

Finite Element Analysis of a Drum Brake

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MAE 656: Advanced Computer Aided Design

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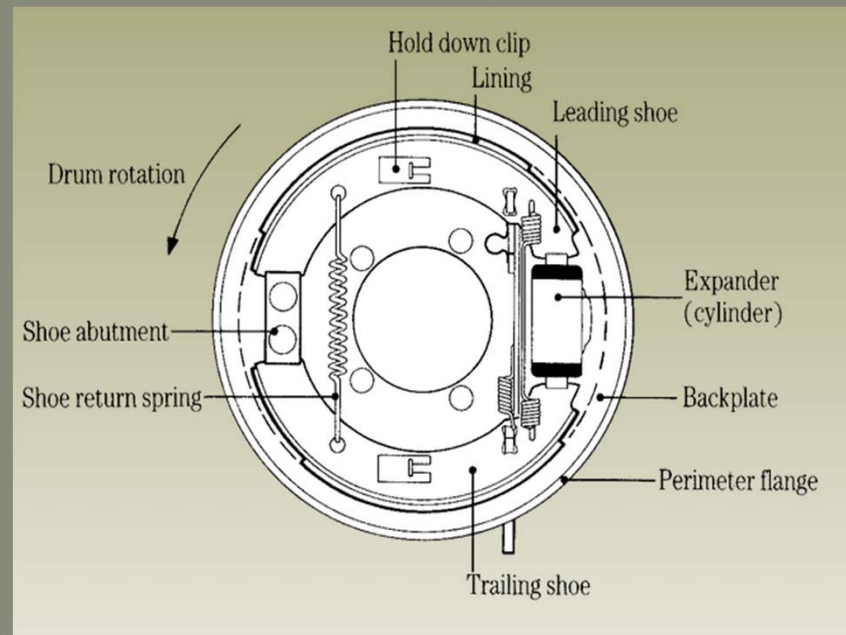
Problem Description

- 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

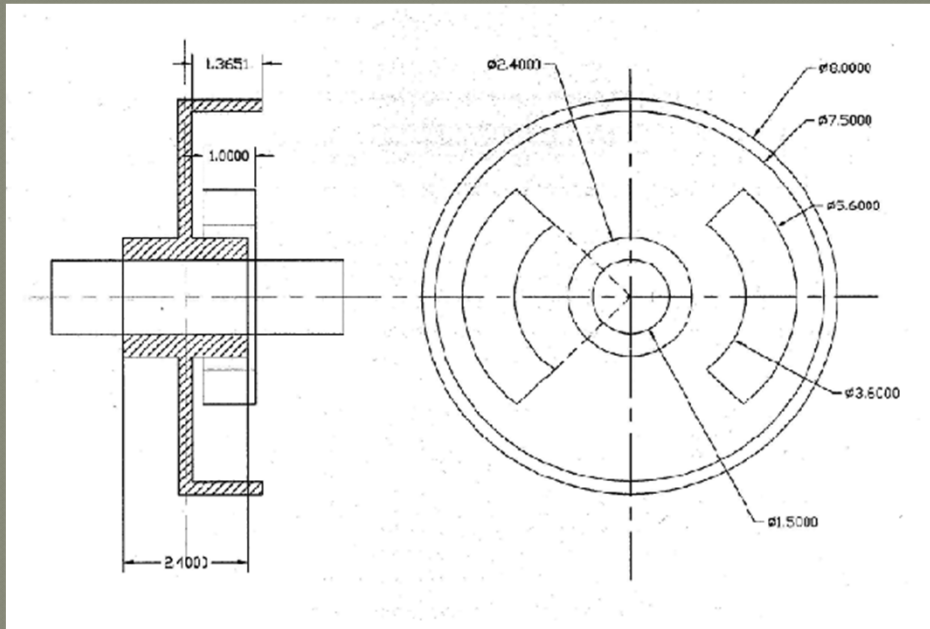
Problem Description



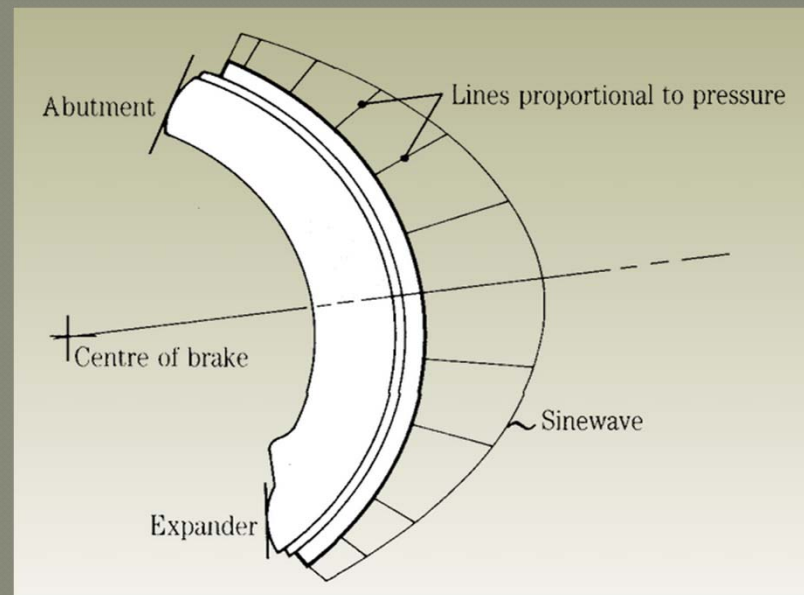
- Drum brakes stop vehicle by pushing shoes out into contact with the inner face of drum, creating a friction force



Problem Definition



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

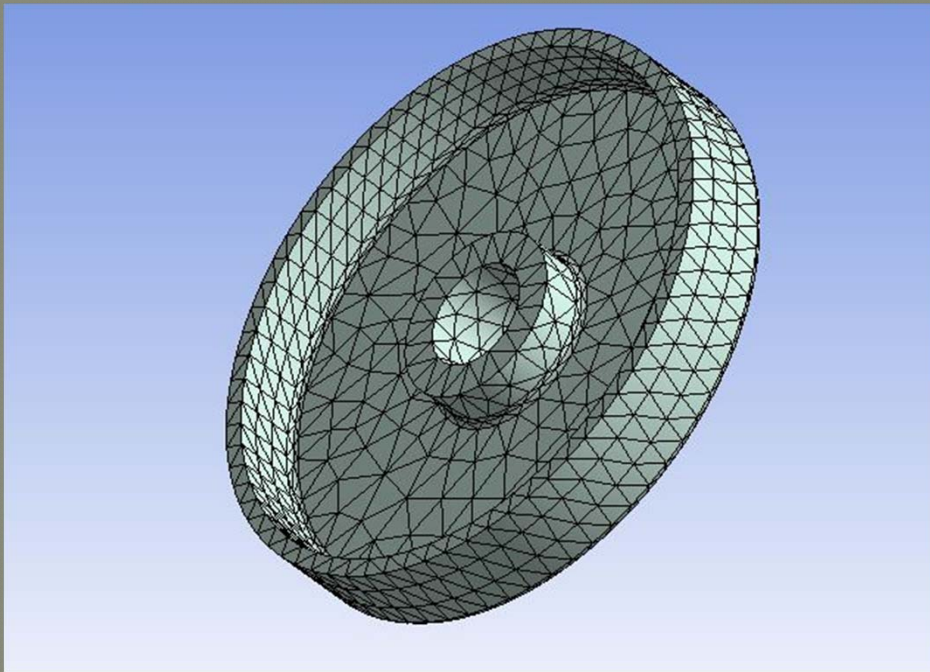


Description of the Model

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

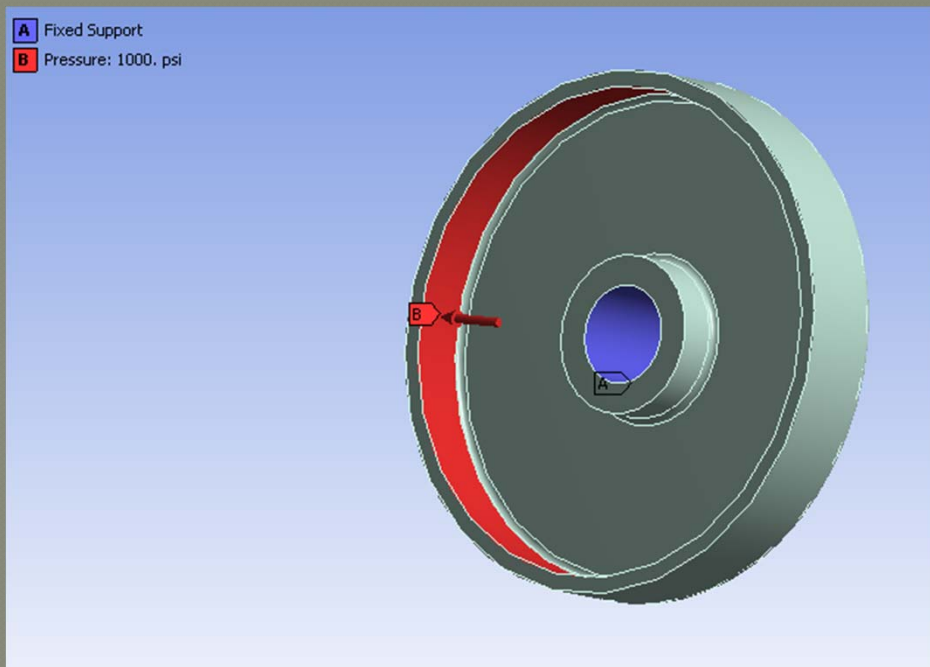
Solid Model- Mesh



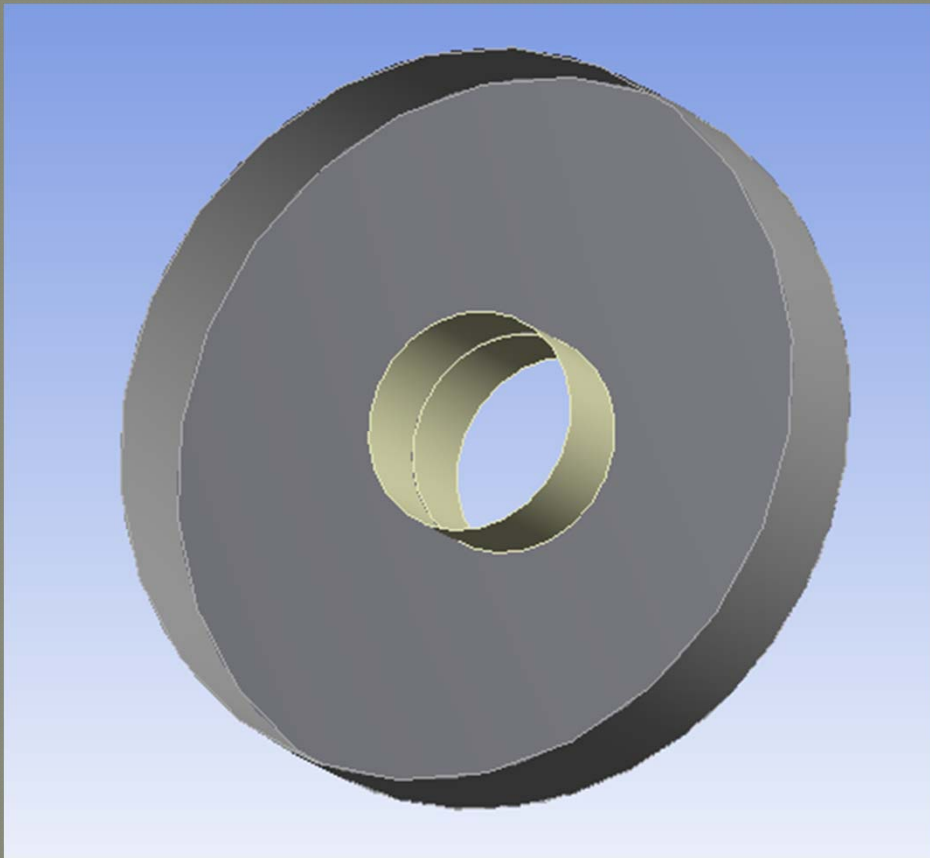
- 0.1 inch fillets applied to sharp edges
- Mesh relevance of 100
- Mapped face meshing and face sizing applied to inner faces and fillets
 - 9814 nodes
 - 5139 elements

Solid Model- Loads and Supports

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

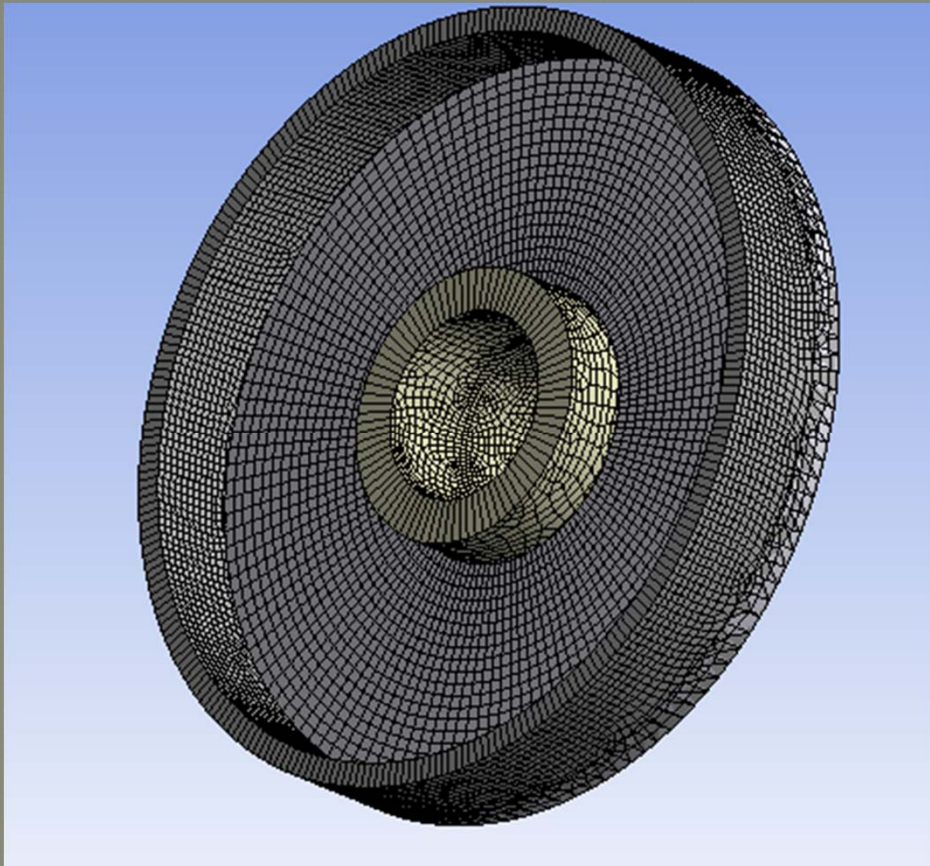


Shell Model- Geometry



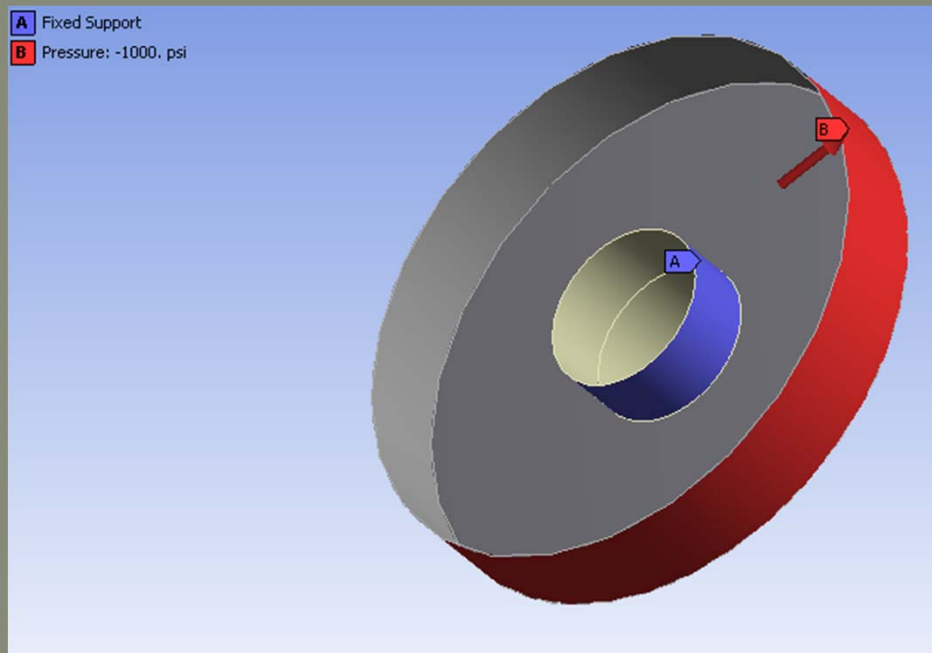
- Constructed according to same dimensions as solid
- Surfaces created from faces for rings
- No fillets applied

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

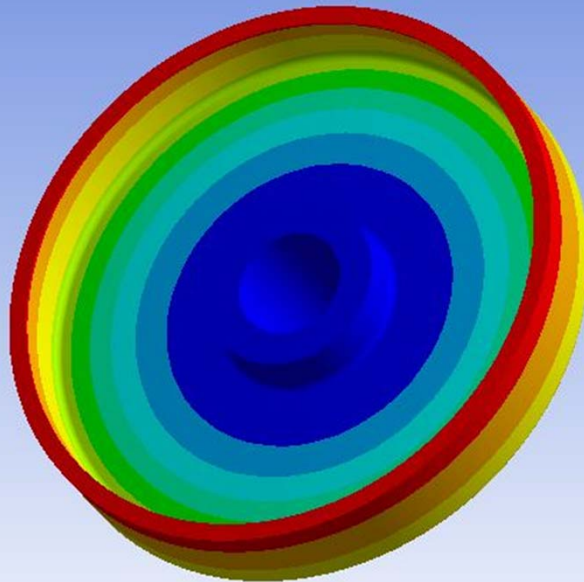


- 1000 psi load applied to inner face of drum
 - Negative direction based on model
- Fixed support on inner surface of center

Results- Total Deformation

B: Drum Brake Solid
Total Deformation
Type: Total Deformation
Unit: in
Time: 1
8/7/2012 2:04 PM

0.0050839 Max
0.004519
0.0039541
0.0033893
0.0028244
0.0022595
0.0016946
0.0011298
0.00056488
0 Min

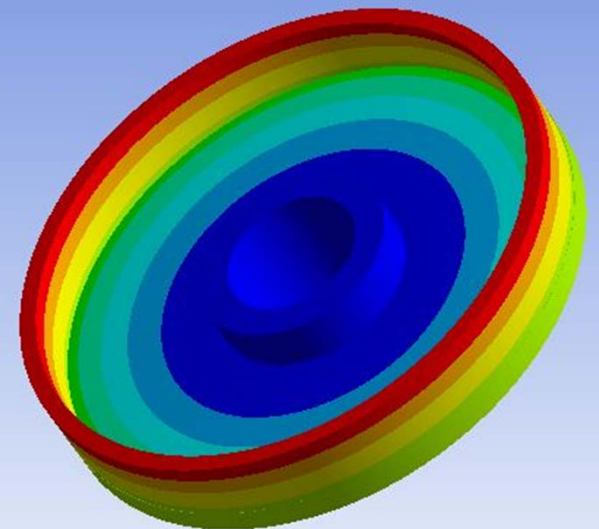


Solid Model

Max: 0.00464 inches

A: Drum Brake Shell
Total Deformation
Type: Total Deformation
Unit: in
Time: 1
8/8/2012 11:34 AM

0.0046476 Max
Automatic
0.0036148
0.0030984
0.002582
0.0020656
0.0015492
0.0010328
0.0005164
0 Min



Shell Model

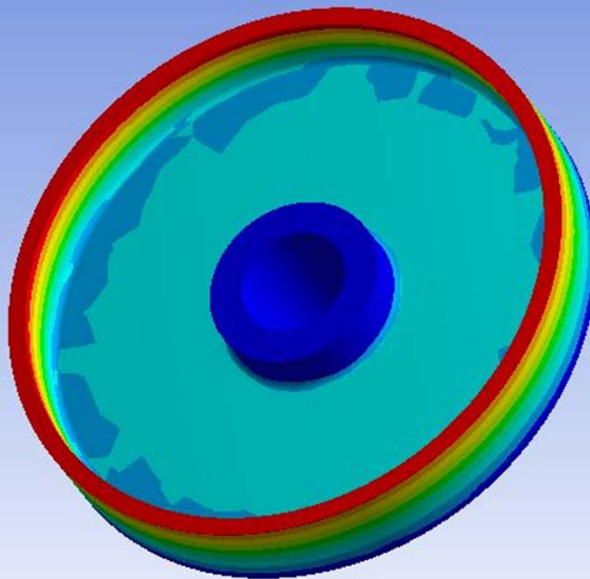
Max: 0.00508 inches

Results- Von Mises Stress

B: Drum Brake Solid

Equivalent Stress
Type: Equivalent (von-Mises) Stress
Unit: psi
Time: 1
8/7/2012 2:08 PM

19465 Max
17302
15140
12977
10814
8651.9
6489.3
4326.7
2164.2
1.5852 Min



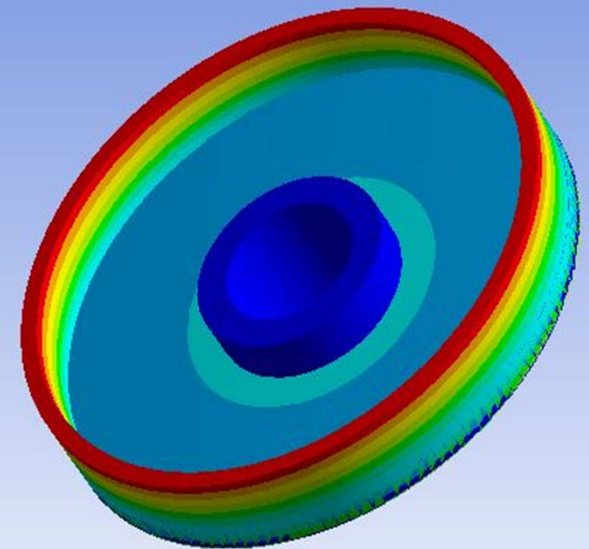
Solid Model

Max: 19465 psi

A: Drum Brake Shell

Equivalent Stress
Type: Equivalent (von-Mises) Stress - Top/Bottom
Unit: psi
Time: 1
8/8/2012 11:35 AM

20262 Max
18011
15759
13508
11257
9005.4
6754
4502.7
2251.3
0 Min



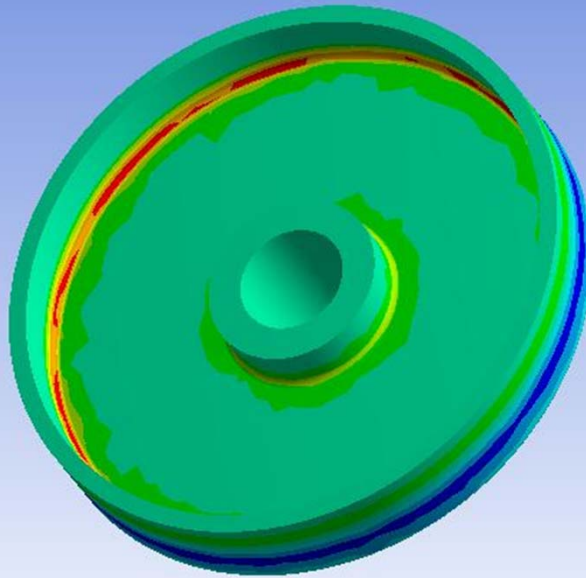
Shell Model

Max: 20262 psi

Results- Normal Z-axis Stress

B: Drum Brake Solid
Normal Stress Z
Type: Normal Stress (Z Axis)
Unit: psi
Global Coordinate System
Time: 1
8/7/2012 2:06 PM

3991.7 Max
3253.1
2514.5
1775.8
1037.2
298.61
-440.01
-1178.6
-1917.2
-2655.9 Min

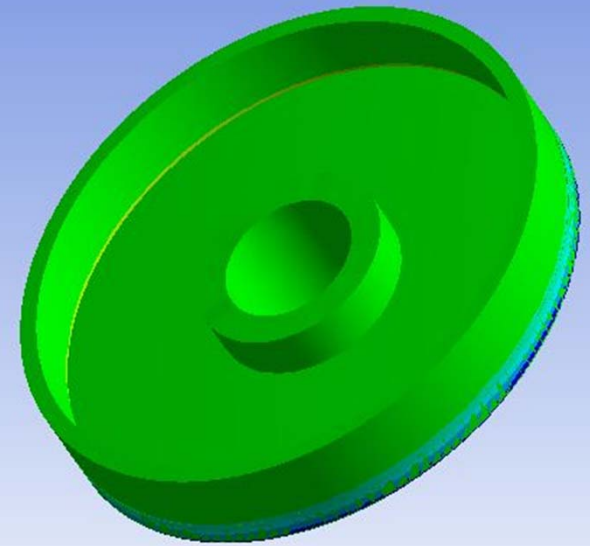


Solid Model

Max: 3991.7 psi

A: Drum Brake Shell
Normal Stress Z
Type: Normal Stress (Z Axis) - Top/Bottom
Unit: psi
Global Coordinate System
Time: 1
8/8/2012 11:36 AM

14758 Max
11481
8205.2
4929.1
1652.9
-1623.2
-4899.4
-8175.6
-11452
-14728 Min



Shell Model

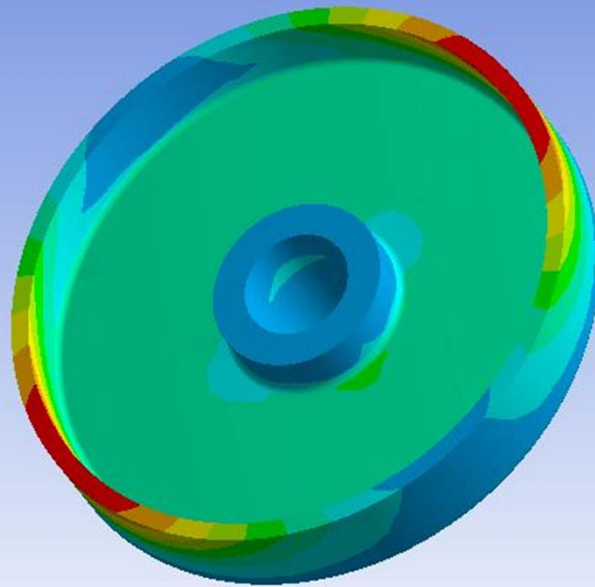
Max: 14758 psi (on outer face)

Results- Normal Y-axis Stress

B: Drum Brake Solid

Normal Stress Y
Type: Normal Stress (Y Axis)
Unit: psi
Global Coordinate System
Time: 1
8/7/2012 2:07 PM

18901 Max
16288
13675
11062
8448.4
5835.1
3221.9
608.6
-2004.7
-4617.9 Min



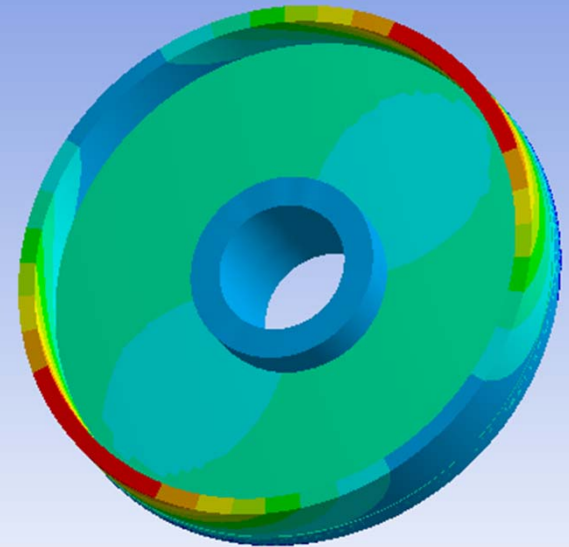
Solid Model

Max: 18901 psi

A: Drum Brake Shell

Normal Stress Y
Type: Normal Stress (Y Axis) - Top/Bottom
Unit: psi
Global Coordinate System
Time: 1
8/10/2012 10:52 AM

20190 Max
17470
14751
12032
9312.8
6593.6
3874.4
1155.2
-1564
-4283.2 Min



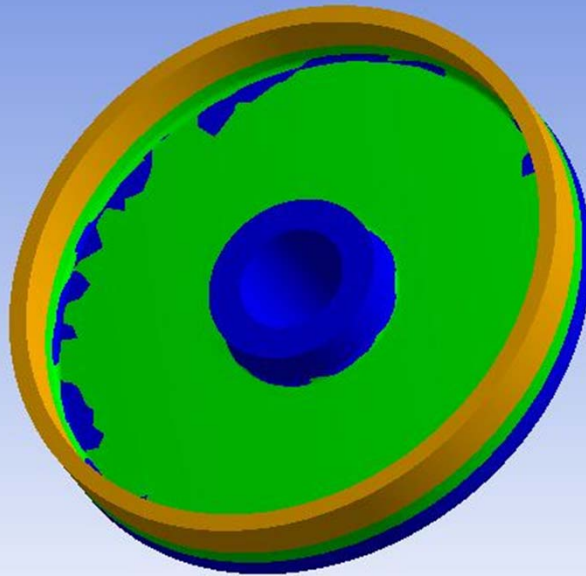
Shell Model

Max: 20190 psi

Results- Safety Factor

B: Drum Brake Solid
Safety Factor
Type: Safety Factor
Time: 1
8/7/2012 2:05 PM

15 Max
10
2.0566 Min
0

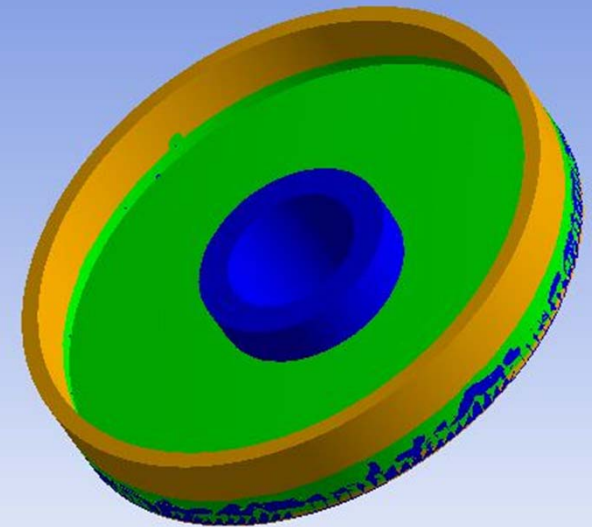


Solid Model

Min: 2.057

A: Drum Brake Shell
Safety Factor
Type: Safety Factor - Top/Bottom
Time: 1
8/8/2012 11:36 AM

15 Max
10
1.9753 Min
0



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?

