ES 240 Final Project

Impact Strength of a Hand-Made Bashring

Tom Milnes – 12/09/2008

What is a Bashring?

- Mountain bike part
- Metal or plastic
- Mounted next to chainrings
- Protects chainrings & chain
- Used for grinding & landing

Who Needs a Bashring?

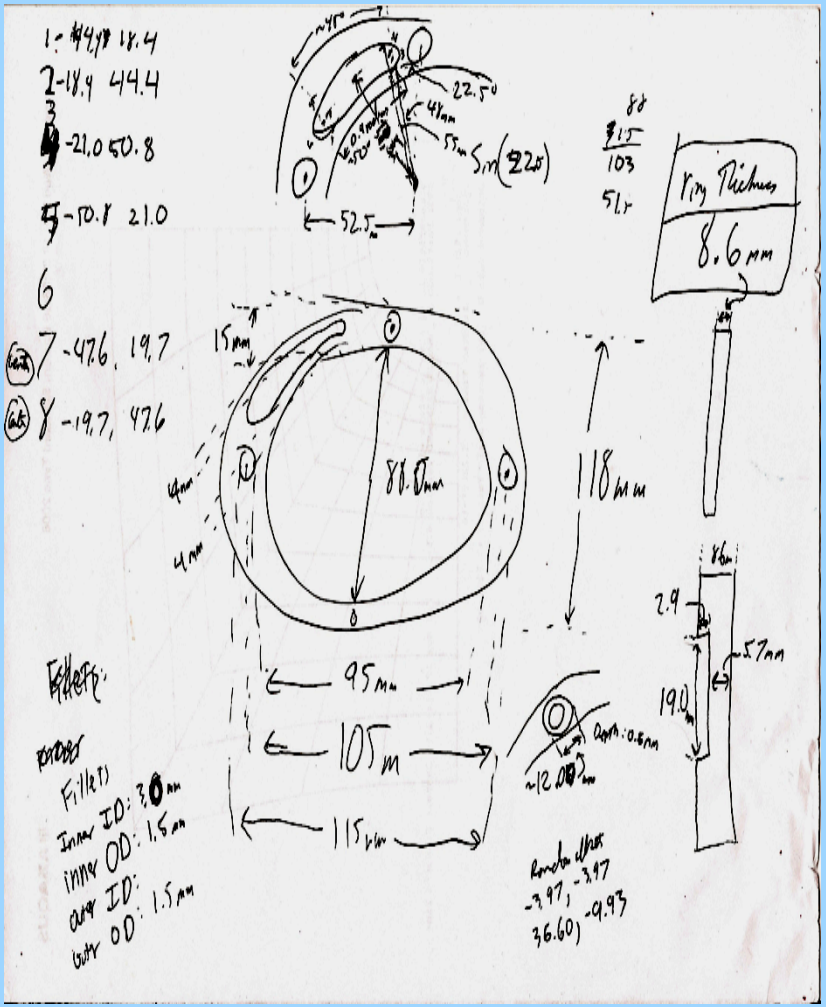
Project Motivation

- Designed ring by “feel,” not formal analysis.
- Relied on intuition for dimensioning, etc.
- No good idealized model for estimating stress.
- Project Goal: how well did I do?
  - Is ring strong enough under primary load?
  - Is ring light enough?
- Finite Elements Analysis can provide the answer.

Finite Element Model: Construction

Step 1: Measurement

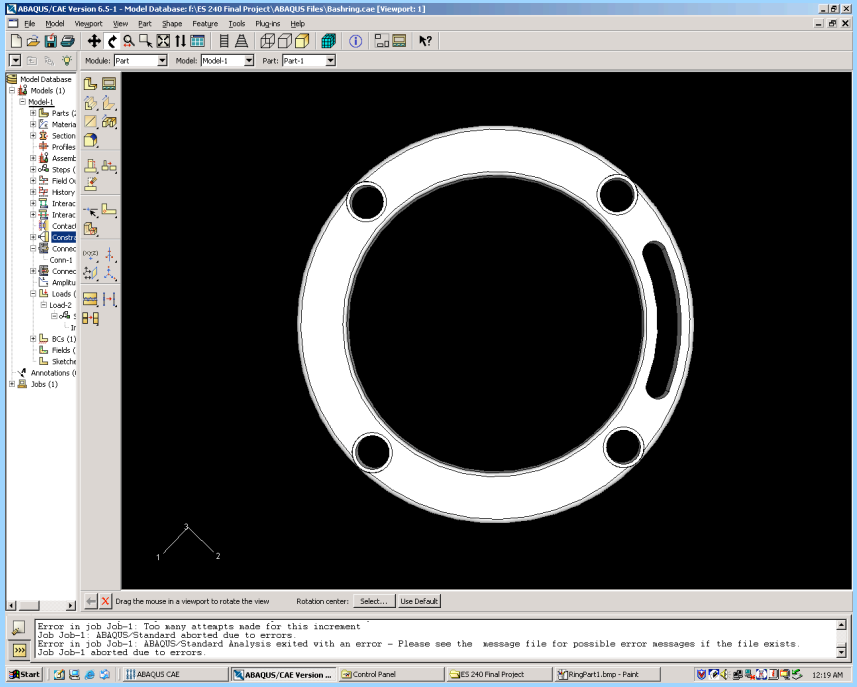
- Create freehand sketch
- Measure all dimensions

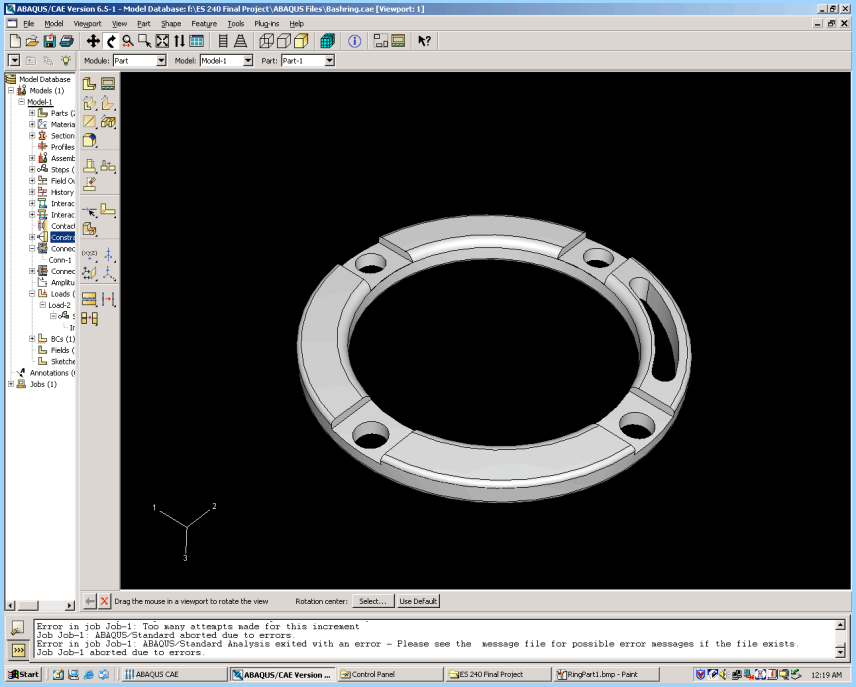


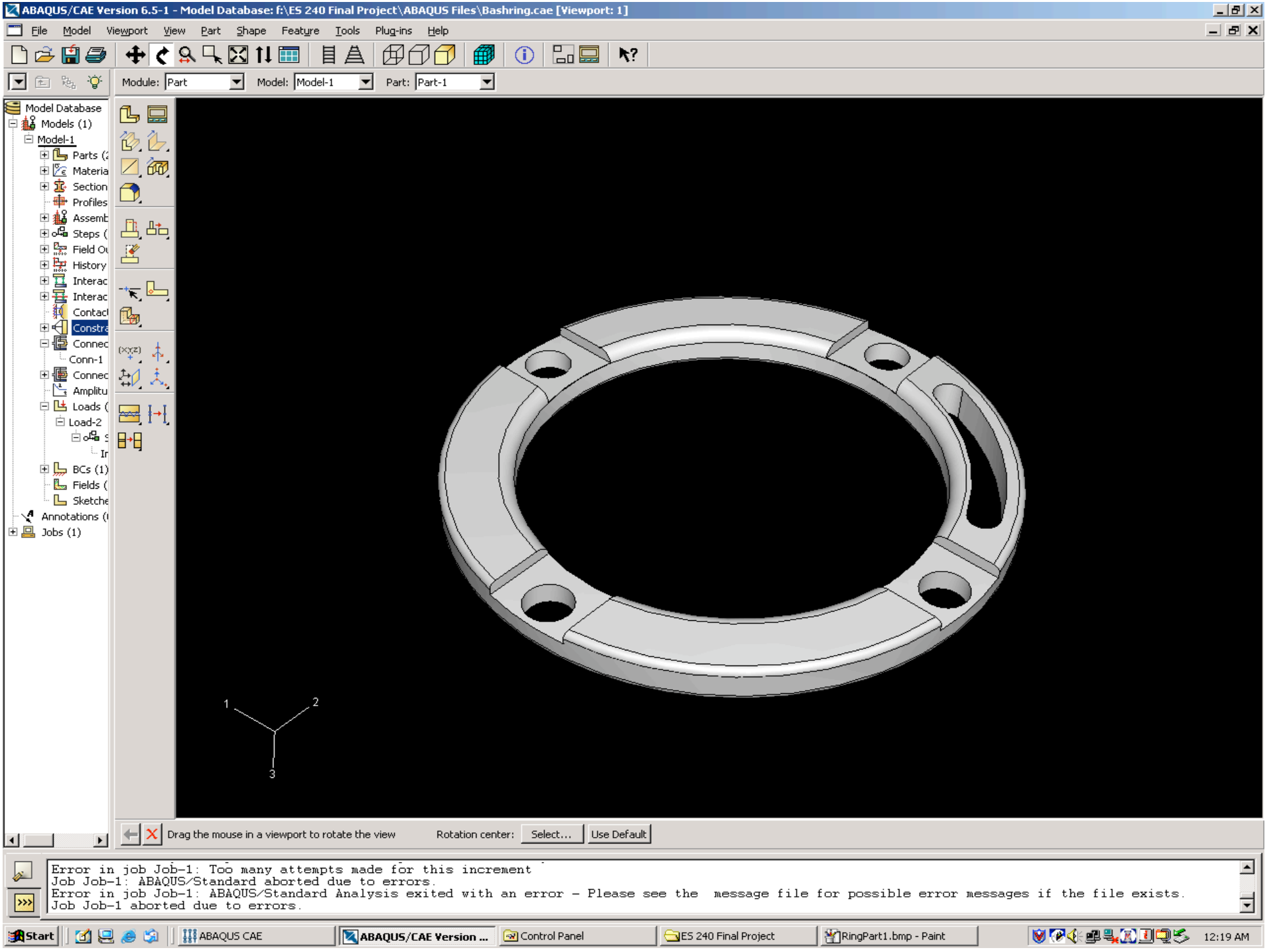
Finite Element Model: Construction

Step 2: Render in ABAQUS

- Lots of extrusion cuts and fillets






ABAQUS/CAE Version 6.5-1 - Model Database: f:\ES 240 Final Project\ABAQUS Files\Bashring.cae [Viewport: 1]
File Model Viewport View Part Shape Feature Tools Plug-ins Help
Module: Part Model: Model-1 Part: Part-1
Model Database
Models (1)
Model-1
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1
2
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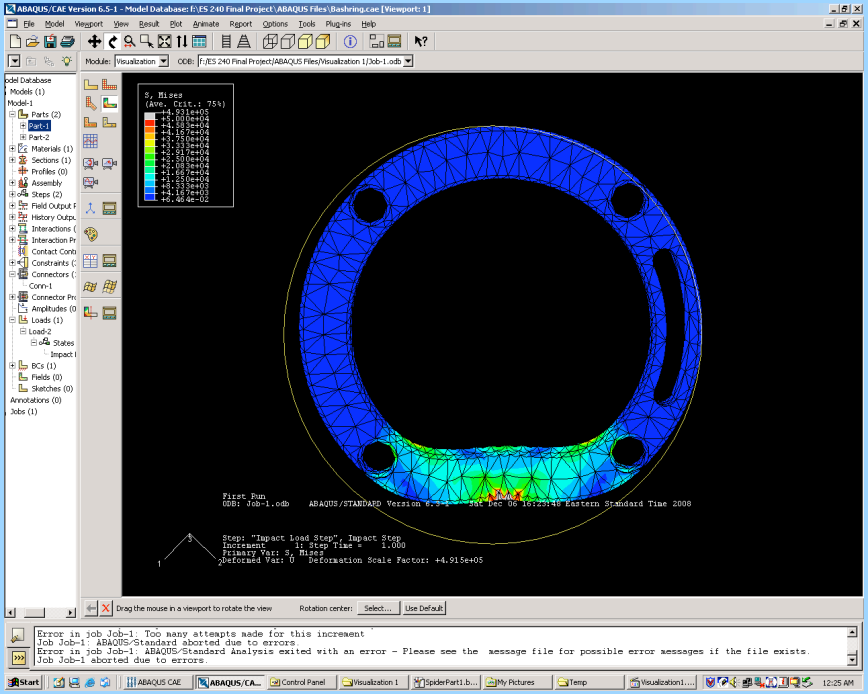
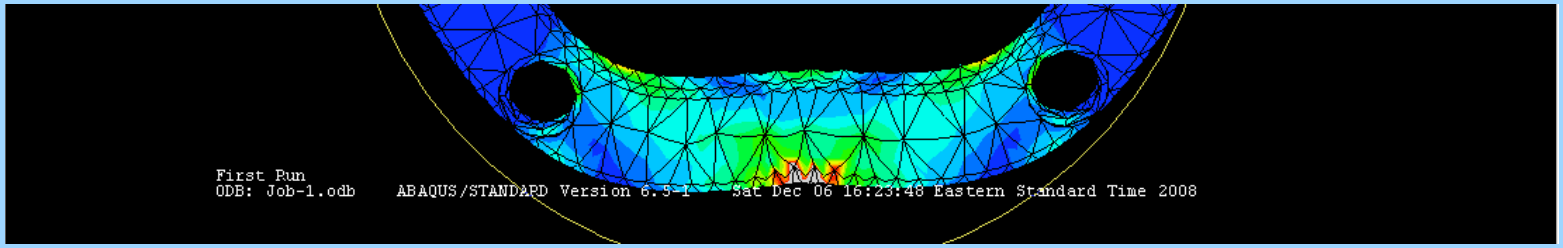
Drag the mouse in a viewport to rotate the view
Rotation center:
Select...
Use Default
Error in job Job-1: Too many attempts made for this increment
Job Job-1: ABAQUS/Standard aborted due to errors.
Error in job Job-1: ABAQUS/Standard Analysis exited with an error - Please see the message file for possible error messages if the file exists.
Job Job-1 aborted due to errors.
Start
ABAQUS CAE
ABAQUS/CAE Version ...
Control Panel
ES 240 Final Project
RingPart1.bmp - Paint
12:19 AM

Analysis of Principal Loading

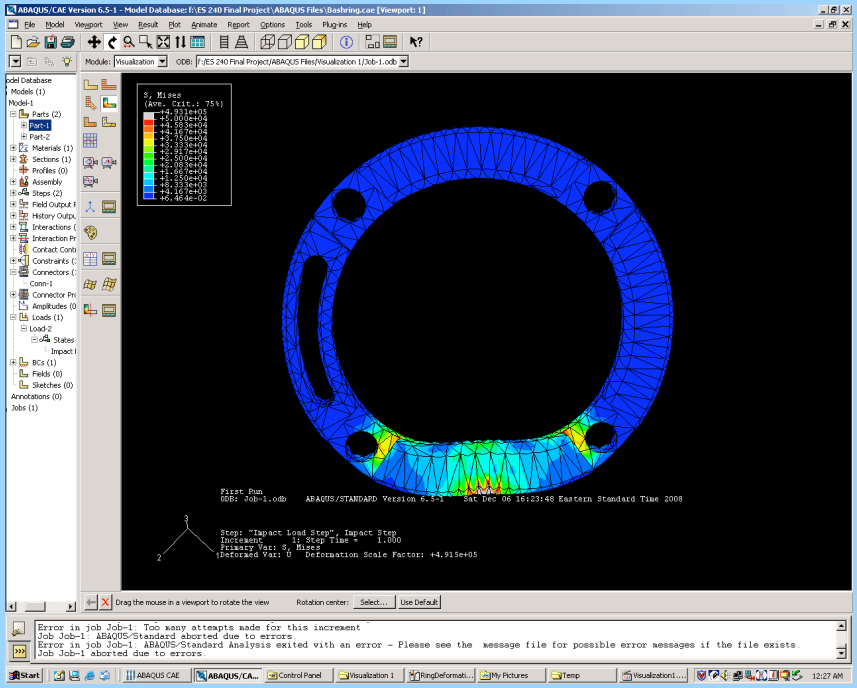
<u>Full-Load Landing:</u>

- Rider & Bike: 210lbs
  - Max deceleration force: 1.5x210lb = **315lbs**
- Rigid edge contact
  - Table edge, railing, etc.
  - Model as point-force
  - Encastred bolt holes
- Quadratic 10-node Tetrahedral elements
  - 4000 of them (C3D10M)





Analysis of Principal Loading (cont.)



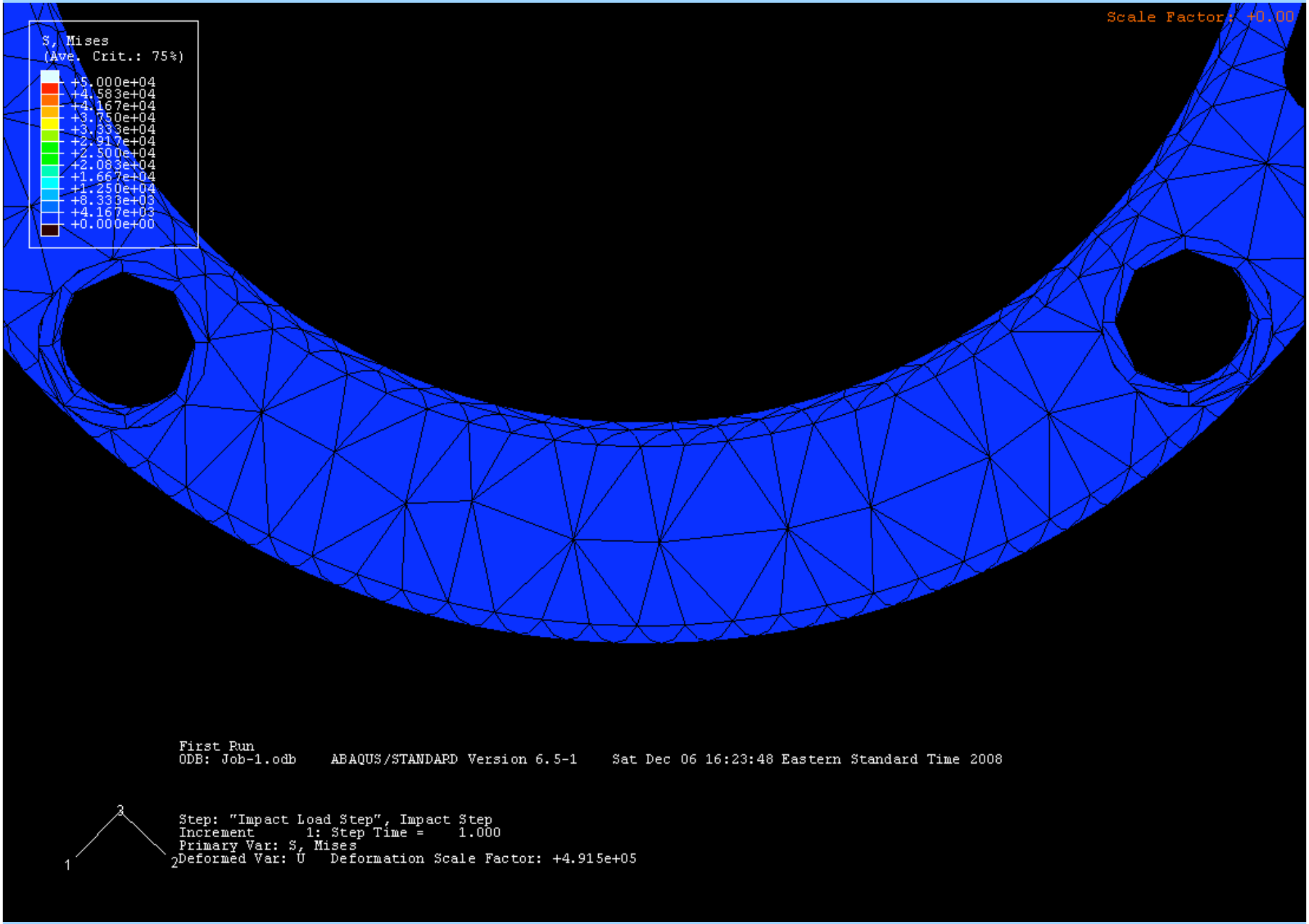
Where is max stress?

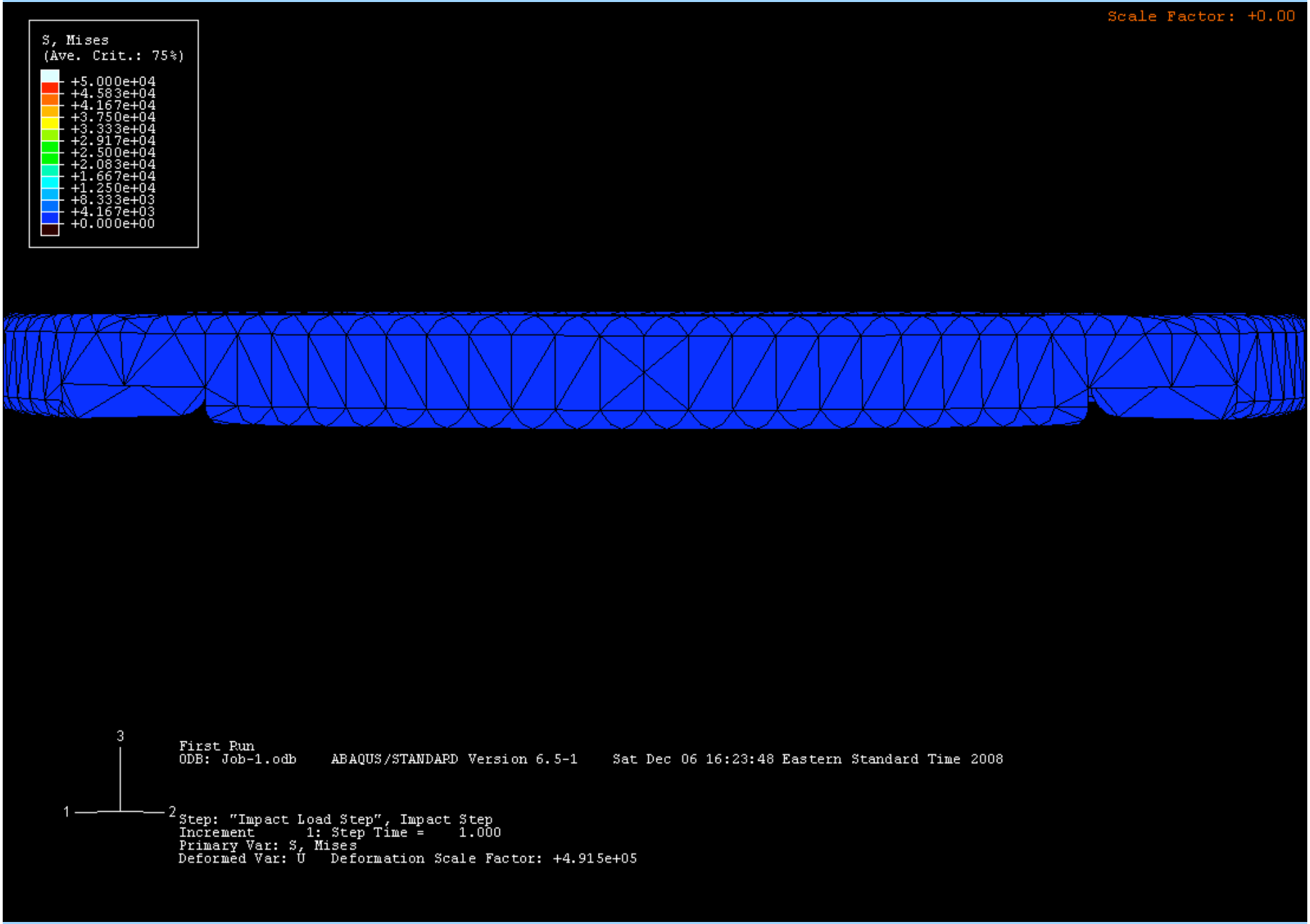
Note on Units

- Length: millimeters
- Force: milliNewtons
- → Stress: kPa

Note on Material

- 7075 Aluminum
  - Yield stress: 95 Mpa
  - Modulus: 75 GPa


S, Mises
(Ave. Crit.: 75%)
+5.000e+04
+4.583e+04
+4.167e+04
+3.750e+04
+3.333e+04
+2.917e+04
+2.500e+04
+2.083e+04
+1.667e+04
+1.250e+04
+8.333e+03
+4.167e+03
+0.000e+00
Scale Factor: +0.00
First Run
ODB: Job-1.odb ABAQUS/STANDARD Version 6.5-1 Sat Dec 06 16:23:48 Eastern Standard Time 2008
Step: "Impact Load Step", Impact Step
Increment 1: Step Time = 1.000
Primary Var: S, Mises
Deformed Var: U Deformation Scale Factor: +4.915e+05
3
1
2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+2.083e+04
+1.667e+04
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+8.333e+03
+4.167e+03
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Scale Factor: +0.00
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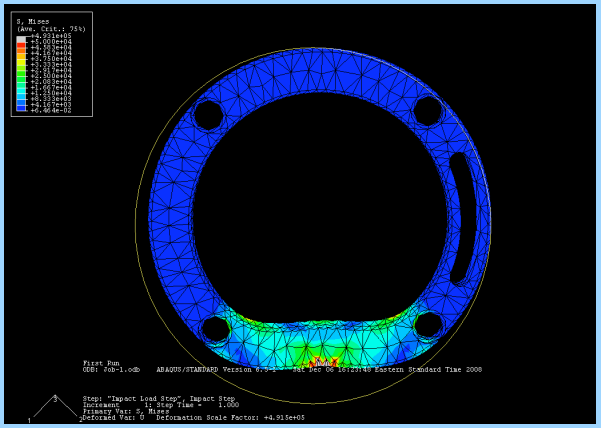
First Run
ODB: Job-1.odb ABAQUS/STANDARD Version 6.5-1 Sat Dec 06 16:23:48 Eastern Standard Time 2008
Step: "Impact Load Step", Impact Step
Increment 1: Step Time = 1.000
Primary Var: S, Mises
Deformed Var: U Deformation Scale Factor: +4.915e+05

Solution Plausibility

Plausible Results

- Symmetric stress field
- Stress largely contained within affected quarter
- Sensible magnitudes
- Predictable deformation



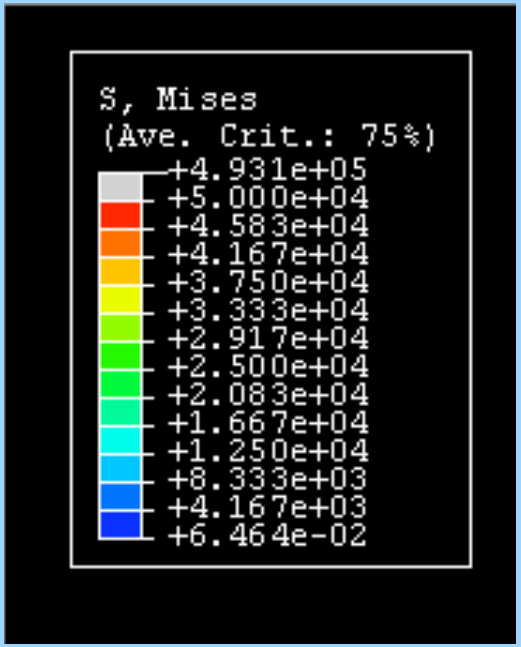
Potential Sources of Error

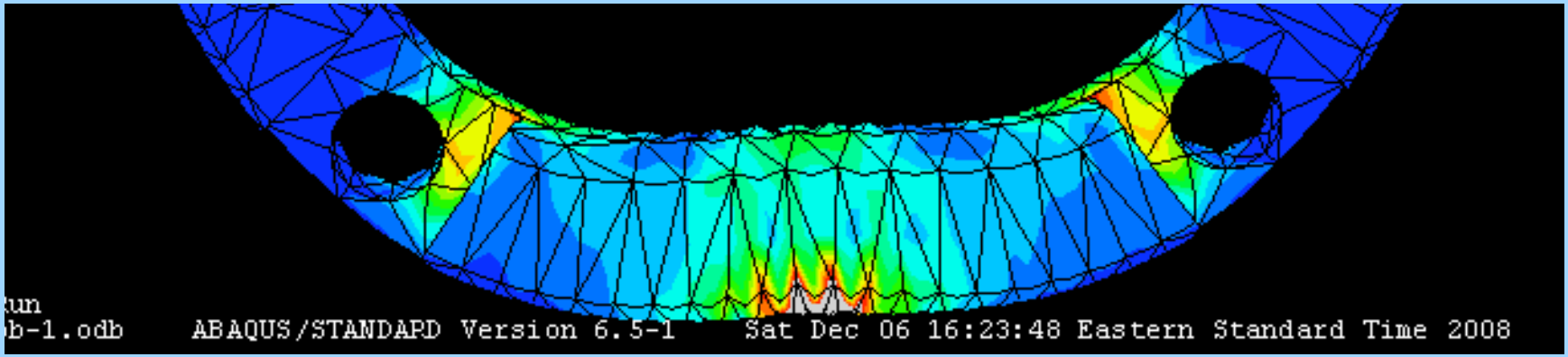
- Encastred bolt holes
  - Rough approximation of tightened bolts
- Point loading
  - No clear method for line-load deformation
  - Must ignore immediate area around load
- Constant load
  - No consideration of strain history!

Analysis of Principal Loading (cont.)

Where is Max Stress?

- Occurs symmetrically
- At the sharp edge
- Max value: ~50 MPa



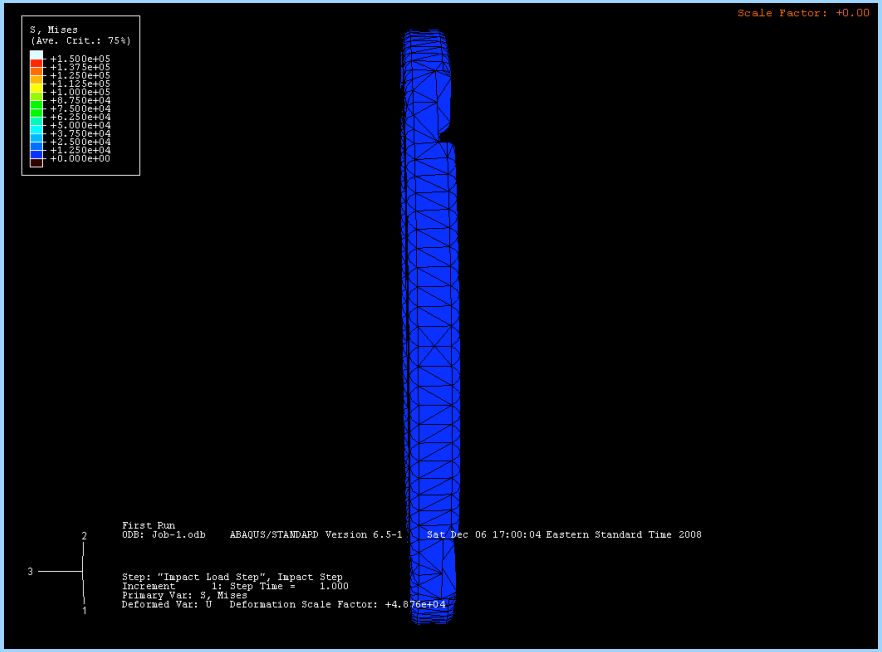


Results & Metrics

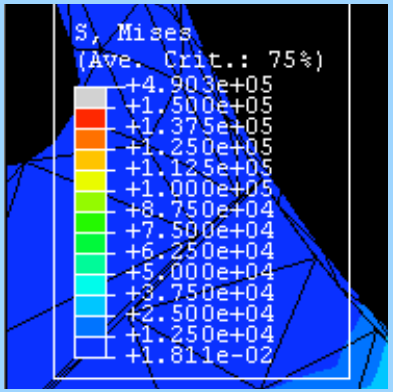
- Anticipated load-induced maximum stress:
  ~50 MPa
- Material Yield Strength:
  ~95 Mpa
- Implied Factor of Safety:
  ~1.9
- Non-critical FoS range for land vehicles:
  1.25 – 2.5

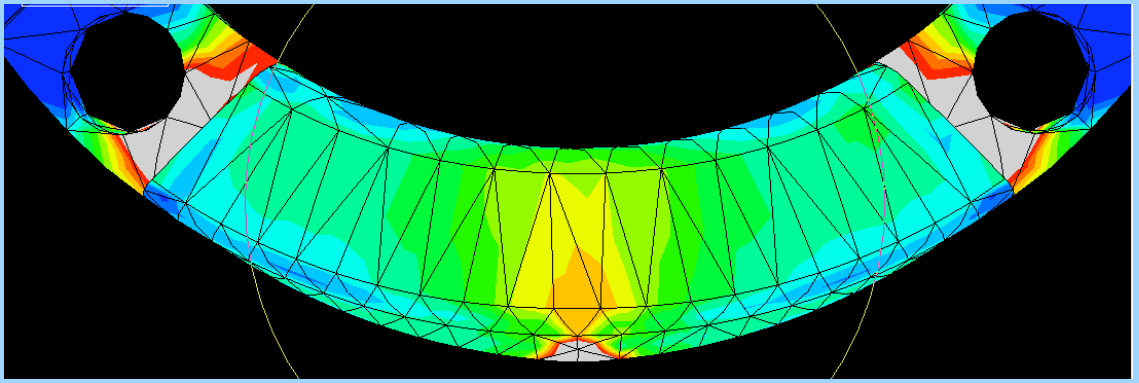
- Conclude that intuition served me well
  - Properly strong
  - Reasonably light

Secondary Loading



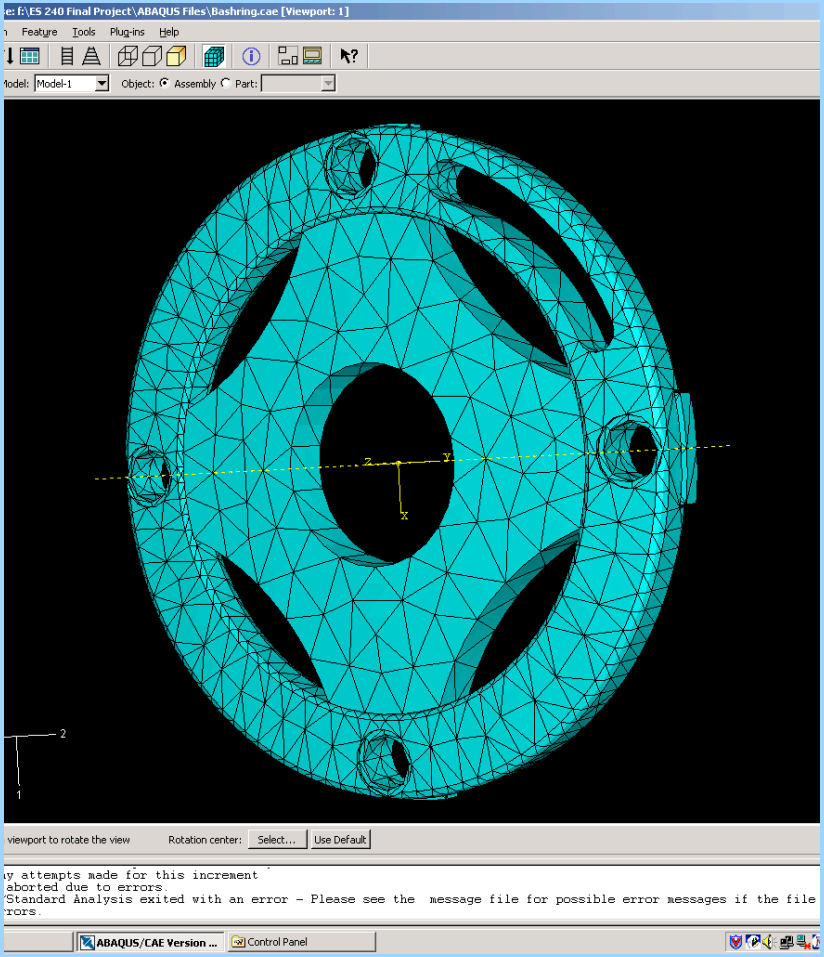
- Analyzed lateral loading
  - Same rider & bike weight
  - Same encastred bolts
  - Different: Sideways landing
  - Similar results: Max Stress: ~50 MPa





Potential Further Work

- Model ring & spider together
  - Are they stronger together?
  - Are Factors of Safety well-matched?
- Trouble mating parts in ABAQUS
- Might need to model bolts to bind assembly together



The End: Questions?