

Inventor Nastran - Hands on Simulation Tips and Tricks

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Simulation Manager @ Symetri



This Class is for...



Users just starting out in Life (Simulation!)



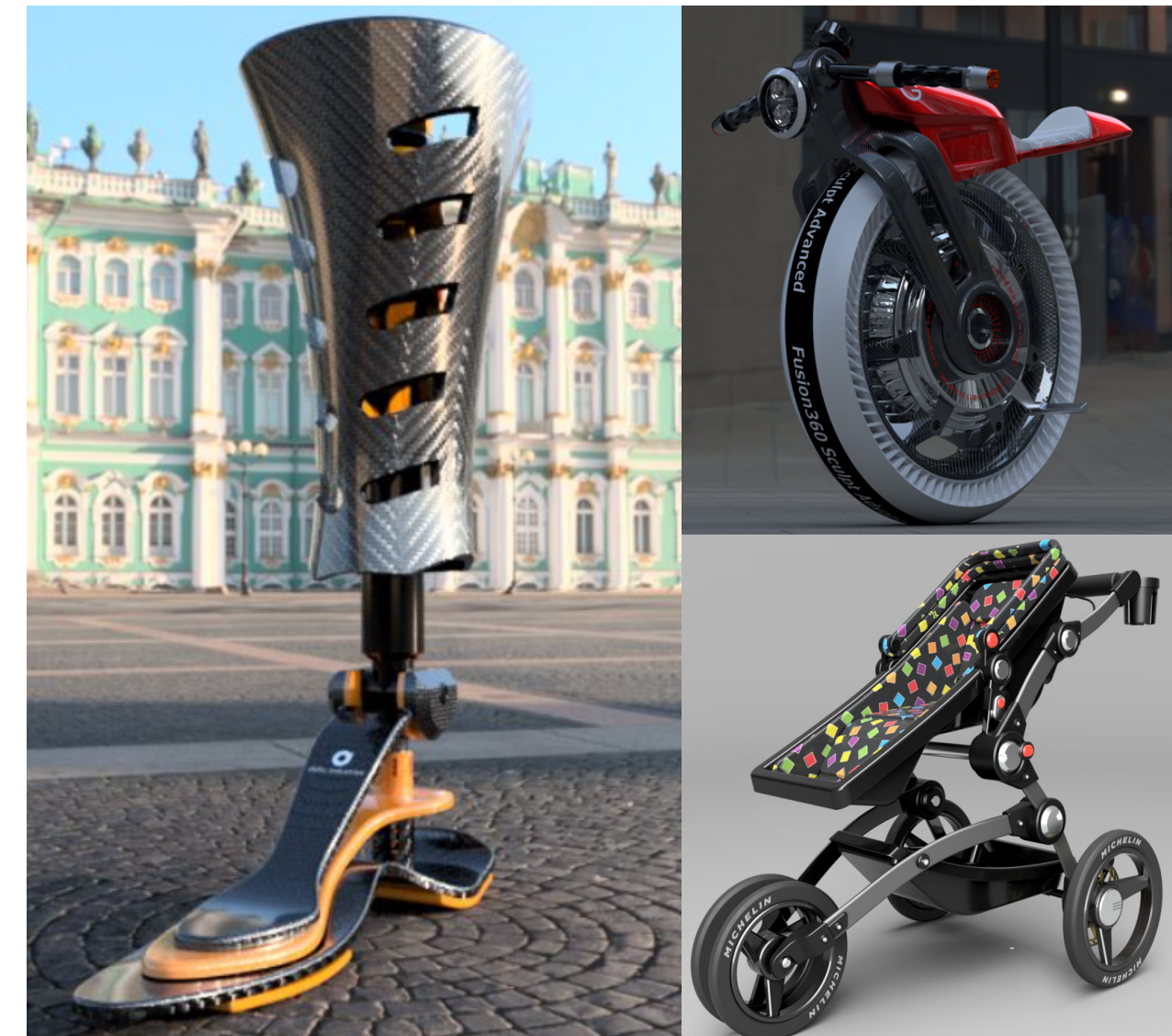
I hope experts may pick up one or two tips.

The goal of this lab is...



To help increase your confidence
in using Simulation

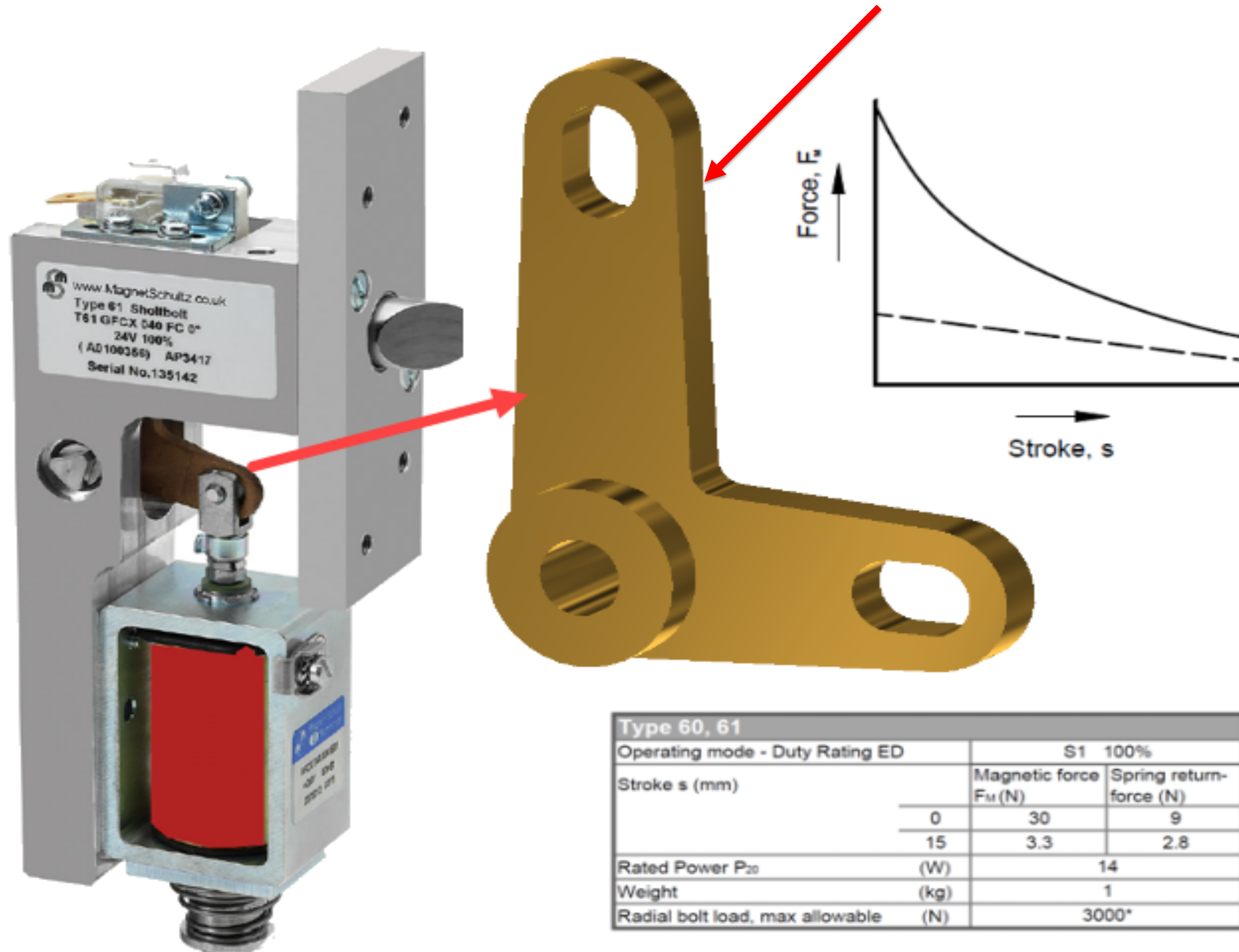
Create great products

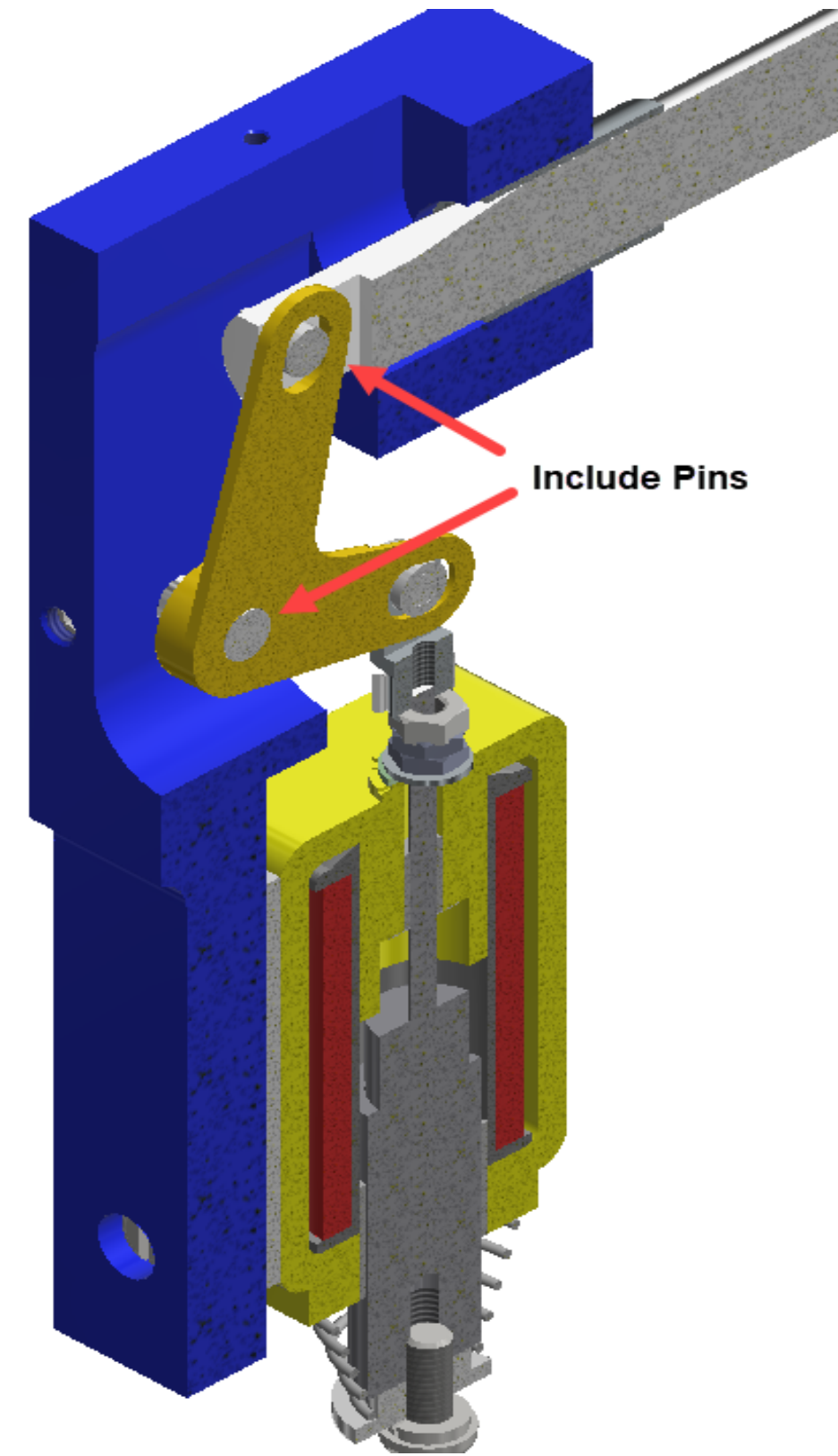


Avoid Over-engineering



Design Problem... Analyse the lever





Single Part or Assembly



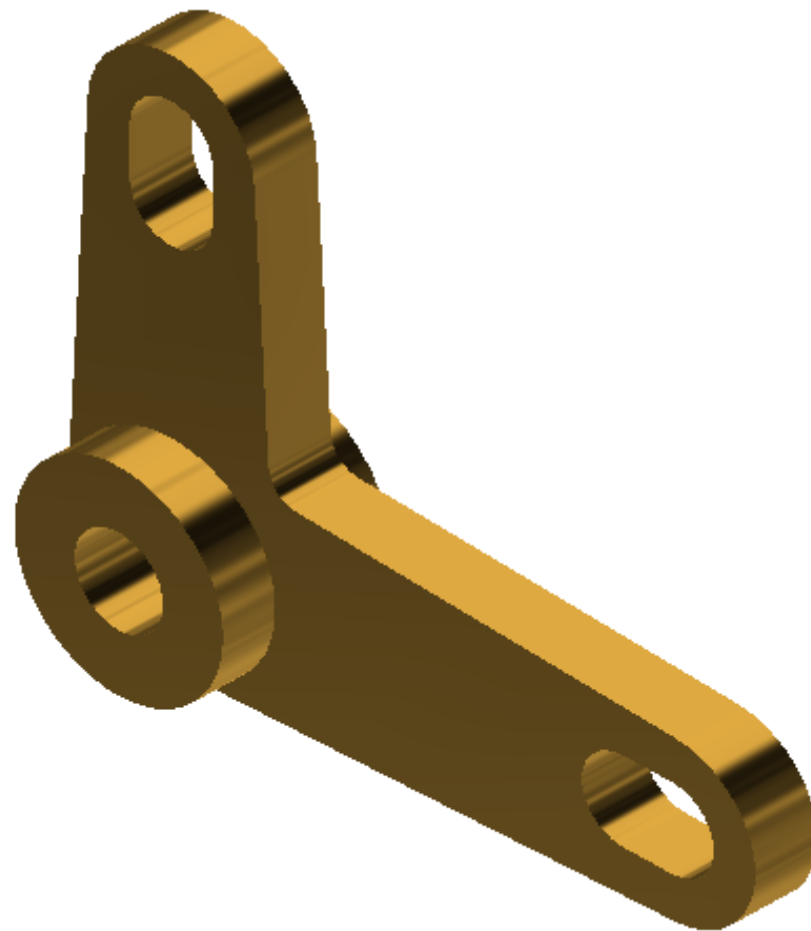
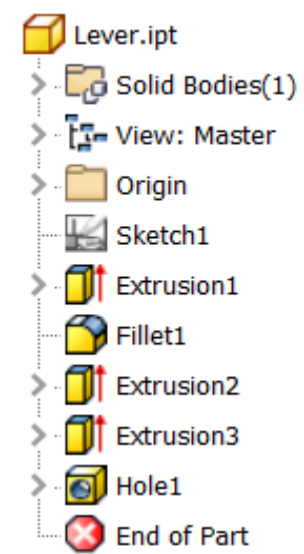
Part or Assembly ?

Pro

Easier setup
Less Elements
No contacts

Cons

Over stiffness

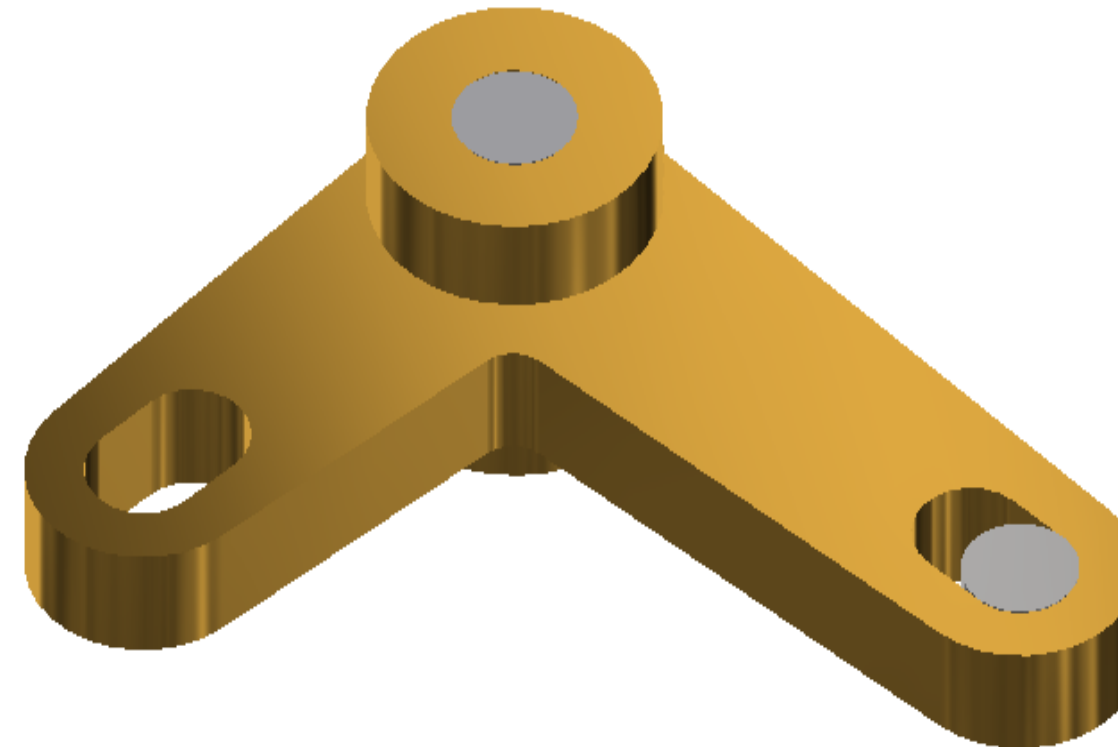
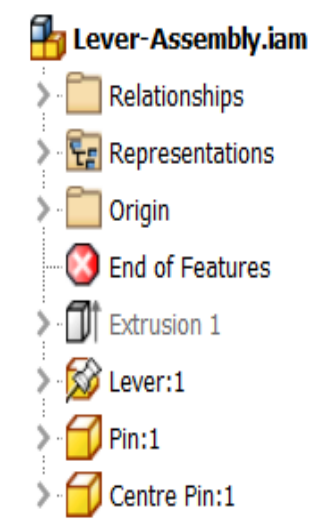


Pro

Better Pin/Lever
behaviour

Cons

Longer runtimes



The Big Myth

Question

.... How do I know my results are correct?



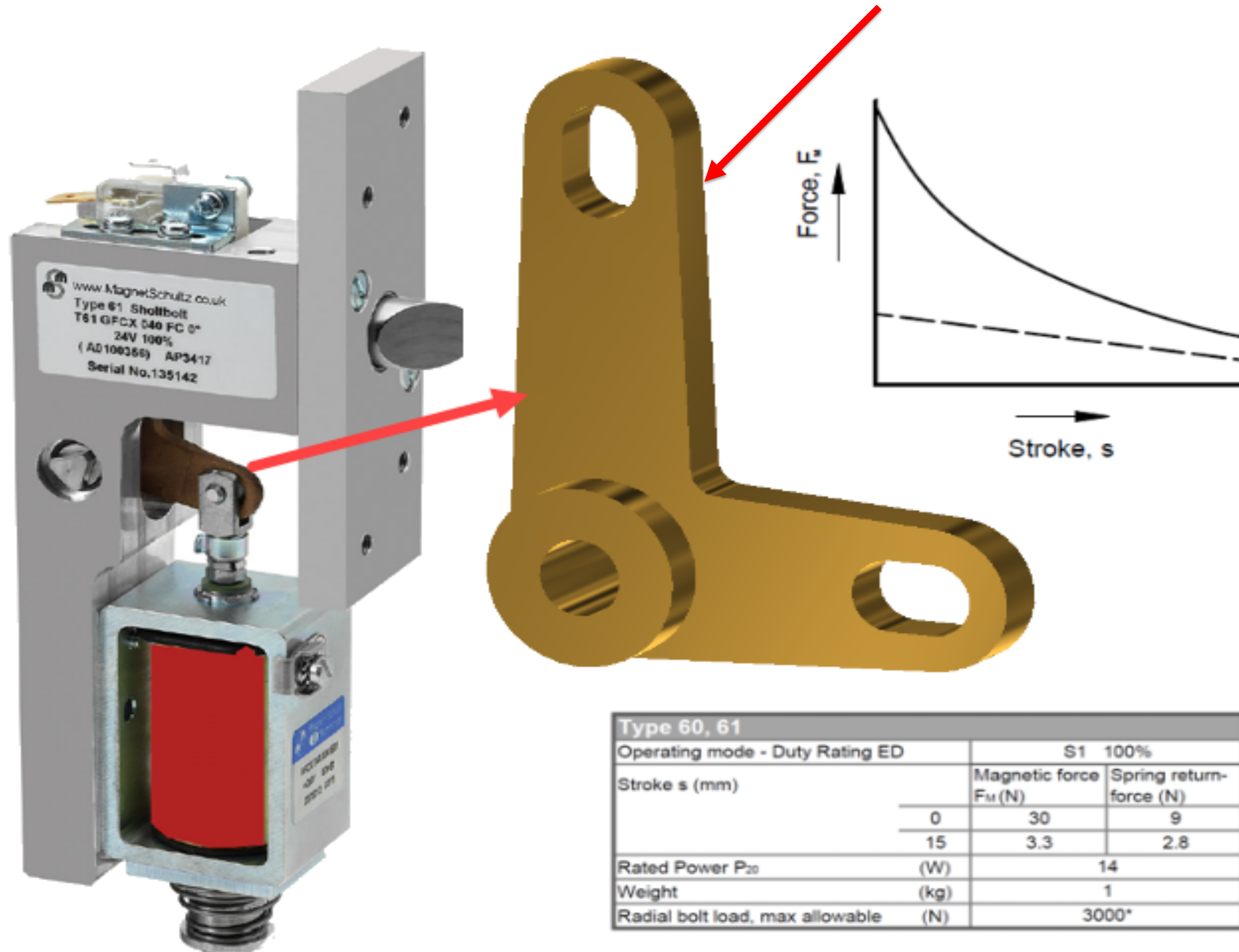
Results are not
as I expected

Which analysis
results do I use
for my design

Why do I need to
run more than
one analysis

What mesh size
do I use

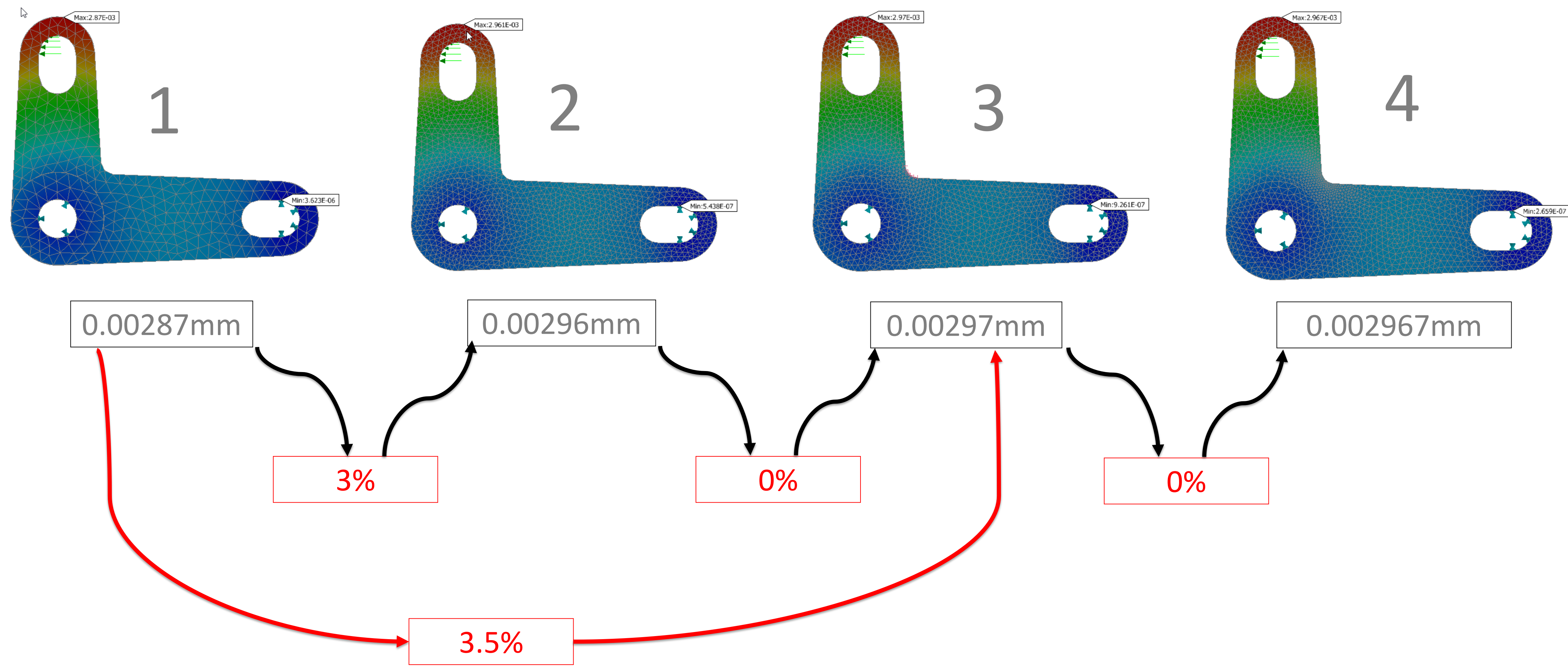
Exercise 1 – Part Analysis



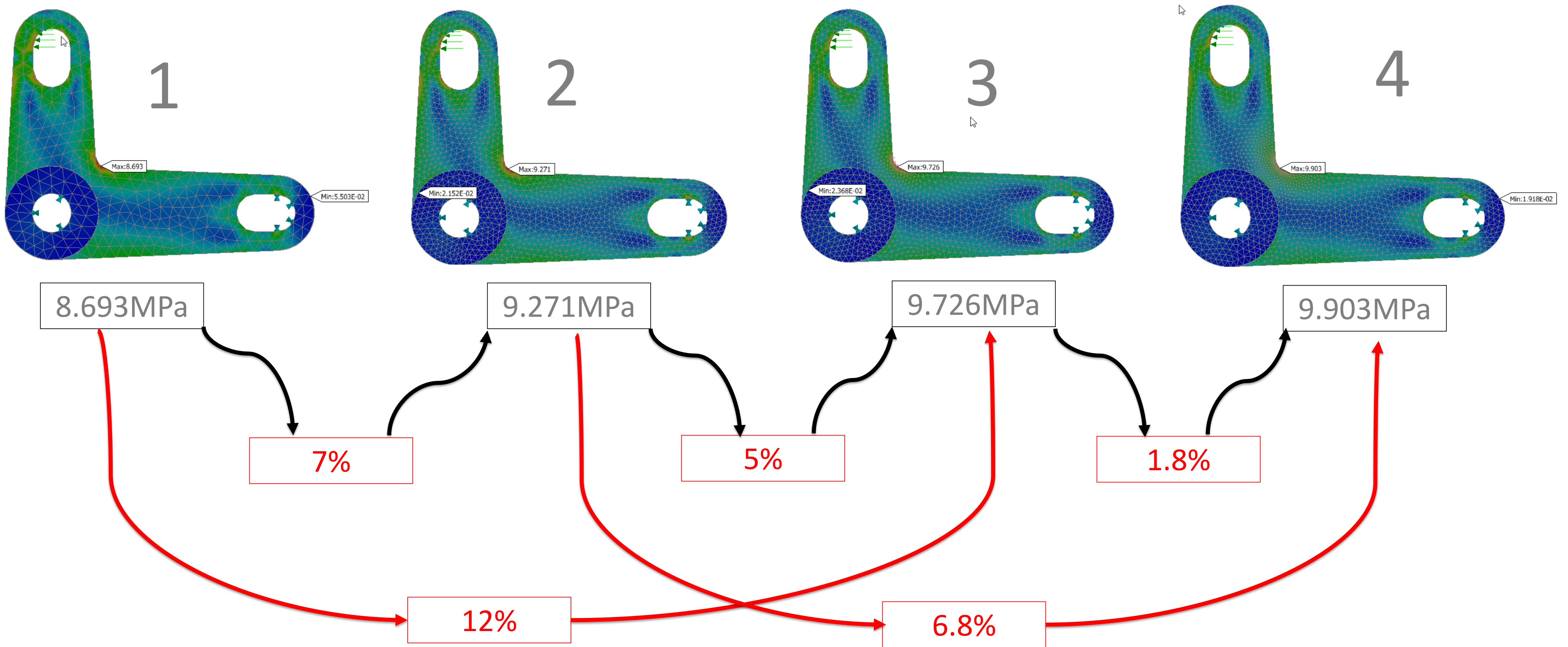
Hands on Session 1 – Lets Start



Exercise 1 – Displacement Results

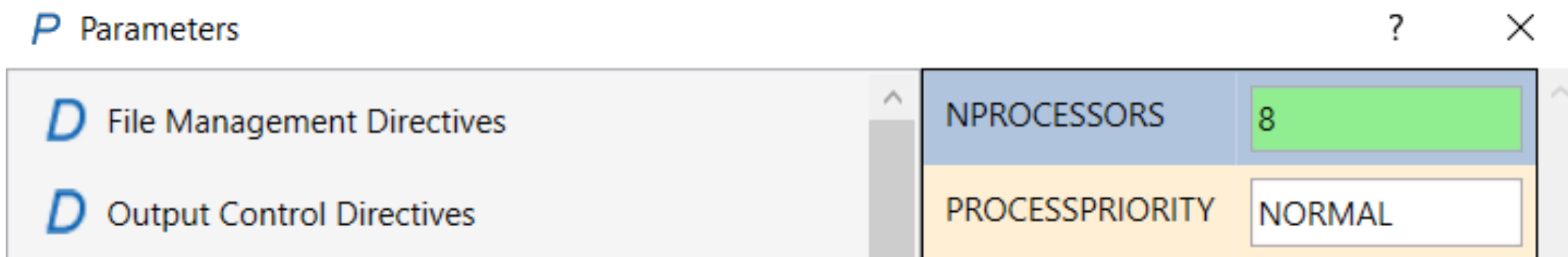


Exercise 1 – Stress Results Convergence

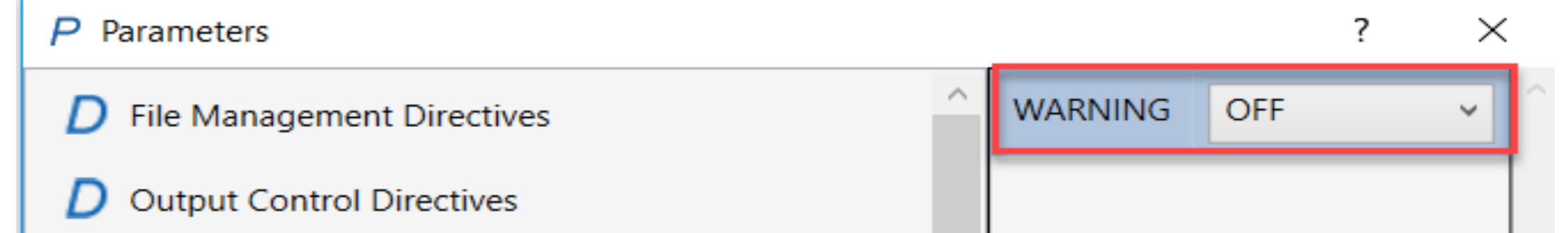


Exercise 1 – Parameters

NPROCESSORS



WARNING



```
WARNING G3015: TET ELEMENT 1847 HAS AN INTERIOR ANGLE LESS THAN 10.0
OPERATION RESUMED
PERCENT COMPLETE:      0

WARNING G3015: TET ELEMENT 1849 HAS AN INTERIOR ANGLE LESS THAN 10.0
OPERATION RESUMED
PERCENT COMPLETE:      0

WARNING G3015: TET ELEMENT 2005 HAS AN INTERIOR ANGLE LESS THAN 10.0
OPERATION RESUMED
PERCENT COMPLETE:      0

WARNING G3015: TET ELEMENT 2007 HAS AN INTERIOR ANGLE LESS THAN 10.0
OPERATION RESUMED
PERCENT COMPLETE:      0

WARNING G3015: TET ELEMENT 2287 HAS AN INTERIOR ANGLE LESS THAN 10.0
OPERATION RESUMED
PERCENT COMPLETE:      0

WARNING G3015: TET ELEMENT 2289 HAS AN INTERIOR ANGLE LESS THAN 10.0
OPERATION RESUMED
PERCENT COMPLETE:      0

WARNING G3015: TET ELEMENT 2565 HAS AN INTERIOR ANGLE LESS THAN 10.0
OPERATION RESUMED
PERCENT COMPLETE:      0

WARNING G3015: TET ELEMENT 2567 HAS AN INTERIOR ANGLE LESS THAN 10.0
OPERATION RESUMED
PERCENT COMPLETE:      0

WARNING G3015: TET ELEMENT 2754 HAS AN INTERIOR ANGLE LESS THAN 10.0
OPERATION RESUMED
PERCENT COMPLETE:      0
```


Exercise 1 – Parameters

TETFACEMINIATOL

```
GENERATING RESULTS NEUTRAL FILE
PERCENT COMPLETE: 100


DELETING FILE:  dfdbybvw4.ECD

MODEL ANALYSIS TIME SUMMARY

TOTAL CPU TIME = 12.7 SECONDS
WALLCLOCK TIME = 12.9 SECONDS


EXECUTION TERMINATED NORMALLY

TOTAL WARNINGS      = 26
TOTAL FATAL ERRORS  = 0
```



P Parameters ? ×

<i>D</i> File Management Directives	TETARTOL	100.0
<i>D</i> Output Control Directives	TETFACEMAXIATOL	170.0
<i>D</i> Memory Management Directives	TETFACEMINIATOL	5.0
<i>D</i> Program Control Directives	TETFACESKEWTOL	80.0
<i>P</i> Model Translator Parameters	TETINODE	OFF



```
DELETING FILE:  dfdbybvw4.NDB

GENERATING RESULTS NEUTRAL FILE
PERCENT COMPLETE: 100

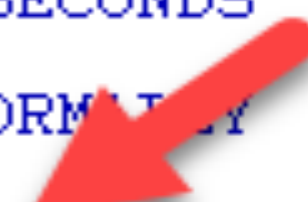
DELETING FILE:  dfdbybvw4.ECD

MODEL ANALYSIS TIME SUMMARY

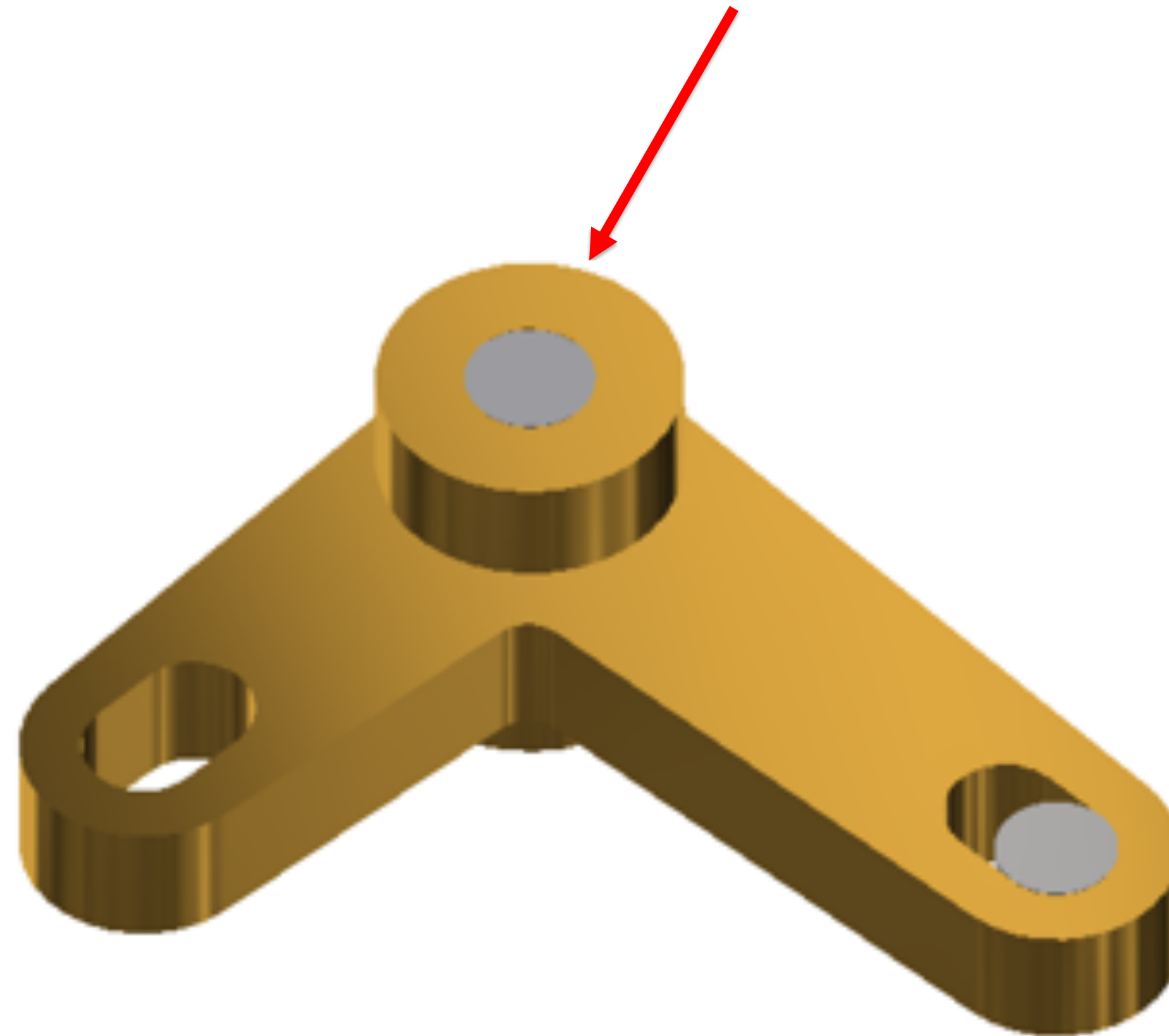
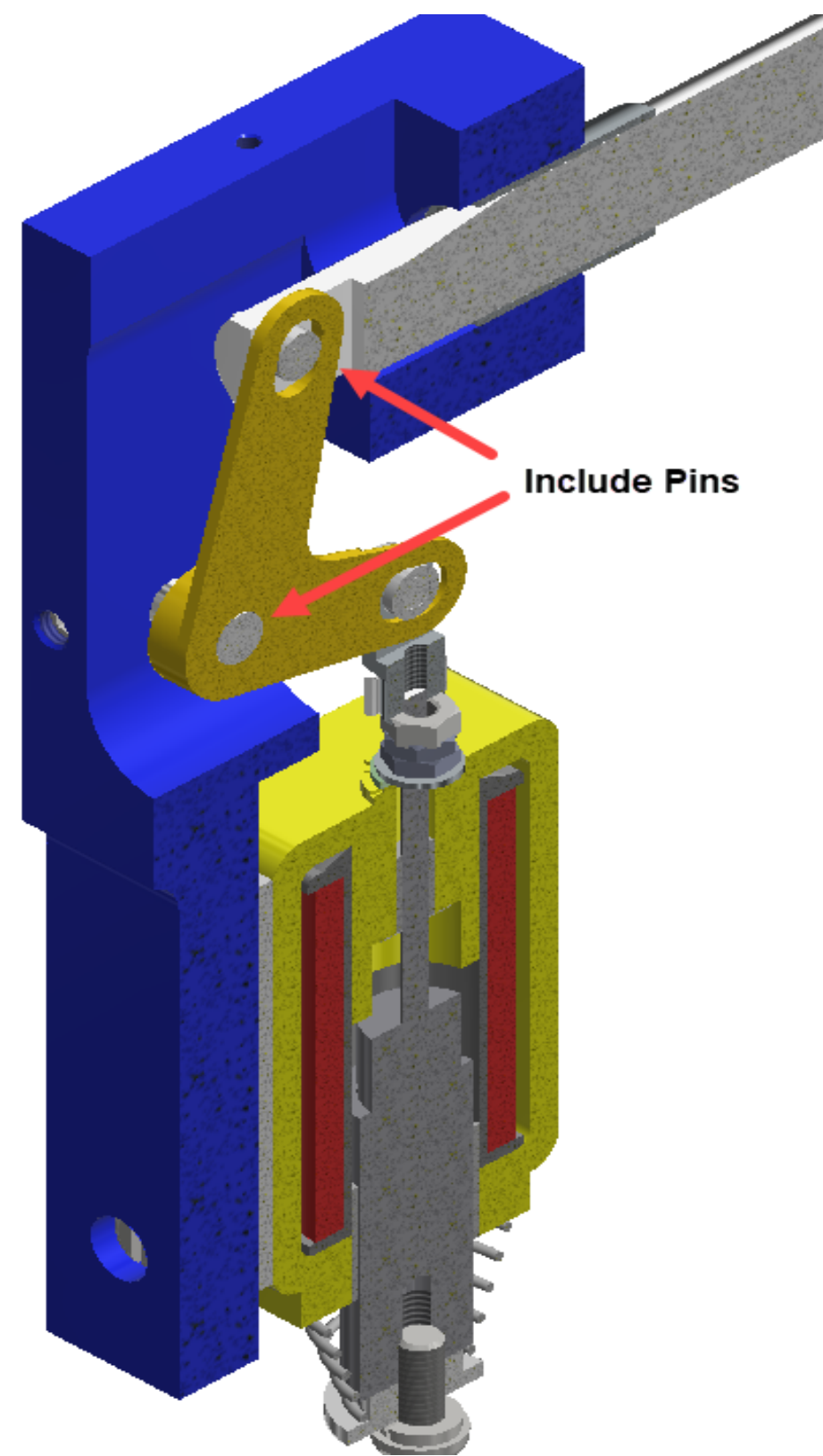
TOTAL CPU TIME = 13.8 SECONDS
WALLCLOCK TIME = 14.1 SECONDS

EXECUTION TERMINATED NORMALLY

TOTAL WARNINGS      = 0
TOTAL FATAL ERRORS  = 0
```



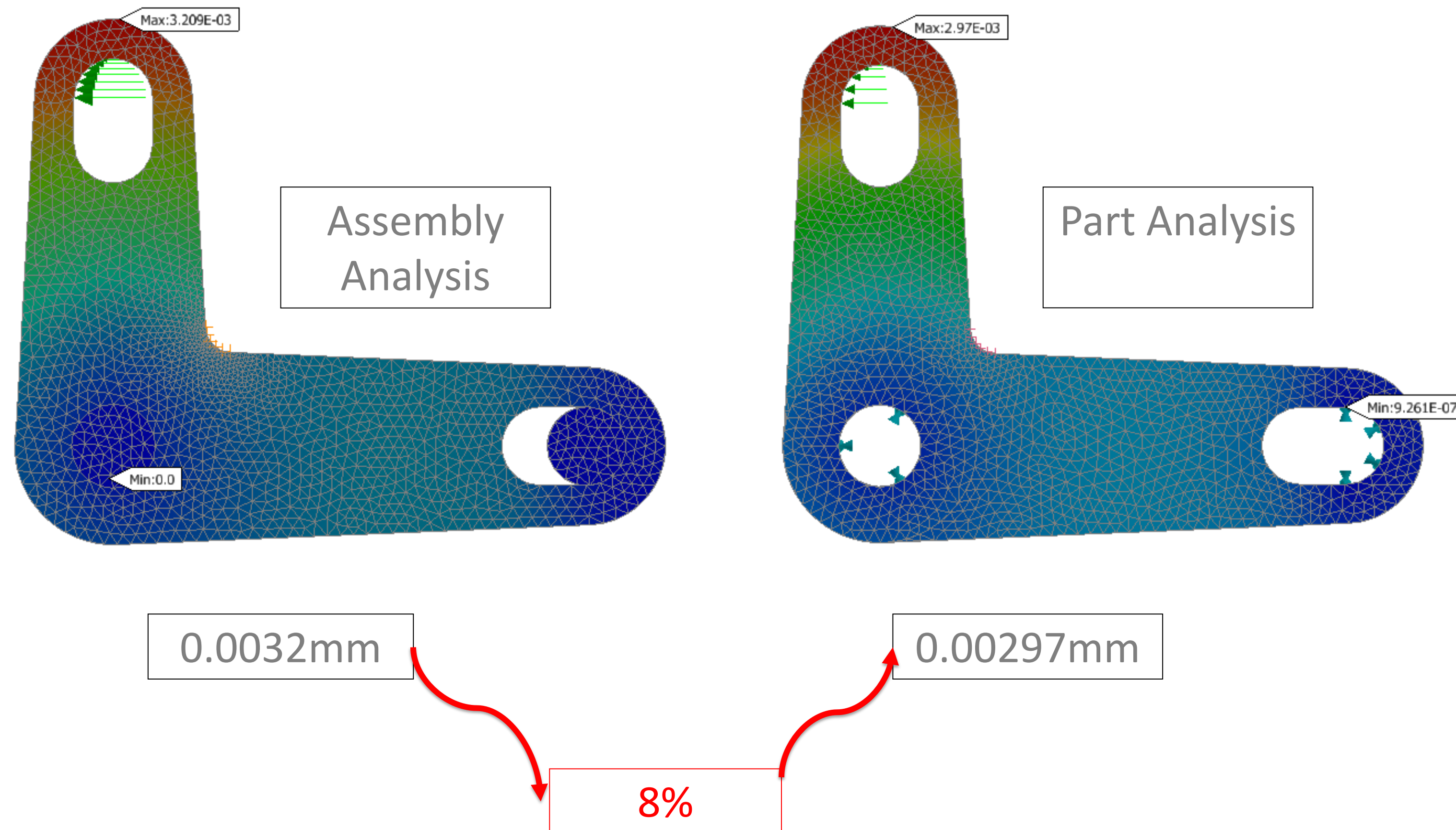
Exercise 2 – Assembly Analysis



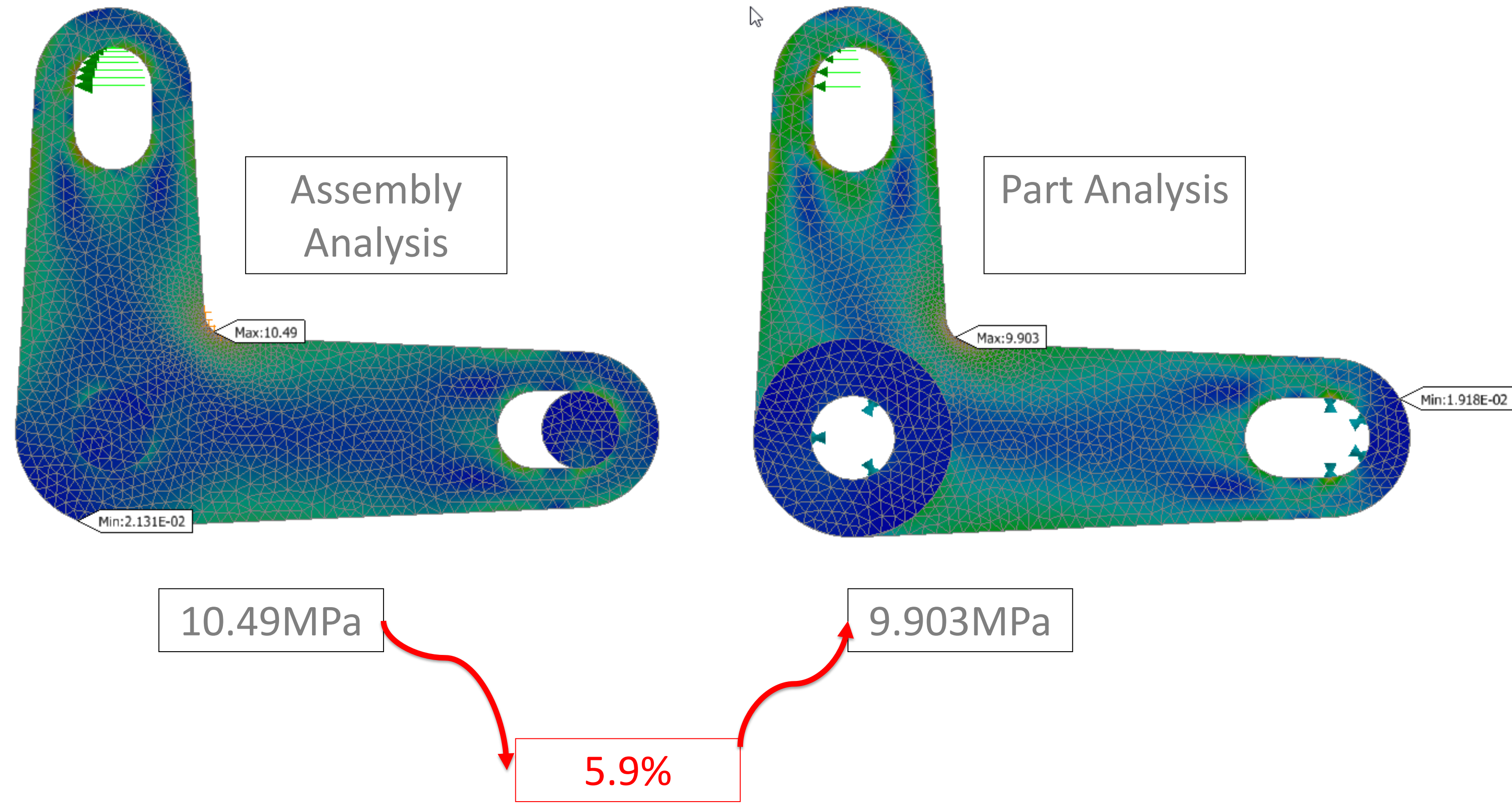
Hands on Session 2 – Lets Continue



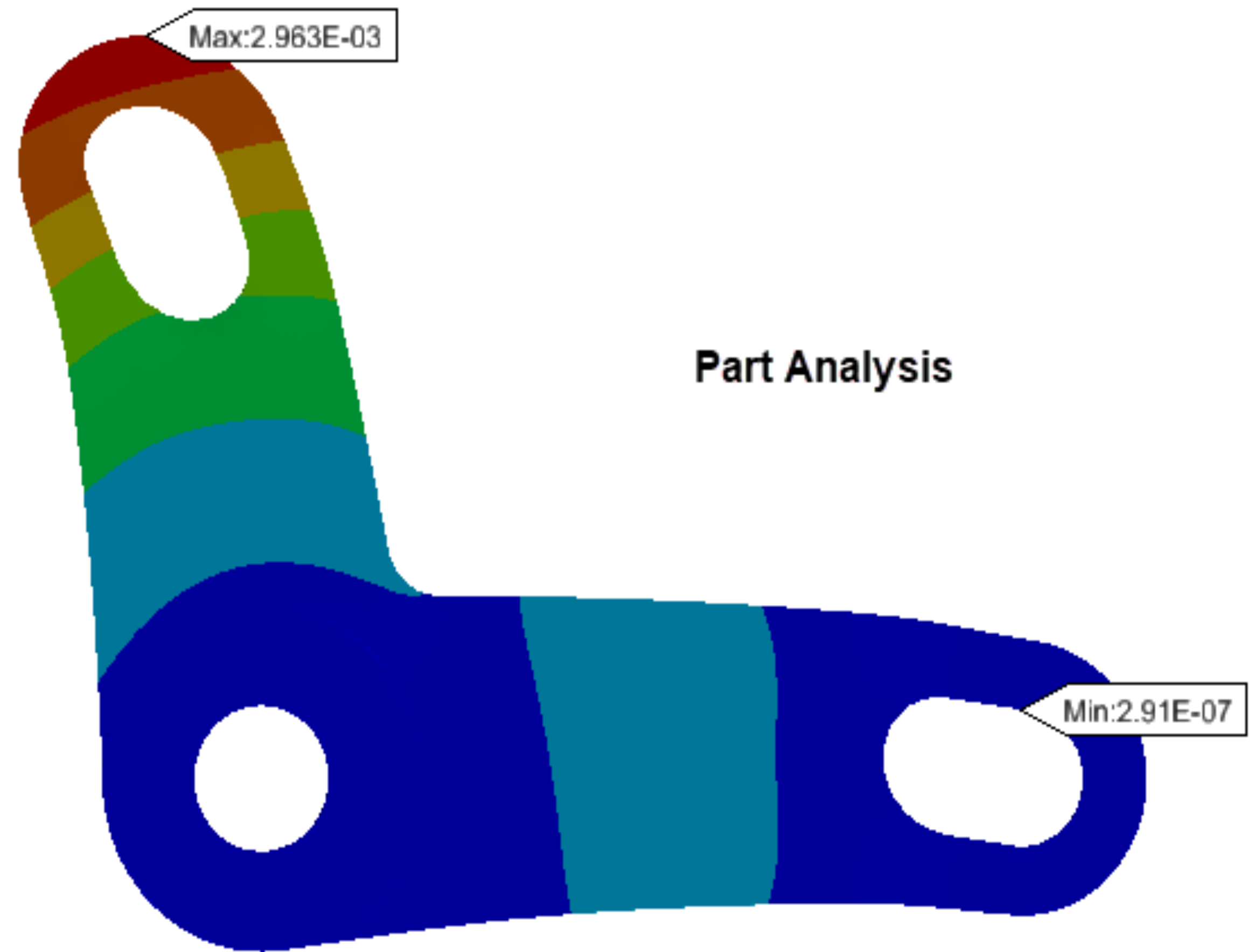
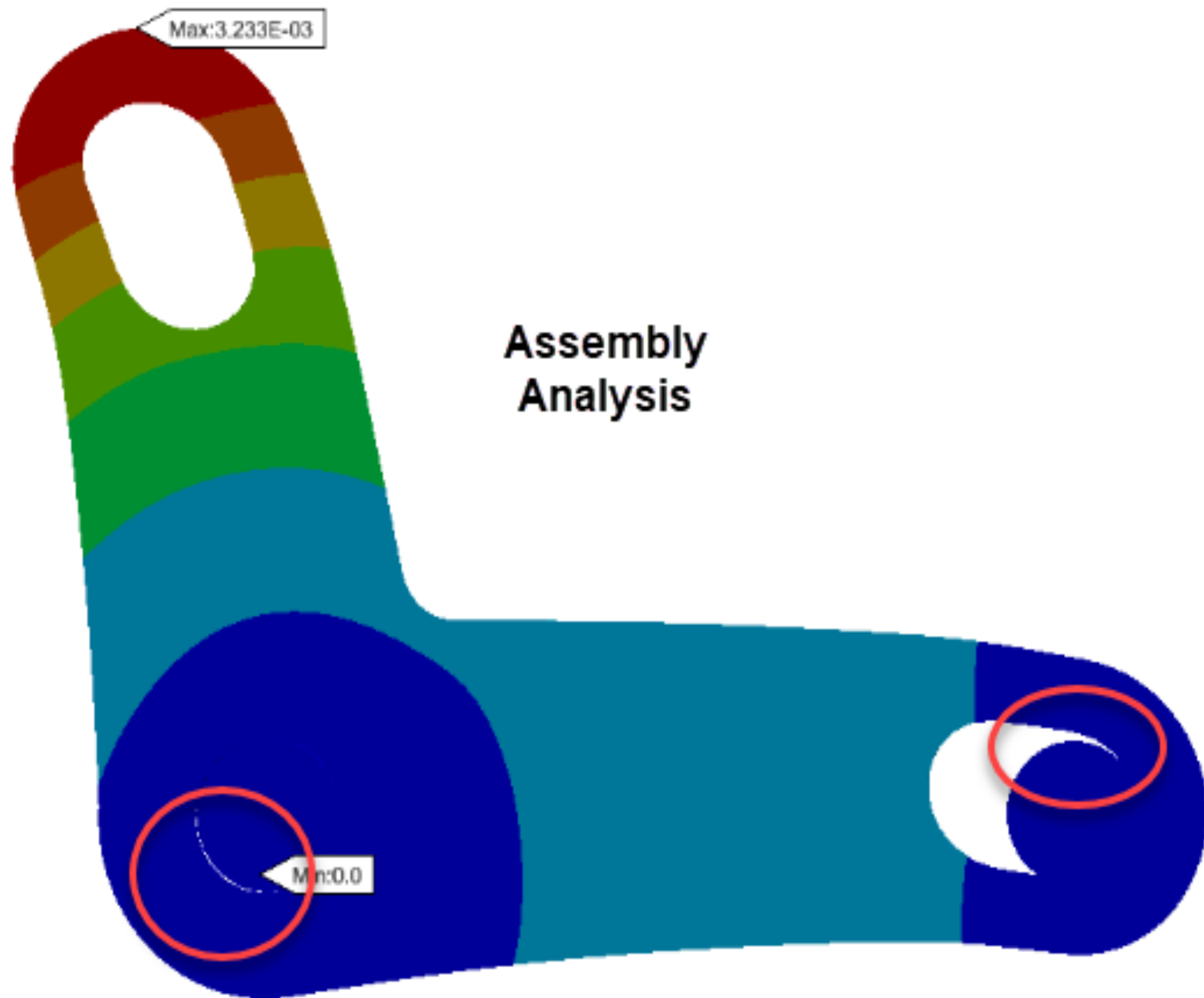
Exercise 2 – Displacement Results



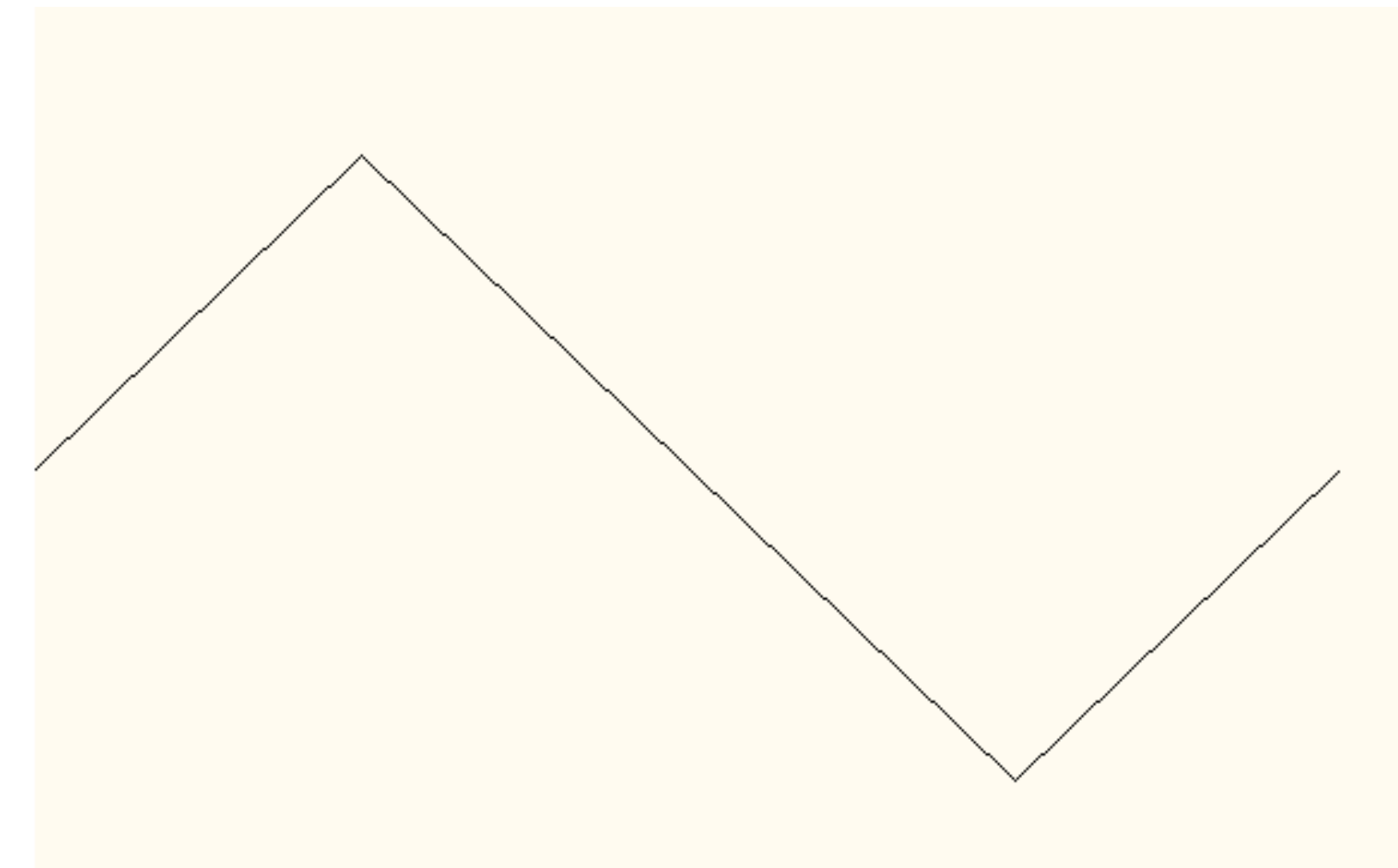
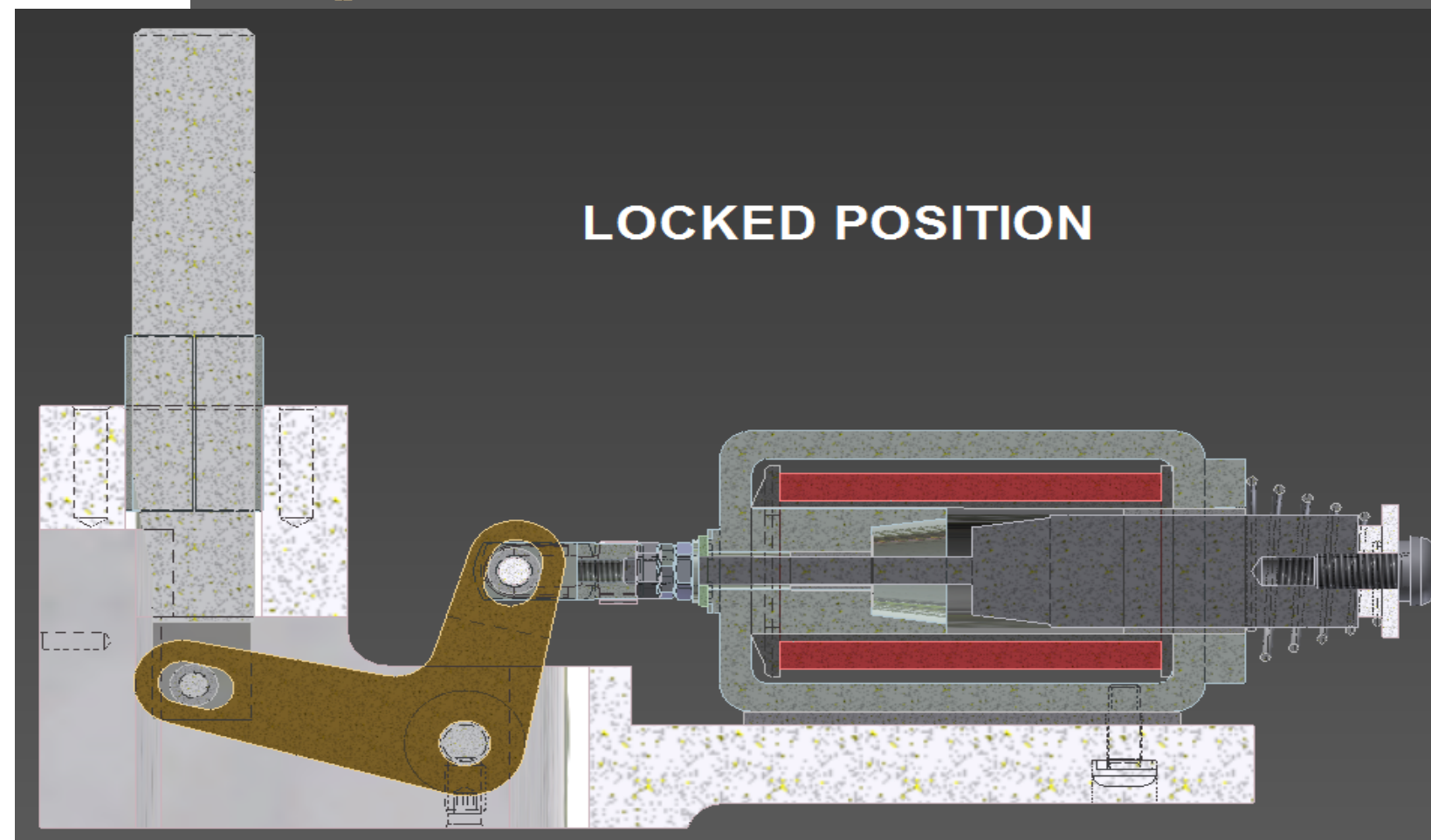
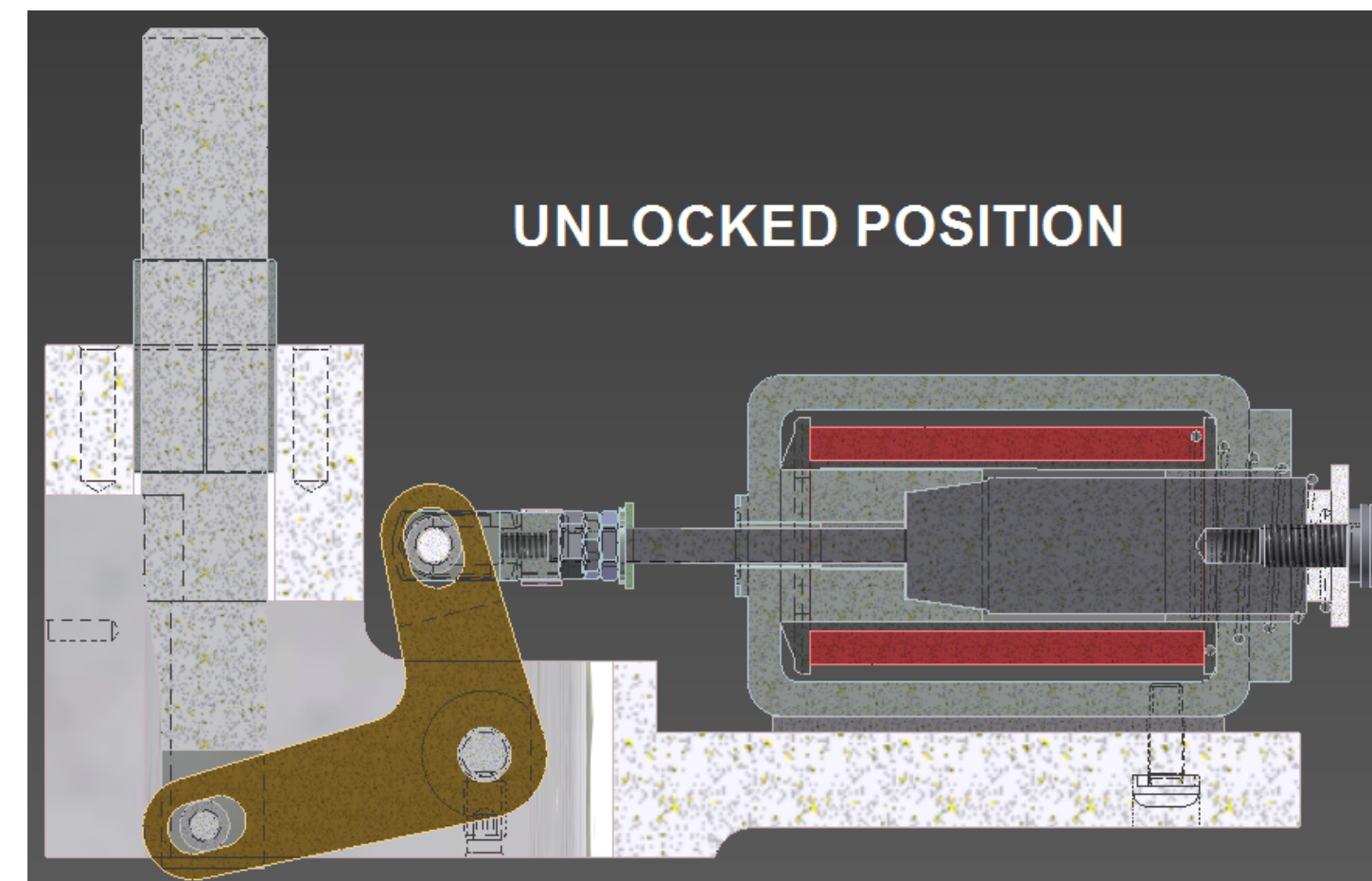
Exercise 2 – Stress Results Comparison



Exercise 2 – Why is there a difference

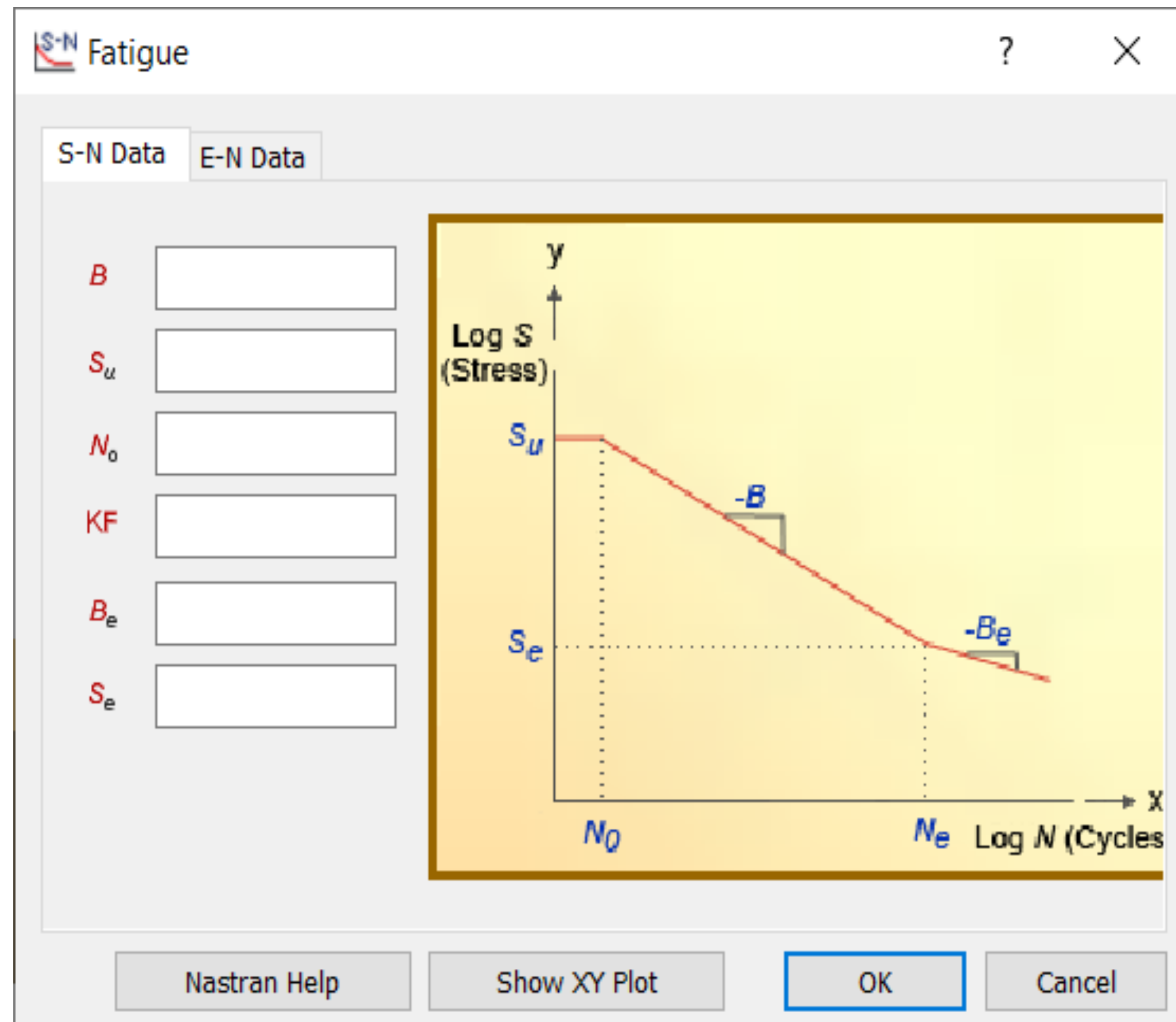


Exercise 3 – Fatigue Analysis



Assuming fully reverse loading

Exercise 3 – Fatigue Analysis



Typically we only need to specify the following values.

- B – Gradient of the curve in the high cycle region.
- S_e – Endurance limit.
- S_u – UTS value of material (Need to specify S_f)
- N_0 – Beginning of high cycle fatigue

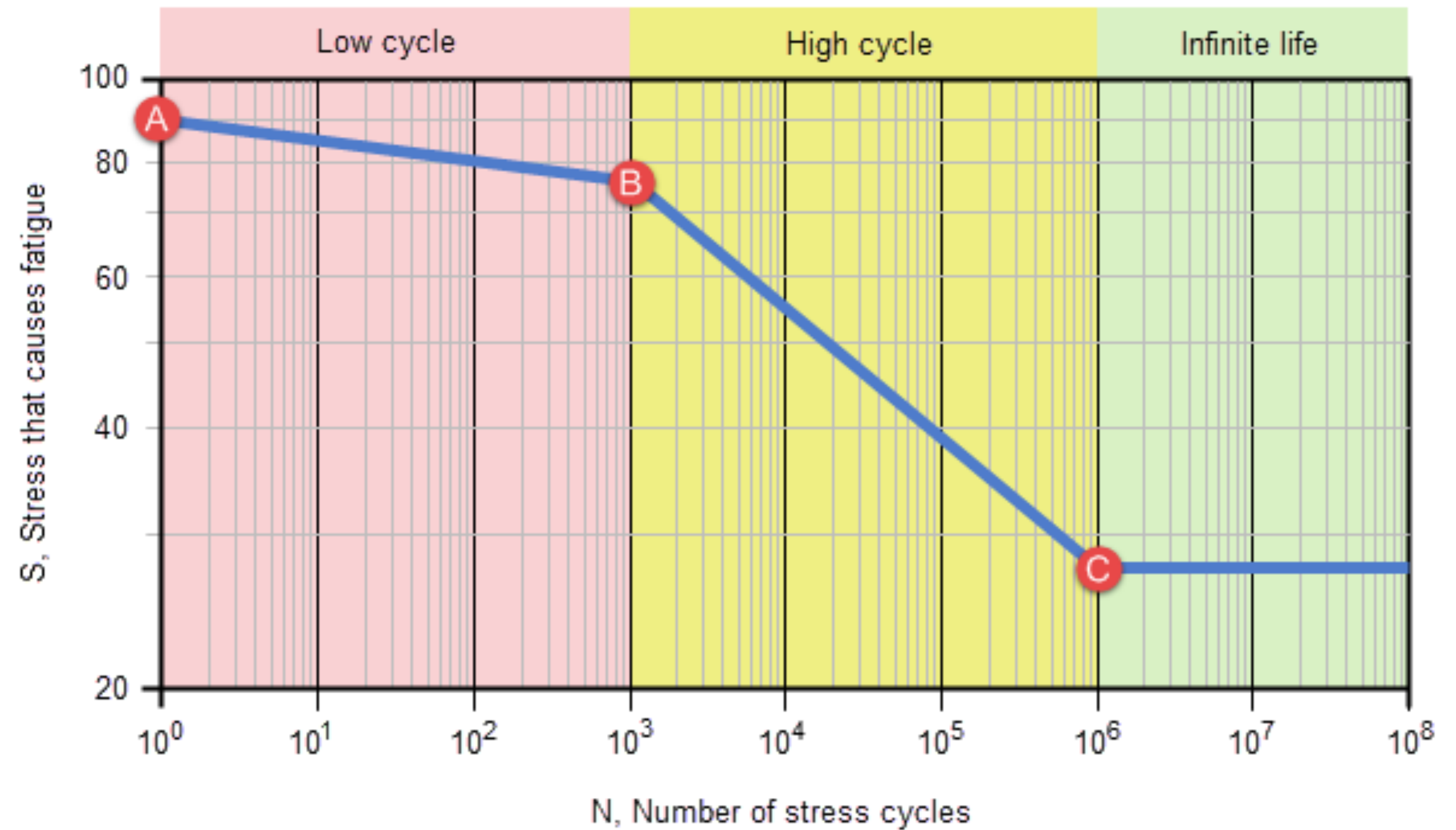
Exercise 3 – Fatigue Analysis

Lets first have a look at N_o

N_o – Is the number of cycles at the beginning of High Cycle Fatigue region.

And typically is 1000 cycles

N_o – 1000



Exercise 3 – Fatigue Analysis

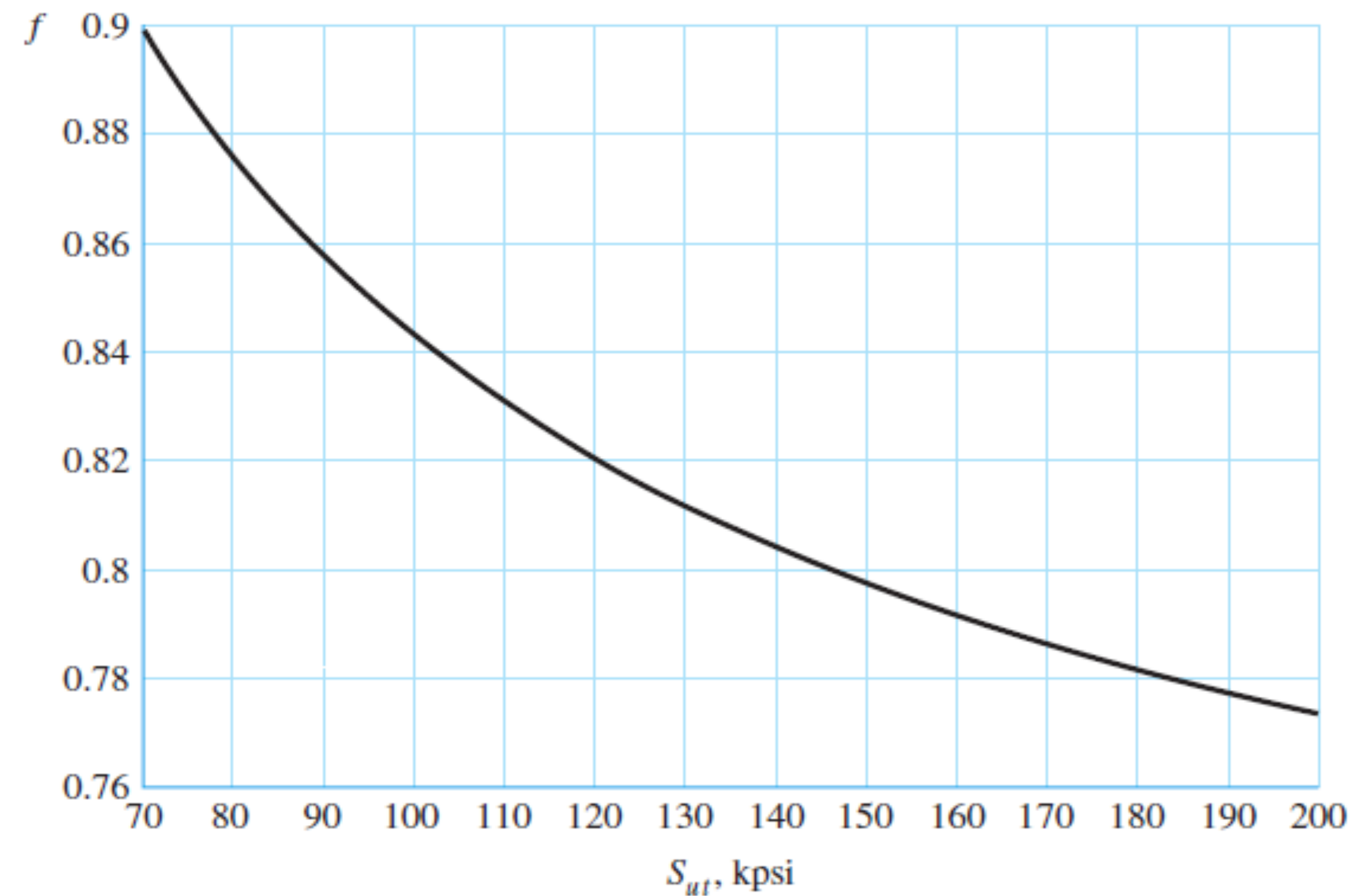
UTS information is widely available.

$$S_u - 340$$

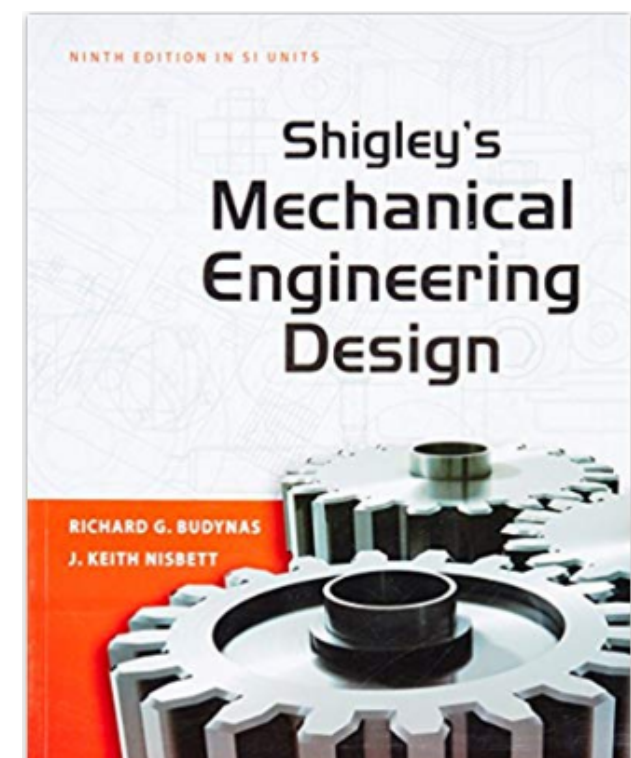
S_u @ 1000 Cycles is defined as

$$S_f = S_u \times f$$

$$S_f - 340 \times 0.9 = 306$$



70 kpsi = 482MPa & 200 kpsi = 1379MPa



Exercise 3 – Fatigue Analysis

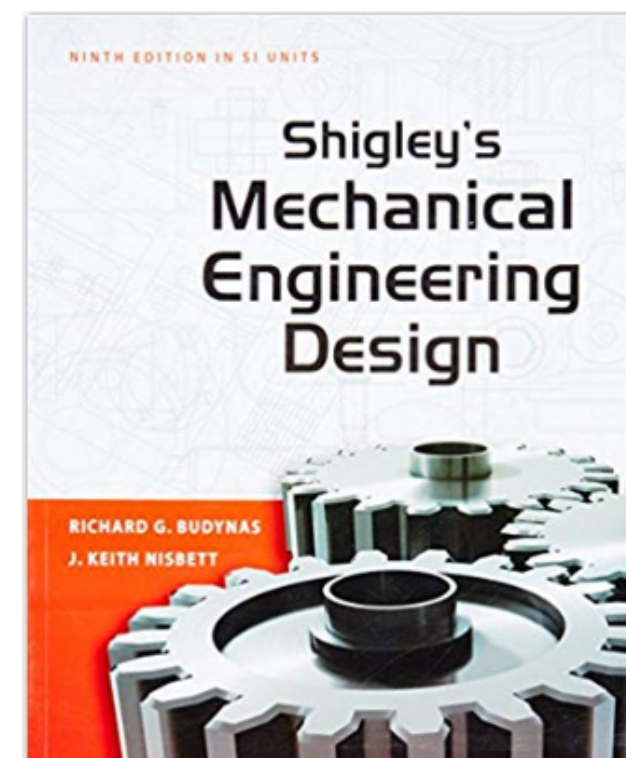
Now Endurance limit is not so obvious

$$S_e = k_a k_b k_c k_d k_e k_f S'_e$$

Typically for Steel component

$$S'_e = 0.5S_u$$

- S'_e is endurance limit of a test specimen
- k_a is a surface factor that accounts for the finish (ground, machined, forged, and so on).
- k_b is a size factor that accounts for the size of the part.
- k_c is a loading factor that accounts for different types of loading (bending, axial, torsion).
- k_d is a temperature factor.
- k_e is a reliability factor to account for scatter in the test results from one specimen to another.
- k_f is a miscellaneous factor to account for everything else (residual stress, directional characteristics, corrosion, electrolytic plating, and so on).



Exercise 3 – Fatigue Analysis

In this example we are going to assume all k values as 1 except k_a

$$k_a = aS_u^b$$

$$k_a = 4.51 \times 340^{-0.265}$$

$$k_a = 4.51 \times 0.2134 = 0.962$$

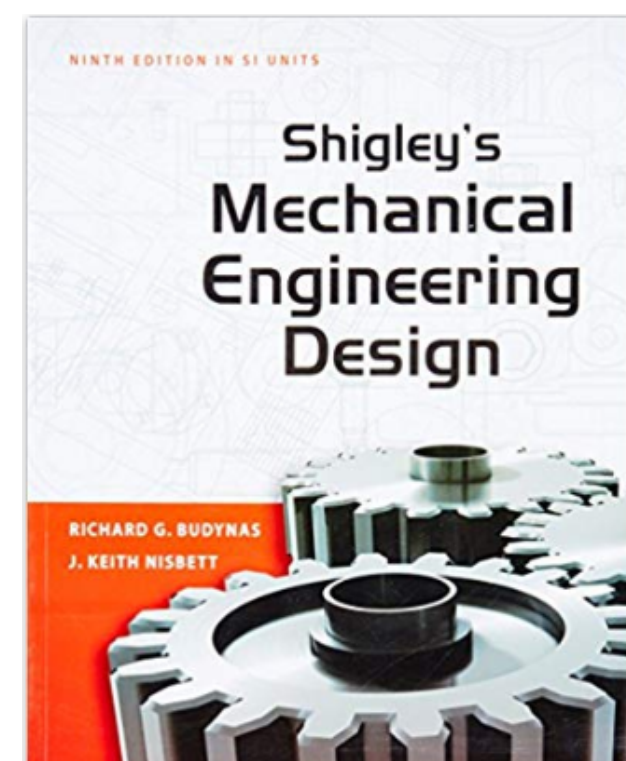
So

$$S_e = 0.962 \times 0.5S_u$$

$$S_e = 0.962 \times 0.5 \times 340$$

$$\mathbf{S_e = 163.54}$$

Surface Finish	Factor a (MPa)	Exponent b
Ground	1.58	-0.085
Machined or cold-drawn	4.51	-0.265
Hot-rolled	57.7	-0.718
As-forged	272	-0.995



Exercise 3 – Fatigue Analysis

We now have all the information required to calculate B from the following equation.

The slope of the S-N curve is

$$B = \frac{\log(S_u) - \log(S_e)}{\log(N_e) - \log(N_0)}$$

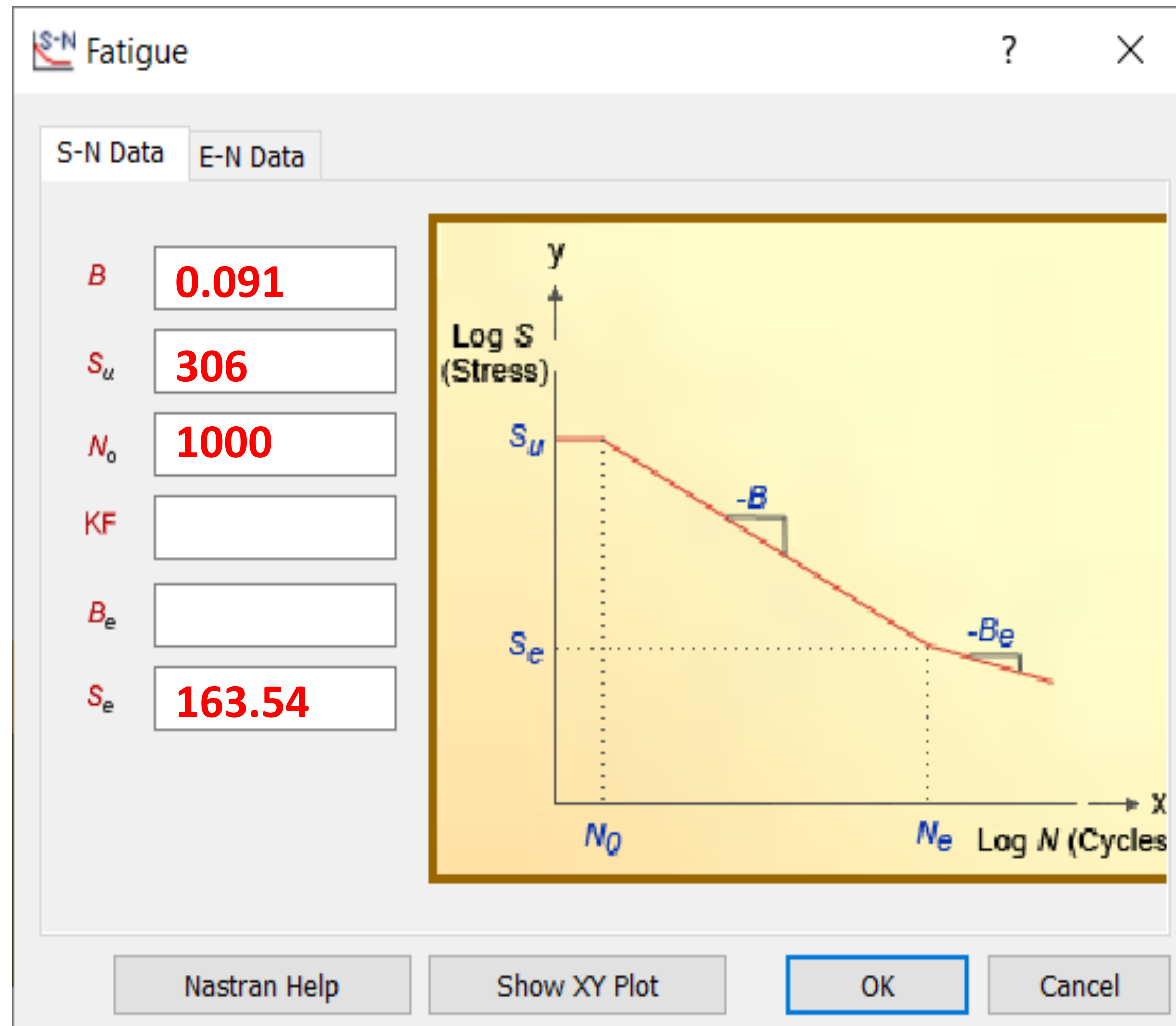
Where Ne is usually 1 million cycles.

$$B = \frac{\log(306) - \log(163.54)}{\log(1E6) - \log(1E3)}$$

$$B = \frac{2.486 - 2.214}{6 - 3}$$

$$**B** = \frac{0.272}{3} = 0.091$$

Exercise 3 – Fatigue Analysis



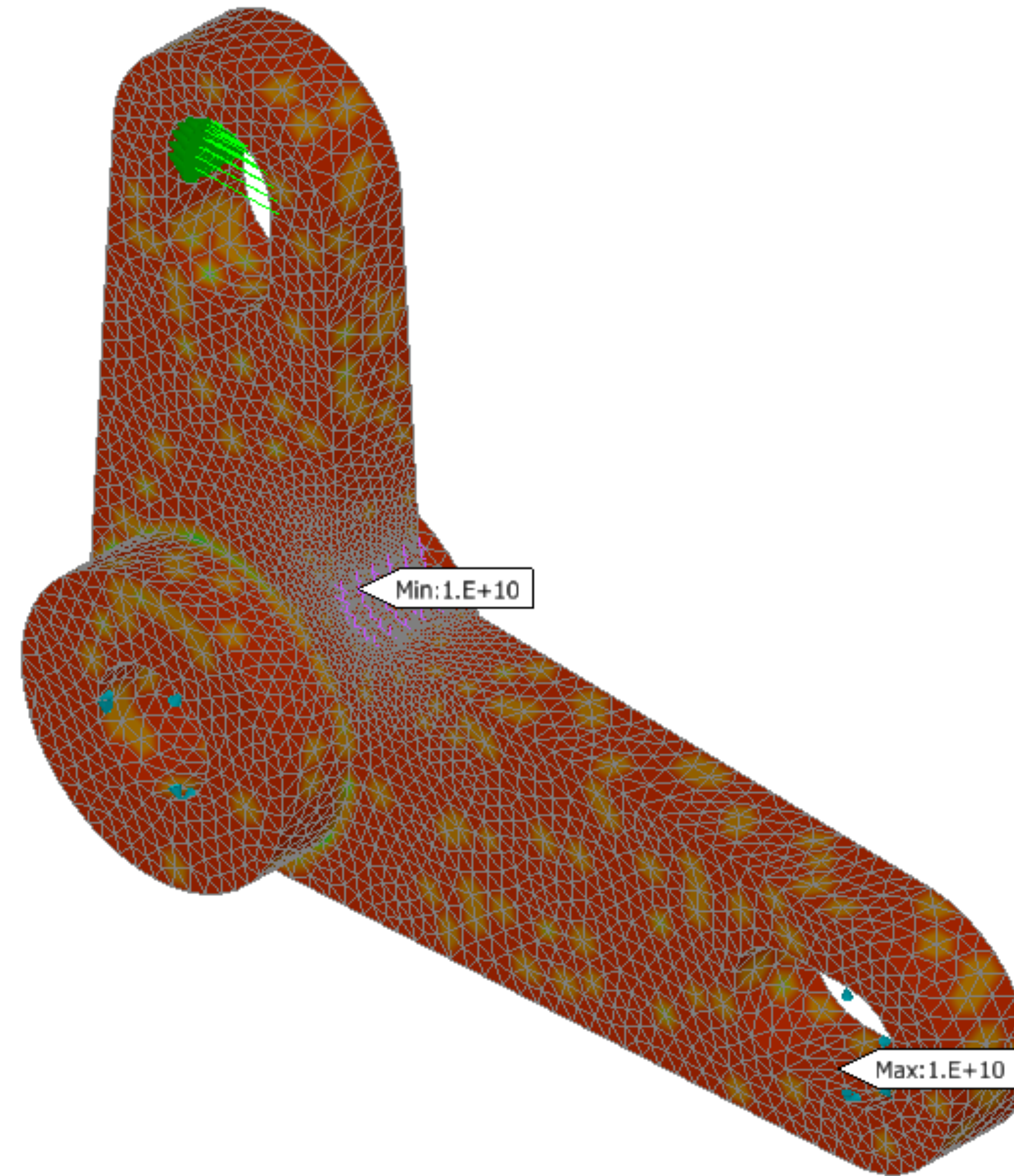
Hands on Session 3



Exercise 3 – Fatigue Analysis

Fatigue life is $1e10$.

Because Maximum Stress value
is below Endurance Limit



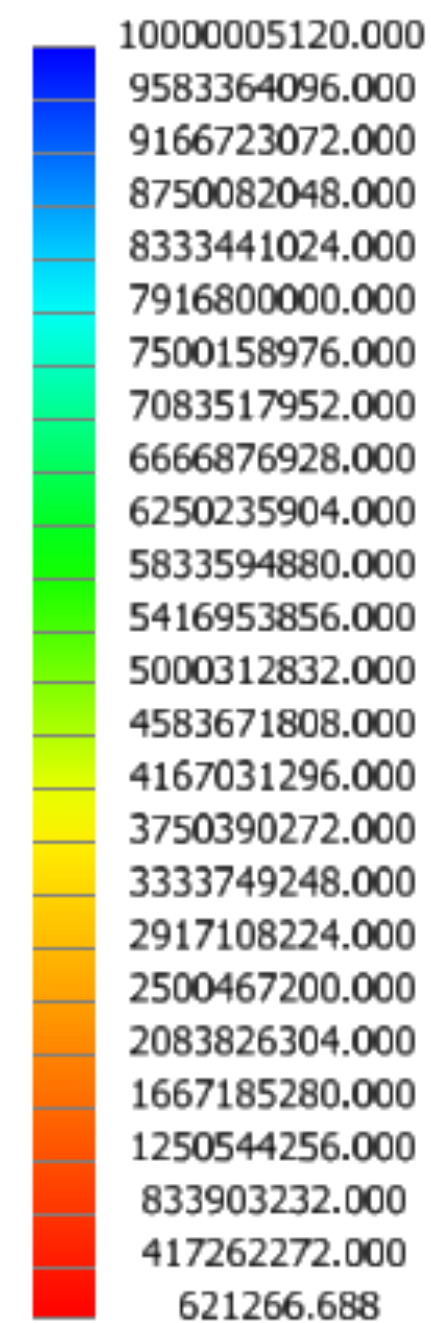
Exercise 3 – Fatigue Analysis

Now increase load from -30N to -500N.

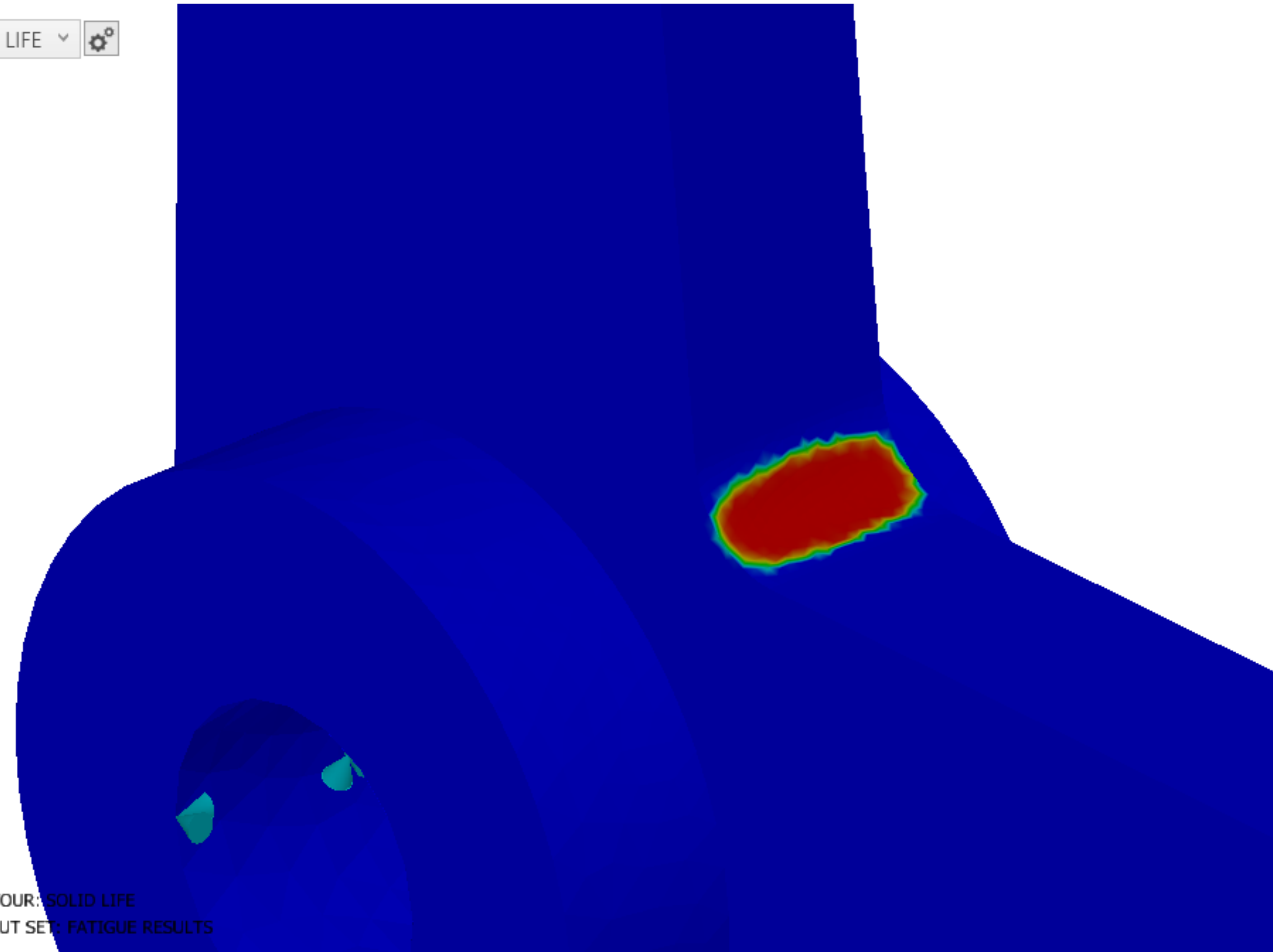
Fatigue

What is now the minimum life?

621266



CONTOUR: SOLID LIFE
OUTPUT SET: FATIGUE RESULTS



Exercise 4 – Design Optimisation

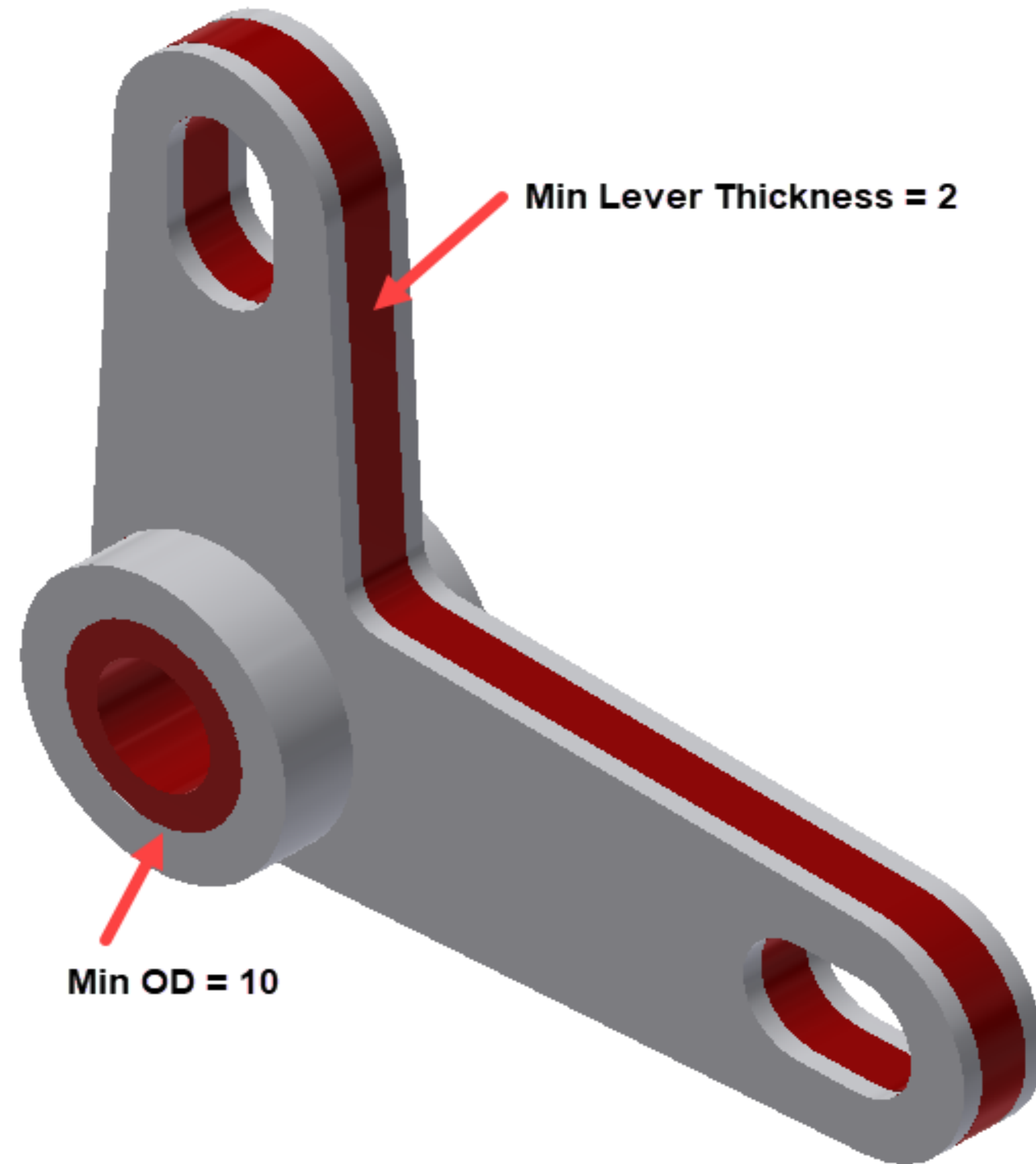
Design Restrictions

Minimum thk ≥ 2 mm

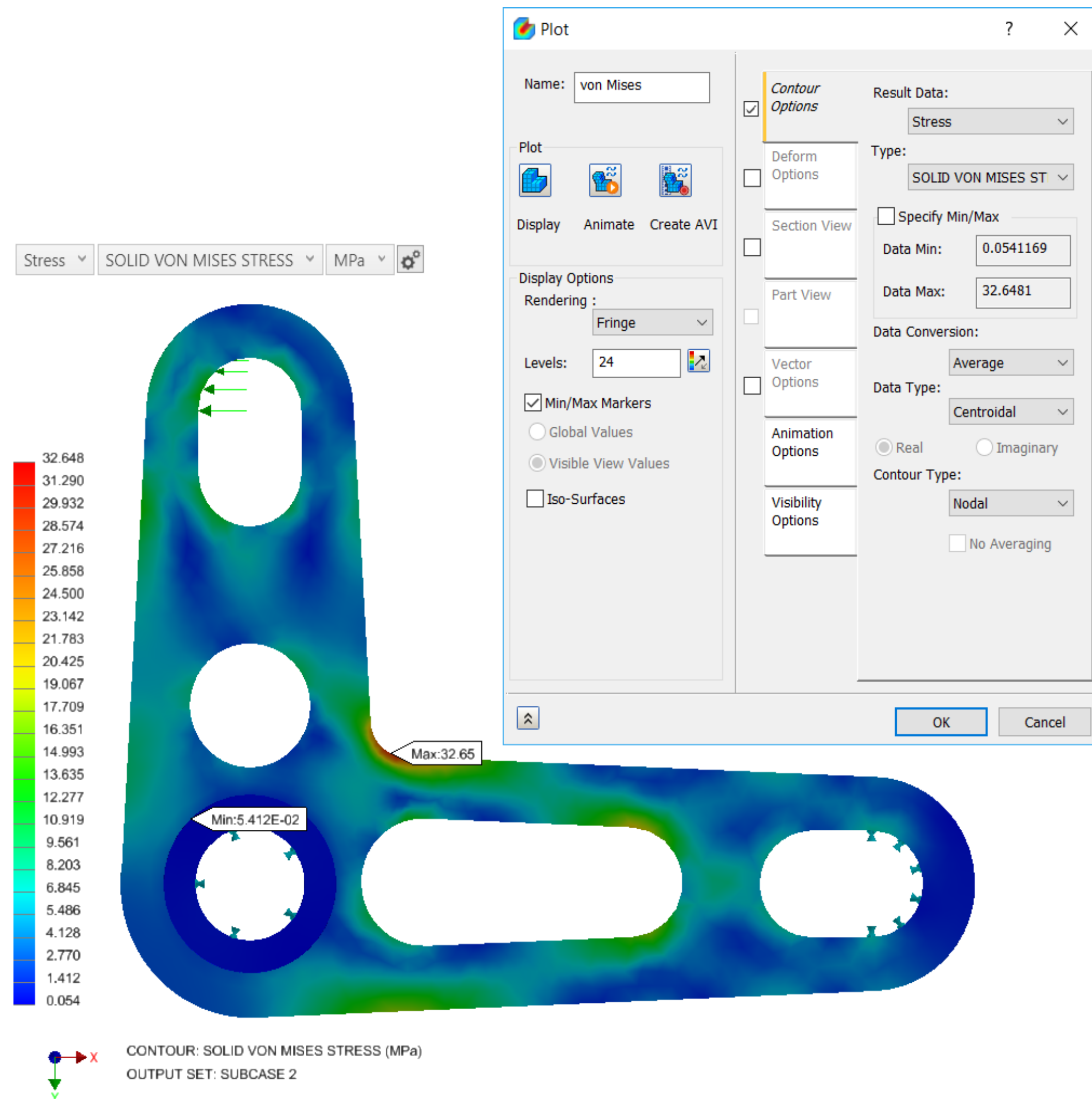
OD of circular hole ≥ 10 mm

Slot shapes cannot be altered

Target Safety Factor is 5



Exercise 4 – Design Optimisation



Maximum Stress is 32.65 MPa

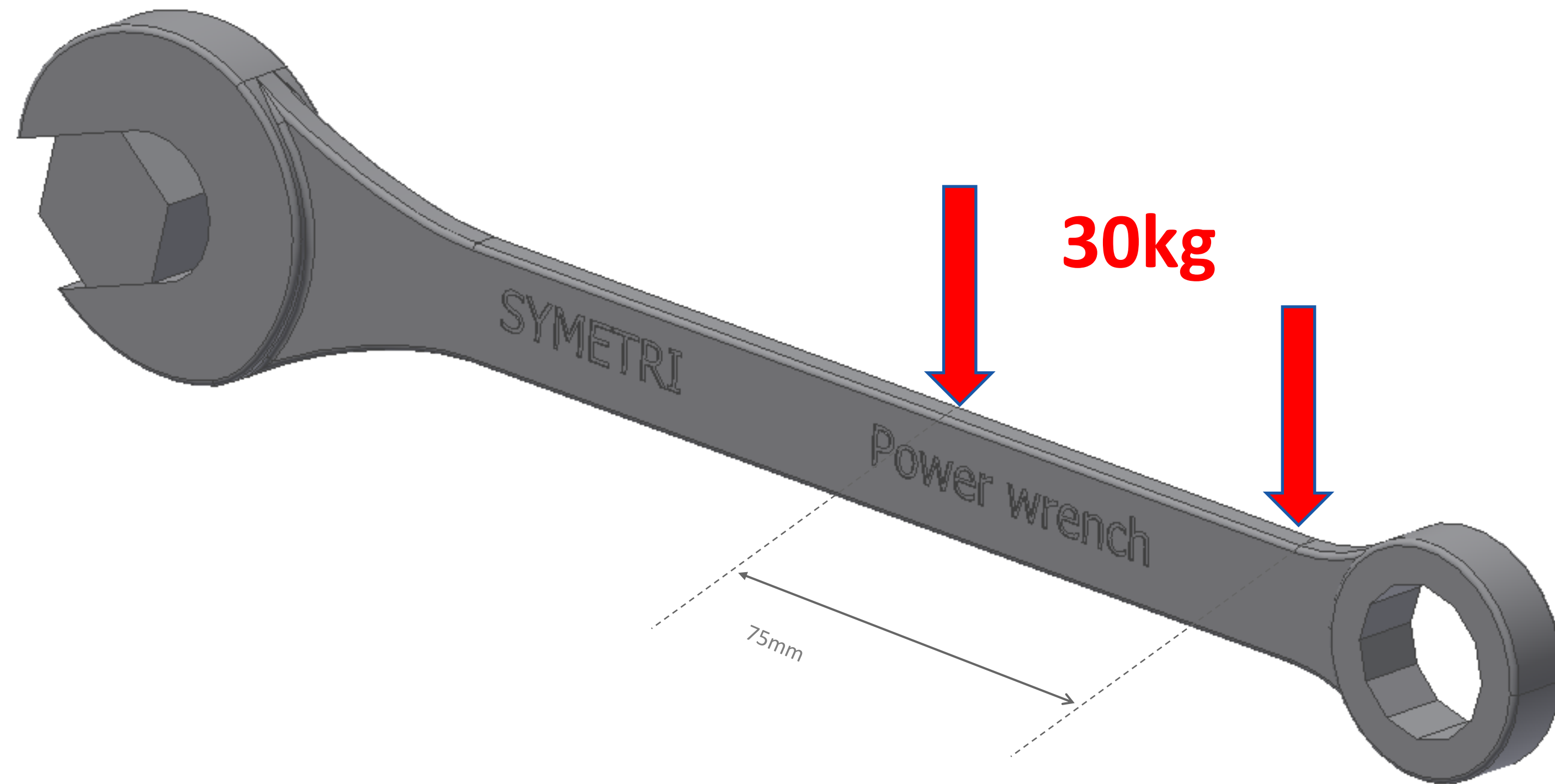
Therefore Safety Factor is

$$SF = 200/32.65 = 6.12$$

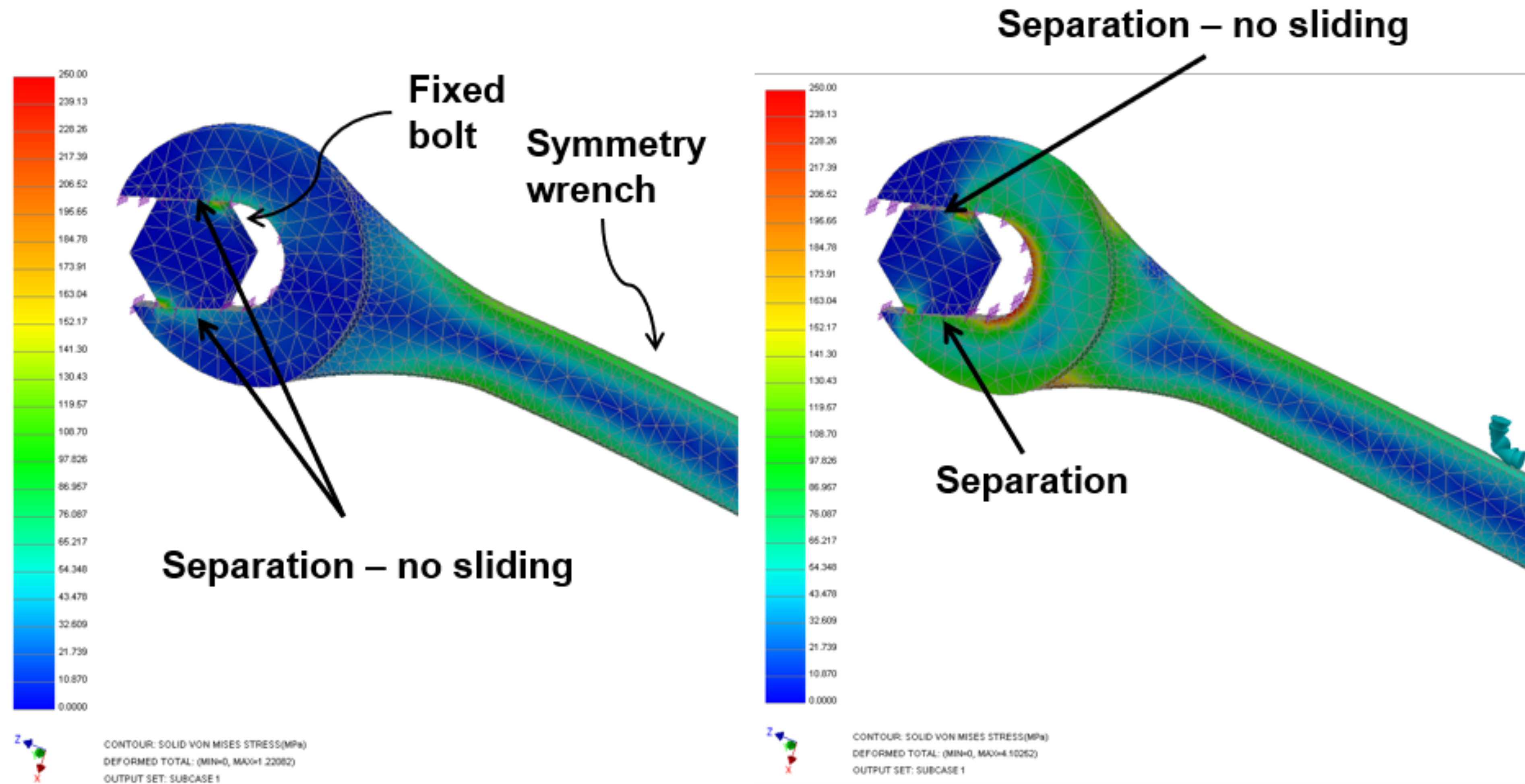
Exercise 5 – Practice Exercise

Analyze this wrench and determine the highest von Mises stress.
Can we do any simplifications? How should we apply the contact?

Material: Steel
Load: 30kg

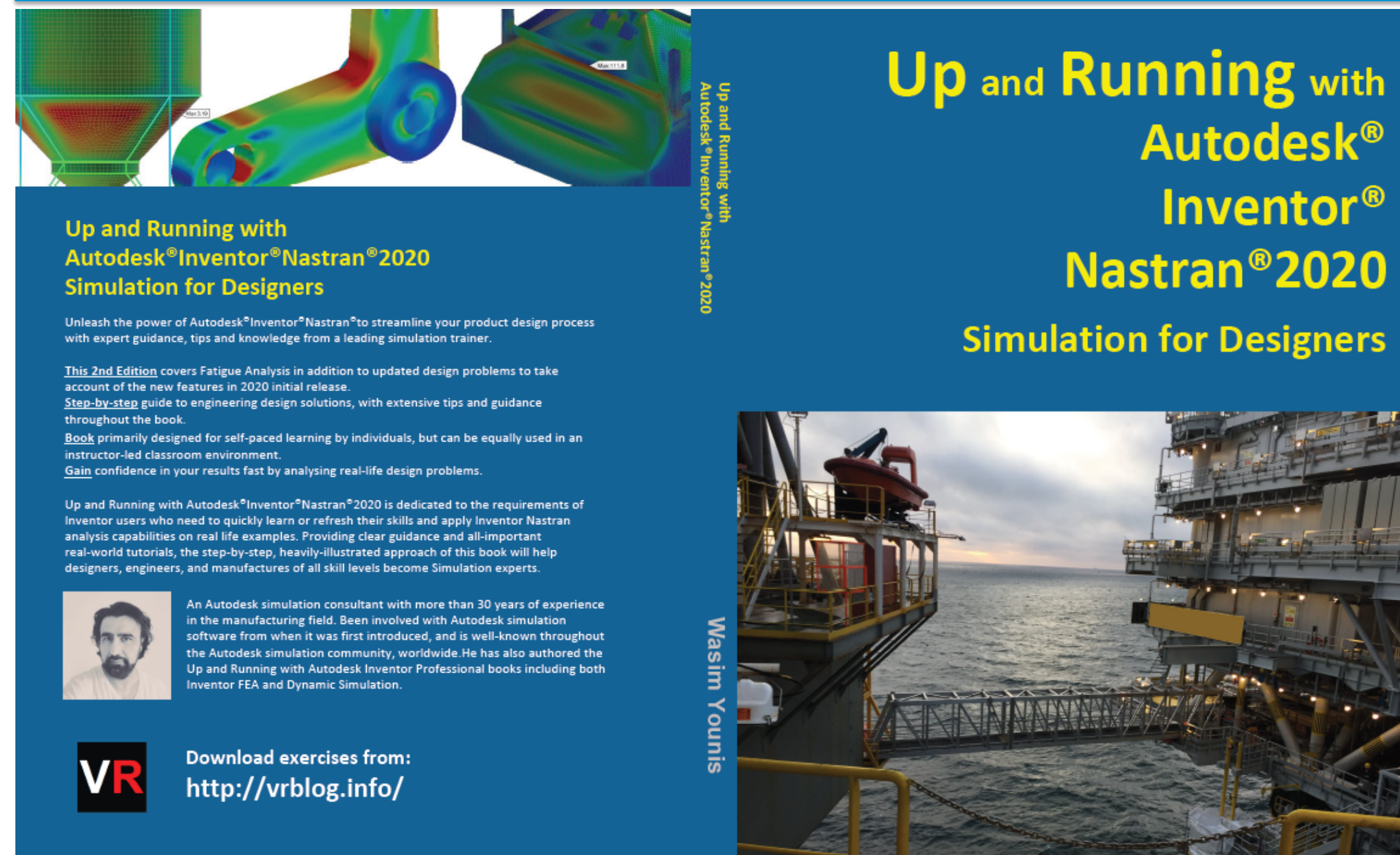


Exercise 5 – Practice Exercise



Resources to help you accelerate learning...

Available on Amazon worldwide



Self –paced learning with real world examples.

<https://forums.autodesk.com/t5/nastran-in-cad-forum/bd-p/75>

Cannot apply constraints/loads on beam idealisations automatically created

I have a simple test model and have the following issues

1. When entering the nastran environment the solid geometry does not automatically hide. I have to select/unselect cad bodies from object visibility to hide them so can select beam elements
2. I can get warning not selected on valid FEA geometry when running the model.

I have attached model for your attention

Tags: Beam Elements

Report

simple-model.zip

0 LIKES

REPLY

MESSAGE 2 OF 2



KubliJ in reply to: wasim.younis

Friday

Re: Cannot apply constraints/loads on beam idealisations automatically created

Hi @wasim.younis,

Thanks for sharing your experience with In-CAD and the use of frame generated models. There are some known issues with the workflow currently. Solid Object visibility being one of them, the other is with the selection process when applying loads and constraints. The problem with the loads and constraints is that they are being applied to the original sketch entities and not being translated/transferred to the meshed model. It can be resolved easily, you just need to hide the sketch used to create the frame. A more [detailed explanation can be found here](#).

Nastran In-CAD Forum - Excellent resource for any questions you may have



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