Finite Element Analysis of a Drum Brake

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MAE 656: Advanced Computer Aided Design

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Outline

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2. Description of the Numerical Model
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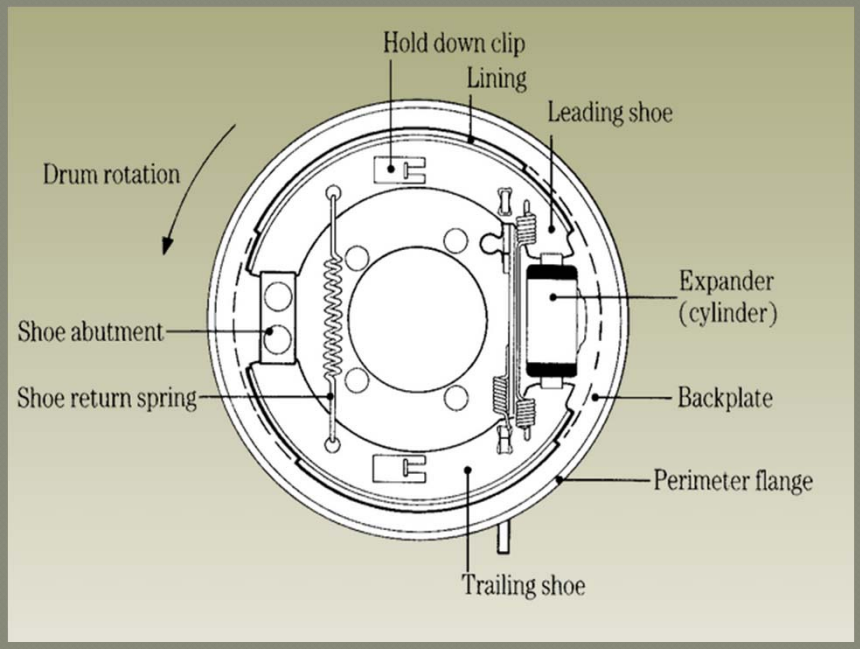
4. Conclusions and Summary

Problem Description

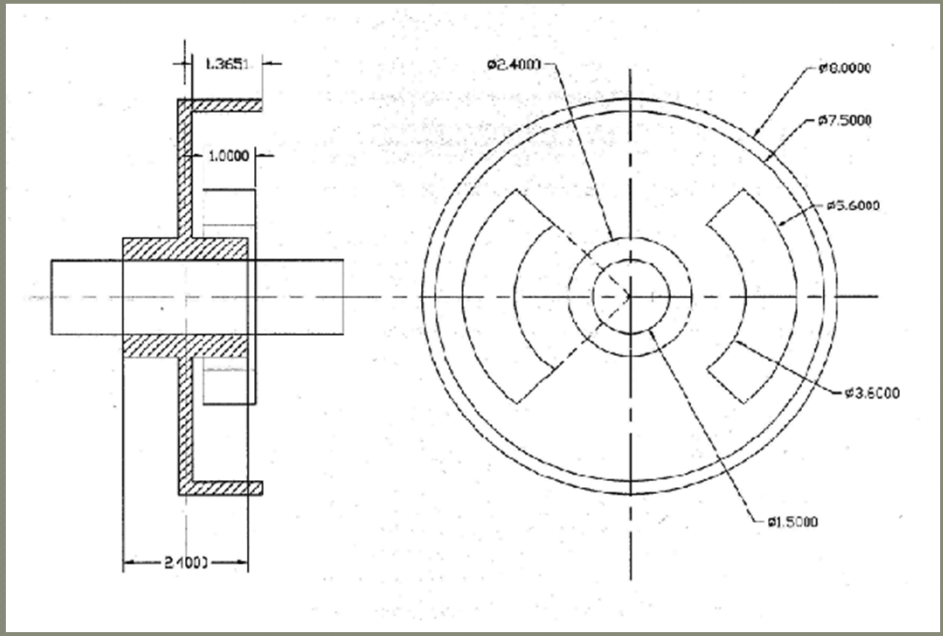
- Use FEM to analyze performance of a drum brake during emergency stop
- Calculate:
  - Total deformation
  - Von Mises and equivalent stresses
  - Safety factor
- Use both shell and solid elements to perform simulation

Problem Description

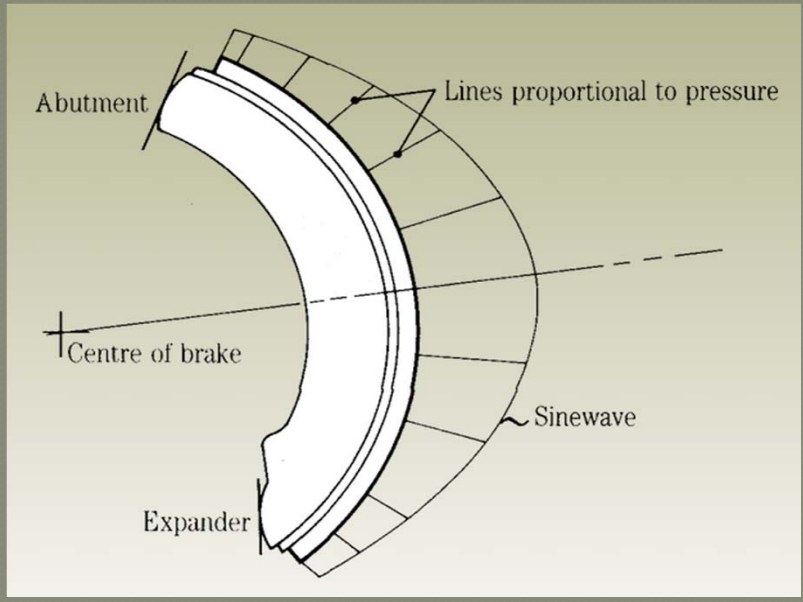
- Drum brakes stop vehicle by pushing shoes out into contact with the inner face of drum, creating a friction force



Problem Definition



- Drum assembly and drum combined in model
- Assume brake pressure constant about whole inner face of drum

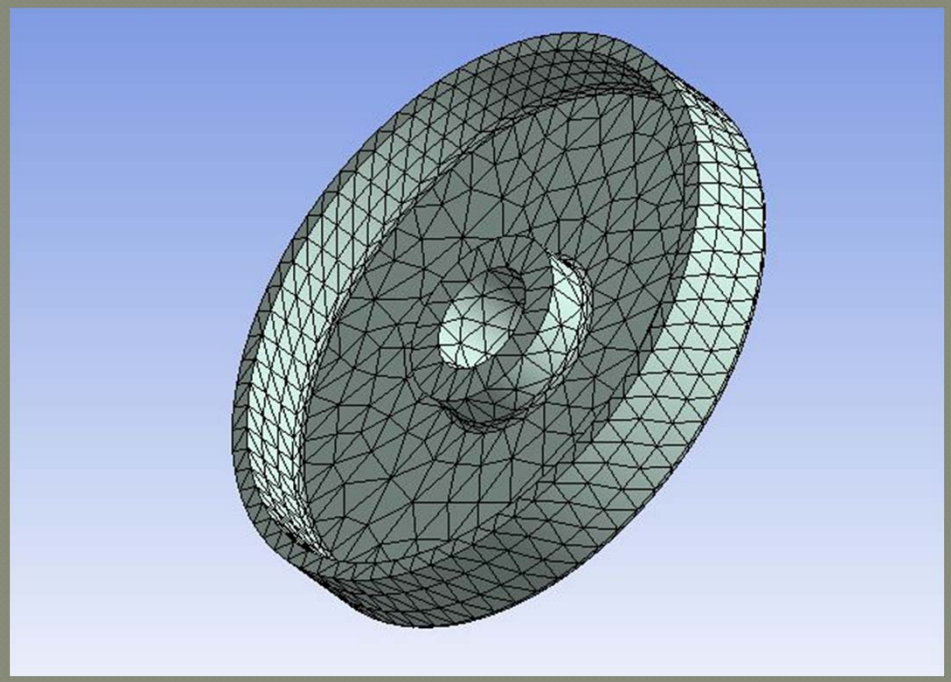


Description of the Model

Properties of Outline Row 4: SAE G3000 Grey Iron			
	A	B	C
1	Property	Value	Unit
2	Density	7100	kg m^-3
3	Isotropic Elasticity		
4	Derive from	Young's M...	
5	Young's Modulus	1.57E+05	MPa
6	Poisson's Ratio	0.26	
7	Bulk Modulus	1.0903E+11	Pa
8	Shear Modulus	6.2302E+10	Pa
9	Tensile Yield Strength	276	MPa
10	Tensile Ultimate Strength	430	MPa

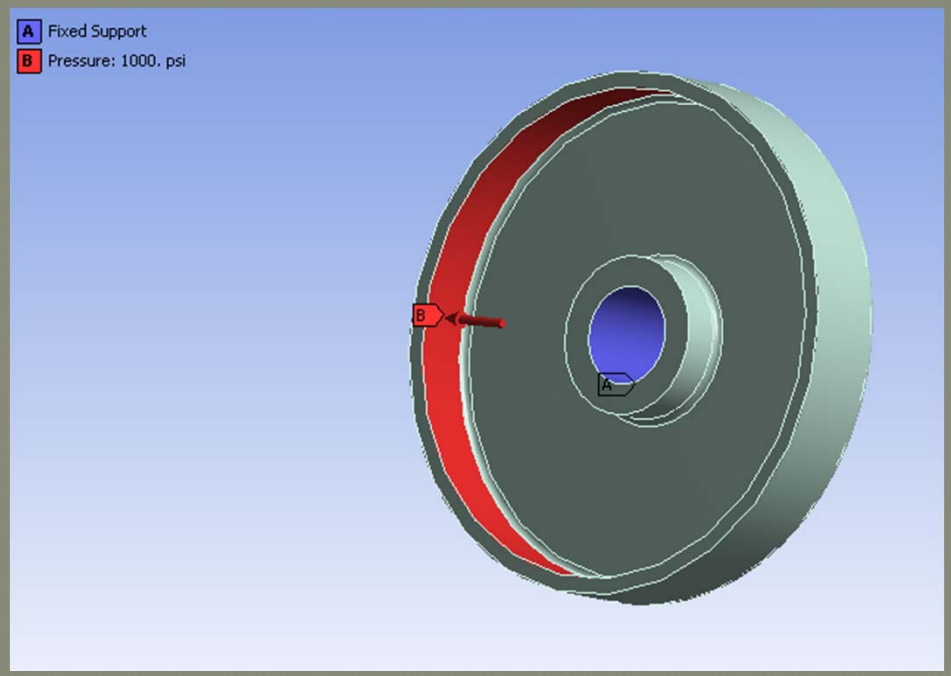
- Brake drums made from SAE G3000 Grey Iron (autozone.com)
- Material properties for Grey Iron were used
  - Maximum values chosen

Solid Model- Mesh



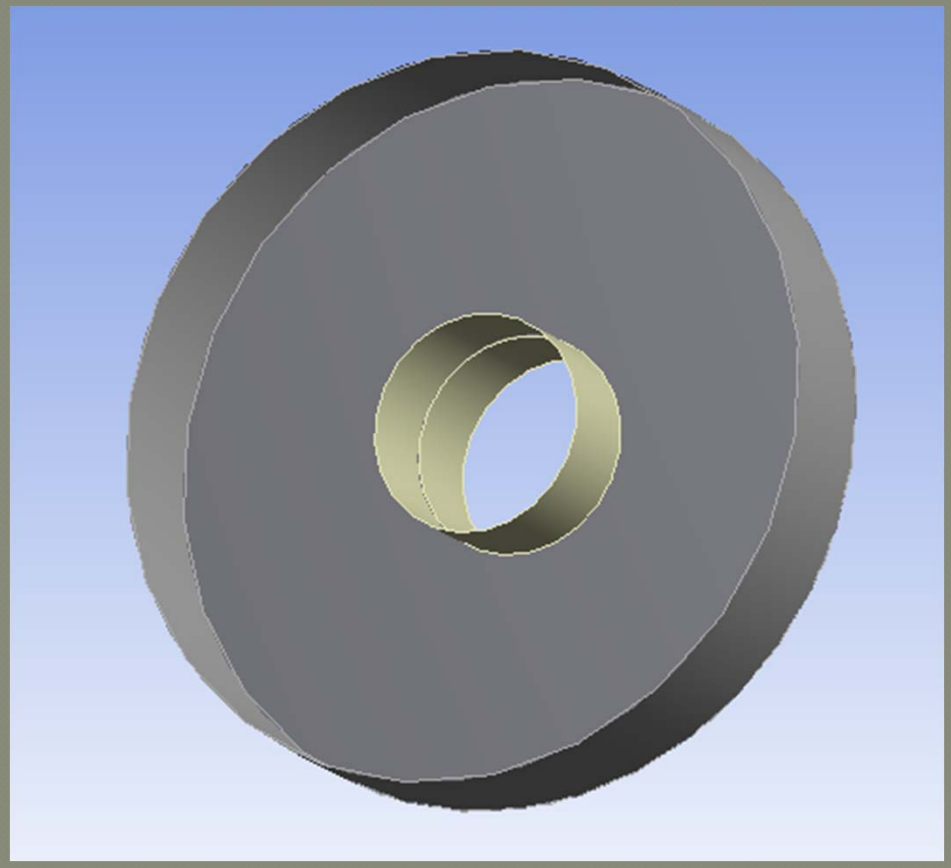
- O.1inch fillets applied to sharp edges
- Mesh relevance of 100
- Mapped face meshing and face sizing applied to inner faces and fillets
  - 9814 nodes
  - 5139 elements

Solid Model- Loads and Supports



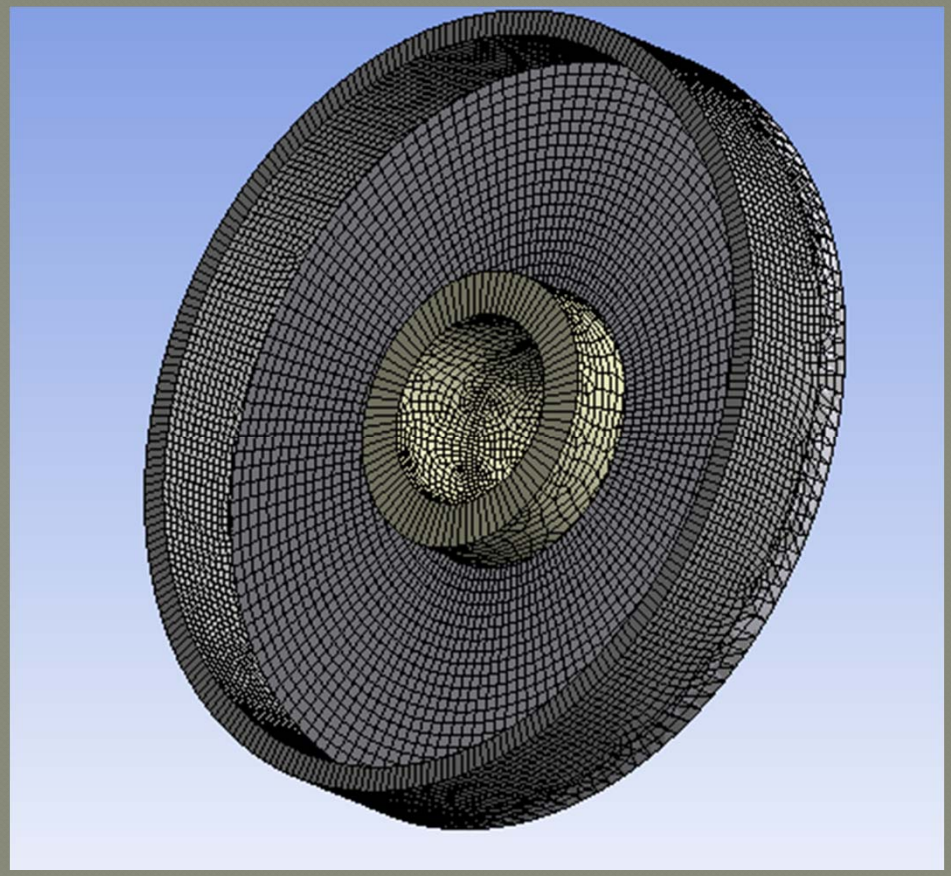
- 1000 psi load applied to inner face of drum
- Fixed support on inner surface of center

Shell Model- Geometry



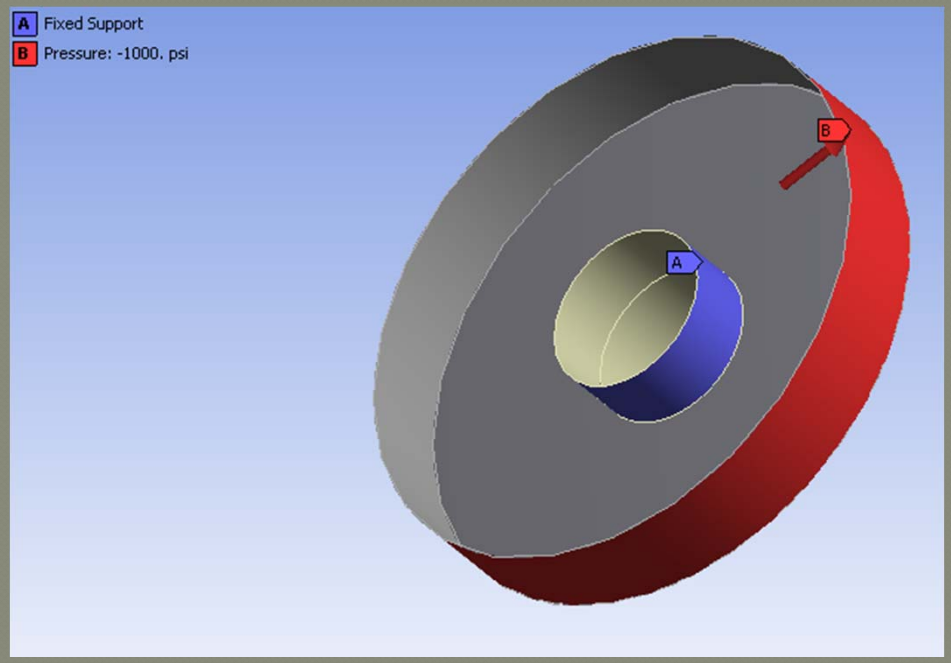
- Constructed according to same dimensions as solid
- Surfaces created from faces for rings
- No fillets applied

Shell Model- Mesh



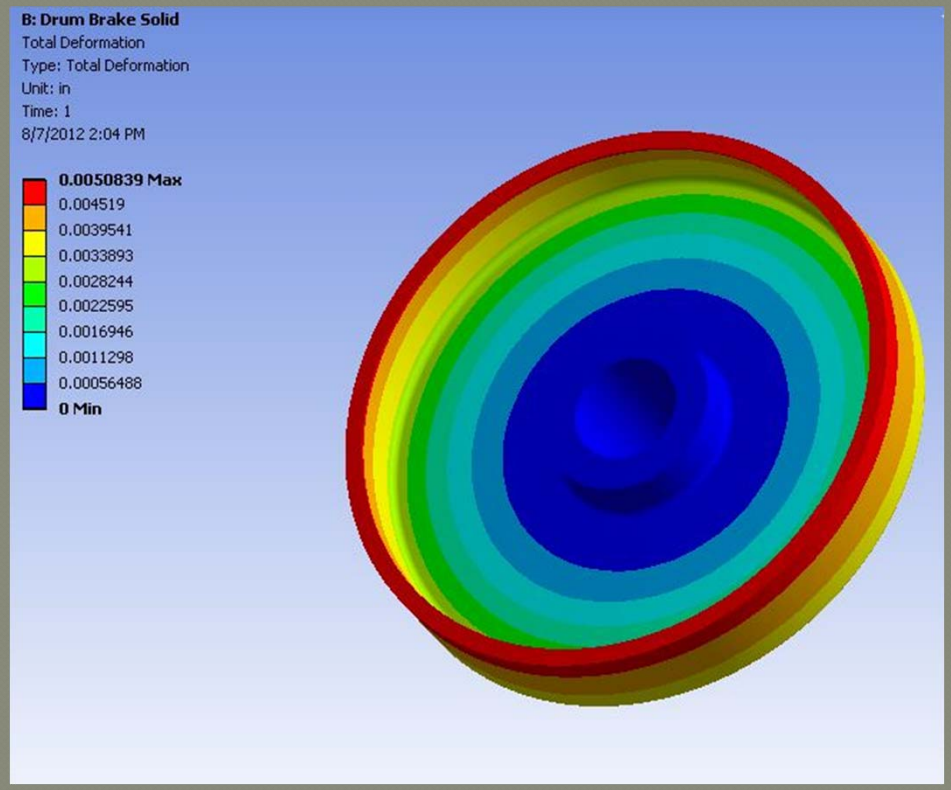
- Mesh relevance of 100 and mapped face meshing applied to inner faces
  - 9000 nodes
  - 8845 elements
  - Not substantially different from solid geometry

Shell Model- Loads and Supports



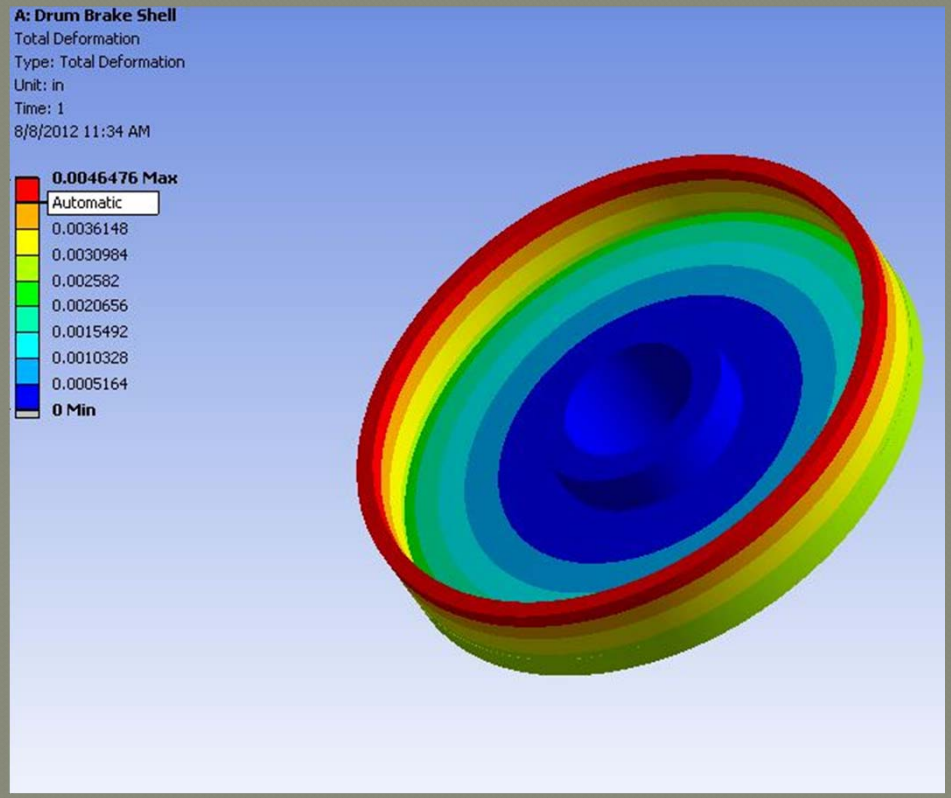
- 1000 psi load applied to inner face of drum
  - Negative direction based on model
- Fixed support on inner surface of center

Results- Total Deformation



Solid Model

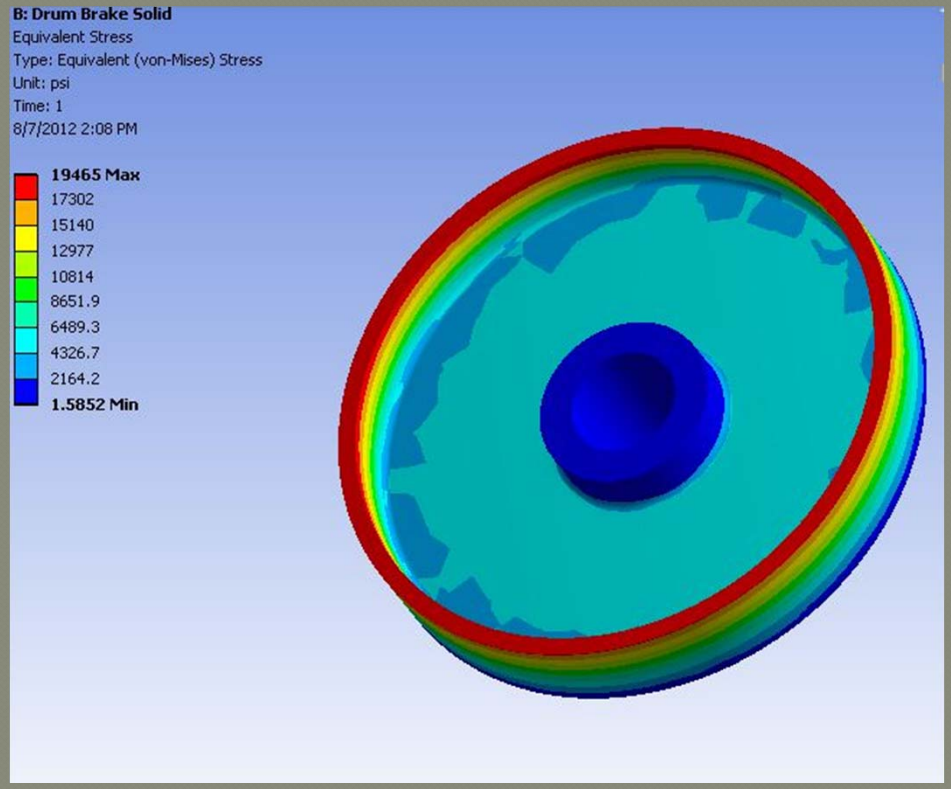
Max: 0.00464 inches



Shell Model

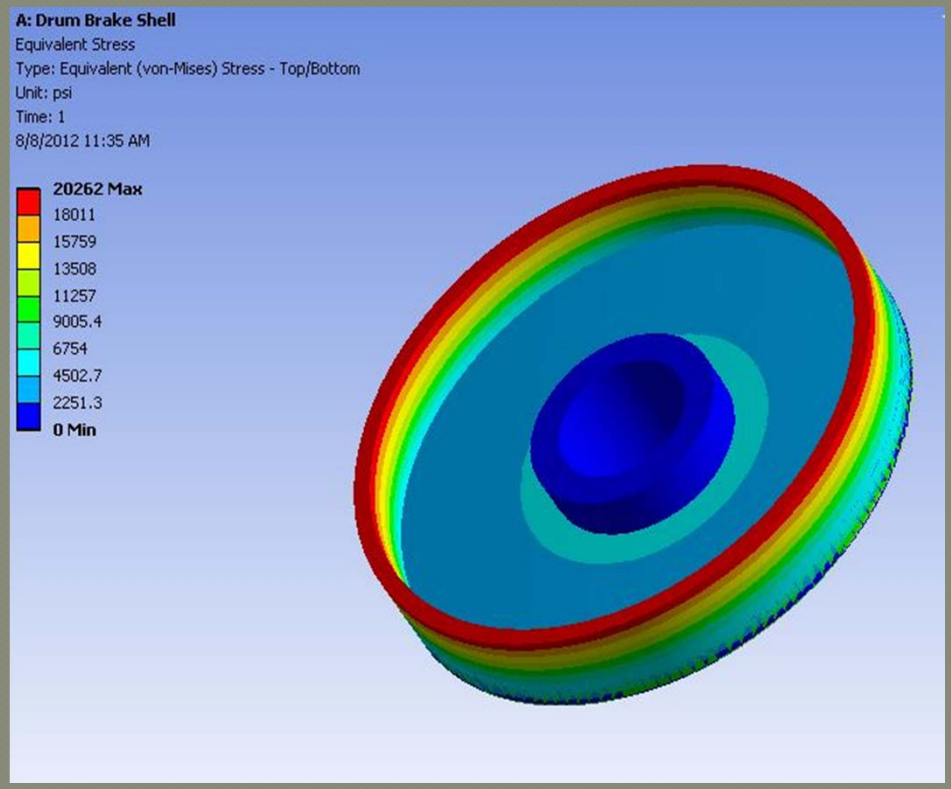
Max: 0.00508 inches

Results- Von Mises Stress



Solid Model

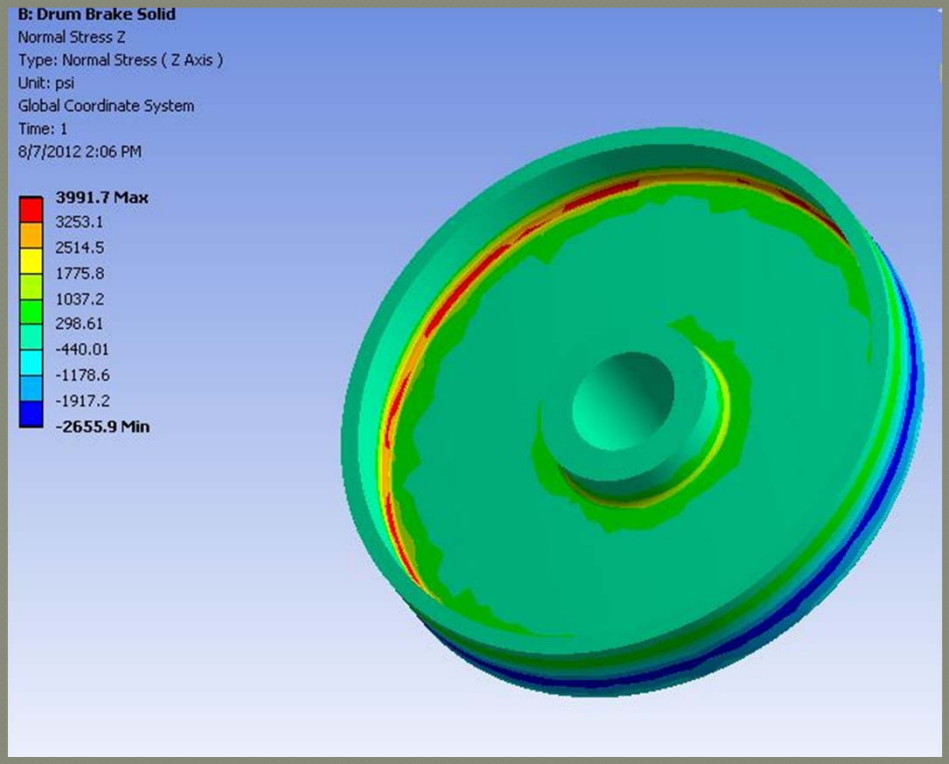
Max: 19465 psi



Shell Model

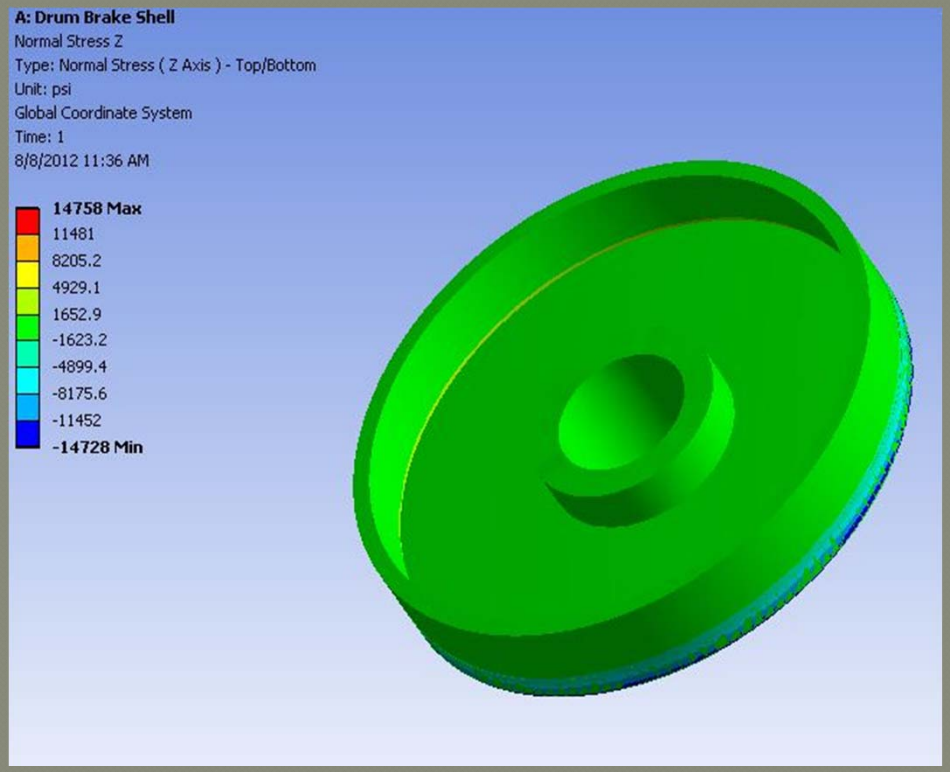
Max: 20262 psi

Results- Normal Z-axis Stress



Solid Model

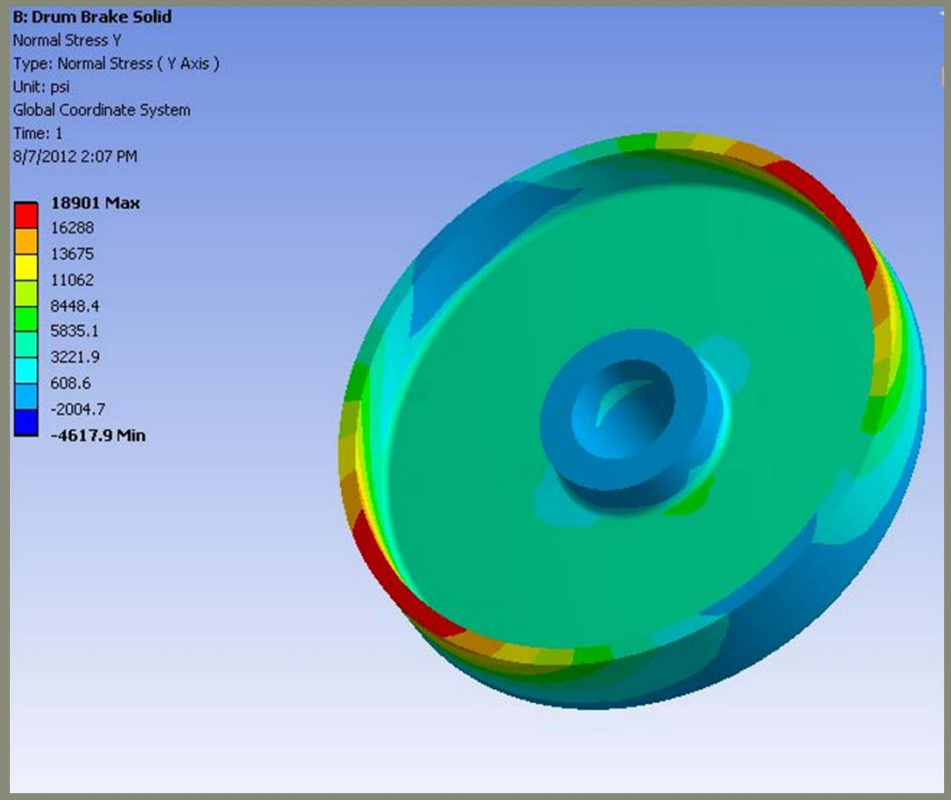
Max: 3991.7 psi



Shell Model

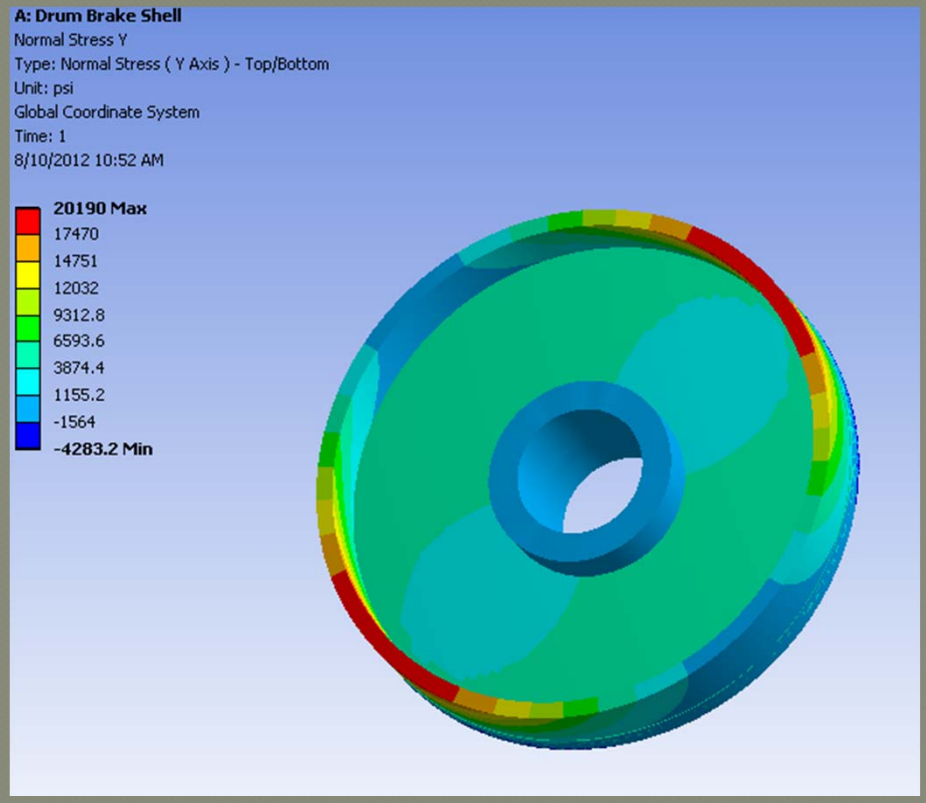
Max: 14758 psi (on outer face)

Results- Normal Y-axis Stress



Solid Model

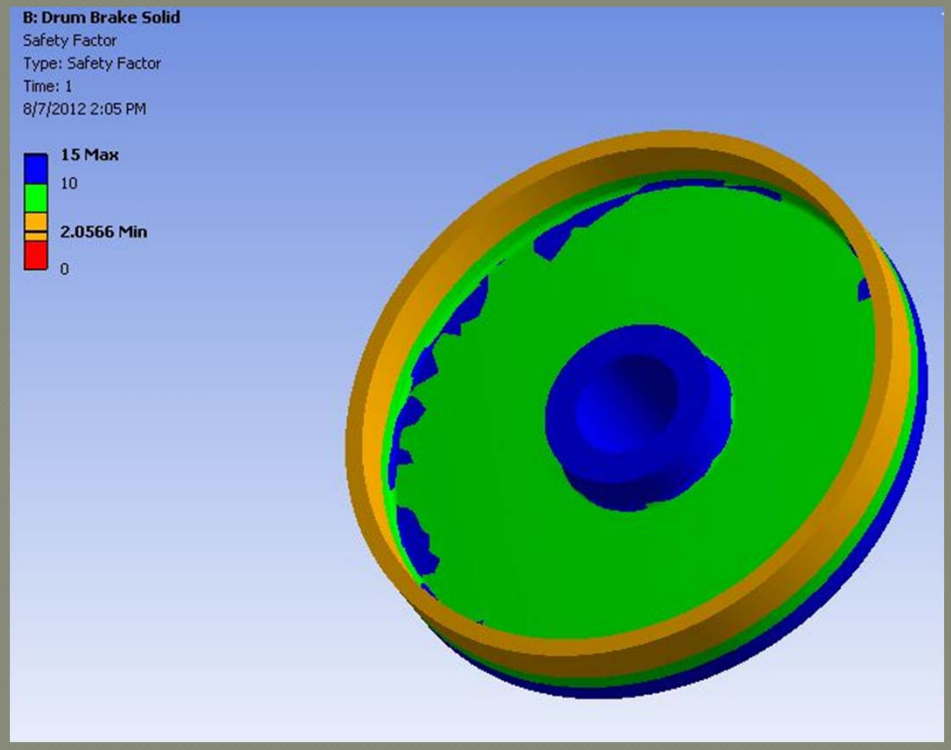
Max: 18901 psi



Shell Model

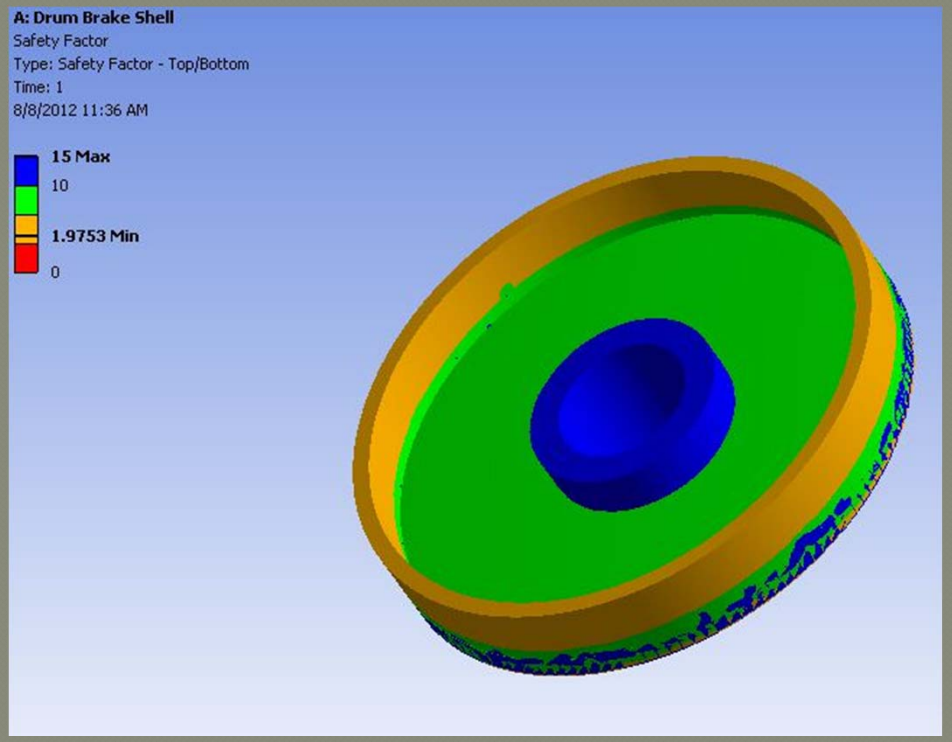
Max: 20190 psi

Results- Safety Factor



Solid Model

Min: 2.057



Shell Model

Min: 1.975

Conclusions and Summary

- Both solid and shell models produced useful results
  - Solid model produced more accurate results
  - No fillets in shell model did not represent stress concentrations properly
  - Von Mises stress values did not differ by much
- Safety factors of 2.057 and 1.975 show that the drum won't fail from applied load
- Overall deformation in the magnitude of 10^{-3} inches

Questions?