

Modal Analysis of a Cantilever beam

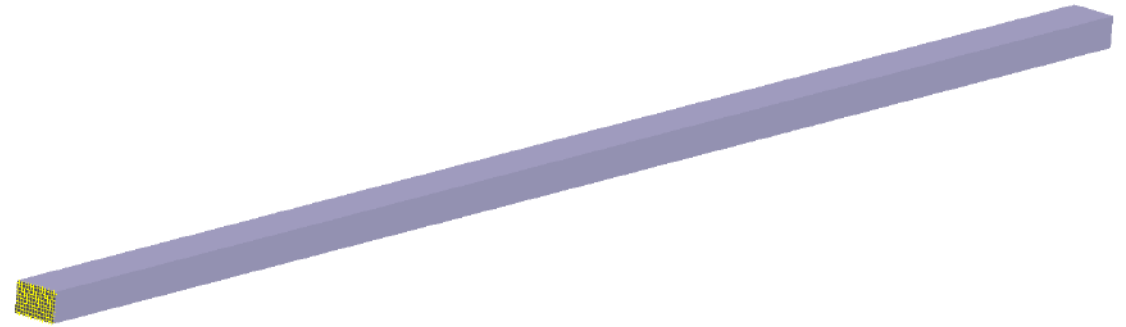
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ALGO
Engineering
Simplifying FEA

Model Description

- Modal analysis of a Cantilever beam was conducted to evaluate mode shapes and frequencies:
- Modal frequencies are compared to hand calculations.
- Note: This analysis does not model material failure.



Model Parameters

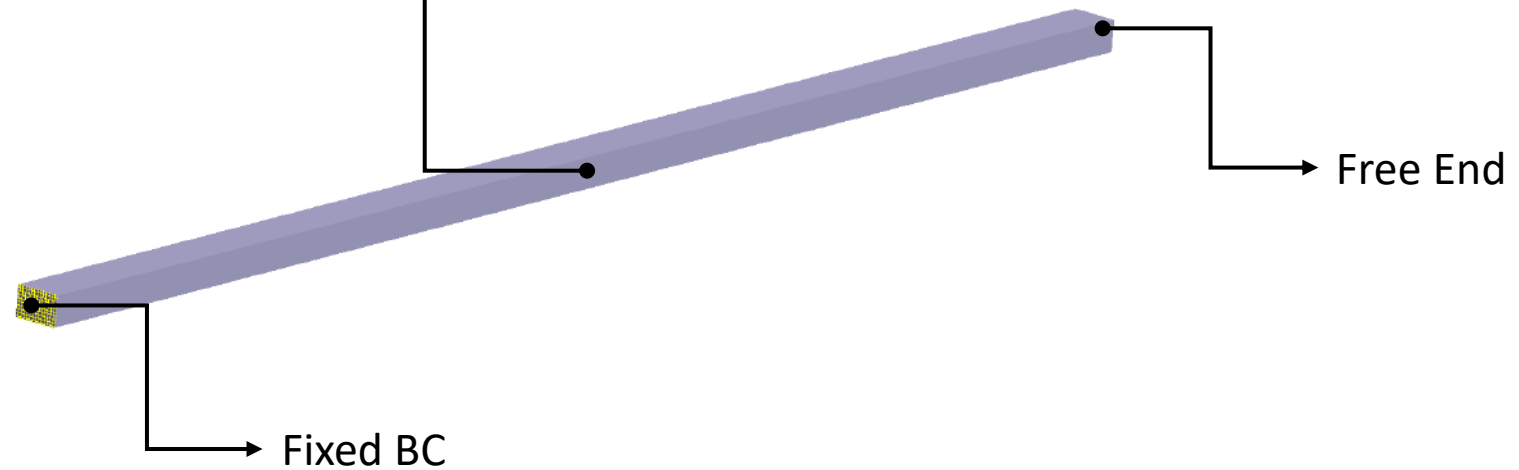
Entity	Type
Solver	Altair SIMSOLID
Version	2022.2.1
CPU	Intel(R) Core(TM) i7-9750H CPU @ 2.60GHz

FEA Entities	Type
Analysis Type	Structural non-linear
Unit System	kg, m, s

Analysis Setup

Steel Beam

- Young's modulus – 206 GPa
- Density – 7800 kg/m³
- Rectangular cross section

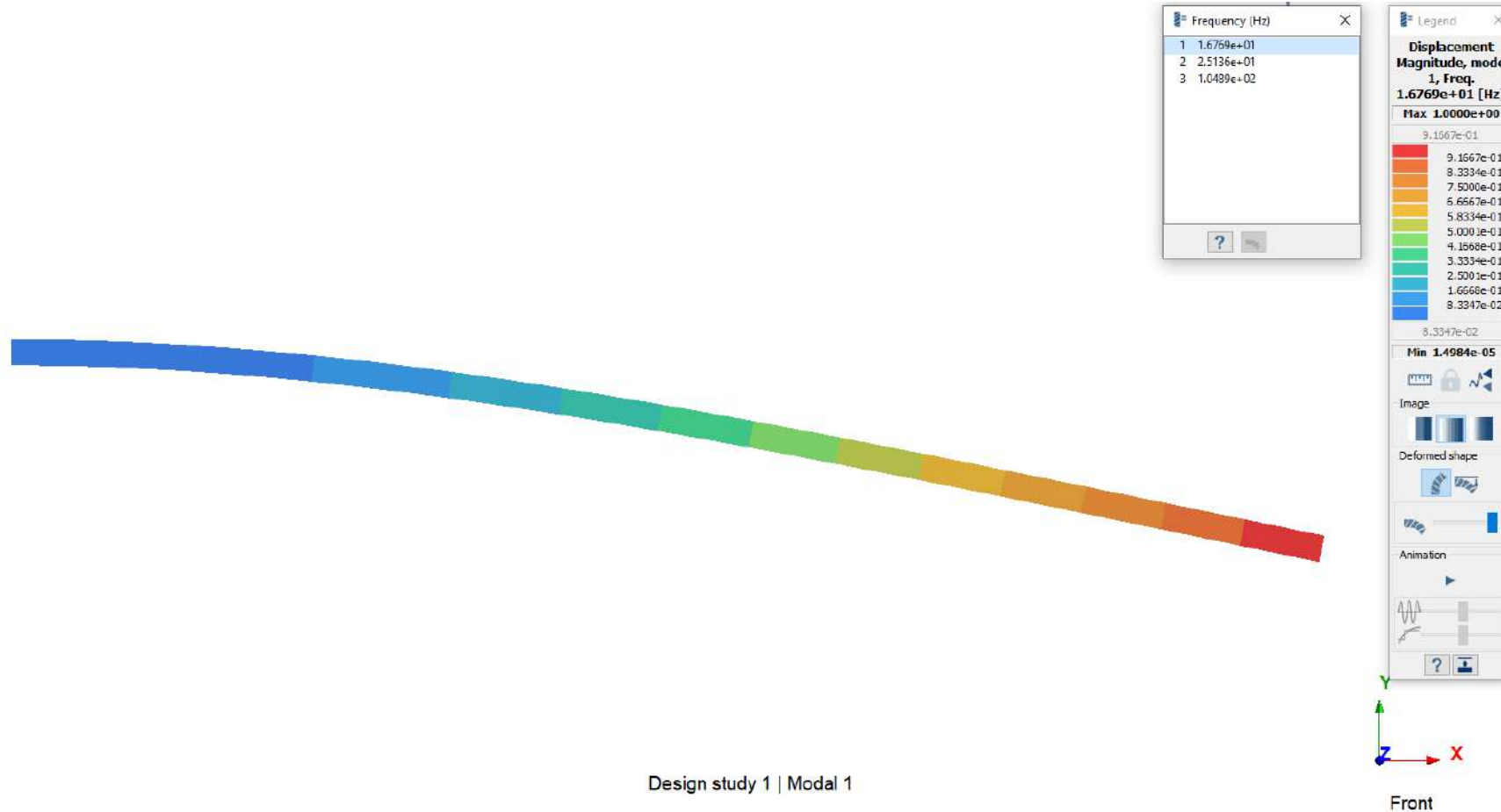


Analysis Assumptions and Limitations

- Mode Shape function calculations are omitted.

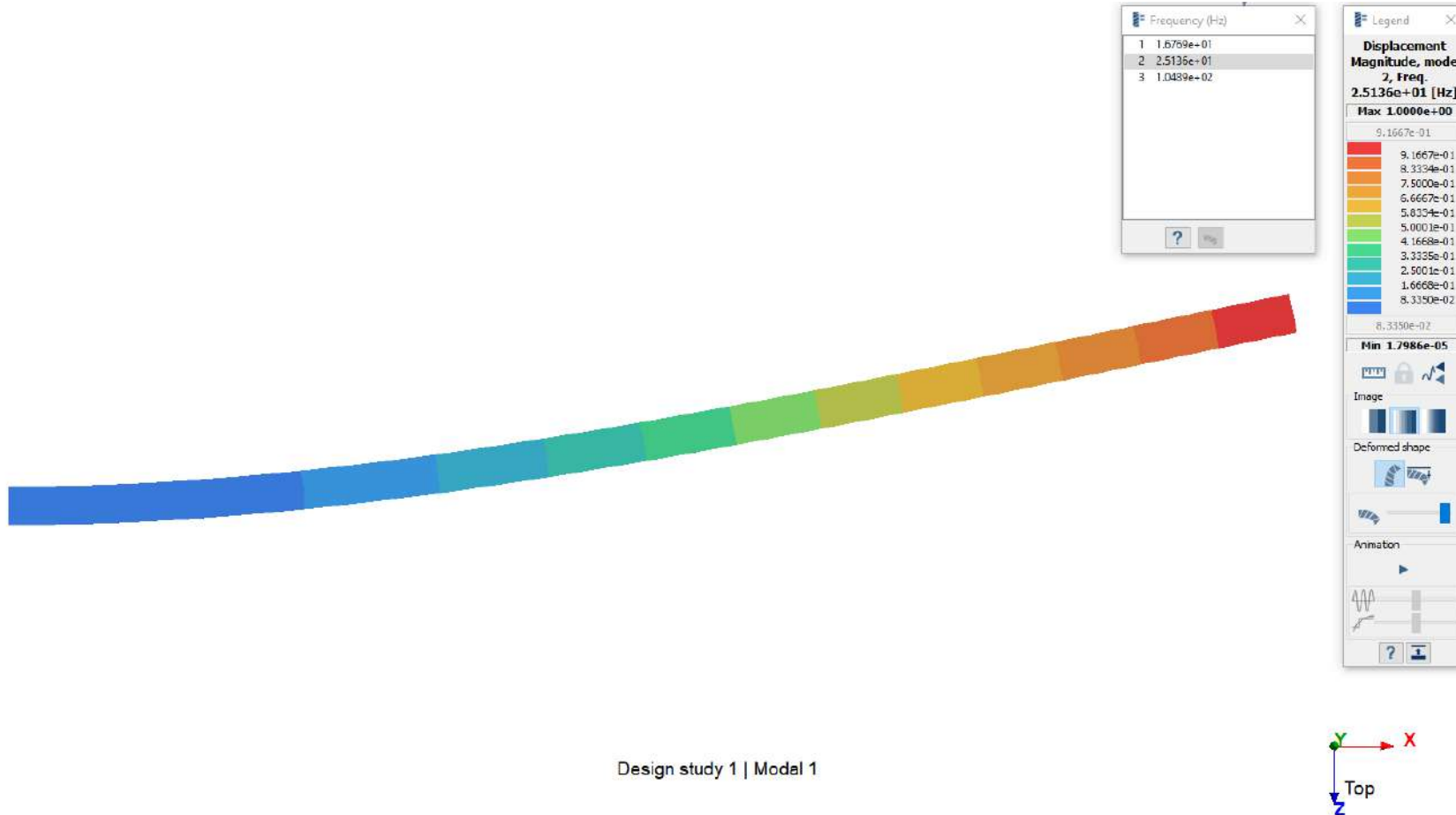
Analysis Results

1st Mode Shape



Analysis Results

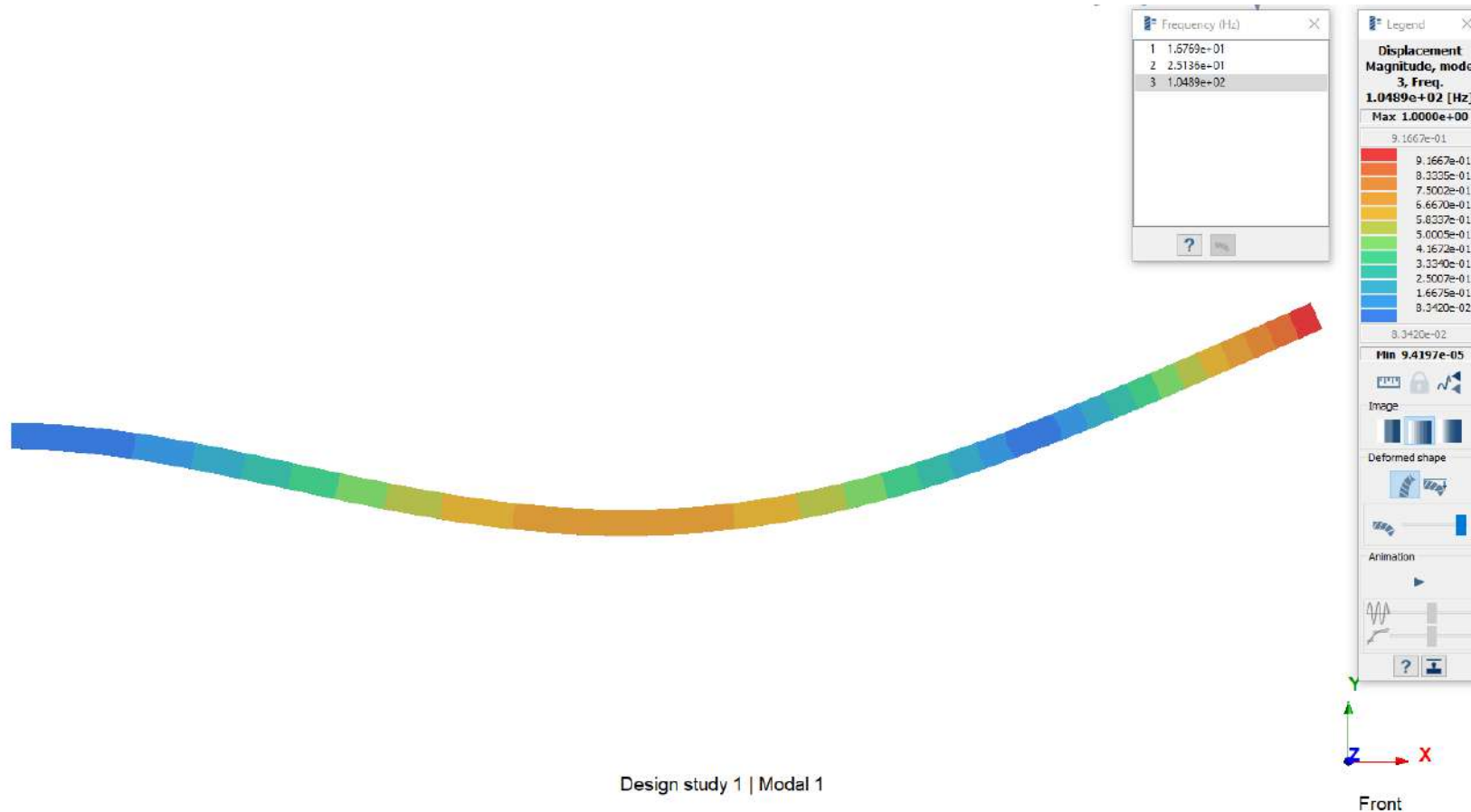
2nd Mode Shape



Design study 1 | Model 1

Analysis Results

3rd Mode Shape



Analysis Results

Frequencies

Modal participation factors

Coordinate system: Global coordinate system

Modal participation factors	Effective mass	Cumulative mass		
Flexible mode	Frequency	X	Y	Z
1	1.6769e+01	5.9219e-12	7.8278e-01	1.0307e-07
2	2.5136e+01	5.2484e-11	1.0614e-07	7.8285e-01
3	1.0489e+02	4.6981e-11	4.3406e-01	2.4770e-09

Total ---> X: 1.0539e-10 Y: 1.2168e+00 Z: 7.8285e-01

? Show histogram Save to CSV Close

Hand Calculations

- 1st Mode Shape

$$f = \frac{1.875^2}{2\pi} \sqrt{\frac{EI}{\rho A}} = \frac{1.875^2}{2\pi} \sqrt{\frac{(206 \times 10^9) \times \left(\frac{1}{12} \times 0.03 \times 0.02^3\right)}{7800 \times (0.02 \times 0.03)}} = 16.6 \text{ Hz}$$

- 2nd Mode Shape

$$f = \frac{1.875^2}{2\pi} \sqrt{\frac{EI}{\rho A}} = \frac{1.875^2}{2\pi} \sqrt{\frac{(206 \times 10^9) \times \left(\frac{1}{12} \times 0.02 \times 0.03^3\right)}{7800 \times (0.02 \times 0.03)}} = 24.9 \text{ Hz}$$

- 3rd Mode Shape

$$f = \frac{4.6941^2}{2\pi} \sqrt{\frac{EI}{\rho A}} = \frac{4.6941^2}{2\pi} \sqrt{\frac{(206 \times 10^9) \times \left(\frac{1}{12} \times 0.03 \times 0.02^3\right)}{7800 \times (0.02 \times 0.03)}} = 104.1 \text{ Hz}$$

Comparison of Results

Hand Calculations (Hz)	Simulations (Hz)	Error Percentage (%)
16.6	16.8	1.2
24.9	25.1	0.8
104.1	104.9	0.76

Conclusions

- Modal analysis of a cantilever beam was conducted using Altair SIMSOLID.
- The simulation shows good correlation in mode frequencies when compared to hand calculations.
- This model provides a good starting point for modal analysis FEA and can be further utilized to model damage and failure.