

Deflection of a beam

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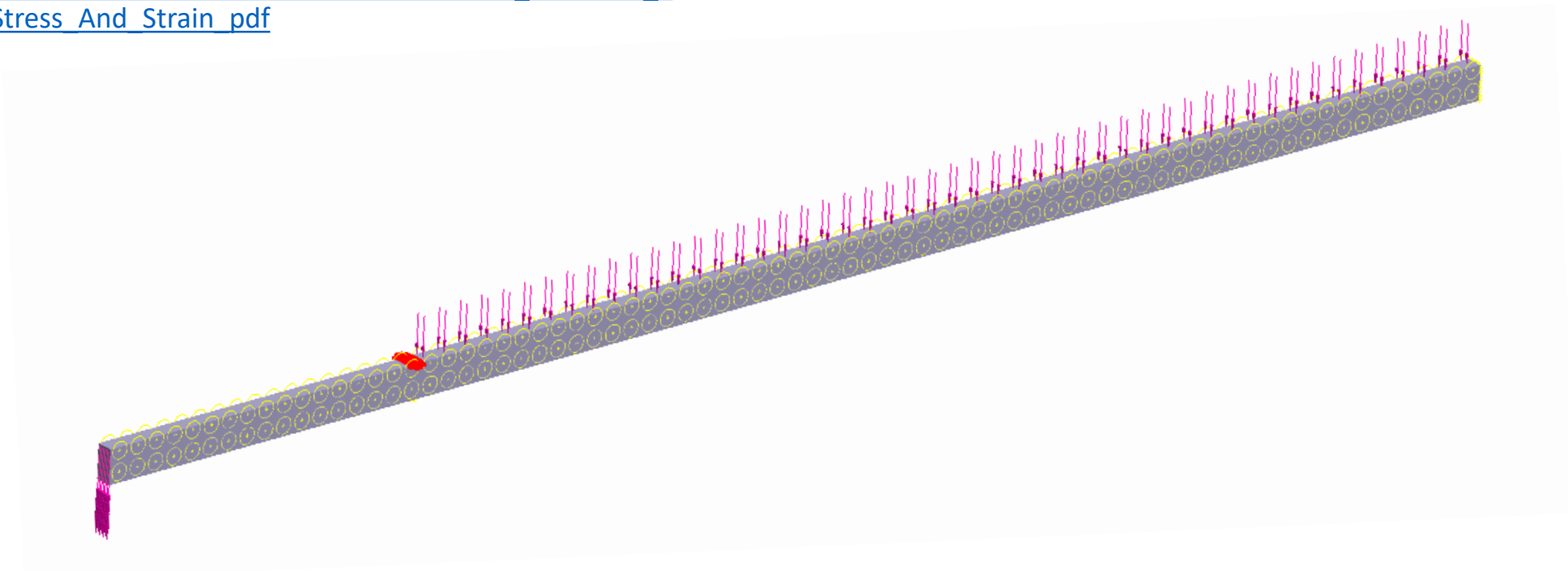
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ALGO
Engineering
Simplifying FEA

Model Description

- Deflection analysis of a beam is based on example question 2 documented in page 133 of the following book :
 - J. Souza, *Roark's Formulas For Stress And Strain-.pdf*.
[Online]. Available:
https://www.academia.edu/37205286/Roarks_Formulas_For_Stress_And_Strain_pdf



Model Description

Young's modulus - 8.963 GPa

Density - 470 kg/m³

Poisson's ratio - 0.35

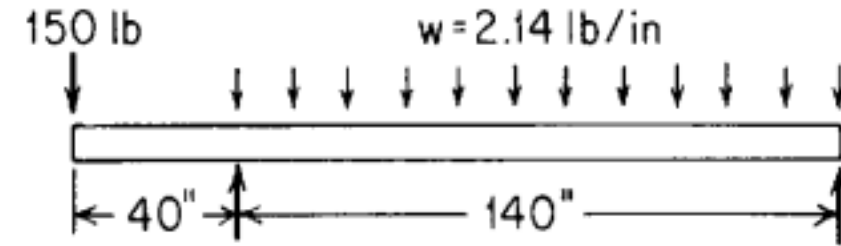
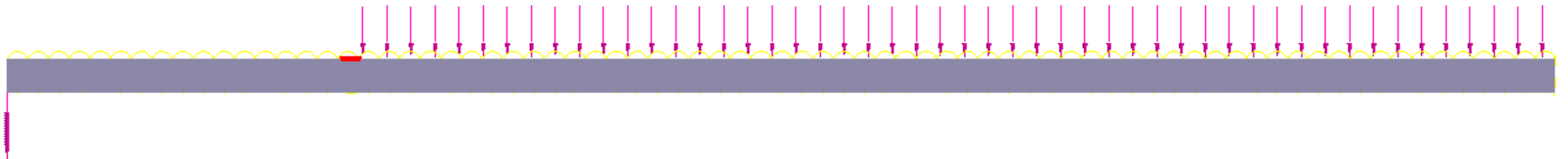


Figure - from above
book

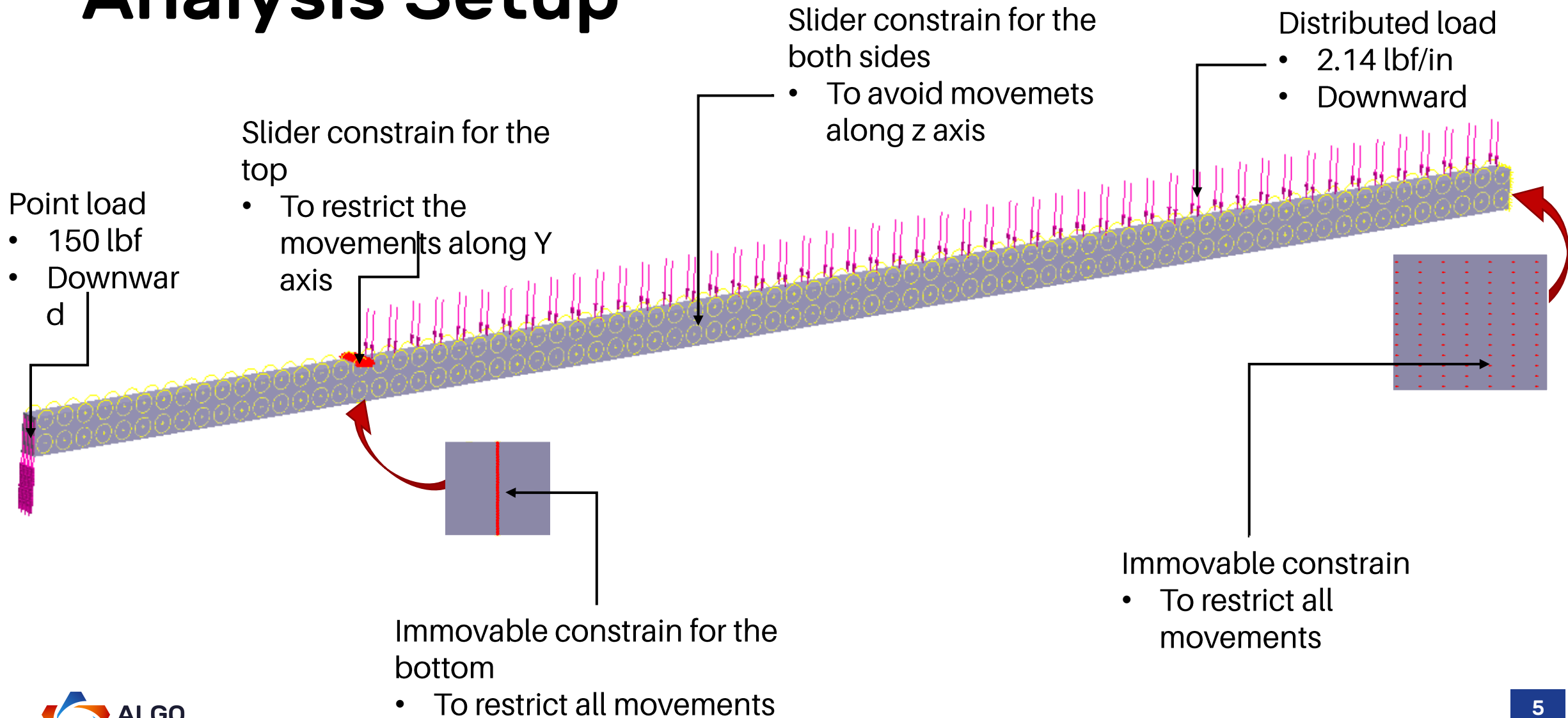


Model Parameters

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

FEA Entities	Type
Analysis Type	Structural linear
Unit System	lb, in, s

Analysis Setup



Analysis Assumptions and Limitations

- Density and poisson's ratio of spruce was not mentioned in the question and is thus assumed.

Hand Calculations

Total deflection is calculated as a superposition of three different cases,

l – length of the portion

Case I (Deflection due to distributed load)

$$y_1 = -l \left[\frac{-w_a}{24EI} (l - a)^2 (l^2 + 2al - a^2) - \frac{w_l - w_a}{360EI} \right]$$

For this problem, $w_a = w_l$ and $a = 0$

Hence,

$$y_1 = \frac{9800000}{EI}$$

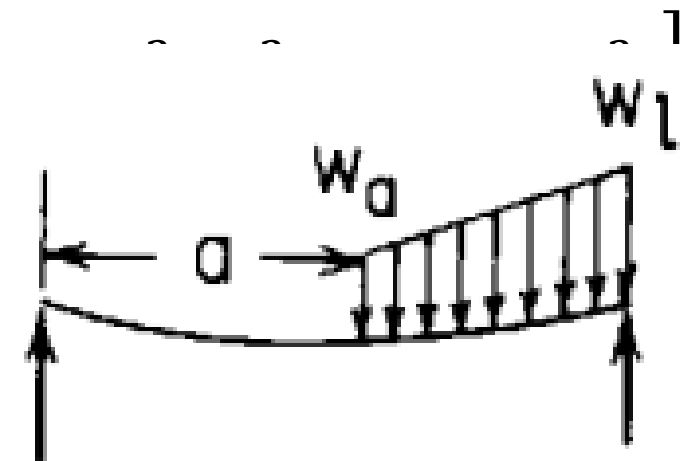


Figure – from above
book

Hand Calculations

Case II (Deflection due to concentrated load)

$$y_2 = \frac{-W}{6EI} (2l^3 - 3l^2a + a^3)$$

For this problem, $a = 0$

Hence,

$$y_2 = -\frac{3200000}{EI}$$

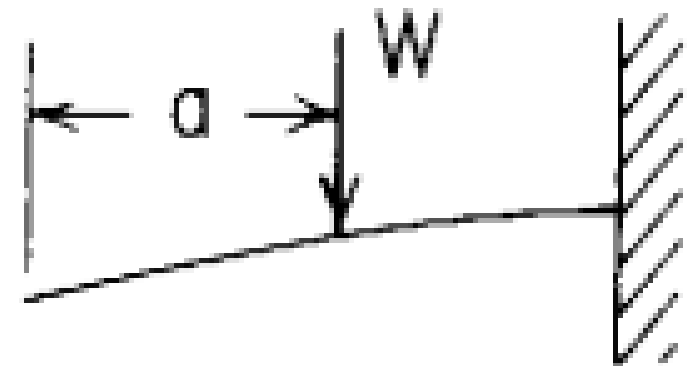


Figure - from above book

Hand Calculations

Case III (Slope produced at the left end of the distributed load)

Couple generated = $150 \times 40 = 6000 \text{ lb} - \text{in}$

$$y_3 = l \left[\frac{-M_o}{6EI} (2l^2 - 6al + 3a^2) \right]$$

For this problem, $a = 0$

Hence,

$$y_3 = -\frac{11200000}{EI}$$

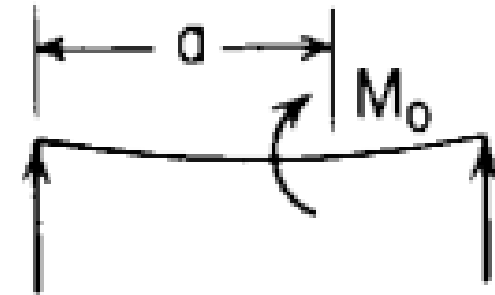


Figure - from above book

Hand Calculations

Therefore,

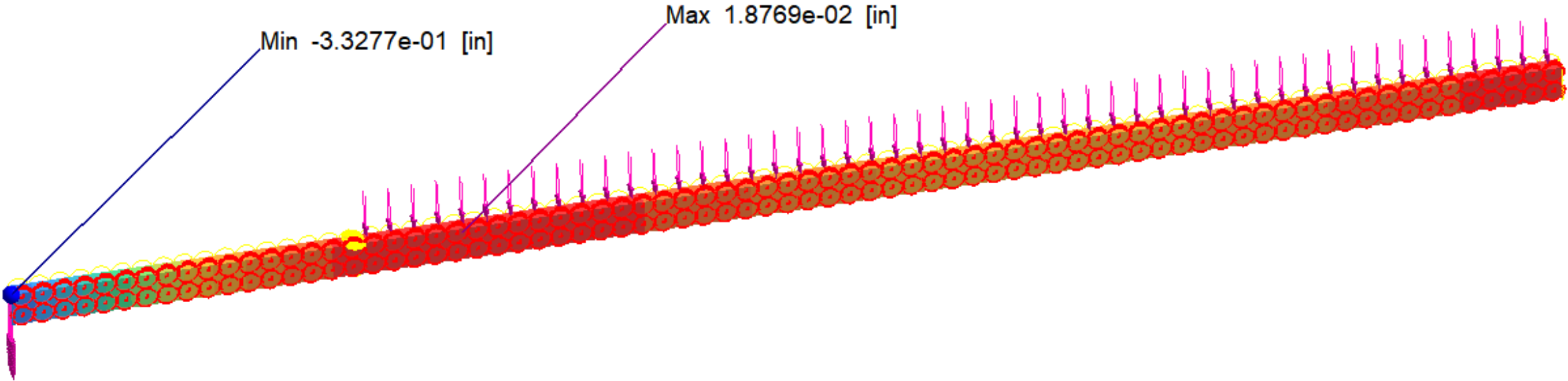
$$\textit{Total deflection} = y_1 + y_2 + y_3$$

$$= \frac{-4600000}{EI}$$

$$= -0.33 \textit{ in (deflection downward)}$$

Analysis Results

Units - in



Analysis Results

- Maximum stress,
Based on hand calculations – 0.33 *in*
From the simulation – 0.332 in

Conclusions

- Deflection analysis of beam 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.