  
S<sub>u</sub> 98  
S<sub>t</sub> 95,29  
Failure Theory von Mises Stress  
Rigid  
Coordinate System: ENR501474\_AU2  
Mass (t):

Material DB

Material Tree  
Autodesk Material Library  
Inventor Material Library  
PTFE

Load Database OK

PTFE 01A.nasmat  
PTFE 10 Ekonol Stiff.nasmat  
PTFE CF10 02A.nasmat  
PTFE CF10 03A.nasmat  
PTFE CF10 04A.nasmat  
PTFE CF10 Isotropic.nasmat  
PTFE CF10 Isotropic01A.nasmat  
PTFE CF10 Mooney-Rivlin 01A.nasmat  
PTFE CF10 Neo-Hookean01A.nasmat  
PTFE Data Test 1.nasmat  
PTFE Data Test 2.nasmat  
PTFE TF1620 Virgin.nasmat  
Silicone HTV HY-MR.nasmat  
Silicone HTV\_Math\_Isotropic.nasmat  
Silicone HTV\_Math\_NH.nasmat  
Silicone\_T001\_HY\_MR\_293K.nasmat  
Silicone\_T001\_HY\_MR\_293K\_NHK.nasmat  
Silicone\_T001\_MR.nasmat  
Victrex PEEK 450 G.nasmat  
Victrex PEEK 450G.nasmat

For Help, press F1  
Type here to search

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ENG DA 25/08/2022



Autodesk Inventor Professional 2023 ENR501474\_AU22\_Assembly\_v2

File Assemble Design 3D Model Sketch Annotate Inspect Tools Manage View Environments Collaborate Electromechanical Fusion 360 Autodesk Inventor Nastran

Default Settings New Edit Import from Stress Analysis Materials Idealizations Connectors Offset Surfaces Structural Members Constraints Loads Auto Manual Mesh Settings Generate Mesh Mesh Control Convergence Settings Run Load Results Object Visibility Help Tutorials Read Me About Autodesk Inventor Nastran Finish Exit

Model iLogic Nastran... X Nastran Out... Nastran File +

Assembly  
Analysis 1 [Nonlinear Static]  
Model  
Materials  
Stainless Steel AISI 301  
PTFE CF10 Isotropic  
Victrex PEEK 450 G  
Idealizations  
Solids  
PTFE 2  
PEEK 3  
Stainless Steel 1  
Shells  
Beams  
Concentrated Masses  
Composite Layups  
Constraints  
Loads  
Connectors  
Dampings  
Tables  
Surface Contacts  
Plot Templates  
Groups  
Parameters  
Coordinate Systems  
ENR501474\_AU22\_Assembly\_v2  
PEEK\_BUR:1  
PTFE\_Seal:1  
Seal\_Groove:1  
Top\_Plate:1  
Cylindrical 5

Material

Select Material

Name: Victrex PEEK 450 G

ID: 3

Type: Isotropic

Sub Type: Neo-Hookean

Idealizations:  
Stainless Steel 1  
PTFE 2  
PEEK 3

Save New Material

Analysis Specific Data  
Nonlinear (on)  
Fatigue  
PPFA

General  
P: 1,3e-9  
GE: 0  
T: 296,15

Structural  
E: 2403,9  
G:   
V: 0,41  
A: 0

Allowables  
S<sub>y</sub>: 106,8  
S<sub>t</sub>: 98  
S<sub>c</sub>:   
S<sub>u</sub>: 95,29

Failure Theory  
von Mises Stress

Thermal  
C: 1e+8  
K: 0,25

Nonlinear Material Data

Type  
☐ None  
☐ Nonlinear Elastic  
☐ Elasto-Plastic (Bi-Linear)  
☒ Plastic

Properties  
Tangent Modulus, E<sub>t</sub> (MPa): 59,8

Hardening Rule: Isotropic

Yield Function  
Yield Criterion: von Mises

Initial Yield Stress (MPa): 95,29

Friction Angle (deg): 0

Dilation Angle (deg): 0

Yield Curve Type: Compression

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

Stress (MPa) Vs Strain

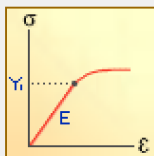
Stress (MPa)

Strain

Strain	Stress (MPa)
0	0
0.03963975207	95.29
0.0408916	97.3289
0.0419344	98.8192
0.0429762	100.099
0.0440169	101.38
0.0450565	102.45
0.046095	103.415
0.0471325	104.167
0.0481689	104.812
0.0492042	105.351
0.0502384	105.783
0.0512716	106.108
0.0523037	106.326
0.0533347	106.436
0.0543647	106.545
0.0553936	106.655
0.0564269	106.678
0.0574535	106.788
0.058479	106.68
0.0595035	106.681
0.0605269	106.681

Type

- ☐ None
- ☐ Nonlinear Elastic
- ☐ Elasto-Plastic (Bi-Linear)
- ☒ Plastic



Properties

Tangent Modulus, Et (MPa):

59,8

Hardening Rule:

Isotropic

Yield Function

Yield Criterion:

von Mises

Initial Yield Stress (MPa):

95,29

Friction Angle: (deg):

0

Dilation Angle: (deg):

0

Yield Curve Type:

Compression

Strain	Stress (MPa)
0	0
0.03963975207	95,29
0.0408916	97,3289
0.0419344	98,8192
0.0429762	100,099
0.0440169	101,38
0.0450565	102,45
0.046095	103,415
0.0471325	104,167
0.0481689	104,8
0.0492042	105,3
0.0502384	105,7
0.0512716	106,1
0.0523037	106,3
0.0533347	106,4
0.0543647	106,5
0.0553936	106,6
0.0566269	106,6
0.0576535	106,7
0.058679	106,8
0.0597035	106,8
0.0607269	106,8

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: 4

Vertical Bar Width: 10 %

Copy Data to Clipboard

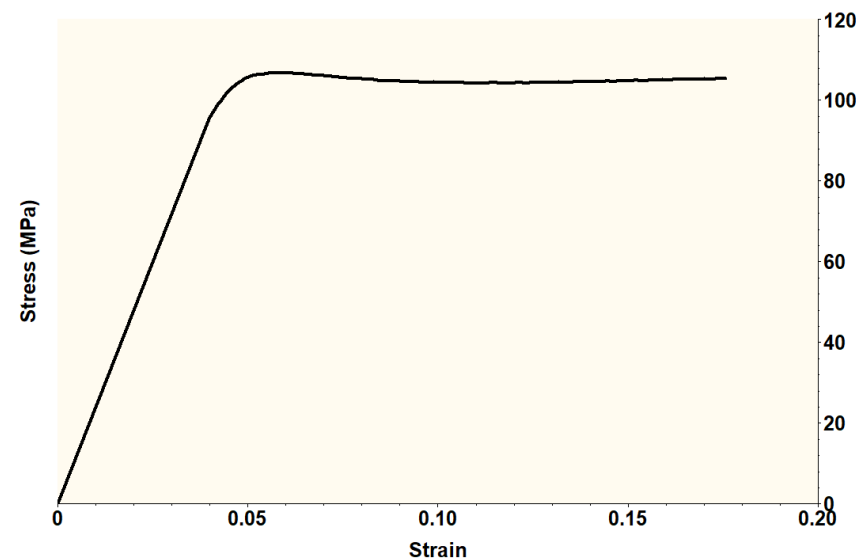
☐ Show Grid

Default Settings

Set As Default Settings

OK

Stress (MPa) Vs Strain



Autodesk Inventor Professional 2023 ENR501474\_AU22\_Assembly\_v2

File Assemble Design 3D Model Sketch Annotate Inspect Tools Manage View Environments Collaborate Electromechanical Fusion 360 Autodesk Inventor Nastran

Default Settings New Edit Import from Stress Analysis Materials Idealizations Connectors Offset Surfaces Structural Members Constraints Loads Auto Manual Mesh Settings Table Generate Mesh Convergence Settings Run Load Results Object Visibility Help Tutorials About Read Me Forum Finish Autodesk Inventor Nastran Exit

Model iLogic Nastran... X Nastran Out... Nastran File +

Assembly

- Analysis 1 [Nonlinear Static]
- Model
  - Materials
    - Stainless Steel AISI 301
    - PTFE CF10 Isotropic
    - Victrex PEEK 450 G
  - Idealizations
    - Solids
      - PTFE 2
      - PEEK 3
      - Stainless Steel 1
    - Shells
    - Beams
    - Concentrated Masses
  - Composite Layups
  - Constraints
  - Loads
  - Connectors
  - Dampings
  - Tables
  - Surface Contacts
  - Plot Templates
  - Groups
  - Parameters
- Coordinate Systems
  - ENR501474\_AU22\_Assembly\_v2
  - PEEK\_BUR:1
  - PTFE\_Seal:1
  - Seal\_Groove:1
  - Top\_Plate:1
  - Cylindrical 5

Idealizations

Name: PTFE 2

ID: 2

Type: Solid Elements

Line Element Type: Bar

Material: PTFE CF10 Isotr

Color: [Blue]

Associated Geometry

Selected Entities: PTFE\_Seal:1

Material Axes

Coordinate System: Cylindrical 5

Nonlinear Material Data

Type

- ☐ None
- ☒ Nonlinear Elastic
- ☐ Elasto-Plastic (Bi-Linear)
- ☐ Plastic

Properties

Tangent Modulus, Et (MPa): 108.3

Hardening Rule: Isotropic

Yield Function

Yield Criterion: von Mises

Initial Yield Stress (MPa):

Friction Angle (deg): 0

Dilation Angle (deg): 0

Yield Curve Type: Compression

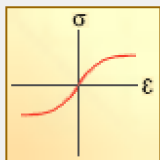
Strain Stress (MPa)

-0.35	-38.586
-0.34923	-38.524
-0.34791	-38.432
-0.3466	-38.35
-0.34527	-38.239
-0.34395	-38.145
-0.34264	-38.055
-0.34132	-37.951
-0.34	-37.849
-0.33868	-37.755
-0.33738	-37.653
-0.33605	-37.542
-0.33474	-37.445
-0.33343	-37.365
-0.33209	-37.247
-0.33078	-37.138
-0.32946	-37.045
-0.32815	-36.945
-0.32681	-36.825
-0.32551	-36.726
-0.3242	-36.641
-0.32287	-36.516

Show XY Plot OK Cancel

## Type

- ☐ None
- ☒ Nonlinear Elastic
- ☐ Elasto-Plastic (Bi-Linear)
- ☐ Plastic



## Properties

Tangent Modulus, Et (MPa):

108,3

Hardening Rule:

Isotropic

## Yield Function

Yield Criterion:

von Mises

Initial Yield Stress (MPa):

Friction Angle: (deg):

0

Dilation Angle: (deg):

0

Yield Curve Type:

Compression

Strain

-0,35
-0,34923
-0,34791
-0,3466
-0,34527
-0,34395
-0,34264
-0,34132
-0,34
-0,33868
-0,33738
-0,33605
-0,33474
-0,33343
-0,33209
-0,33078
-0,32946
-0,32815
-0,32681
-0,32551
-0,3242
-0,32287

Stress (MPa)

-38,586
-38,524
-38,432
-38,35
-38,239
-38,145
-38,055
-37,951

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 %

Show XY Plot

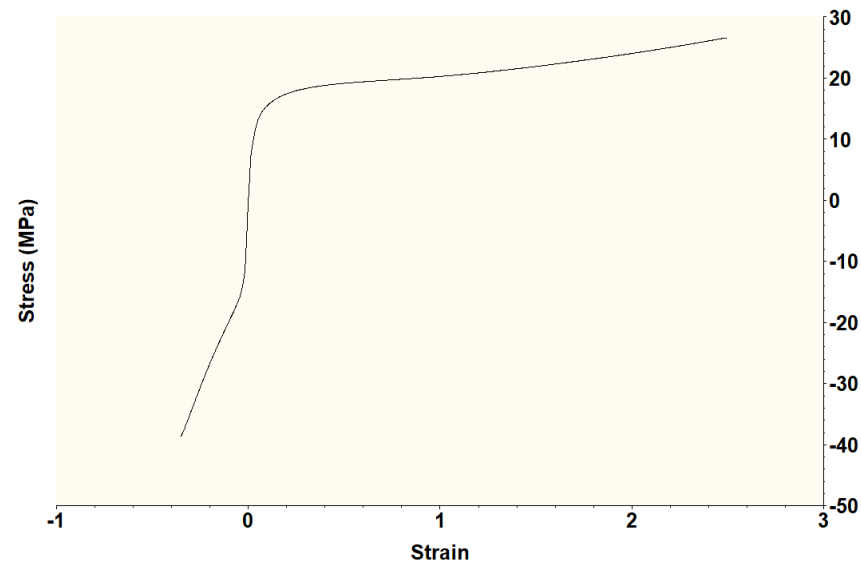
Copy Data to Clipboard

☐ Show Grid

Default Settings

Set As Default Settings

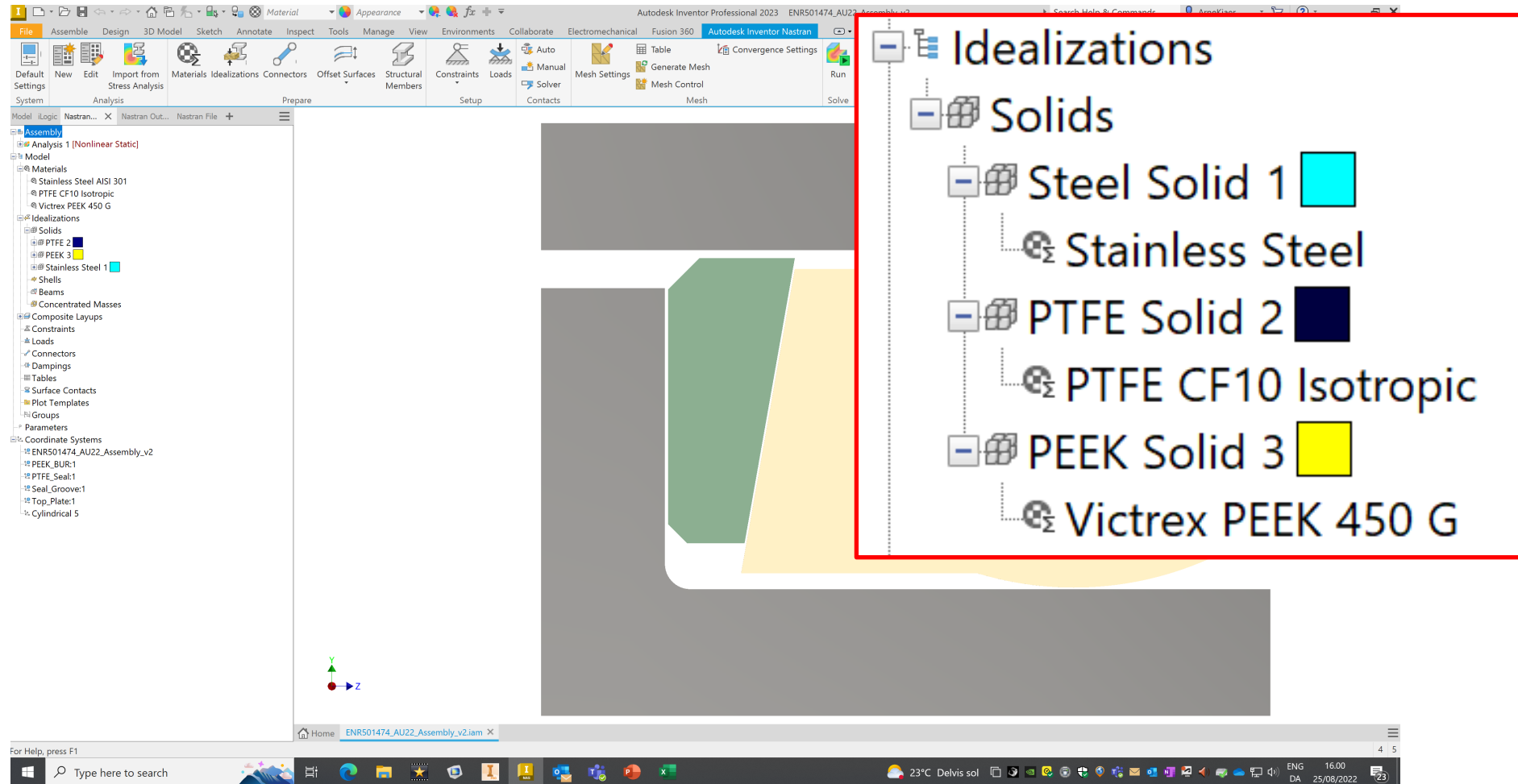
## Stress (MPa) Vs Strain

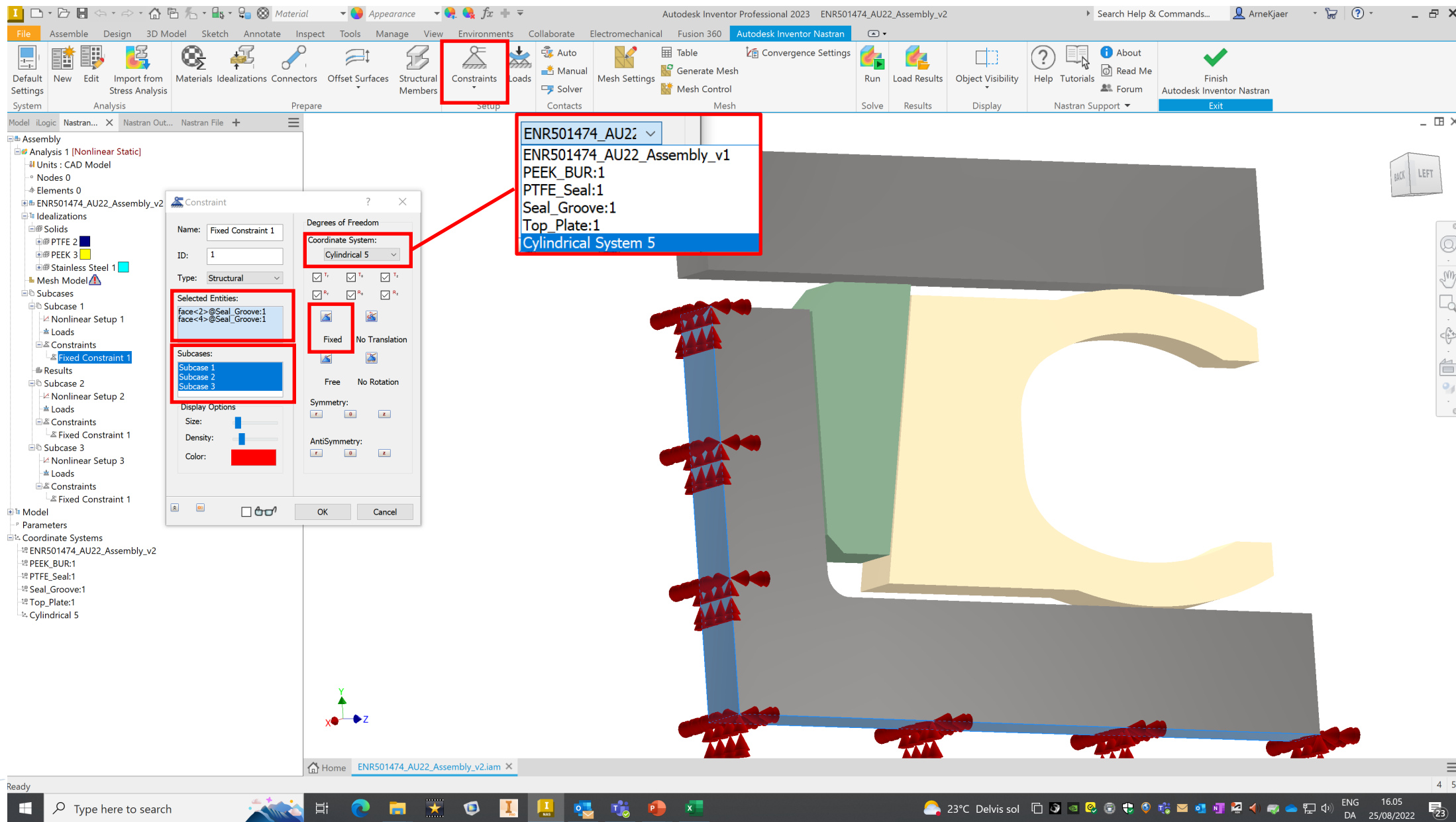


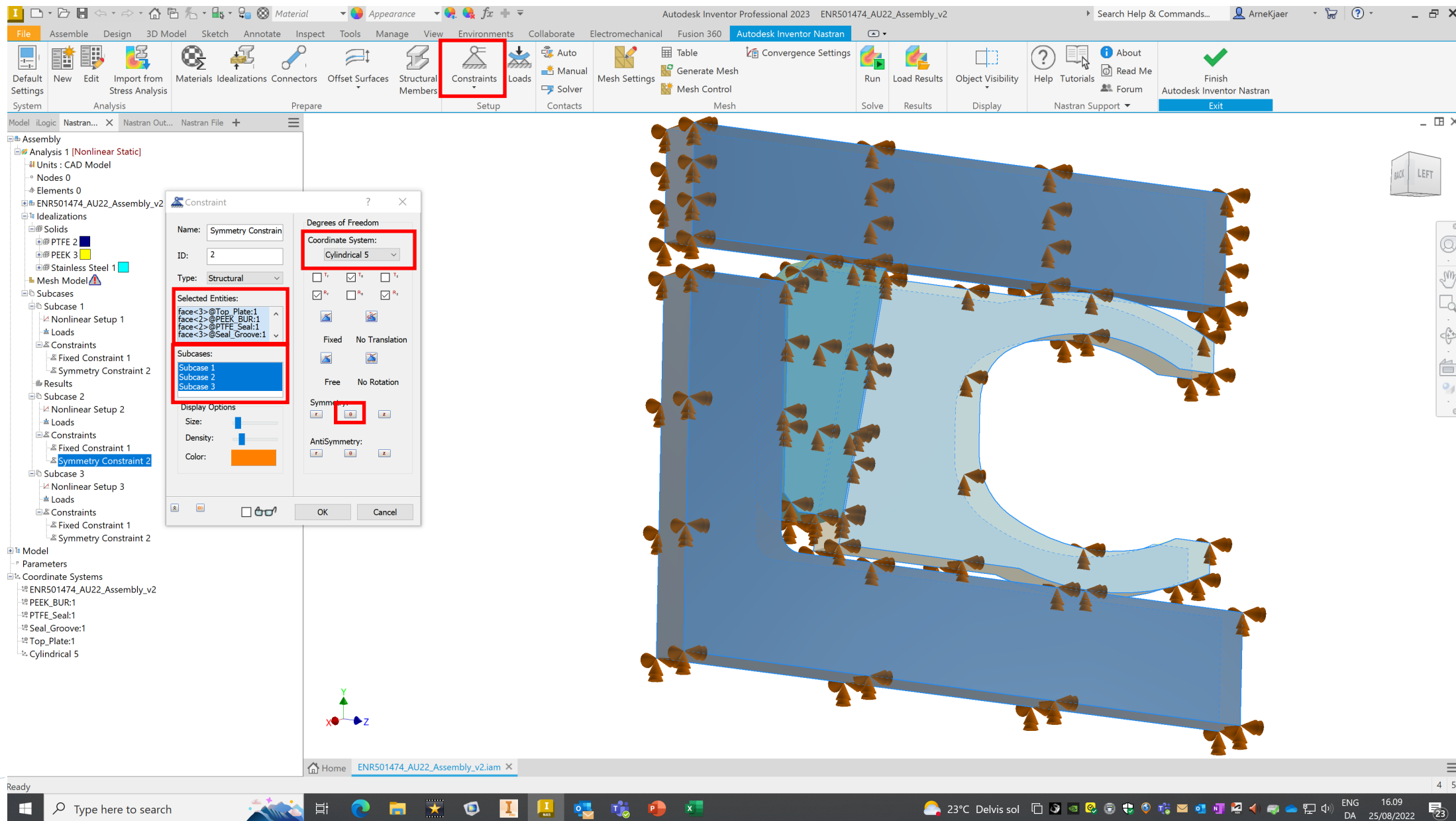
OK

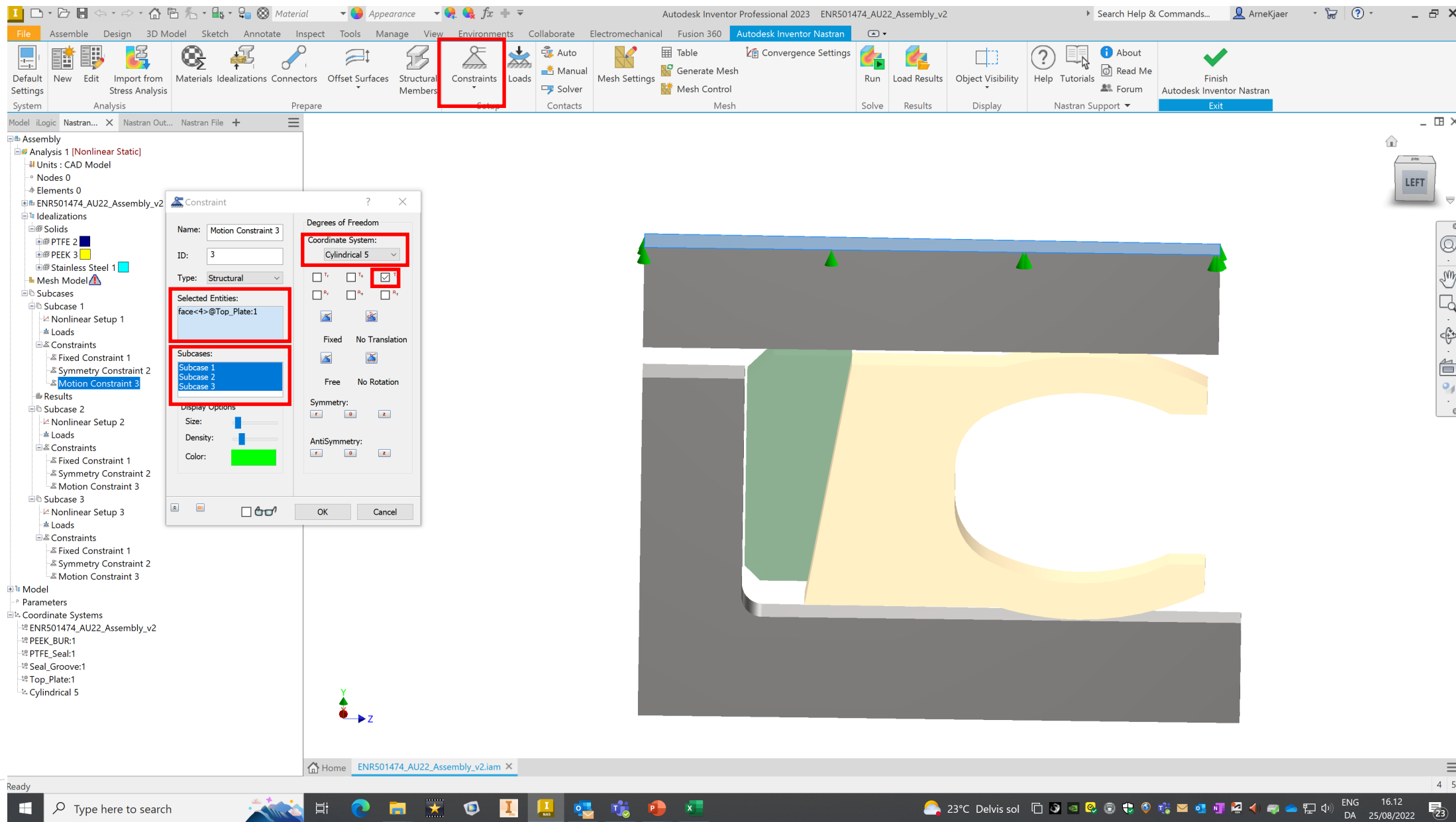


# Nastran 2023 materiale setup

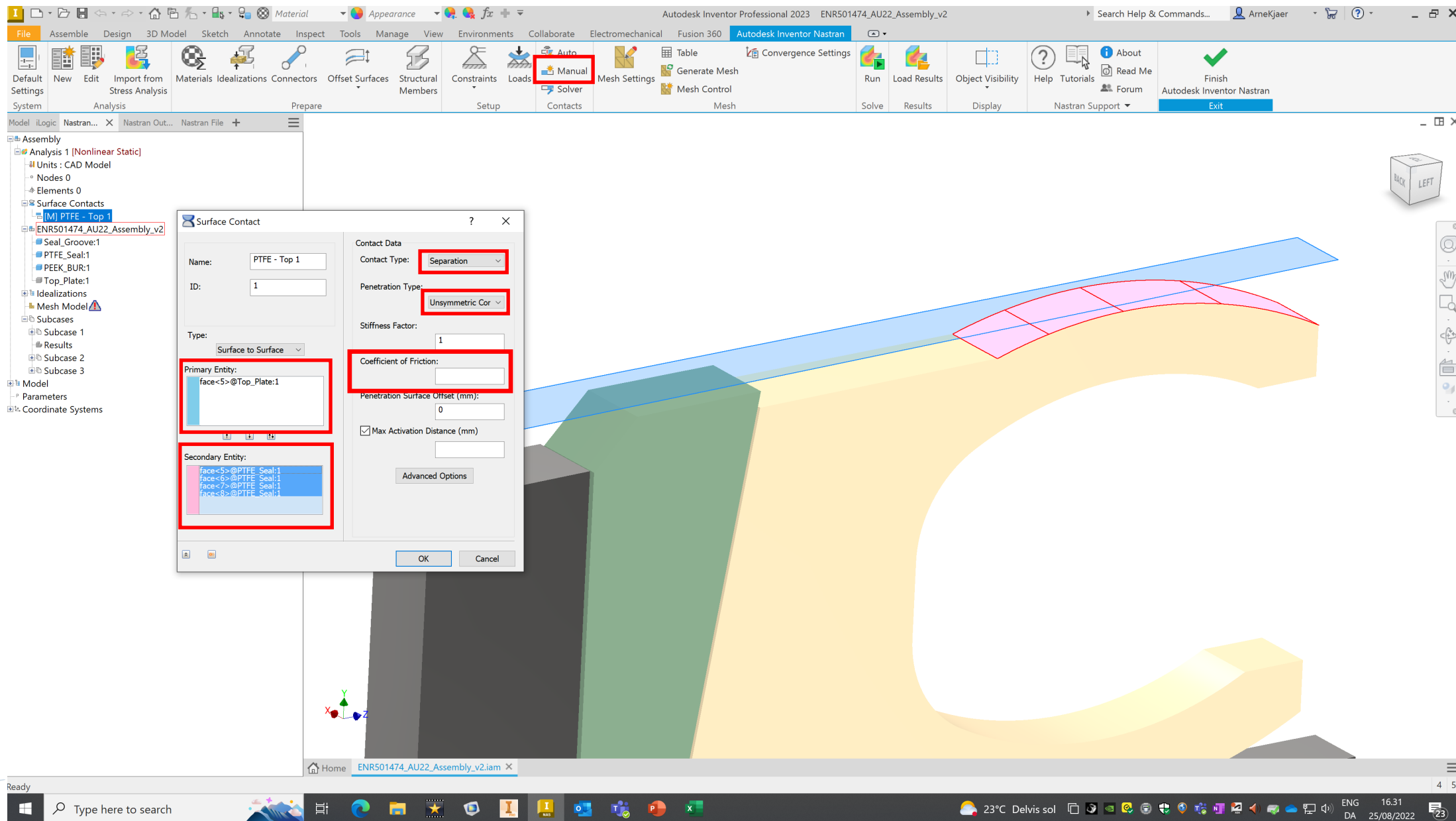












Autodesk Inventor Professional 2023 ENR501474\_AU22\_Assembly\_v2

File Assemble Design 3D Model Sketch Annotate Inspect Tools Manage View Environments Collaborate Electromechanical Fusion 360 Autodesk Inventor Nastran

Default Settings New Edit Import from Stress Analysis Materials Idealizations Connectors Offset Surfaces Structural Members Constraints Loads Auto Manual Solver Mesh Settings Generate Mesh Mesh Control Convergence Settings Run Load Results Object Visibility Help Tutorials Read Me Forum Finish Autodesk Inventor Nastran Exit

Model iLogic Nastran... X Nastran Out... Nastran File +

Assembly

- Analysis 1 [Nonlinear Static]
  - Units: CAD Model
  - Nodes 0
  - Elements 0
  - Surface Contacts
    - [M] PTFE - Top 1
    - [M] PTFE - Groove Contact 2
    - [M] PEEK - PTFE Contact 3
    - [M] PEEK - Top Contact 4
    - [M] PEEK - Groove Contact 5
  - ENR501474\_AU22\_Assembly\_v2
    - Seal\_Groove:1
    - PTFE\_Seal:1
    - PEEK\_BUR:1
    - Top\_Plate:1
  - Idealizations
    - Mesh Model
  - Subcases
    - Subcase 1
      - Nonlinear Setup 1
        - Loads
          - Enforced Motion 1
        - Constraints
          - Fixed Constraint 1
          - Symmetry Constraint 2
          - Motion Constraint 3
        - Results
      - Subcase 2
        - Nonlinear Setup 2
          - Loads
            - Enforced Motion 1
          - Constraints
            - Fixed Constraint 1
            - Symmetry Constraint 2
            - Motion Constraint 3
        - Subcase 3
          - Nonlinear Setup 3
            - Loads
              - Enforced Motion 1
            - Constraints
              - Fixed Constraint 1
              - Symmetry Constraint 2
              - Motion Constraint 3

Load

Name: Enforced Motion 1

ID: 1

Type: Enforced Motion

Sub Type: Displacement

Selected Entities: face<4>@Top\_Plate:1

Subcases: Subcase 1, Subcase 2, Subcase 3

Display Options: Size, Density, Color

Advanced Options >>

Load Definition

Direction: Components

Coordinate System: Cylindrical 5

Magnitude (mm):

$T_r$

$T_\theta$

$T_z$  -0,15

Coordinate System:

Cylindrical Syster

ENR501474\_AU22\_Assembly\_v1

Cylindrical System 5

Seal\_Groove:1

PTFE\_Seal:1

PEEK\_BUR:1

Top\_Plate:1

Magnitude

$T_r$

$T_\theta$

$T_z$  -0,15

Type: Enforced Motion

Sub Type: Force, Moment, Distributed Load, Hydrostatic Load, Pressure, Gravity, Remote Force, Bearing Load, Rotational Force, Enforced Motion

Selected: face<4>

Subcase: Initial Condition, Body Temperature, Temperature, Convection, Radiation, Heat Generation, Heat Flux, From Output, Rigid Motion(Explicit)

Display: Heat Generation, Heat Flux

Size: From Output

Density: Rigid Motion(Explicit)

Color: Rigid Motion(Explicit)

Ready

Type here to search

23°C Delvis sol

ENG DA 16.47 25/08/2022

nti









Autodesk Inventor Professional 2023 ENR501474\_AU22\_Assembly\_v2

File Assemble Design 3D Model Sketch Annotate Inspect Tools Manage View Environments Collaborate Electromechanical Fusion 360 Autodesk Inventor Nastran

Default Settings New Edit Import from Stress Analysis Materials Idealizations Connectors Offset Surfaces Structural Members Constraints Loads Auto Manual Solver Contacts Mesh Settings Table Generate Mesh Mesh Control Convergence Settings Run Load Results Object Visibility Help Tutorials Read Me About Autodesk Inventor Nastran Finish Exit

Model iLogic Nastran... X Nastran Out... Nastran File

ENR501474\_AU22\_Assembly\_v2

Idealizations

Mesh Model

Mesh Control

Mesh Control 1

Subcases

Subcase 1

Nonlinear Setup 1

Loads

Enforced Motion 1

Constraints

Fixed Constraint 1

Symmetry Constraint 2

Motion Constraint 3

Results

Subcase 2

Nonlinear Setup 2

Loads

Enforced Motion 1

Enforced Motion 2

Spring Pressure 3

Constraints

Fixed Constraint 1

Symmetry Constraint 2

Motion Constraint 3

Subcase 3 - Copy

Nonlinear Setup 4

Loads

Enforced Motion 1 - Copy

Enforced Motion 2 - Copy

Spring Pressure 3 - Copy

Hydraulic Pressure 4 - Copy

Constraints

Fixed Constraint 1 - Copy

Symmetry Constraint 2 - Copy

Motion Constraint 3 - Copy

Model

Parameters

Coordinate Systems

For Help, press F1

Home ENR501474\_AU22\_Assembly\_v2.iam

Subcase 4

LEFT FRONT

22°C Mest skyet 17.15 25/08/2022

Autodesk Inventor Professional 2023 ENR501474\_AU22\_Assembly\_v2

File Assemble Design 3D Model Sketch Annotate Inspect Tools Manage View Environments Collaborate Electromechanical Fusion 360 Autodesk Inventor Nastran

Default Settings New Edit Import from Stress Analysis Materials Idealizations Connectors Offset Surfaces Structural Members Constraints Loads Auto Manual Solver Contacts Mesh Settings Table Generate Mesh Convergence Settings Run Load Results Object Visibility Help Tutorials Read Me About Finish Autodesk Inventor Nastran Exit

Model iLogic Nastran... X Nastran Out... Nastran File +

Surface Contacts  
ENR501474\_AU22\_Assembly\_v2  
Idealizations  
Mesh Model  
Mesh Control  
Mesh Control 1  
Subcases  
Subcase 1  
Nonlinear Setup 1  
Loads  
Enforced Motion 1  
Constraints  
Fixed Constraint 1  
Symmetry Constraint 2  
Motion Constraint 3  
Results  
Subcase 2  
Nonlinear Setup 2  
Loads  
Enforced Motion 1  
Enforced Motion 2  
Spring Pressure 3  
Constraints  
Fixed Constraint 1  
Symmetry Constraint 2  
Motion Constraint 3  
Subcase 3  
Nonlinear Setup 3  
Loads  
Enforced Motion 1  
Enforced Motion 2  
Spring Pressure 3  
Hydraulic Pressure 4  
Constraints  
Fixed Constraint 1  
Symmetry Constraint 2  
Motion Constraint 3  
Subcase 4  
Nonlinear Setup 4  
Loads  
Hydraulic Pressure 4 - Copy  
Spring Pressure 3 - Copy  
Enforced Motion 2 - Copy  
Constraints  
Symmetry Constraint 2 - Copy  
Motion Constraint 3 - Copy  
Fixed Constraint 1 - Copy

Load

Name: Enforced Motion 2 -  
ID: 8  
Type: Enforced Motion  
Sub Type: Displacement  
Selected Entities: face<4>@Top\_Plate:1  
Subcases: Subcase 1, Subcase 2, Subcase 3, Subcase 4  
Display Options: Size, Density, Color  
Advanced Options >>

Load Definition  
Direction: Components  
Coordinate System: Cylindrical 5  
Magnitude (mm):  
T<sub>r</sub>:  
T<sub>θ</sub>:  
T<sub>z</sub>: 0

LEFT FRONT

I Subcase 4  
Fjern Enforced Motion 1 - Copy  
Sæt Hydraulic Pressure 4 og  
Spring Pressure 3 til 0 MPa  
Sæt Enforced Motion 2 til 0

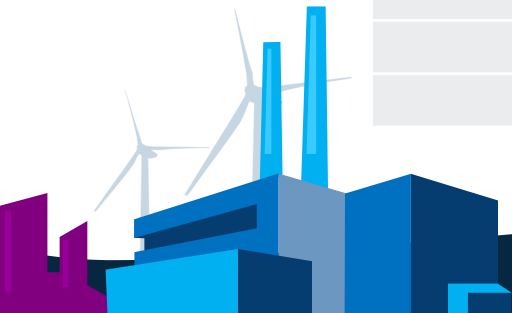
Ready Type here to search 22°C Mest skyet 17.20 DA 25/08/2022





# Mesh og Mesh Control

Relative	Mesh	Mesh Control	Nodes	Elements	Max Stress	Wall clock time
500%	0,3035	NA	28582	17297	58,02	576,16
175%	0,4307					
150%	0,4534					
125%	0,4818	NA	8046	4217	23,12	202,55
120%	0,4884					
110%	0,5028					
100%	0,5190	NA	6968	3583	23,52	182,92
100%	0,5190	0,3035	11720	6255	20,50	297,36
80%	0,5591					
75%	0,5712					
50%	0,6539	NA	3375	1492	21,45	129,10
25%	0,8239					
15%	0,9768					
10%	1,1182					
5%	1,4088					



Autodesk Inventor Professional 2023 ENR501474\_AU22\_Assembly\_v2

File Assemble Design 3D Model Sketch Annotate Inspect Tools Manage View Environments Collaborate Electromechanical Fusion 360 Autodesk Inventor Nastran

Default Settings New Edit Import from Stress Analysis Materials Idealizations Connectors Offset Surfaces Structural Members Constraints Loads Auto Manual Mesh Settings Table Generate Mesh Convergence Settings Run Load Results Object Visibility Help Tutorials About Read Me Forum Finish Autodesk Inventor Nastran Exit

Model iLogic Nastran... X Nastran Out... Nastran File +

Assembly

- Analysis 1 [Nonlinear Static]
  - Units : CAD Model
    - Nodes 11894
    - Elements 6363
  - Surface Contacts
  - ENR501474\_AU22\_Assembly\_v2
    - Idealizations
    - Mesh Model
      - Mesh Control
        - Mesh Control 1
    - Subcases
    - Model
      - Parameters
    - Coordinate Systems

Parameters

CONTACTSTAB AUTO

ON

OFF

Find contactstab ☒ Advanced Setting Reset OK Cancel

LEFT FRONT

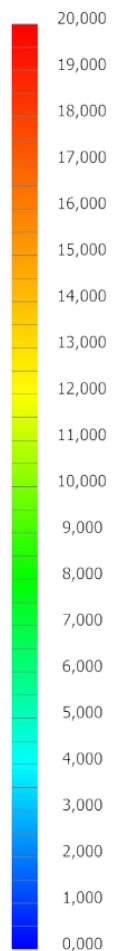
CONTACTSTAB = ON  
For at stabilisere  
kontakterne. En kurvet  
overflade mod en flad gør  
det vanskeligere at  
beregne kontakt  
punkterne.

For Help, press F1

Type here to search

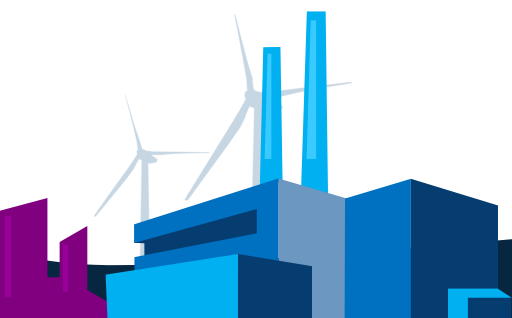
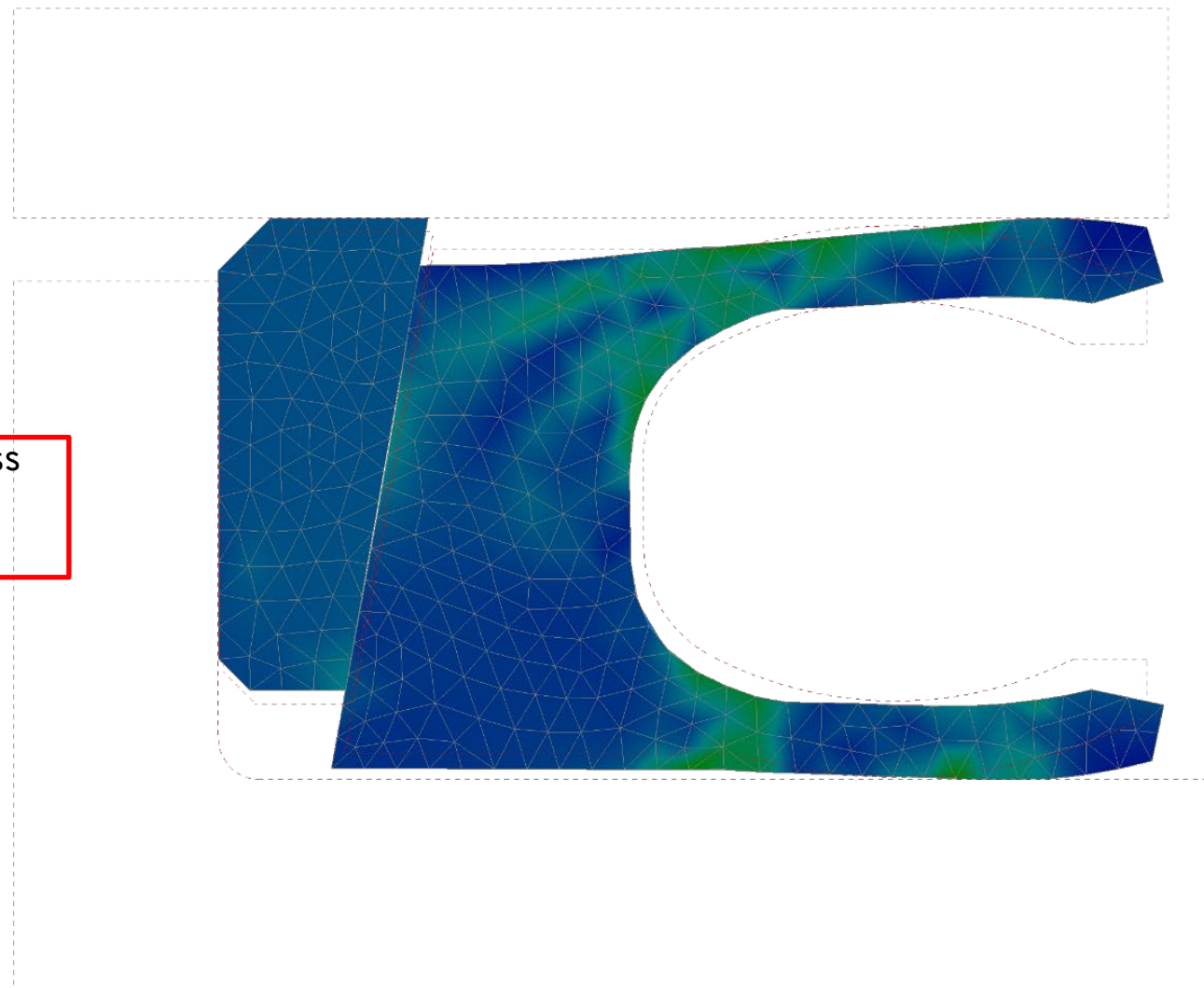
22°C Mest skyet

ENG 17.11  
DA 25/08/2022



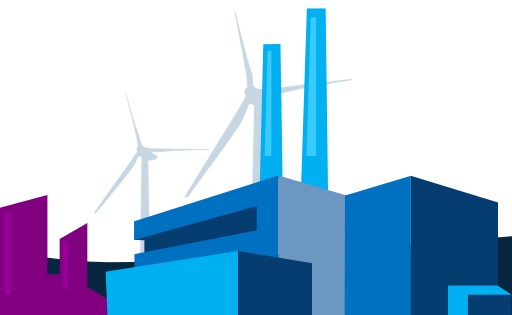
Deformation og Stress  
efter Subcase 4  
PTFE TF1620

CONTOUR: SOLID VON MISES STRESS (MPa)  
DEFORMED TOTAL: (MIN =0, MAX=0,611222)  
OUTPUT SET: INCR 11, LOAD=4.0  
ANALYSIS: Analysis 1

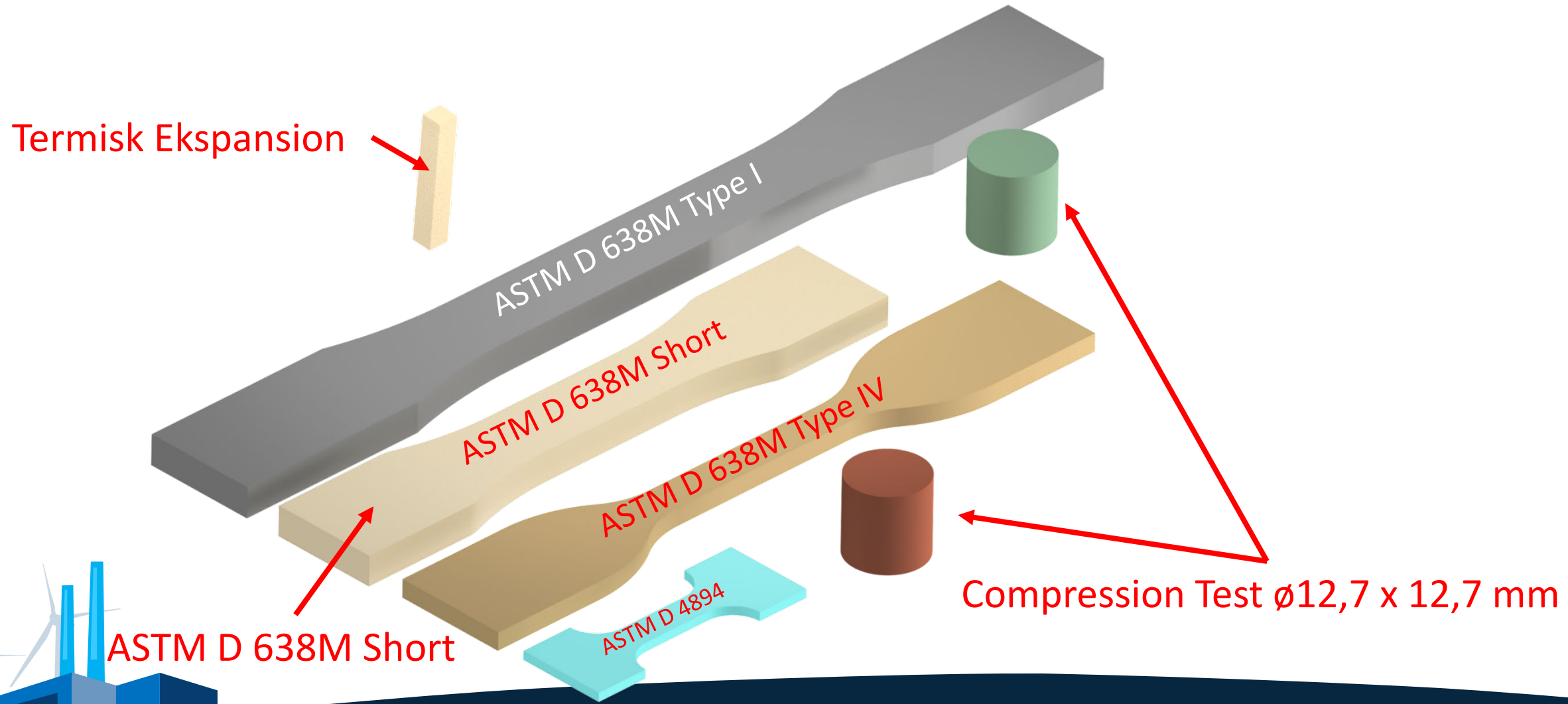


# PTFE Engineering A/S

- Det er helt klar muligt at benytte Inventor Nastran 2023 til sammenligne to forskellige materialer med hensyn til livende deformation og stress

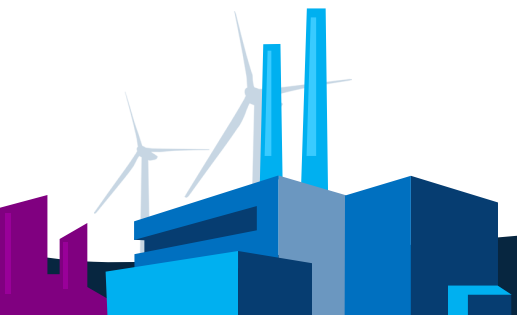


# Materialdata fra egne måle resultater.



# PTFE Engineering A/S

- Resultatet fra FEA beregninger er lige så præcise som de variabler man lægger ind i sine beregninger.
- Data til materiale modellen er ofte meget vanskeligt at få nøjagtigt.
- I Inventor Nastran 2023 er der et meget begrænset antal plast materialer til rådighed.
- PTFE Engineering A/S anbefaler altid at man benytter sig af specifikke målinger for at kende den præcise baggrund for de data der benyttes.

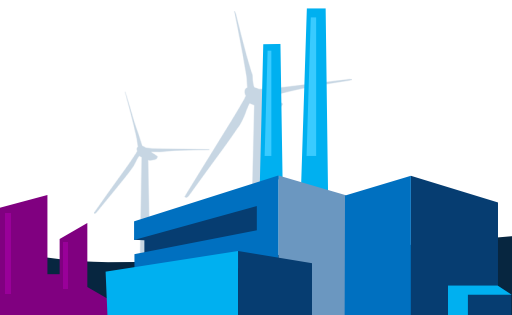
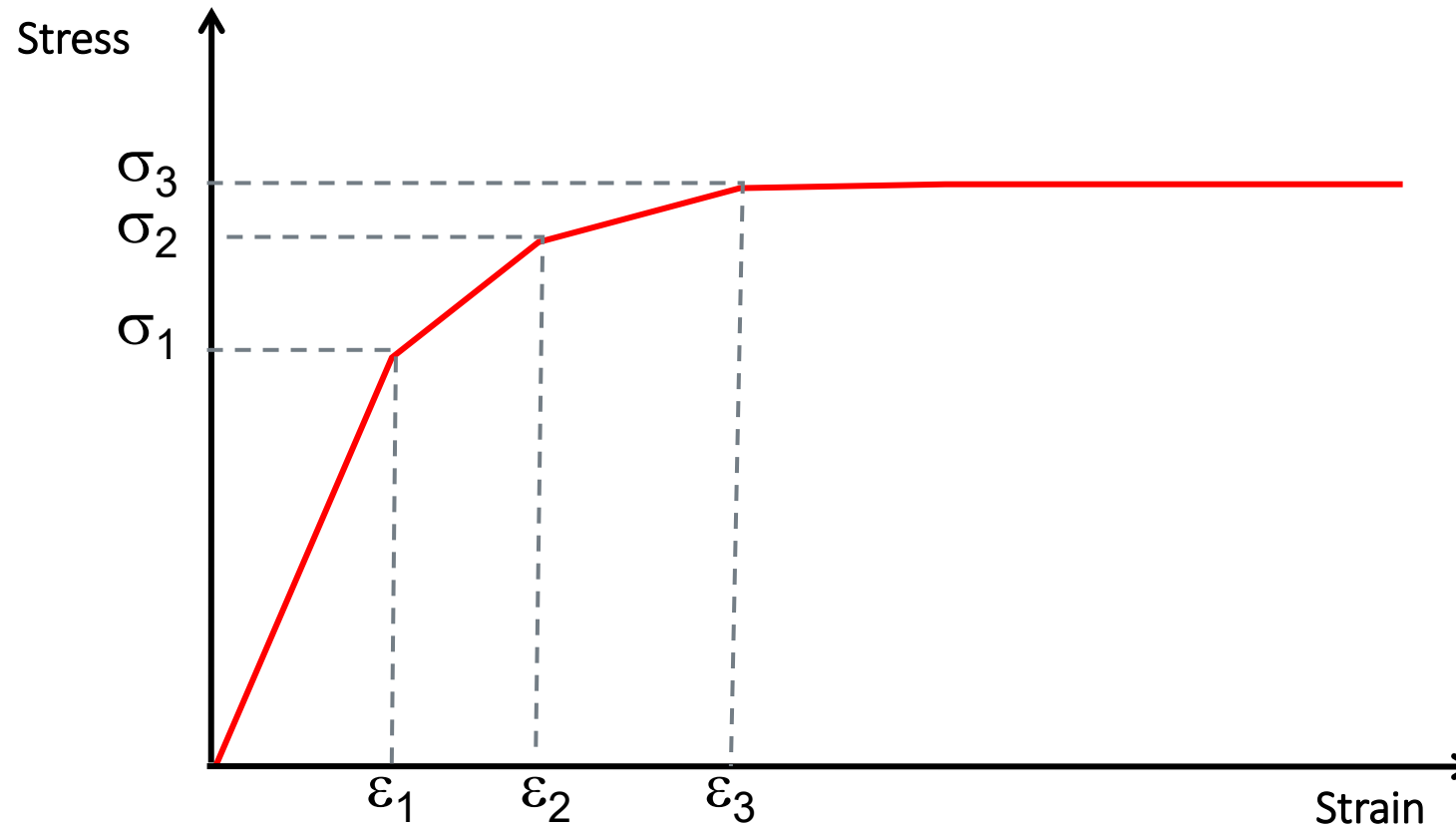


# Elastoplastic material model

Professor Nam-Ho Kim  
Mechanical and Aerospace Engineering  
University of Florida

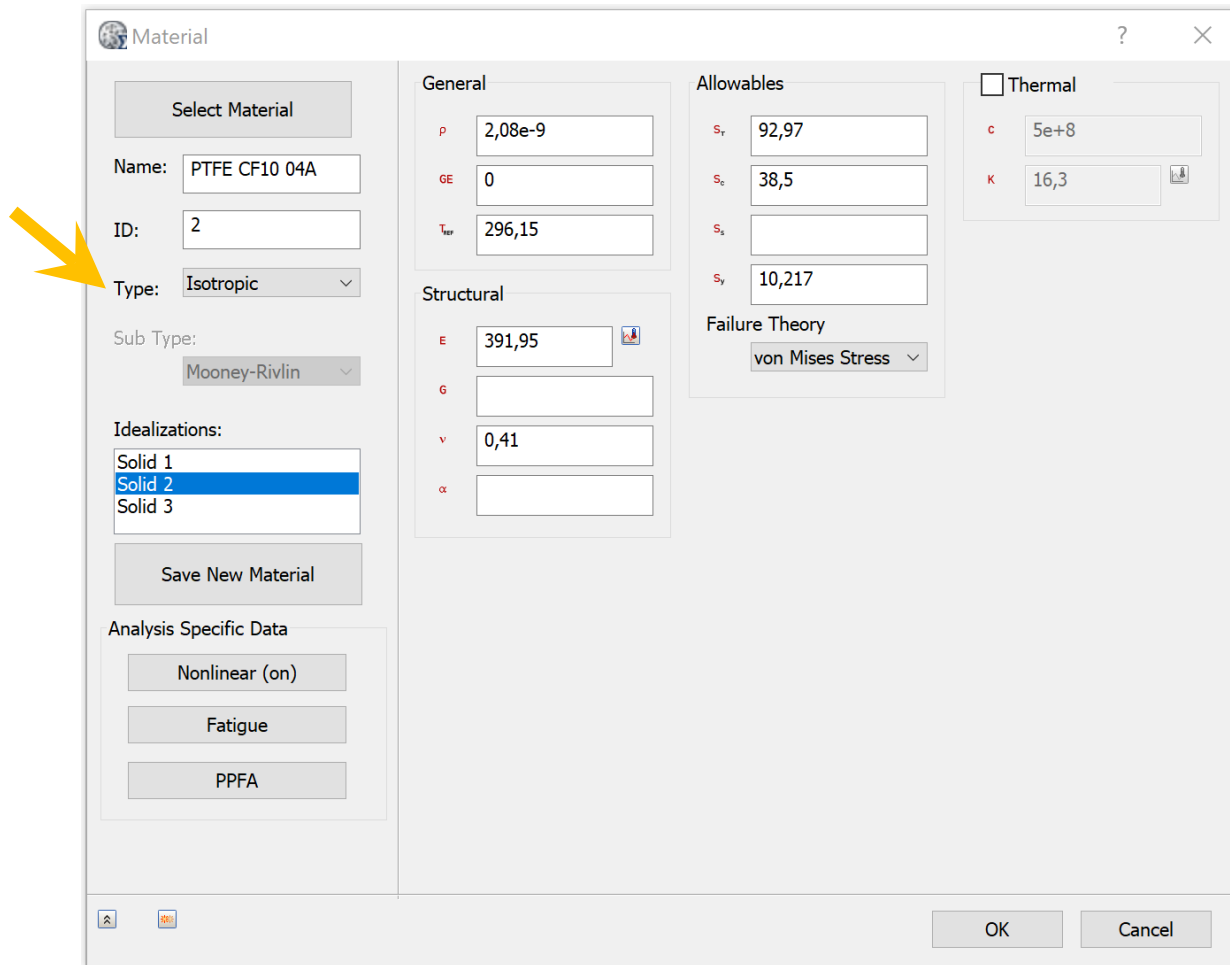
Strain-hardening model in Nastran

- Incrementally linear hardening model
- The slope of initial yield ( $\epsilon_1, s_1$ ) must be Young's modulus



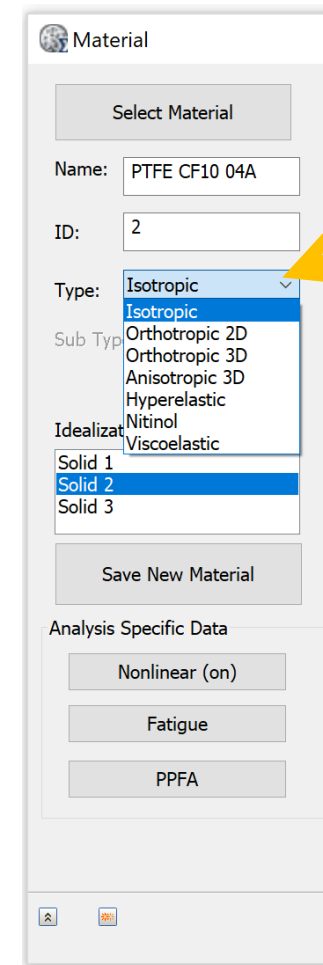
# PTF Engineering A/S

Material  
Type



The screenshot shows the 'Material' dialog box with the 'Type' dropdown menu open. The 'Isotropic' option is selected. The dialog box contains the following fields and sections:

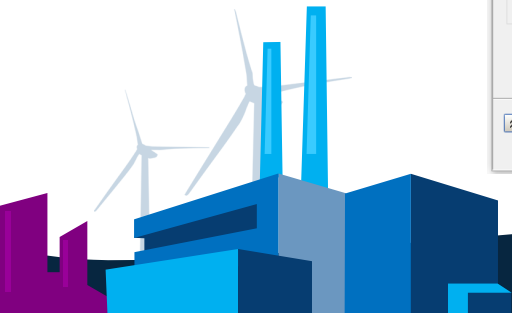
- Select Material** button
- Name:** PTFE CF10 04A
- ID:** 2
- Type:** Isotropic (dropdown menu is open showing options: Isotropic, Orthotropic 2D, Orthotropic 3D, Anisotropic 3D, Hyperelastic, Nitinol, Viscoelastic)
- Sub Type:** Mooney-Rivlin (dropdown menu)
- Idealizations:** Solid 1, Solid 2 (selected), Solid 3
- Save New Material** button
- Analysis Specific Data** section with buttons: Nonlinear (on), Fatigue, PPFA
- General** section with fields:  $\rho$  (2,08e-9),  $G_E$  (0),  $T_{ref}$  (296,15)
- Structural** section with fields:  $E$  (391,95),  $G$  (empty),  $\nu$  (0,41),  $\alpha$  (empty)
- Allowables** section with fields:  $S_r$  (92,97),  $S_e$  (38,5),  $S_s$  (empty),  $S_y$  (10,217)
- Failure Theory** dropdown menu: von Mises Stress
- Thermal** section with fields:  $c$  (5e+8),  $K$  (16,3)
- OK** and **Cancel** buttons



The screenshot shows the 'Material' dialog box with the 'Type' dropdown menu open. The 'Isotropic' option is selected. The dialog box contains the following fields and sections:

- Select Material** button
- Name:** PTFE CF10 04A
- ID:** 2
- Type:** Isotropic (dropdown menu is open showing options: Isotropic, Orthotropic 2D, Orthotropic 3D, Anisotropic 3D, Hyperelastic, Nitinol, Viscoelastic)
- Sub Type:** Mooney-Rivlin (dropdown menu)
- Idealizations:** Solid 1, Solid 2 (selected), Solid 3
- Save New Material** button
- Analysis Specific Data** section with buttons: Nonlinear (on), Fatigue, PPFA
- OK** and **Cancel** buttons

Isotropic





**Nonlinear Material Data**

Type

☐ None

☐ Nonlinear Elastic

☐ Elasto-Plastic (Bi-Linear)

☒ Plastic

Properties

Tangent Modulus,  $E_t$  (MPa): 67,546

Hardening Rule: Isotropic

Yield Function

Yield Criterion: von Mises

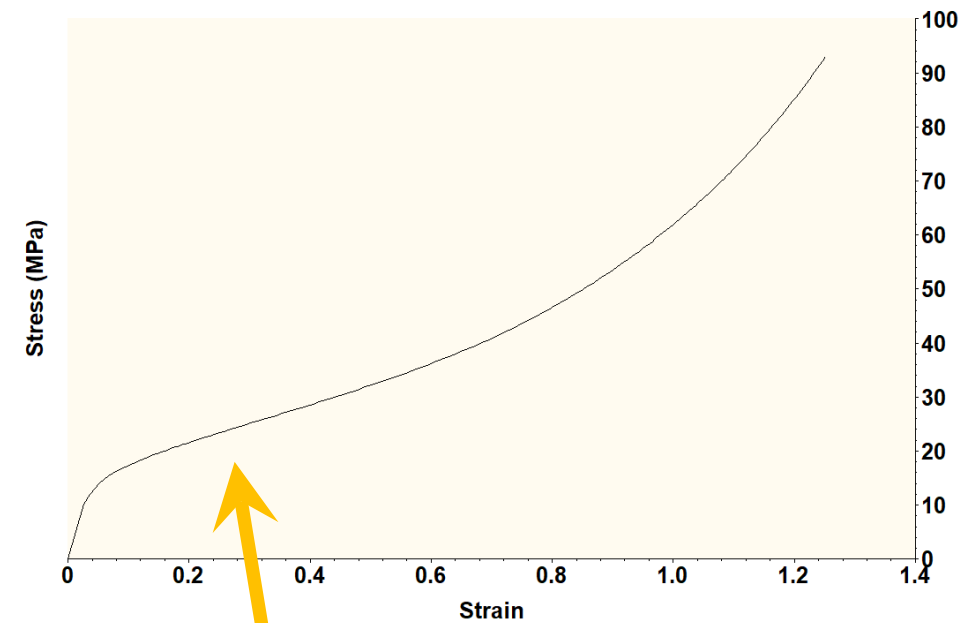
Initial Yield Stress (MPa): 10,217

Friction Angle: (deg): 0

Strain	Stress (MPa)
0	0
0.0260671004	10,217
0.03011	10,9
0.03362	11,529
0.0373	12,119
0.04485	13,143
0.05125	13,965
0.05975	14,799
0.06684	15,349
0.07404	15,828
0.0807	16,27
0.08764	16,678
0.0947	17,059
0.10122	17,406
0.10802	17,745
0.11493	18,074
0.12148	18,375
0.12799	18,678
0.13477	18,975
0.14119	19,255
0.14757	19,527
0.15422	19,796

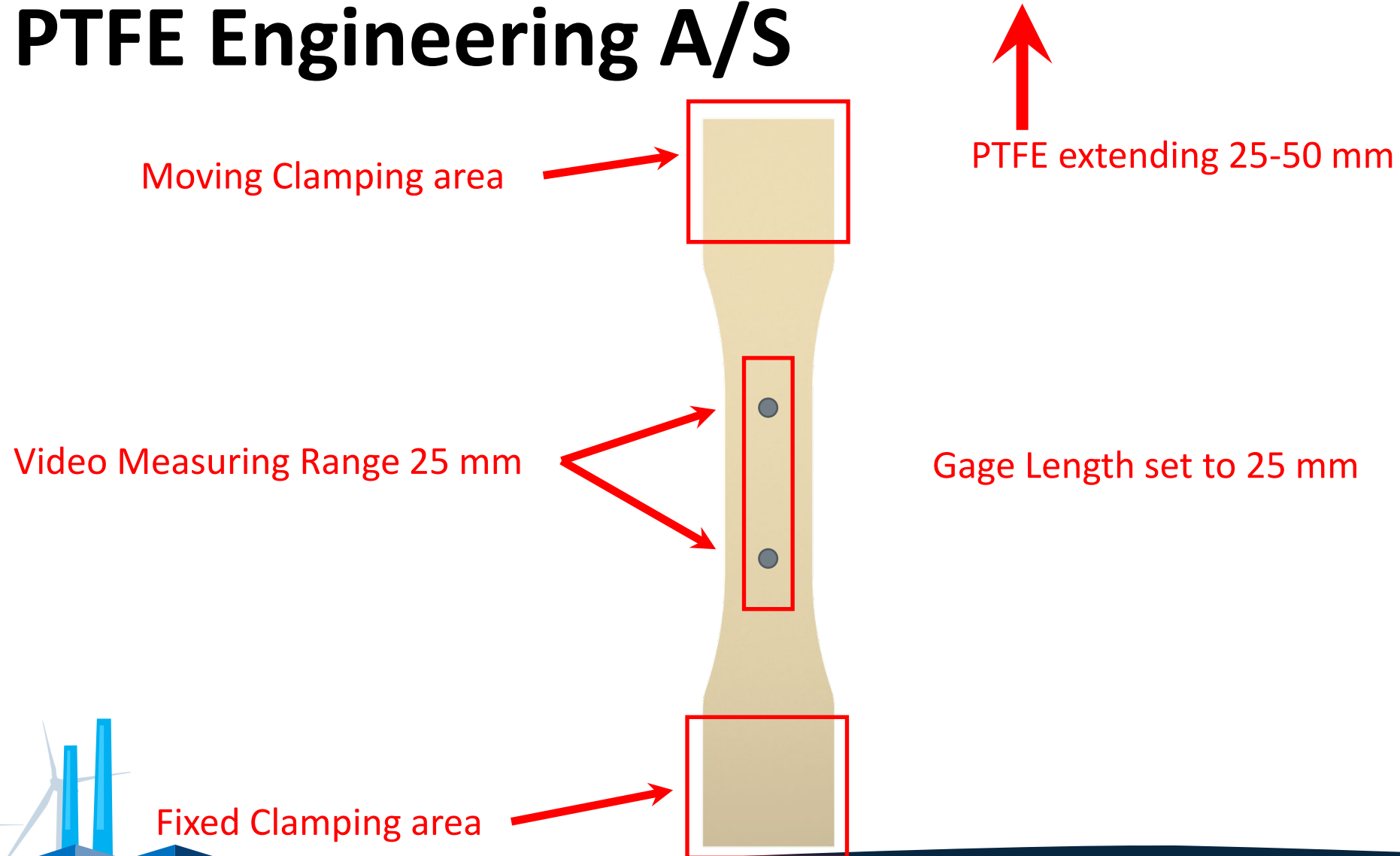
Show XY Plot OK Cancel

Stress (MPa) Vs Strain

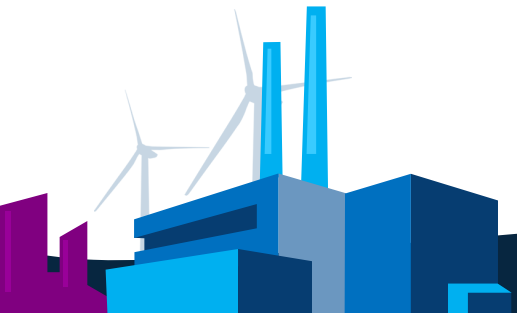
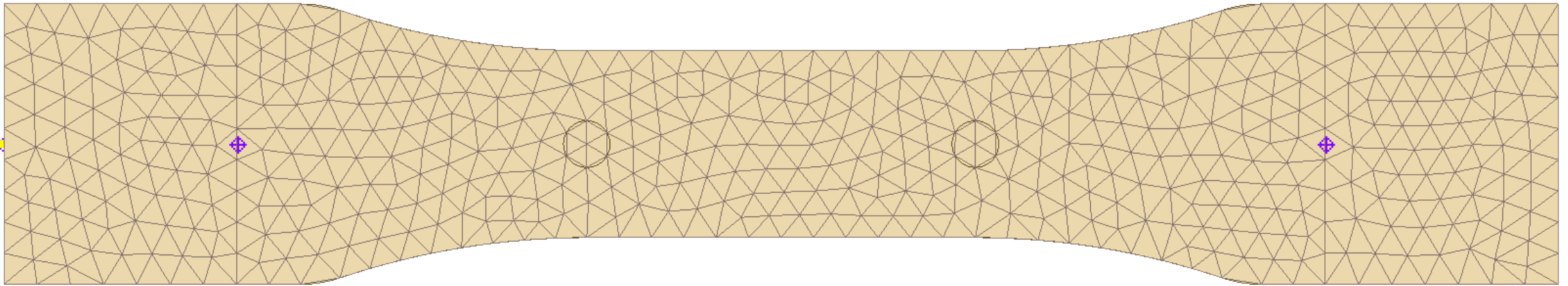


True Stress - Strain

# PTFE Engineering A/S



# PTFE Engineering A/S



# PTFE Engineering A/S

