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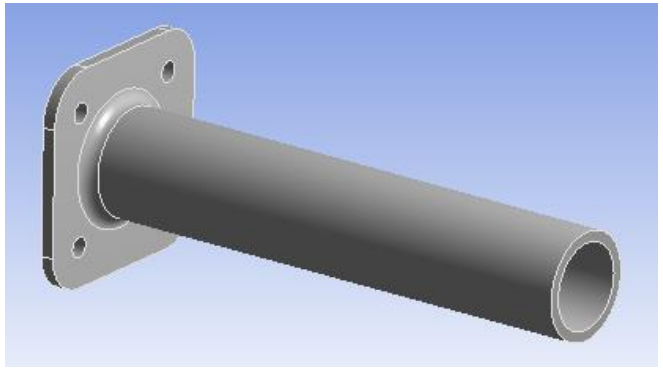
Effect of End Fixity Modeling on Vibration Behavior of Bolted Components

Background Information

- Boundary conditions for bolted joints are usually modelled as fixed constraints at bolt holes.
- Three approaches are discussed for modeling bolted joints:
    1. Fixed constraints at bolt holes
    2. Explicit modeling of bolts and attachment
    3. Fixing remote points associated with bolt holes
- Component simplified as cantilevered cylinder with end flange attached with four bolts



- Modal and random vibration results are compared for the three approaches

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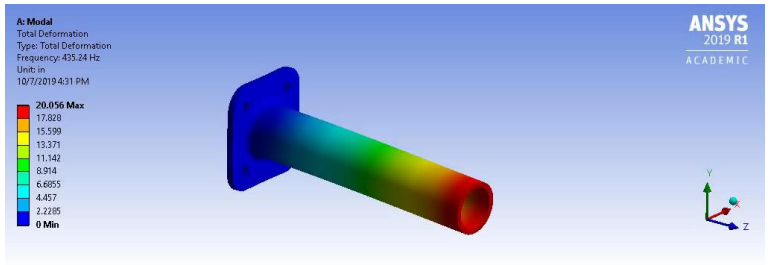
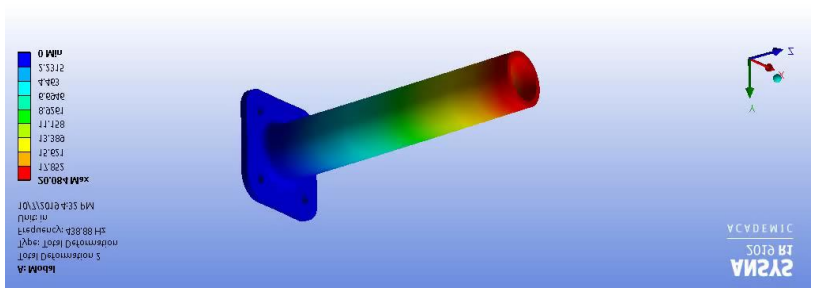
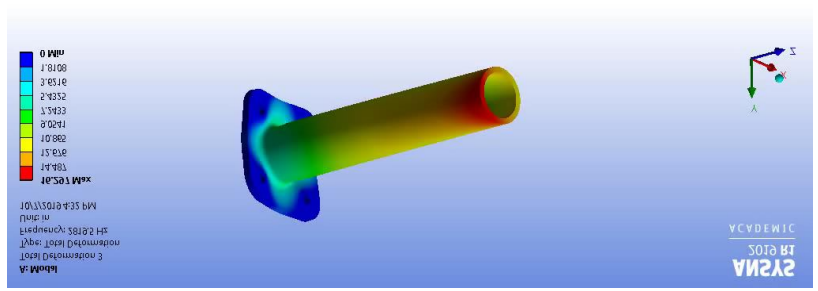
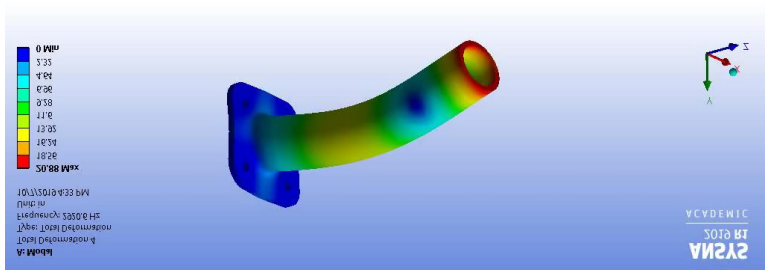
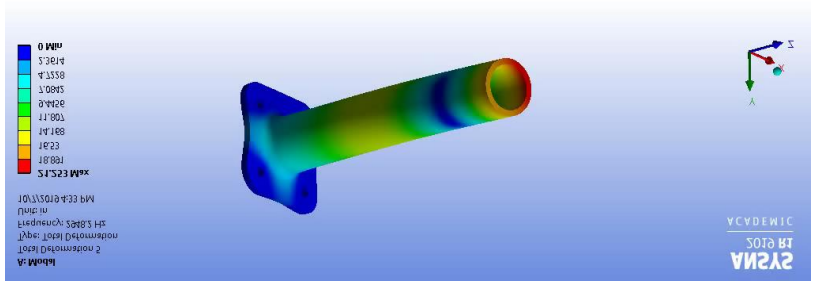
Modal Analysis of Component with Fixed Constraints at Bolt Holes

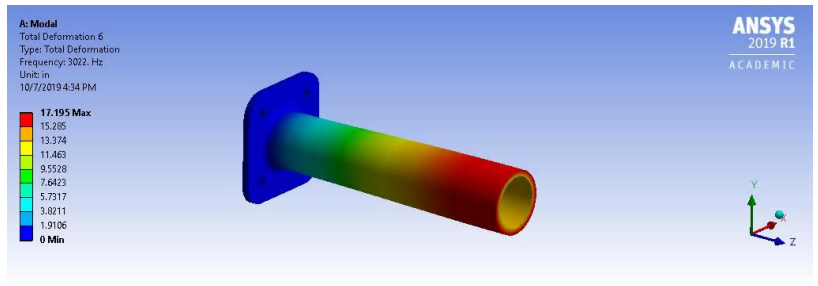












First Six Modes with Holes Fixed

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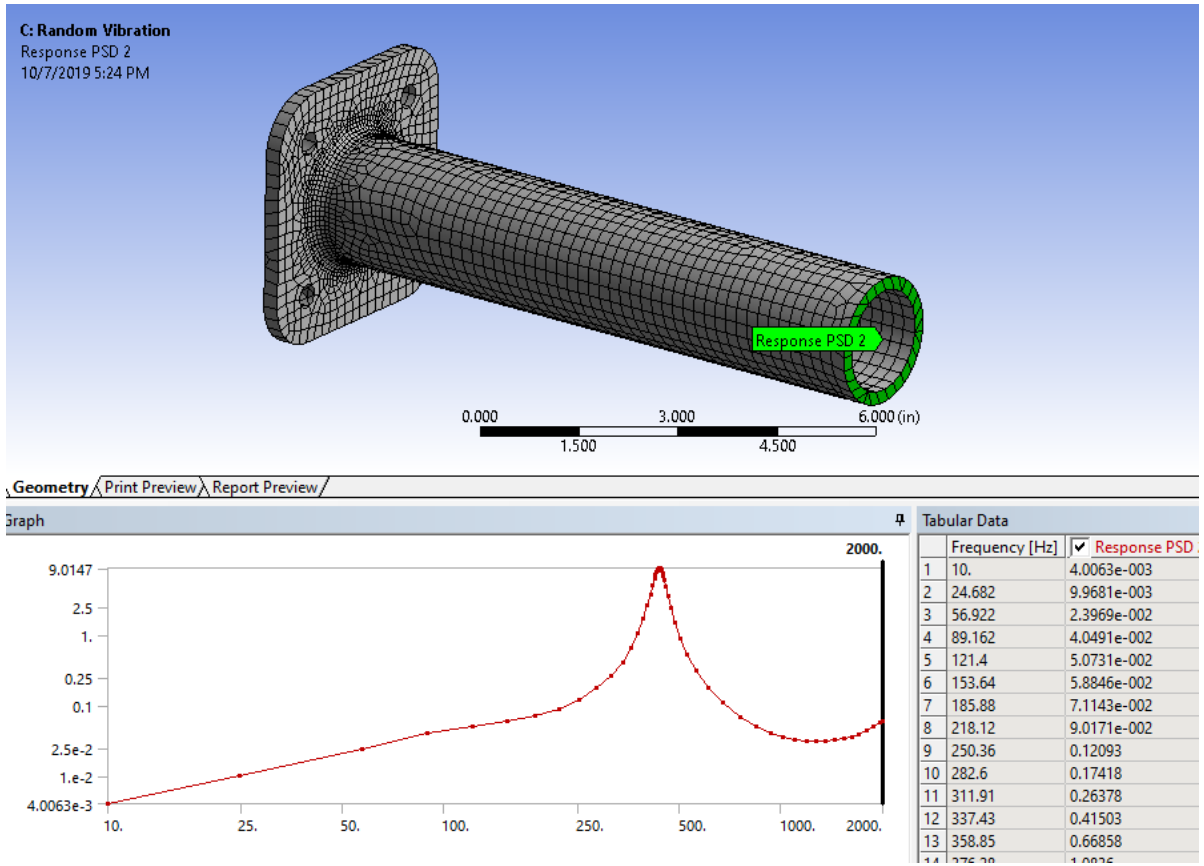
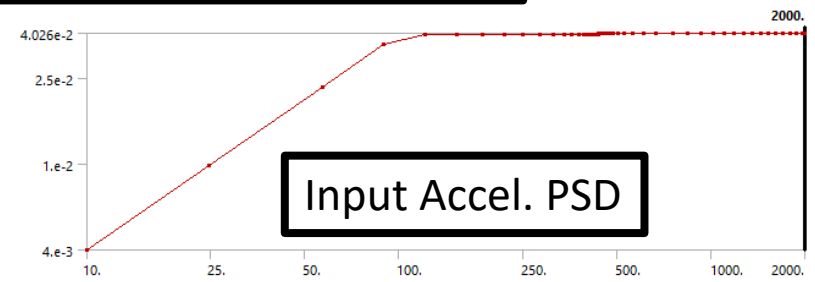
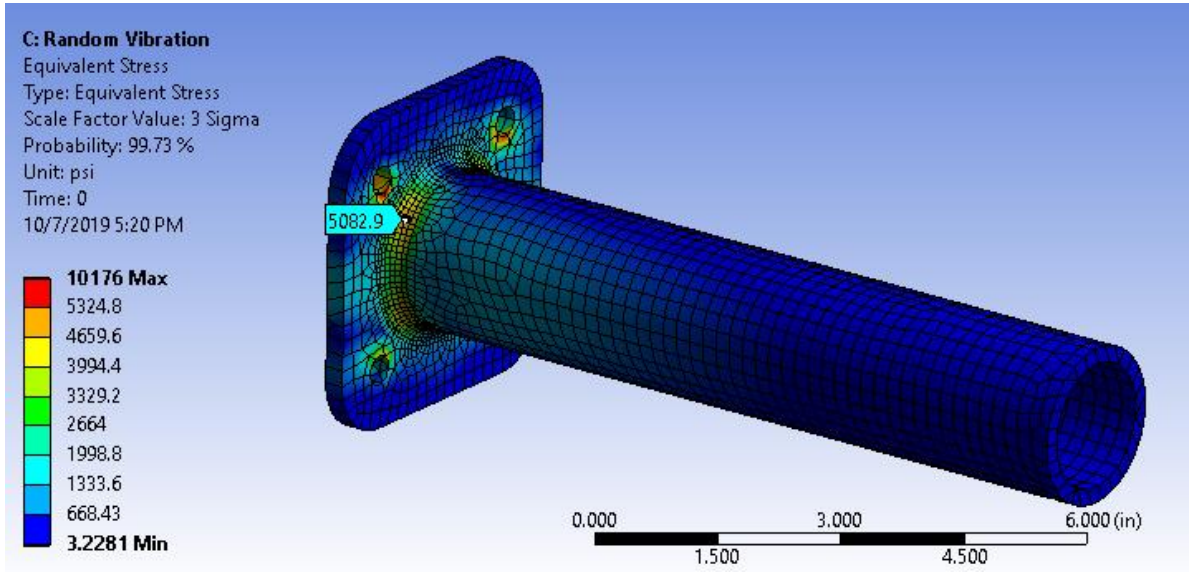
Acceleration & Stress Response to Random Vibration







Max. Acc. PSD Response = 9.01 G^2/Hz

Max. Equiv. Stress = 5.1 KSI

E A C

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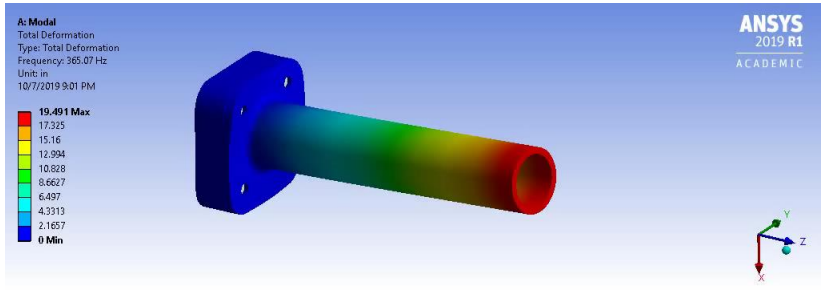
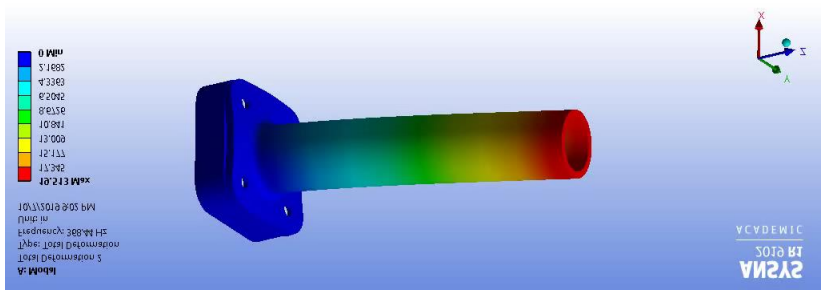
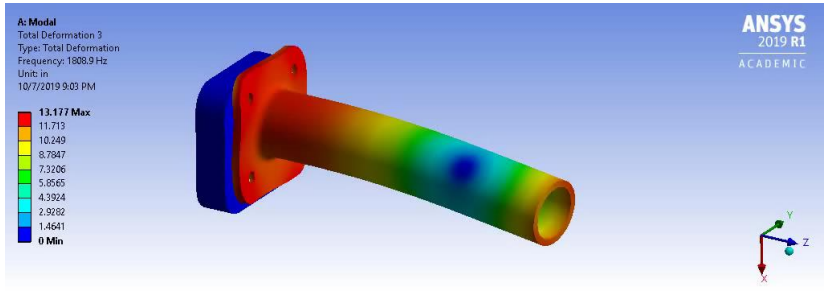
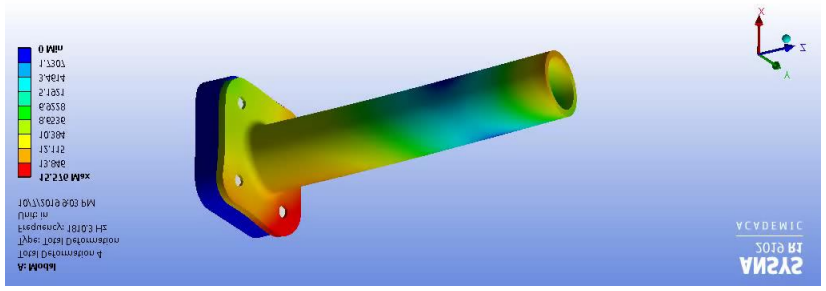
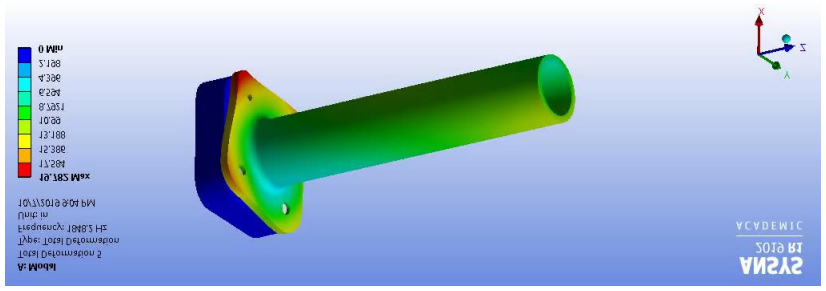
Modal Analysis of Component with Explicit Bolts & Fixture

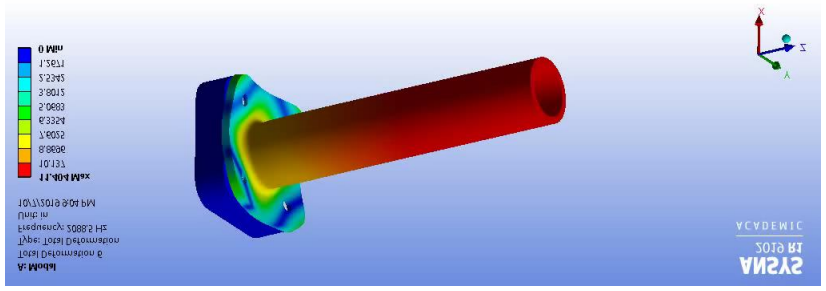












First Six Modes with Explicit Bolts & Fixture

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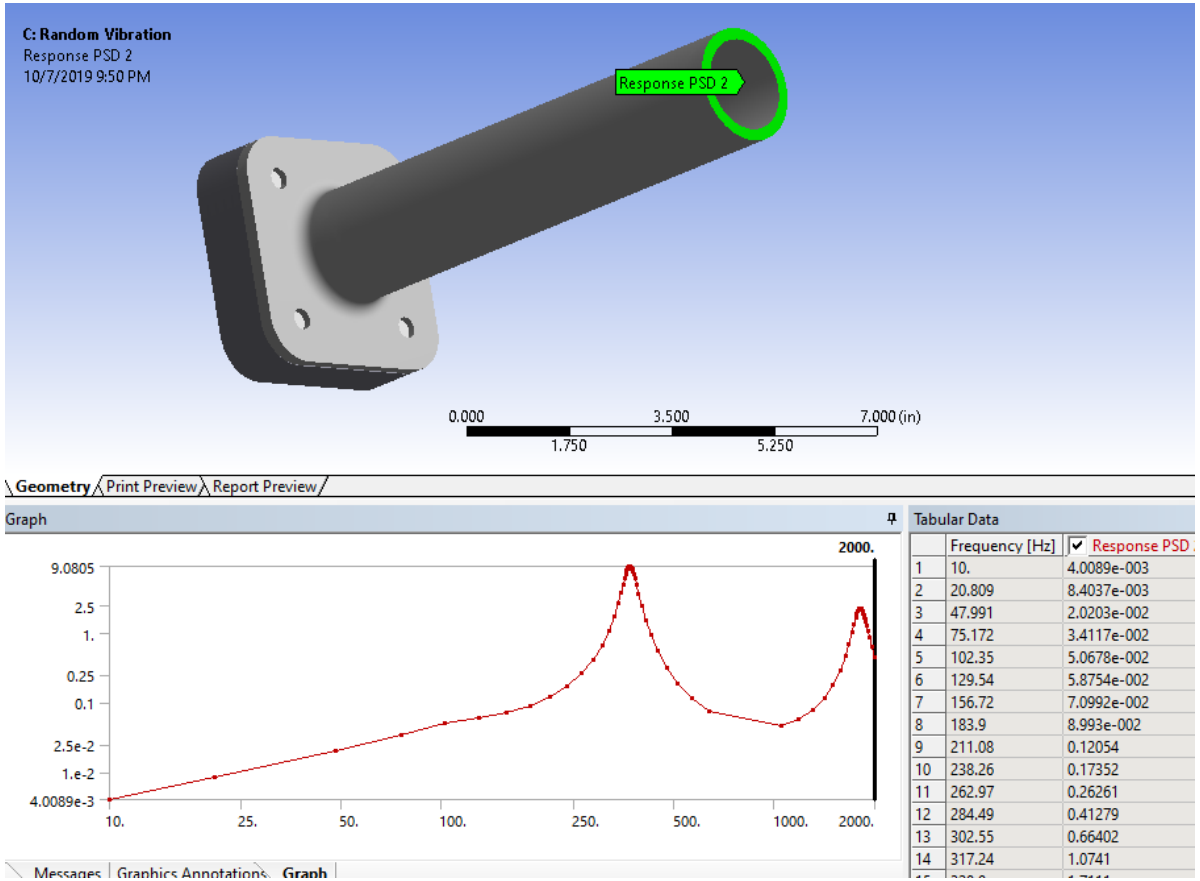
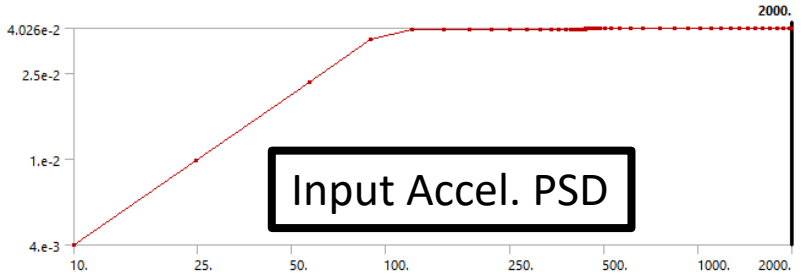
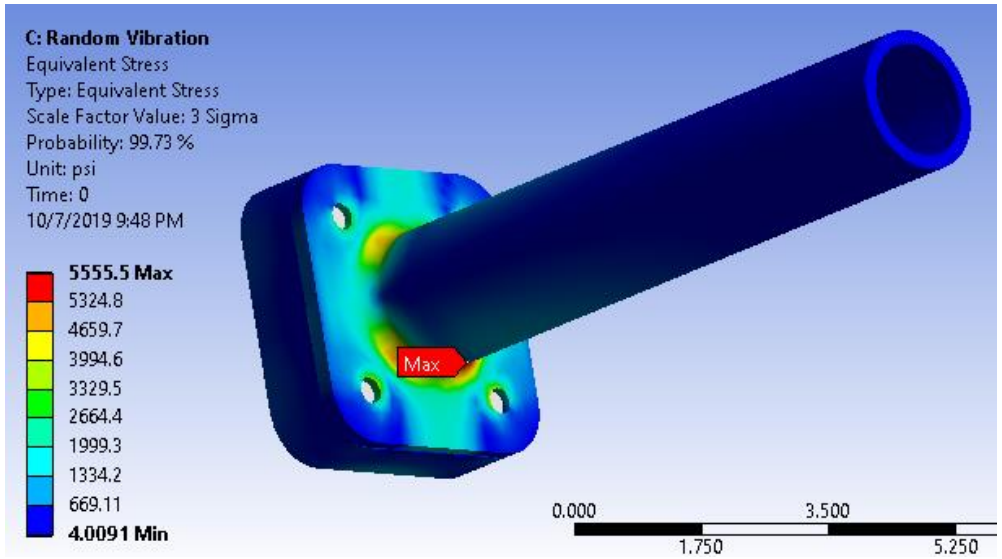
Acceleration & Stress Response to Random Vibration







Max. Acc. PSD Response = 9.08 G^2/Hz

Max. Equiv. Stress = 5.6 KSI

E A C

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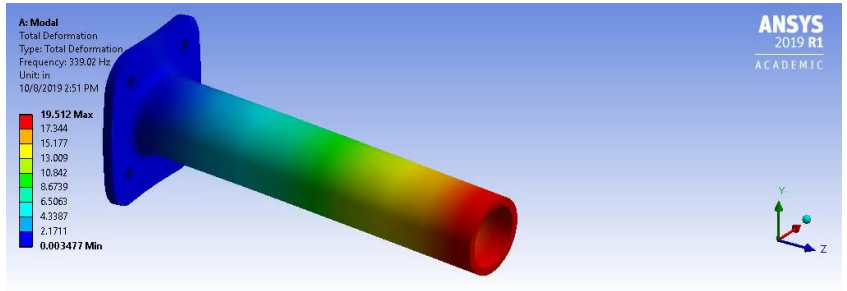
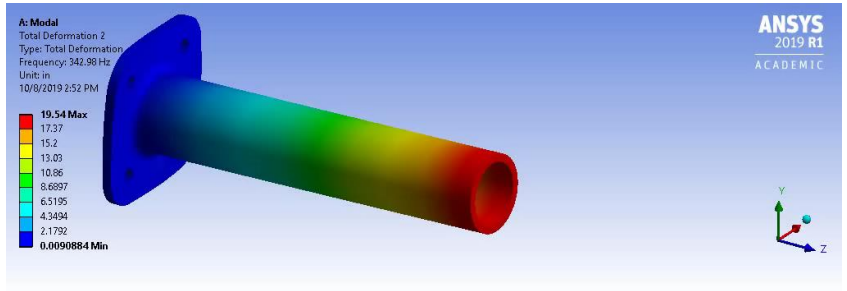
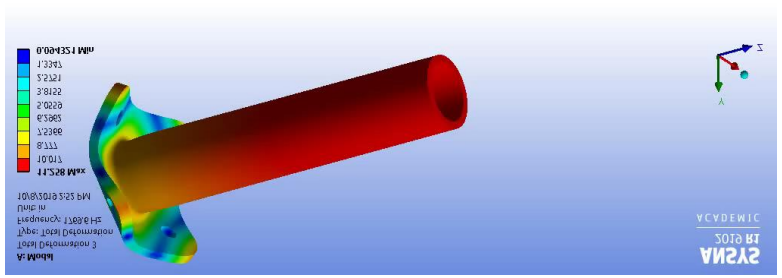
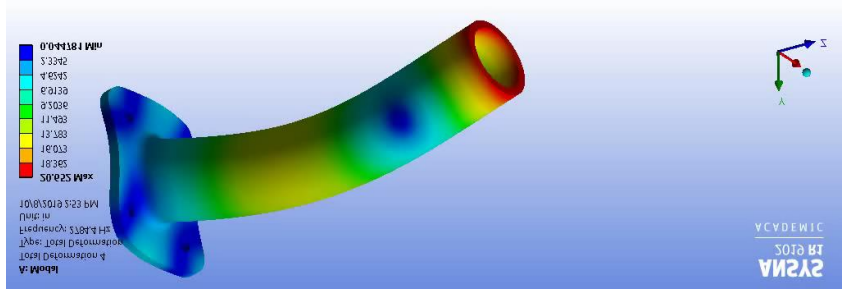
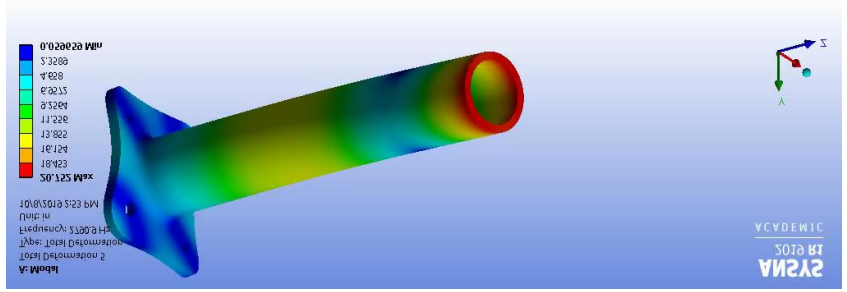
Modal Analysis of Component with Remote Points

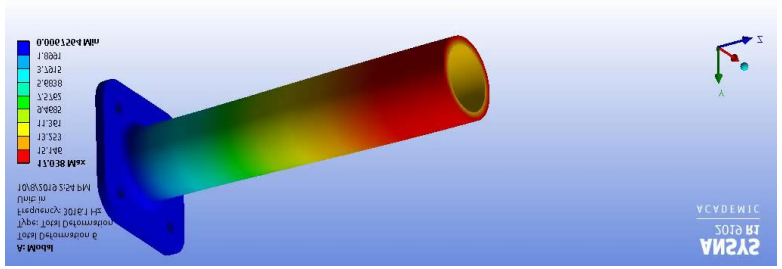












First Six Modes with Remote Points

E A C

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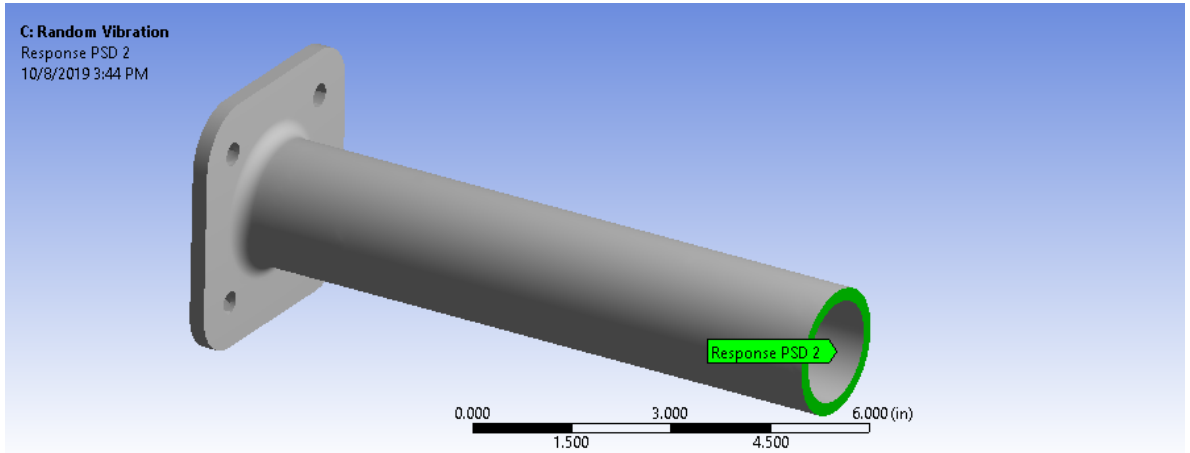
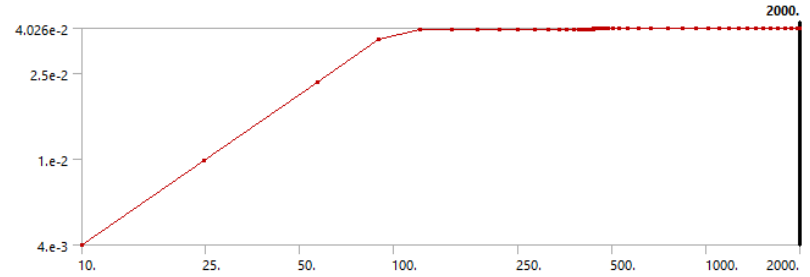
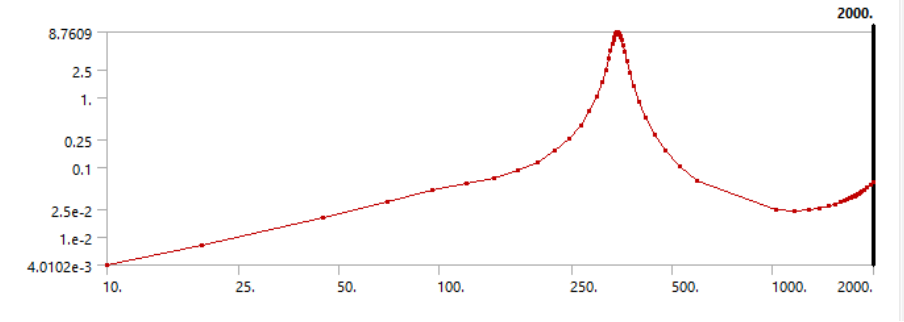
Acceleration & Stress Response to Random Vibration





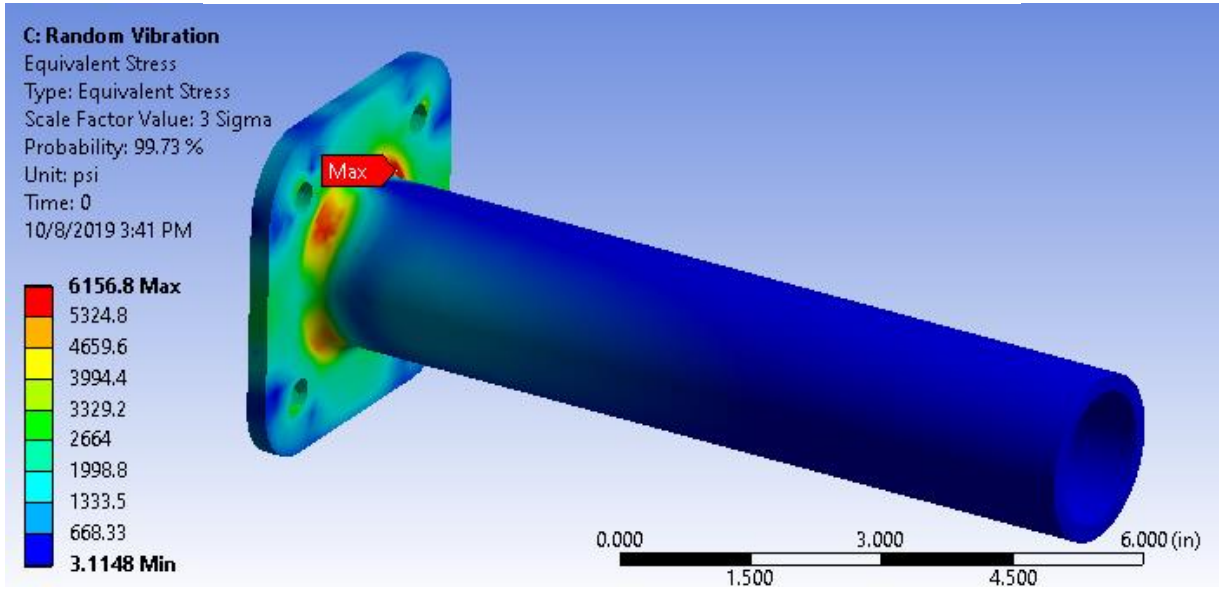
Geometry | Print Preview | Report Preview



Tabular Data

	Frequency [Hz]	Response PSD
1	10.	4.0102e-003
2	19.324	7.8037e-003
3	44.566	1.8759e-002
4	69.807	3.167e-002
5	95.049	4.813e-002
6	120.29	5.8667e-002
7	145.53	7.0814e-002
8	170.77	8.957e-002
9	196.02	0.1198
10	221.26	0.17197
11	244.2	0.25934
12	264.18	0.40604
13	280.96	0.65038

Max. Acc. PSD Response = 8.76 G^2/Hz



Max. Equiv. Stress = 6.2 KSI

Conclusions

- Fixing bolt holes leads to unconservative stress response
- Explicit modelling of bolts, while more laborious, produces higher and more realistic stress estimates.
- Remote point approximation will predict higher stresses and lower accelerations
- Fixing bolt holes may be acceptable for low excitation levels as the bolts will remain tightened.
- For higher excitation level explicit bolt modelling is recommended.