Shear Stress & Torsional Stiffness Analysis of a Round Tube

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For questions, please fill out contact form

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Model Description

- Shear Stress and Torsional Stiffness Analysis of a Round Tube is based on example question 2 documented in page 177 of the following book :
  - AIRFRAME STRESS ANALYSIS AND SIZING BY MICHAEL C.Y. NIU.pdf Accessed: Aug. 31, 2023. [Online]. Available: https://soaneemrana.org/onewebmedia/AIRFRAME%20STRESS%20ANALYSIS%20AND%20SIZING%20BY%20MICHAEL%20C.Y.%20NIU.pdf
- Aluminum is selected as the material for the tube.

Model Description

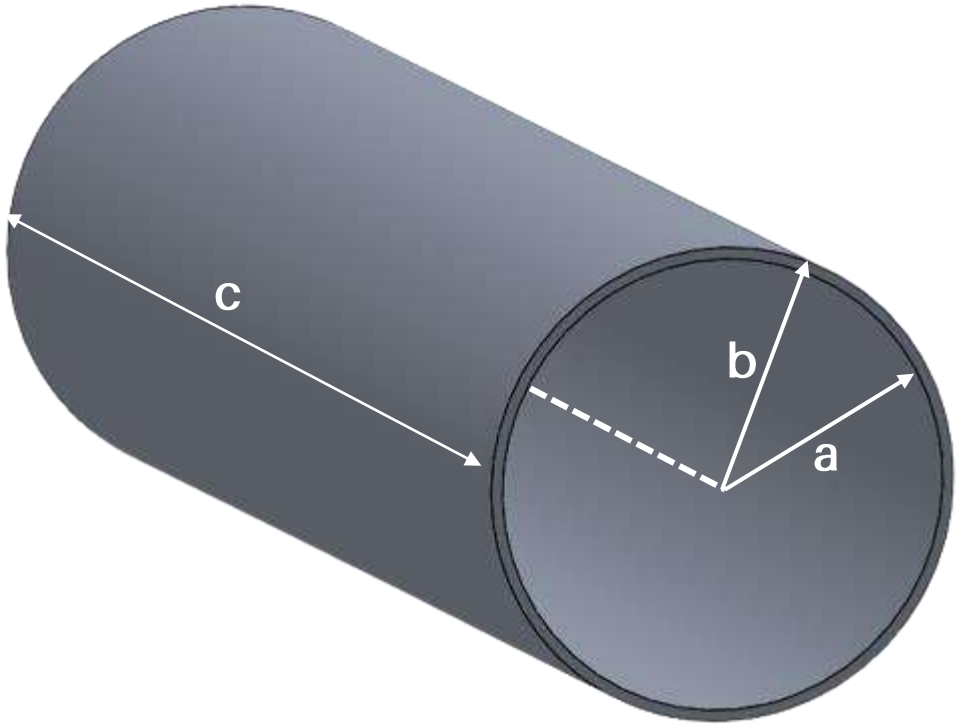
a. Inner radius – $121.875\ mm$

b. Outer radius – $128.125\ mm$

c. Length $(\boldsymbol{L})$ - $1000\ mm$

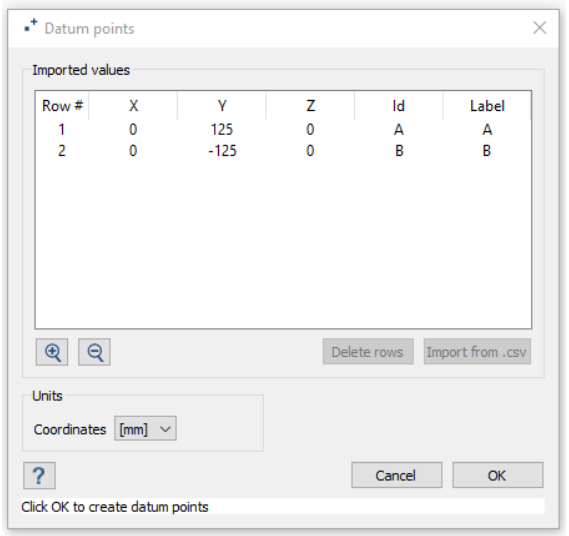
d. Average radius $(\boldsymbol{R})$ - $125\ mm$

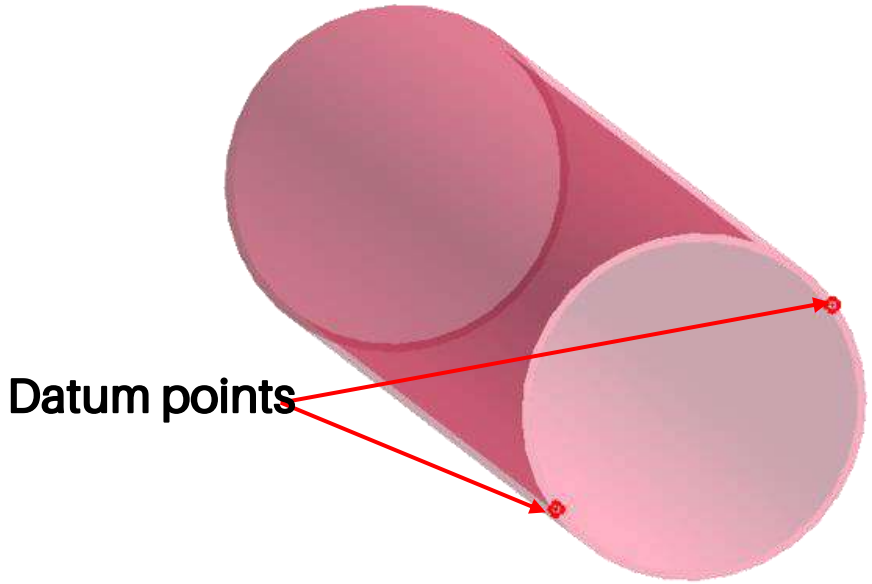
e. Thickness $(\boldsymbol{t})$ – $6.25\ mm$



Model Description

- One end is constrained and $Torque = 1Nm$ is added to the other end.
- ‘Datum point set’ is added to the free end as a reference to measure the rotation under the Torque.





Model Parameters

Entity	Type
Solver	Altair SimSolid
Version	2022.2.1
CPU	Intel(R) Core(TM) i7-9750H CPU @ 2.60GHz

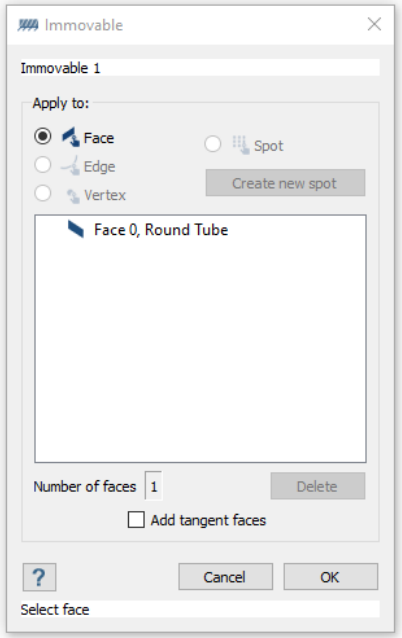
FEA Entities	Type
Analysis Type	Structural linear
Unit System	kg, mm, s

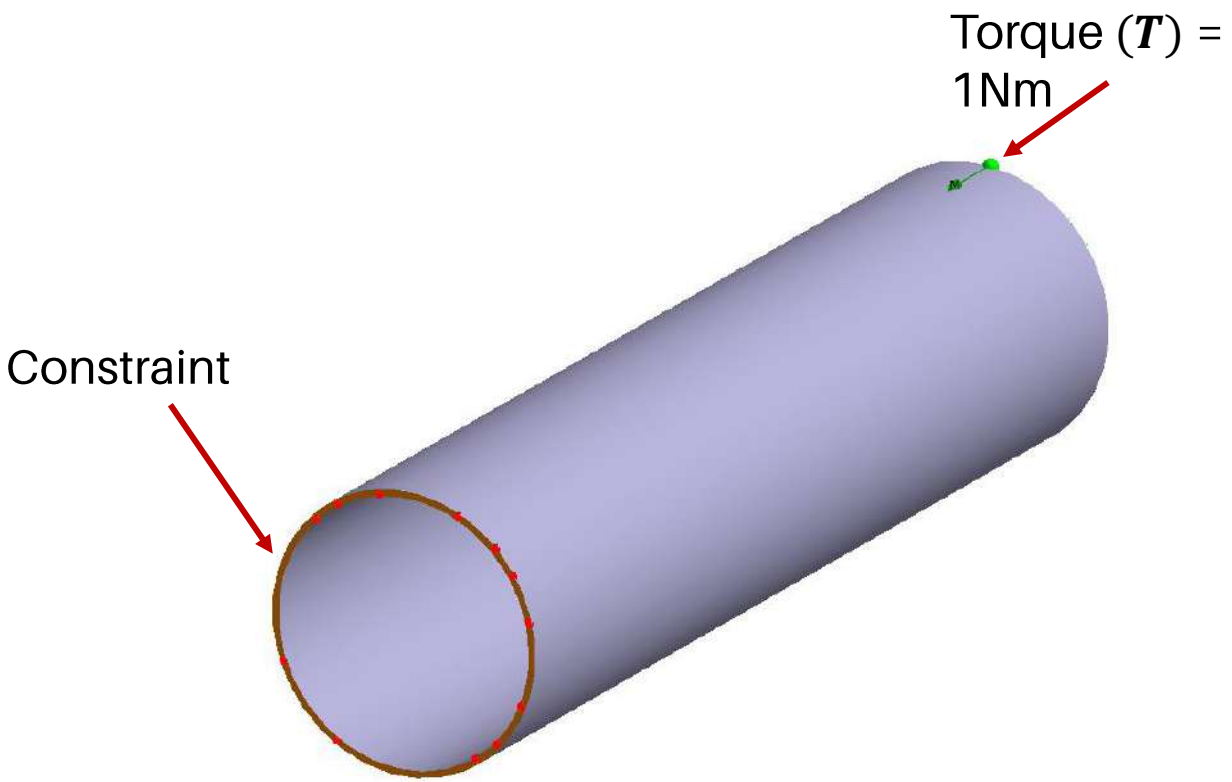
Analysis Assumptions and Limitations

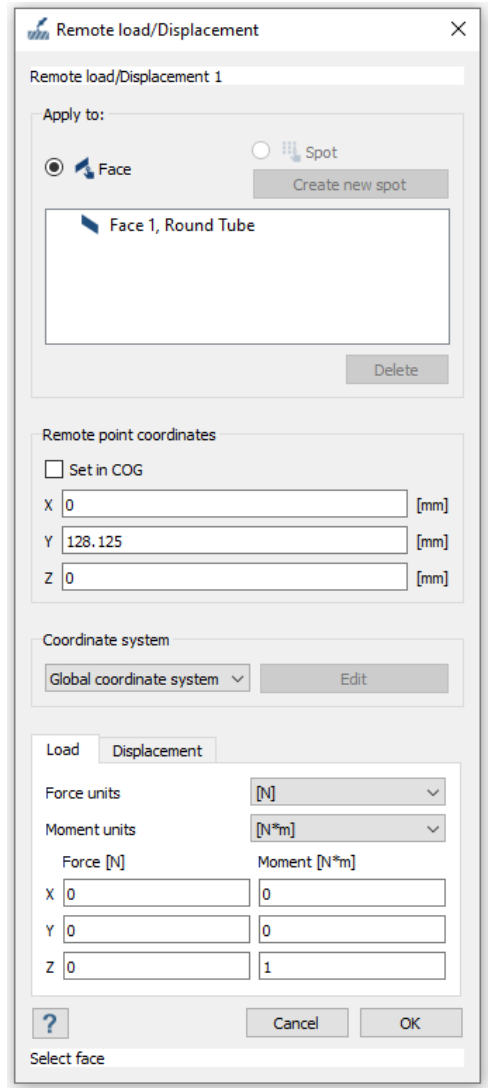
- For the calculations Modulus of Rigidity of Aluminum is assumed as follows,

$$Modulus\ of\ Rigidity\ of\ Aluminium\ (G) = 2.6 * 10^6\ Pa$$

Analysis Setup







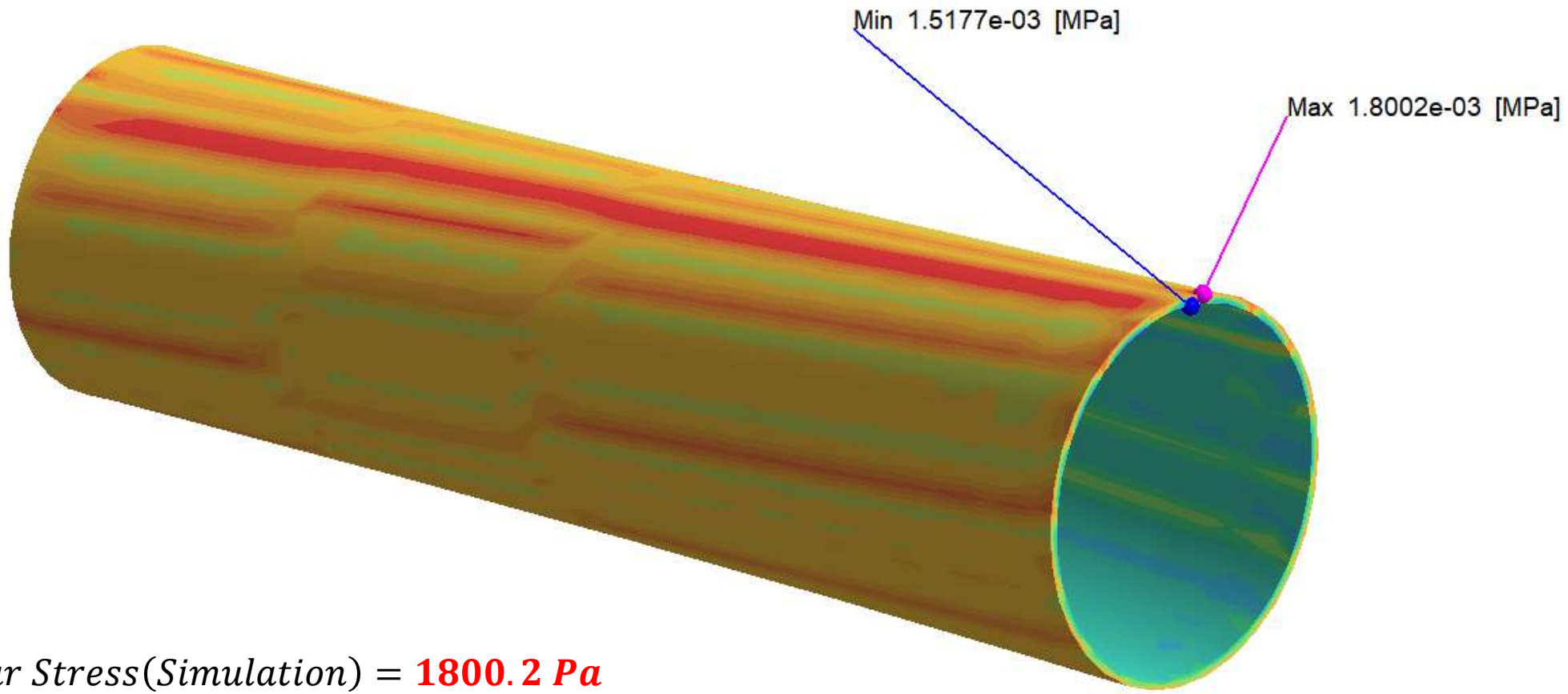
Hand Calculations

- $Torsional\ Shear\ Stress = \frac{T}{2\pi R^2 t} = \frac{1}{2\pi(0.125)^2(0.00625)} = 1629.7466\ Pa$

- $Torsional\ Stiffness = \frac{TL}{(2\pi R^3 t)G} = \frac{1*1}{2\pi(0.125)^3(0.00625)(2.6*10^6)} = 5.01 * 10^{-7}\ rad$

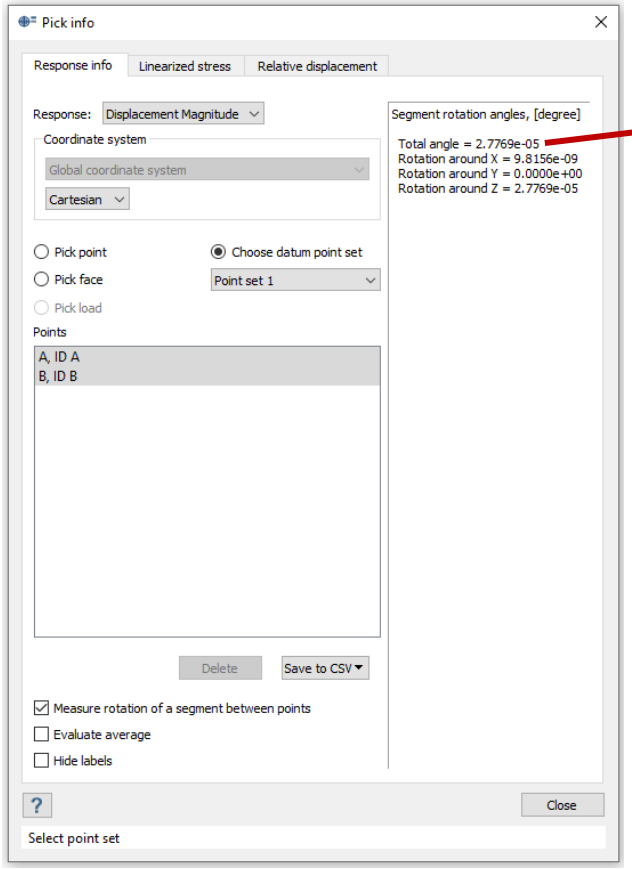
Analysis Results – Shear Stress

Units - *SI*



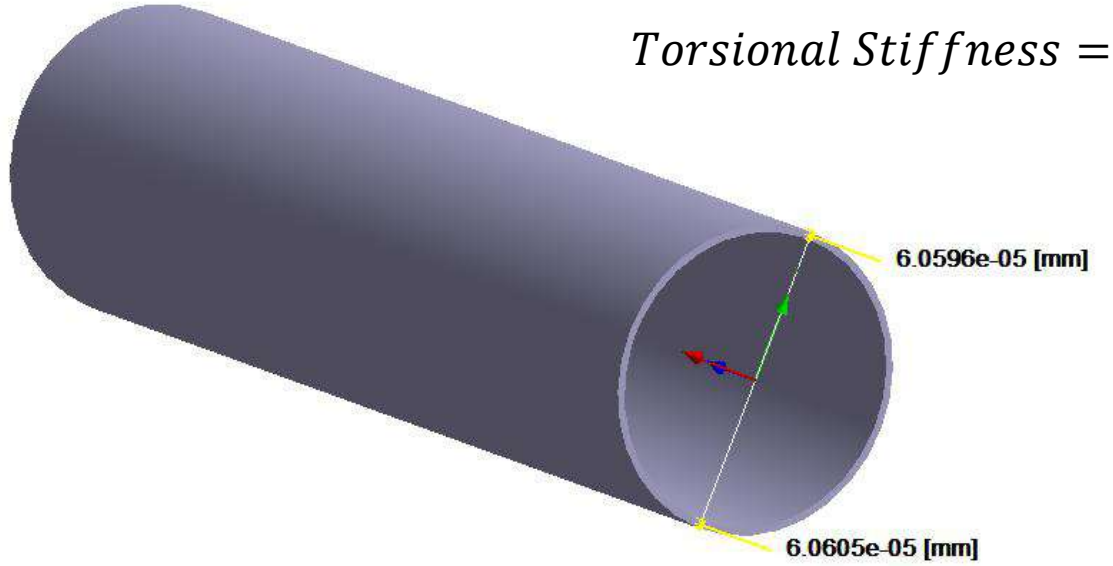
$$Maximum\ Shear\ Stress(Simulation) = \mathbf{1800.2\ Pa}$$

Analysis Results – Torsional Stiffness



$$Total\ Rotation\ Angle = 2.7769 * 10^{-5}\ degrees = \frac{2\pi}{360} * 2.7769 * 10^{-5}\ rad = 4.85 * 10^{-7}\ rad$$

$$Torsional\ Stiffness = \mathbf{4.85 * 10^{-7}\ rad}$$



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Analysis Results – Shear Stress

- Maximum Torsional Shear Stress occur due to the Torque at the free end of tube,

  Based on hand calculations $-1629.7466\ Pa$

  From the simulation $-1800.2\ Pa$

- Error percentage $= \frac{(1800-1629.7466)}{1629.7466} * 100\%$

$$= 10.45\ \%$$

Analysis Results – Torsional Stiffness

- Torsional Stiffness occur due to the Torque at the free end of tube,

  Based on hand calculations $-5.01 * 10^{-7}\ rad$

  From the simulation - $4.85 * 10^{-7}\ rad$

- Error percentage = $\frac{(5.01-4.85)}{5.01} * 100\%$

  $= 3.19\ \%$

Conclusions

- Shear Stress and Torsional Analysis of a Round Tube is conducted using Altair SIMSOLID based on the book listed in slide 2.
- Results of the simulation correlate well to the expected hand calculation value.