Stress & Deformation Analysis of Helical Compression Spring

Group:C24

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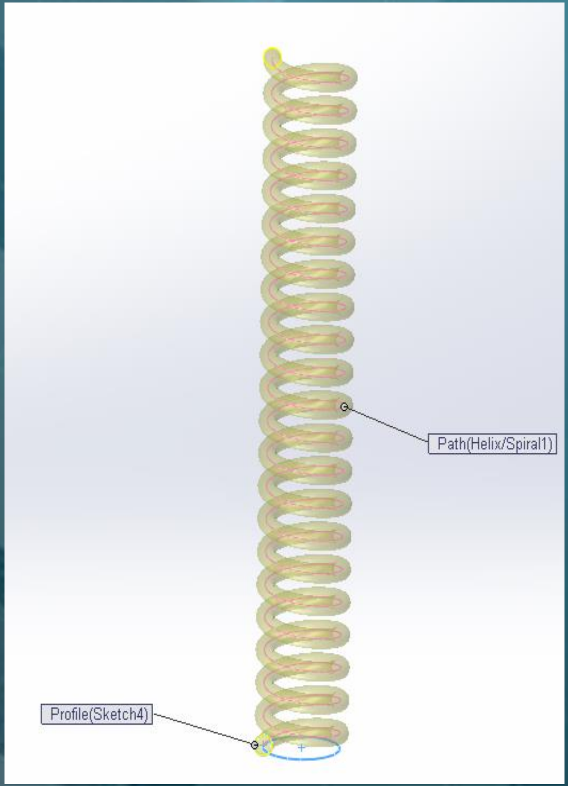
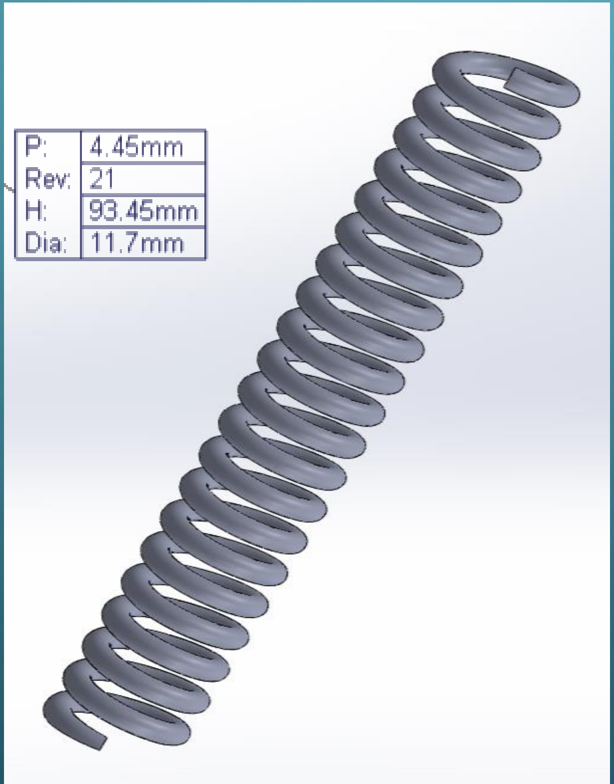
Objectives

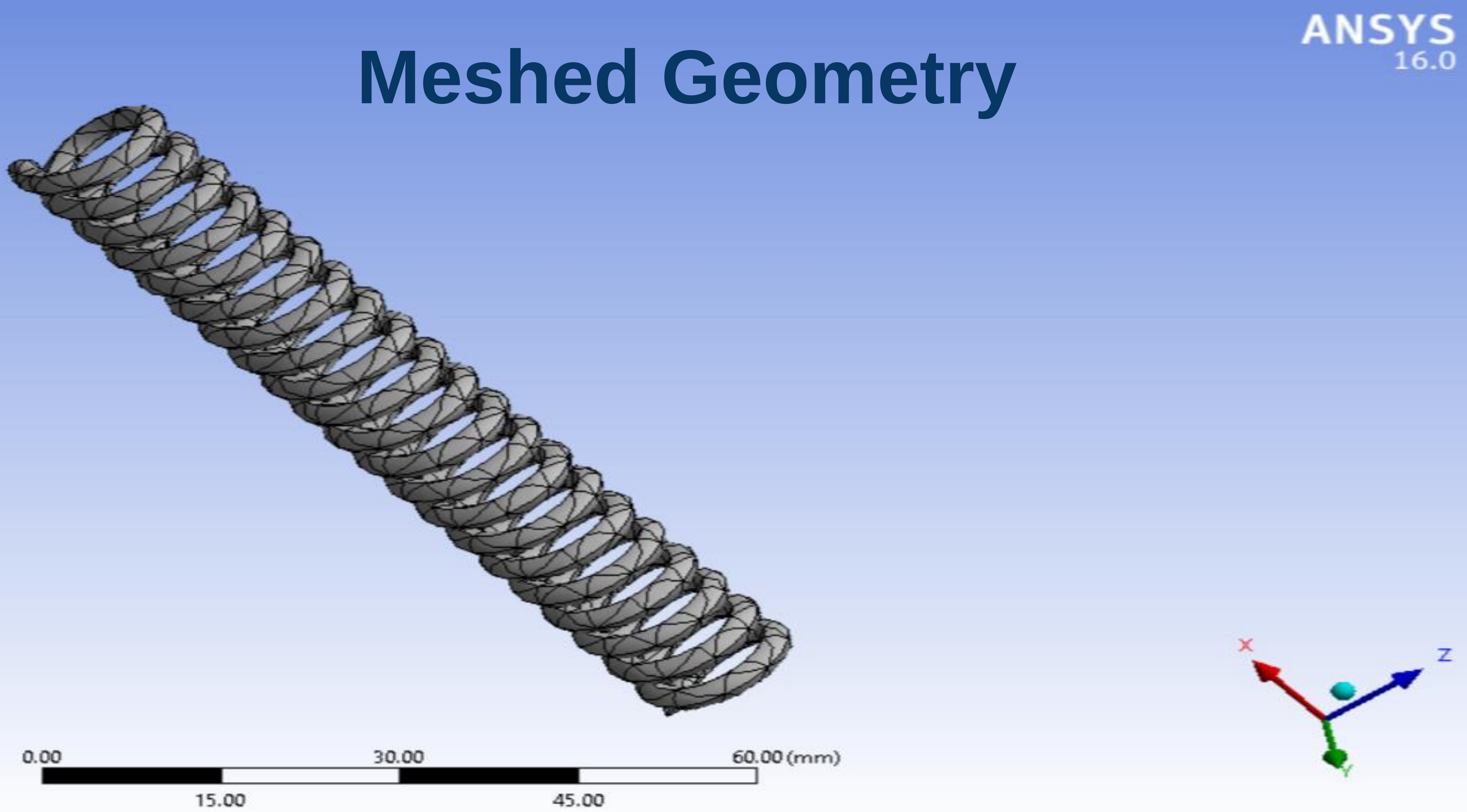
- ***To understand the concept of FEA***
- ***To learn meshing and simulation using ANSYS***
- ***To plot equivalent stress and deformation of a loaded Spring by simulation methodology***
- ***To validate simulation results***
- ***To understand practical importance of structural simulation***

Construction of Geometry

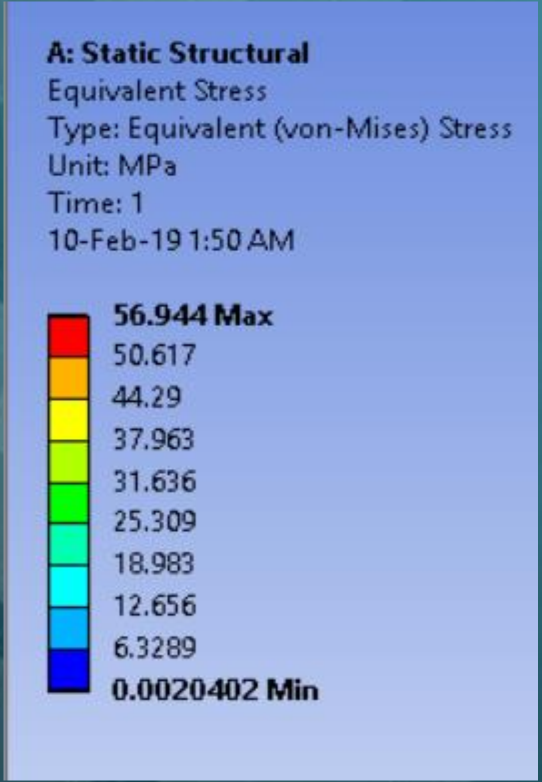


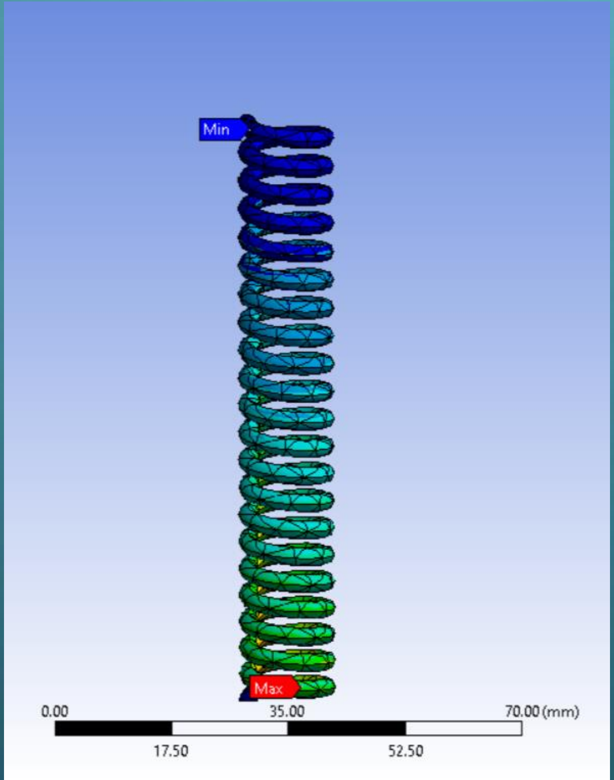


Meshed Geometry

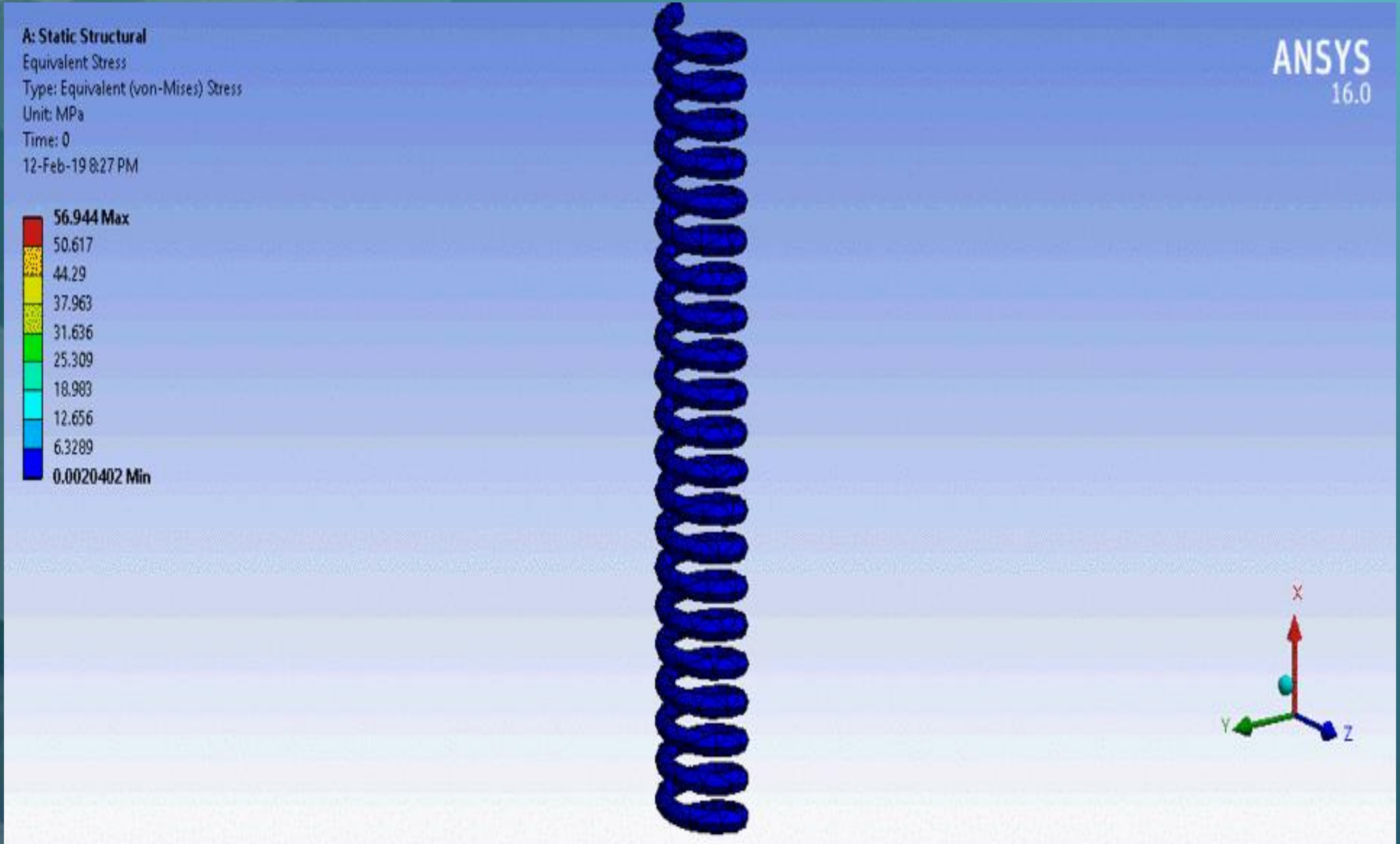


Stress Analysis

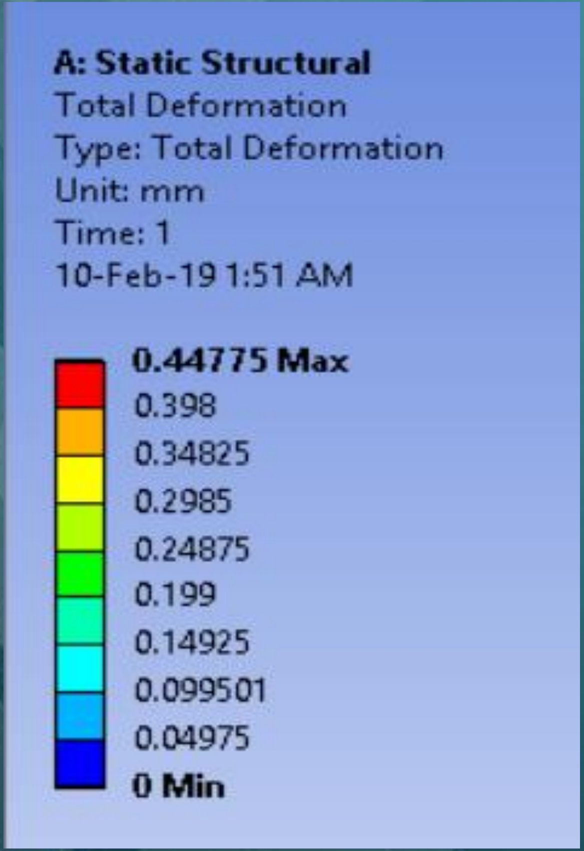


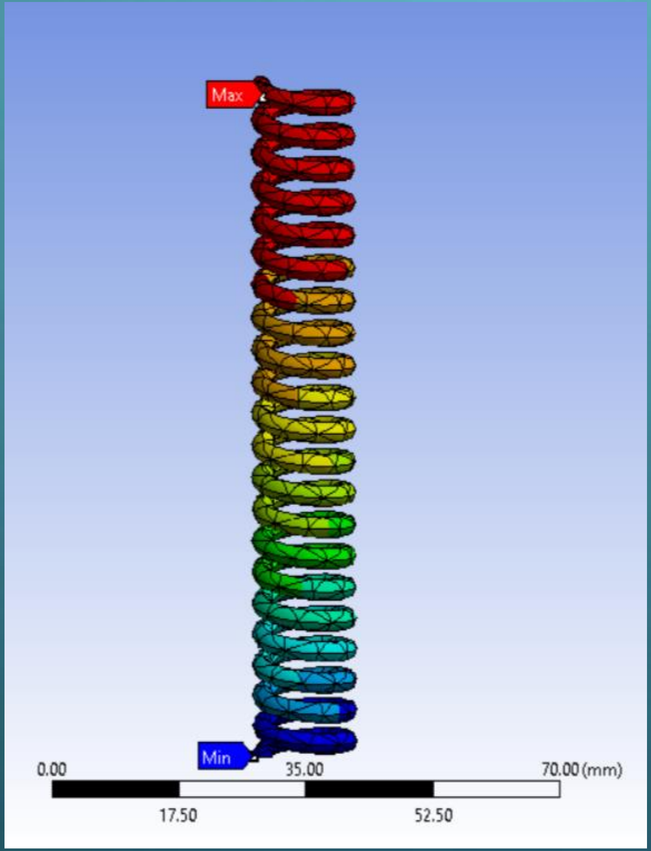


Stress Analysis(contd.)

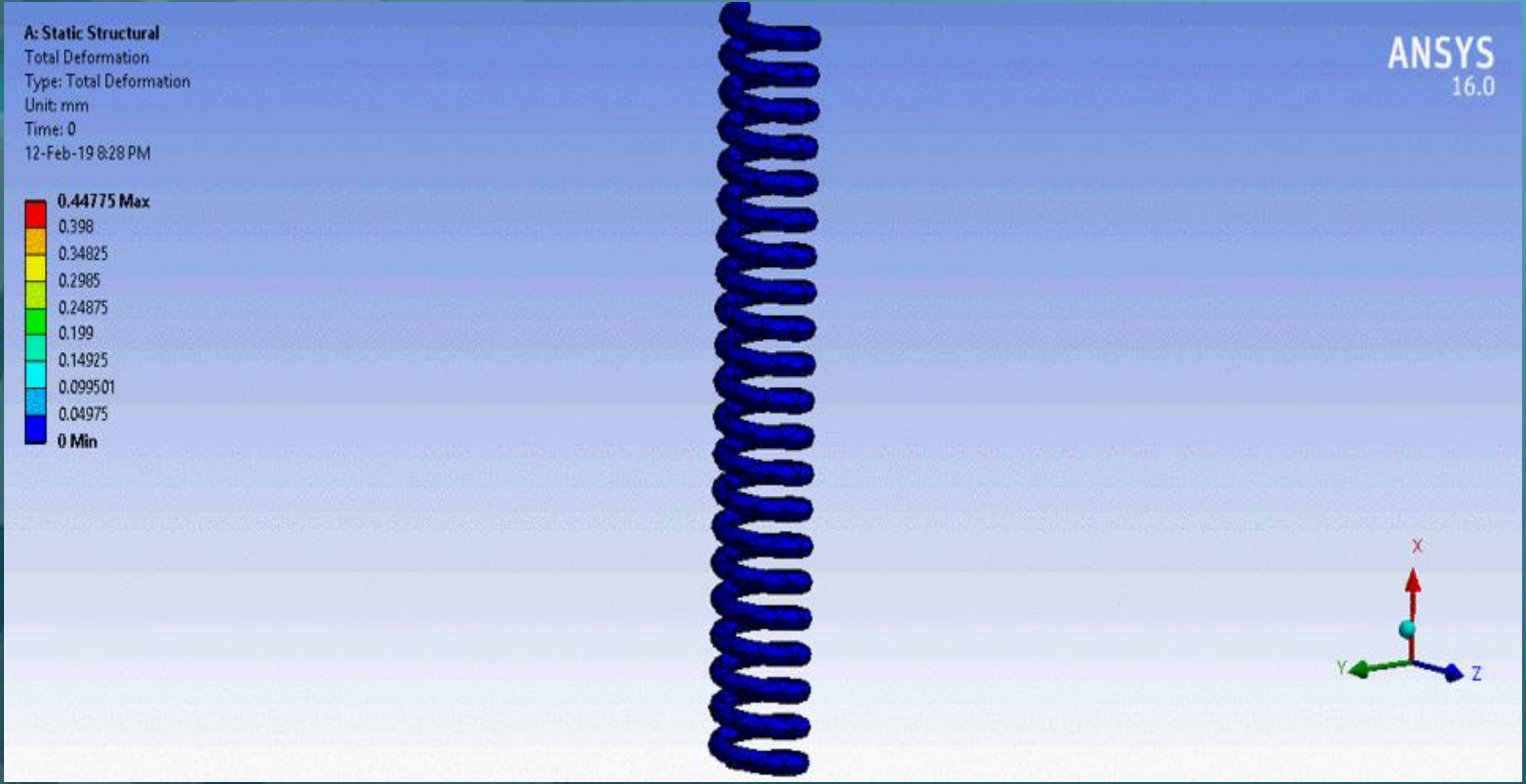


Deformation Analysis





Deformation Analysis(contd.)



Validation

Two possible ways

1. ***Theoretical Estimation(Quantitative)***
2. ***Practical Failure Case Study(Qualitative)***

Theoretical Estimation

Helical Linear Spring Shear Stress Formula

$$\tau = K_s \frac{8FD}{\pi d^3}$$

$$K_s = \frac{(2C+1)}{(2C)} \qquad where\ C = D/d$$

$K_s -$ *spring constant*

$F -$ *applied force in Newton*

$D -$ *mean spring diameter in mm*

$d -$ *wire diameter in mm*

$\tau -$ *shear stress in pascal*

Estimated value of shear stress

=47.91 MPa

Curvature effect small

Theoretical Estimation(contd.)

Stiffness:

$$K = \frac{Gd^4}{8D^3n} \quad \text{N/mm}$$

Deflection:

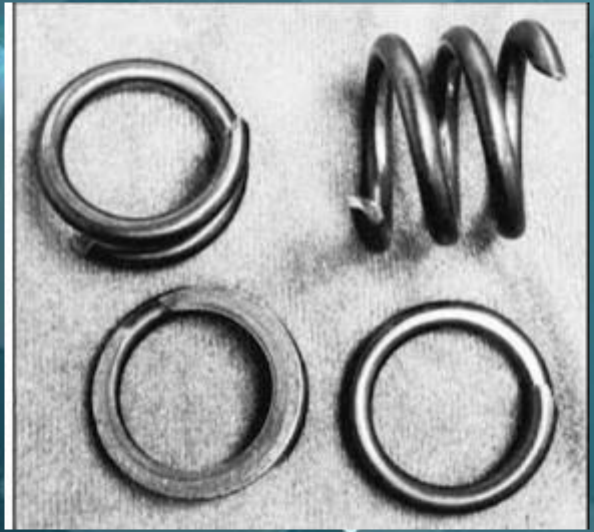
$$\delta = \frac{8WD^3n}{Gd^4} \quad \text{mm}$$

Theoretical deformation=1.7 mm

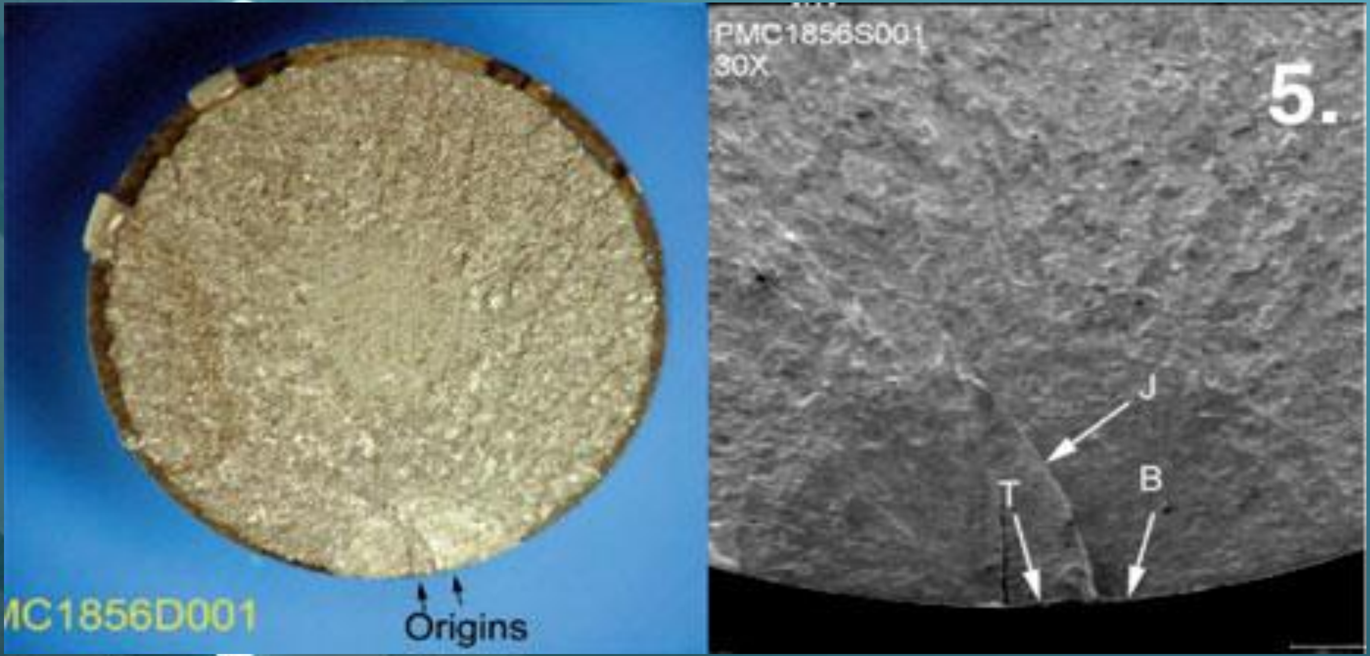
Why the discrepancy?

- ***The simulation works by solving discretely approximated model of the system.Due to computational limitations this discretization was done in relatively larger resolution***
- ***The load was applied on the face of topmost coil.This resulted in induced force effect from coil to coil which is different from the actual case of central load.***
- ***The theory and the numerical model are not based on exactly same assumptions.***

Practical Case Study



Practical Case Study(contd.)

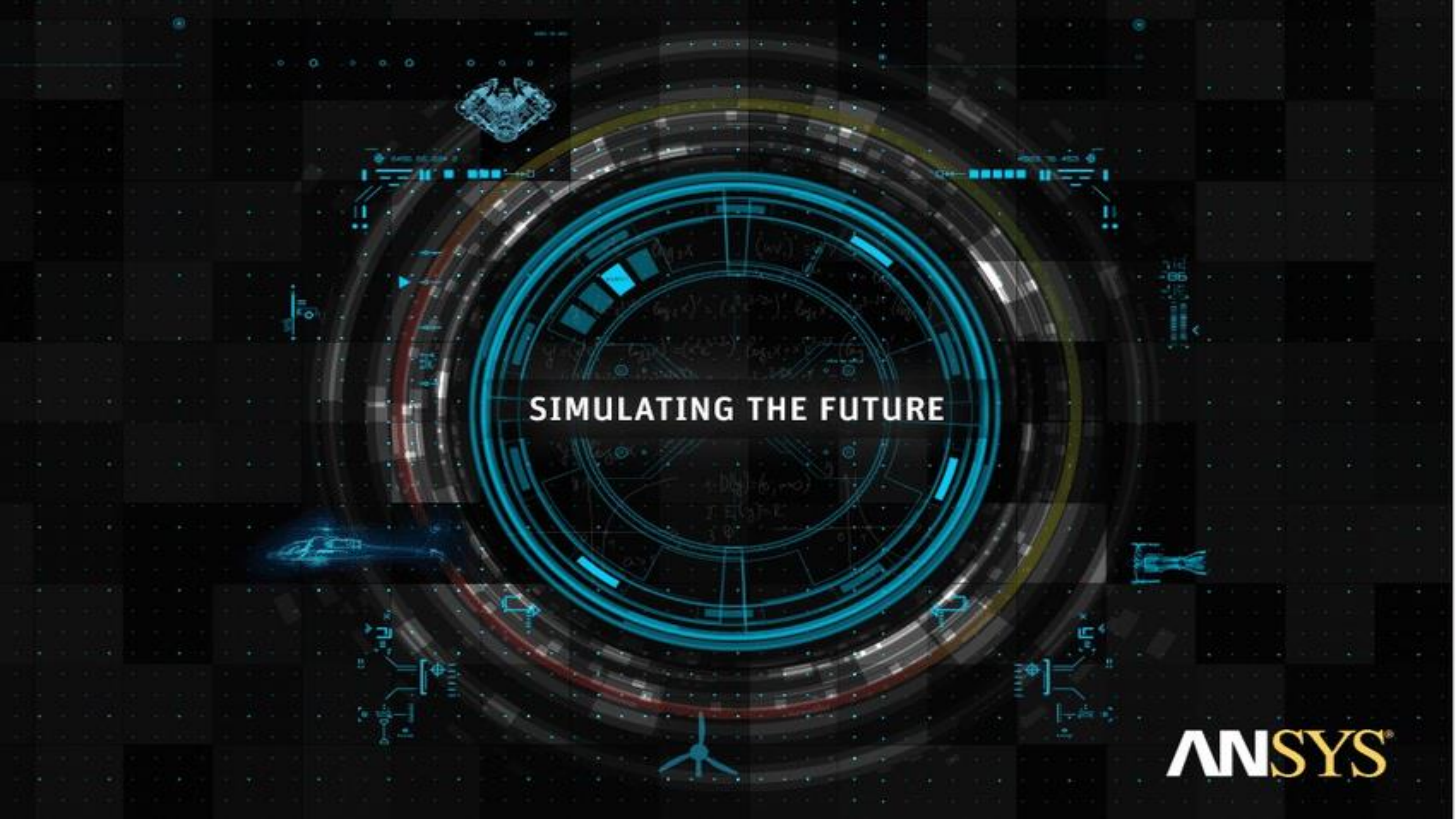


Practical Case Study(contd.)

- The failure modes are all similar as all of them occur as shearing on the wire.The failed surface structure reveals smooth propagation of direct shear as shown in the simulation results.
- The failure occurs from the inner coil and at a position slightly below the loaded coil.This agrees with the stress map prediction.
- The deflected spring is not extremely long even in near critical load.The deformation simulation agrees with it.

Final Comments

- **The ANSYS simulation can reliably predict consequences after loading.**
- **The numerical results are in close agreement with practical scenario.**
- **The simulation agrees with theoretical estimation.**
- **The simulation can be used as a confident guideline for practical design.**


SIMULATING THE FUTURE
ANSYS