Impact Strength of a Hand-Made Bashring

ES 240 Final Project Report

Tom Milnes – 12/16/2008

NOTE BEFORE READING:

The accompanying presentation is an excellent companion to this paper and reading it alongside will add greatly to the information contained herein.

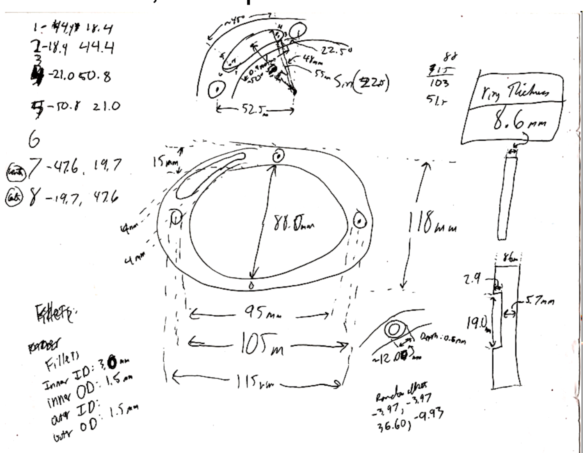
INTRODUCTION:

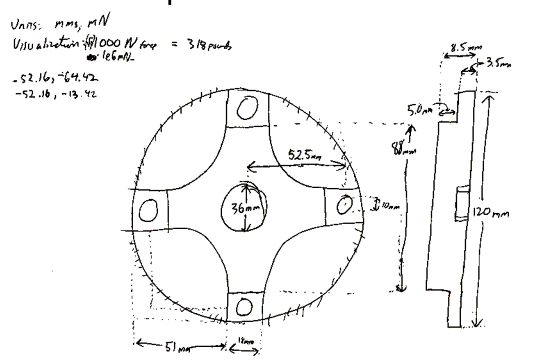
When I was an undergraduate, I spent a lot of time in the machine shop making various things. One day I decided to make a part for my mountain bike, because I couldn't find exactly what I was looking for in stores. The part is a “bashring,” which is designed to protect the front gears of a bicycle. On certain types of bikes, such as those designed for trials mountain biking, the bashring is constantly coming into contact with rocks, walls, benches, etc. Without a bashring, the front gears would quickly become damaged beyond repair.

When I decided to make the ring, I pulled a block of aluminum out of the shop's scrap pile and started milling. I didn't "design" it in the mechanical engineering sense (despite my major). Instead, I eyeballed most of the measurements. I relied on intuition to create a ring that was "beefy enough" for its application, without being too heavy. I have always wanted to formally analyze the bashring to see how strong it is, and to see whether my intuition served me well. This project was the perfect opportunity

METHOD:

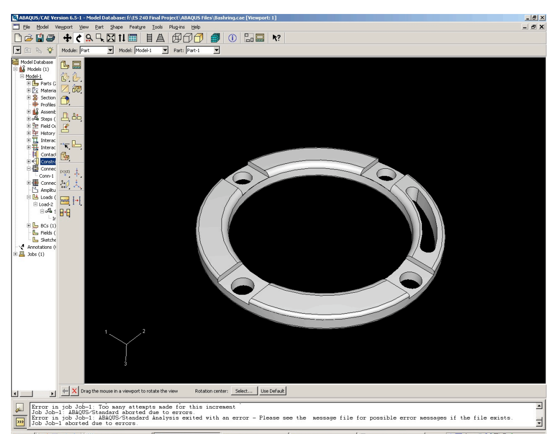
The first step in analyzing the ring was to draw up schematics for it's many dimensions. Because I built the ring on intuition, I didn't know any of the dimensions ahead of time, so I spent an hour or two with a set of calipers. The end results can be



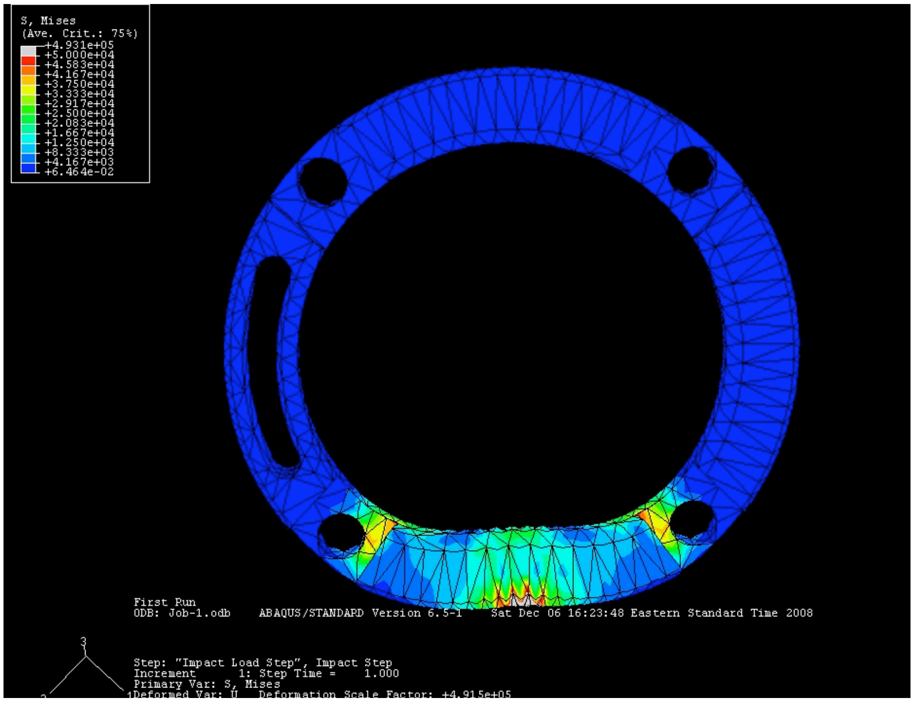


seen in the photos above.

The next step was to import the part into ABAQUS, using these measurements. At first this seemed like it might be a daunting task. However, it actually turned out to be very easy. I started with an extruded disc, and simply cut out the center & bolt holes. Then I filleted each edge and counter-sunk the bolt holes with 4 more extrusion cuts. The whole process (after learning how to draw) took about 2 hours. The image at right shows the finished part in the ABAQUS viewing window.



Once the part was drawn, it was time to mesh, apply loads, and analyze. I won't go into the detail of meshing, loading, etc. because those topics are better learned from the ABAQUS documentation. A quick summary will suffice: the part was meshed with about 4500 quadratic 10-node tetrahedral elements, which were recommended by the documentation for their flexibility across various problem types. The load is applied to a single point on the bottom of the ring. It would be more realistic to apply the load as a line force or as a deformable body, but ABAQUS doesn't appear to have a good way of doing that. So, the entire 315lb load is applied to a single point. The load represents the maximum force of a rider & bike landing squarely on the ring.

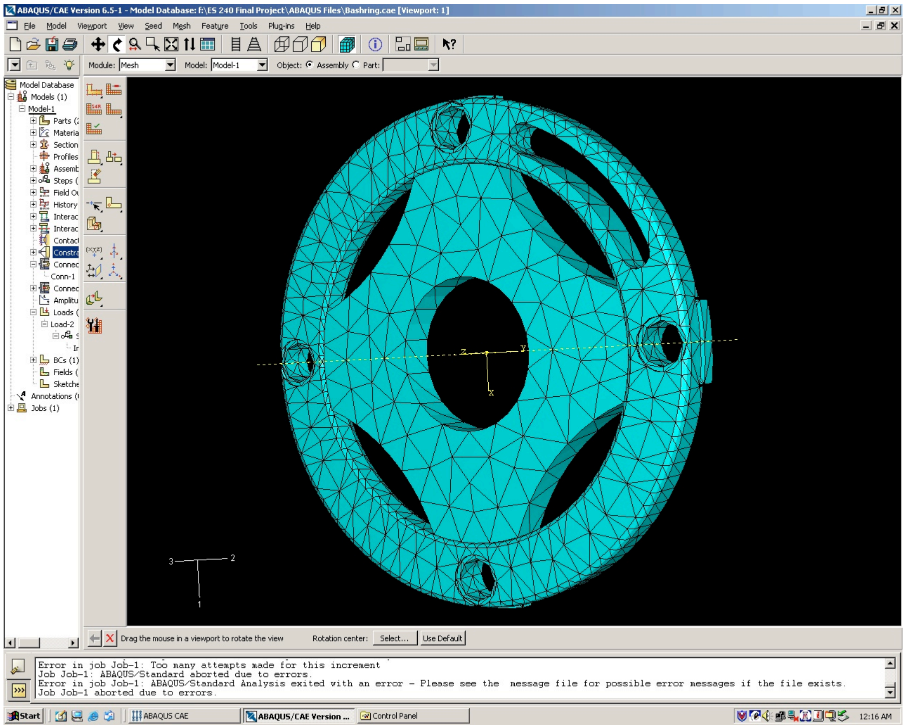


The results for the analysis are fairly interesting. As the photo at left shows, the maximal stresses occur at the loading point, and at the two sharp edges near the bolt holes. The figures and analyses are all based on Von Mises stress, since a part only fails as the result of tensile stress. Because of the awkward loading condition, the area immediately around the load can safely be ignored. As a result, we can say that maximal loading occurs at the two sharp edges near the bolts, with a rough magnitude of 50MPa. Given that aluminum's yield strength is ~95MPa, the ring has an effect factor of safety of ~1.9. This is good news for my intuition, since 1.25-2.50 is the standard range of factors of safety for non-critical land vehicle parts.

FURTHER WORK:

Once the above primary analysis was done, I went on to look at secondary loading conditions. The results are available in the accompanying presentation, but to summarize the findings, the ring has similar factors of safety for the secondary loading condition I looked at.

As a final step, I wanted to analyze the ring and the spider it is attached to together. I drew the spider in ABAQUS and spent several hours trying to mate the parts and properly constrain them together. Unfortunately I was not successful, as this sort of work isn't covered well if at all in the documentation, so it may not even be possible. Nonetheless, if I had more time and was able to get it to work, it would make for some interesting results.



CONCLUSION:

The project was very interesting for me. I feel that I was able to analyze a problem that I felt was intersting, and come out with some useful results. I'm also happy to know that the intuition I exercised so many years ago in building this ring served me so well. Perhaps I'll find myself in a similar class later in life, and I will be able to take the analysis even further.