

Machine Modeling

Static and Modal Analysis of the Axis Enclosure: Part I

Getachew A. Ambaye

Industrial Systems and Manufacturing Engineering (ISME)

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Outlines

- Grid sensitivity Analysis
- Modal Analysis
 - Natural Frequencies
 - Mode Shapes
- Harmonic Response
- Static load and Stiffness Analysis

A-Axis Enclosure

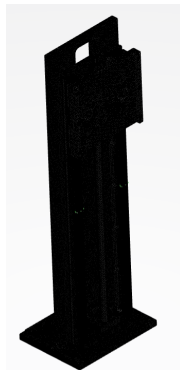
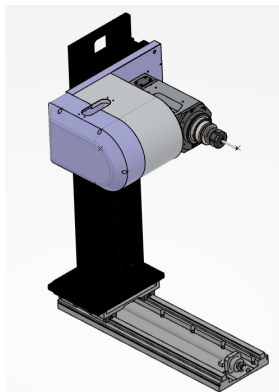
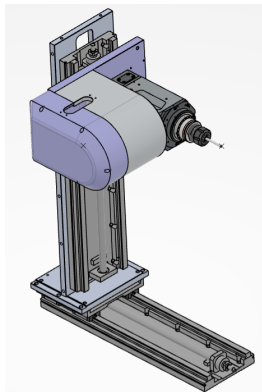


Figure: A-Axis Enclosure: 3D AND FE

- Element Type: Parabolic Tetrahedron (C3D10HS)
- Material : 6061 Alloy

Grid Sensitivity Analysis

- A $[100, -100, 100]$ N is applied along direction of $[X,Y,Z]$.
- The load is applied at the location where the cutting tool tip is located as a remote load.

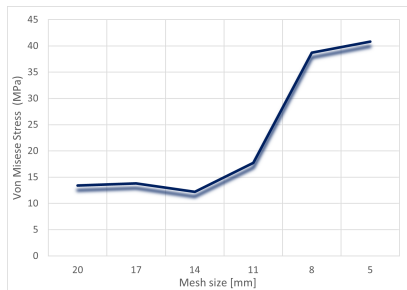
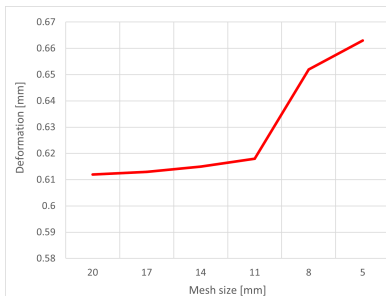


Figure: Deformation (right) and Von Mises stress (left)

Modal Analysis

Natural Frequencies

Mode	Natural Frequency (Hz)
1	36.56
2	168.467
3	169.553
4	226.146
5	259.309
6	316.446
7	459.301
8	474.756
9	816.102
10	885.511

Mode-shapes

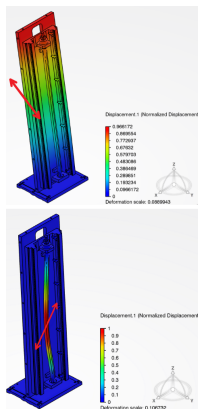


Figure: Mode 1 and 2

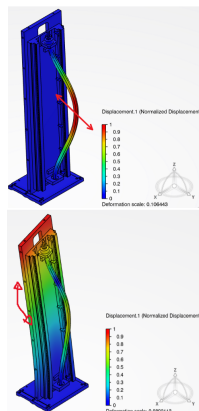
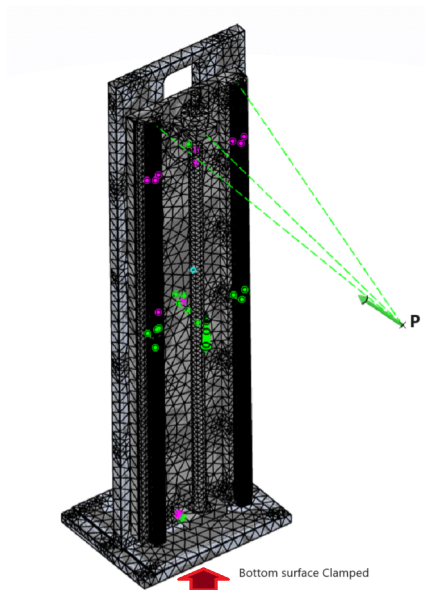


Figure: Mode 3 and 4

Harmonic response

- A $[100, -100, 100]$ N load is applied along $[X, Y, Z]$ direction at the cutting tool tip distance.



Cont.

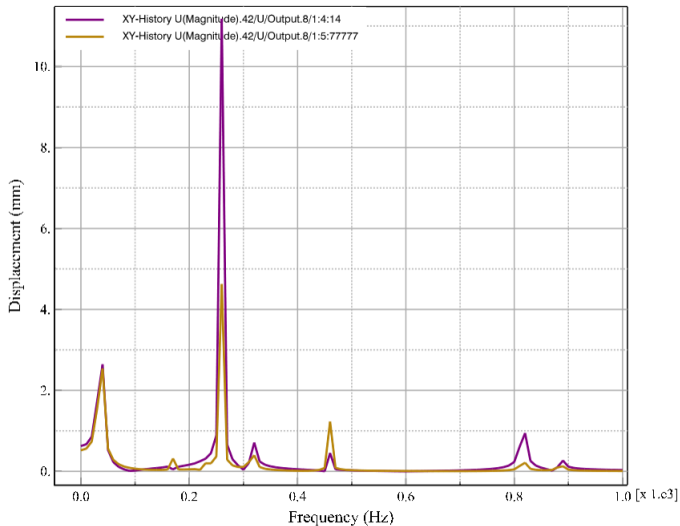


Figure: Deformation and frequency

Static load and Stiffness Analysis

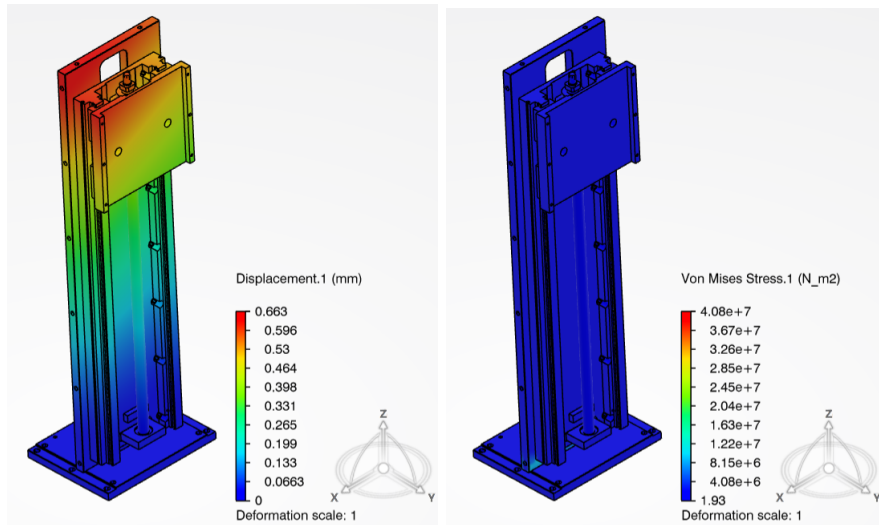


Figure: Frequency displacement relation

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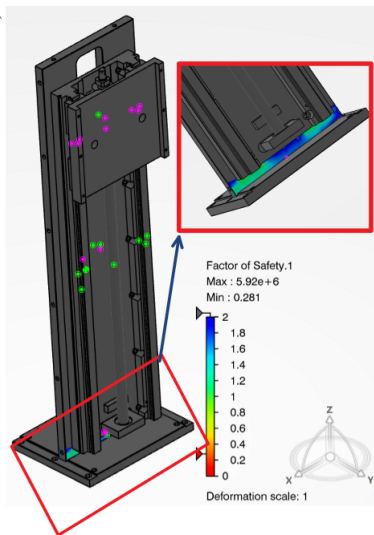


Figure: Factor of safety

$$P = \sqrt{F_x^2 + F_y^2 + F_z^2}$$

$$K = \frac{P}{\delta}$$

$$K = \frac{173.2050808N}{0.663mm} = 261.2445KN/m$$

or 0.2612 N/ μm .

In most literature the stiffness of a 3 axis machine tool are greater than 12 N/ μm .

Archenti A, Nicolescu M (2017),
Salgado et al. (2005)