Fermilab

Particle Physics Division
Mechanical Department Engineering Note

Number: MD-ENG-366 Date: 19 July 2011

Project Internal Reference:

Project: CDF

Title: Structural Analysis of CDF Wedge Stand

Author(s): Bianca Brandveen

Reviewer(s): Dave Pushka D. PUSHKA 7-20-2011

Key Words: stand, support, wedge, welded, bolted, CDF

Applicable Codes: AISC Steel Construction Manual, 9th ed.

Abstract Summary:

This fixture is currently supporting a wedge on display in the CDF building. No driven FESHM requirement for a stand like this currently exists, but since the stands are already supporting a wedge we can assume that they have not been under-designed.

I have modeled this stand and created an FEA solution using NX 7.5. I applied an 8 ton load for the simulation, since the wedge lifting fixture is rated for 16 tons and there are two wedge stands taking this load. The wedge stand geometry is shown on the next few pages. The material for the stand is A36 steel. The bolts are A325.

Shear stress in the bolts is what we are mostly concerned about. The bolt pattern consisting of 8 bolts exists on the back wall (see Figure 3).

GIVEN:

Figure 1: Left side view of wedge stand.

Figure 2: Another view of the wedge stand. Notice the quality of the welds.

Figure 3: Front view of the wedge stand. There are a total of 8 bolts in the bolt pattern.

Figure 4: Another view of the wedge stand from the right side.

From the view of Figure 3, the stand is 51 ¾ inches tall and 60 inches wide.

FIND:

- Are the stresses on the bolts greater than allowable according to AISC?

CONSTRAINTS:

The allowable shear stress in a ¾" bolt, F_v, is 7.51 ksi according to AISC 9th edition page 4-5.

SOLUTION:

Hand Calculations

Since we are concerned with the bolts and bolt holes, we check to see how much single shear stress they experience.

$$f_{v,bolt} = \frac{2\ kip}{\frac{1}{2}(\frac{3}{4}\ in * \ \pi)} = 1.697\ ksi$$

This is less than the allowable stress, so it is acceptable. To confirm the hand calculations, a finite element model was created in NX 7.5.

Finite Element Analysis

Since the total load on each stand is 8 tons (16,000 pounds) and there are 8 bolts in the pattern, I applied a 2,000 pound load to every bolt hole. I also applied a gravity force on the entire system. I fully fixed the base with a "fixed" constraint. This resulted in maximum values for Max Shear stress and Von-Mises stress of 311 psi and 590 psi, respectively.

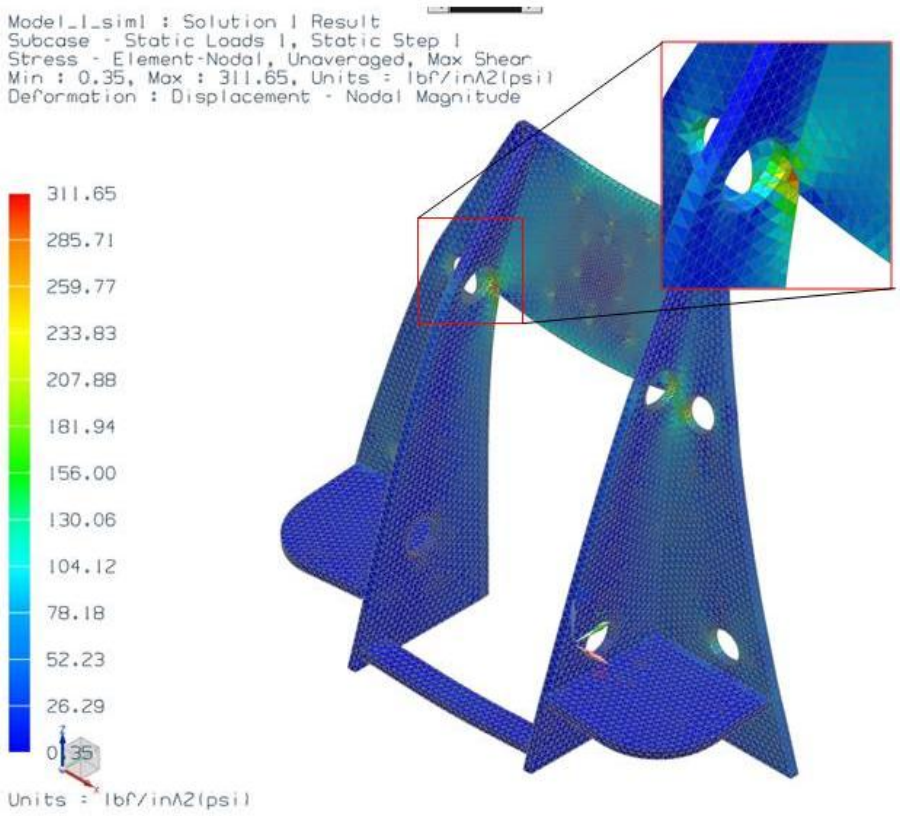

Figure 5: FEA Results for Maximum Shear Stress

The maximum displacement of the wedge stand occurs on the back wall. Its value is very small, at 0.000676 inches.

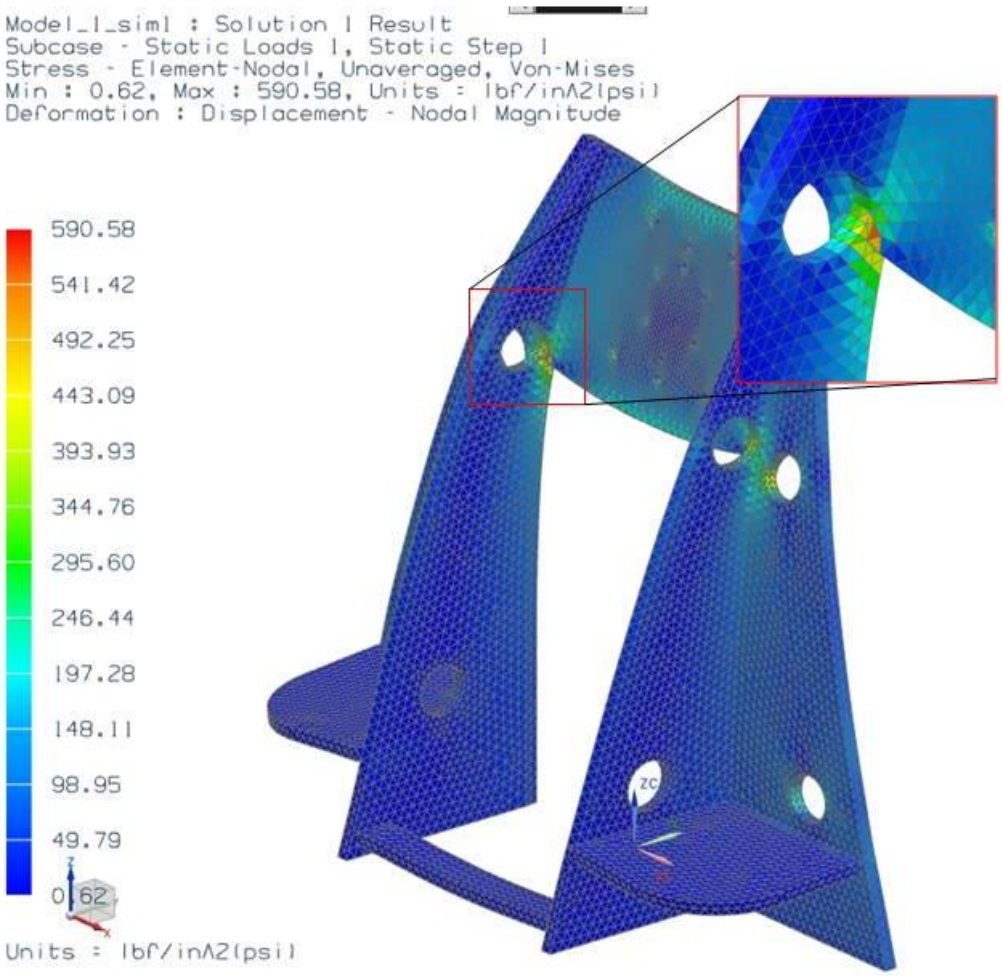

Figure 6: FEA Results for Von-Mises Stress