K1DM3 Design Note
Swing Arm Pivot Pin Loads
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INTRODUCTION

The swing arm pivot pin was investigated for structural integrity due to concern over loads that may occur during earthquake.

ANALYSIS

A finite element analysis (FEA) was performed on the pivot pin using ANSYS. Beam elements were used and, due to symmetry, only one half of the pin was modeled. A schematic of the geometry is shown in Figure 1. The pin is ½ inch in diameter. The extreme ends of the bearings are 8 inches apart. The area the swing arm contacts the pin is 5/8 inches wide and 60 mils (.060") from the bearing.

The peak response load at the swing arm pivot obtained from the earthquake analysis was 7500 pounds. Due to symmetry, then, 3750 LBS was used in the pin FEA. The load was varied in location throughout the o-ring area. In reality the load will be evenly distributed such the resulting average would be at the center. At the midpoint, x = .3775, the maximum stress was 92.5 KSI. For this load case the stress and displacement plots are shown in Figures 2 & 3. A graph of the stress as a function of the load application point is shown in Figure 4.

RE-DESIGN

Although high grade bolts are available with tensile strength of 150 KSI[1], the joint was re-designed and the o-ring area was reduced to 0.455 inches. This put the average load at 0.2875 inches from the bearing. The resulting stress, as shown in Figure 5, was reduced to 36 KSI, a factor of 2.5 below the original design.

CONCLUSION

With re-design of the pivot joint the anticipated peak stress due to earthquake has been reduced and a high grade bolt of SAE grade 8 or better will provide a safety factor of 4. It should also be noted that the earthquake analysis used a 5 G load level for determining the peak response at the pivot. The K1DM3 Requirements Document specifies only a 2 G load level for earthquake. This provides an overall safety factor of 10.

[1] http://www.engineeringtoolbox.com/steel-bolts-sae-grades-d_1426.html

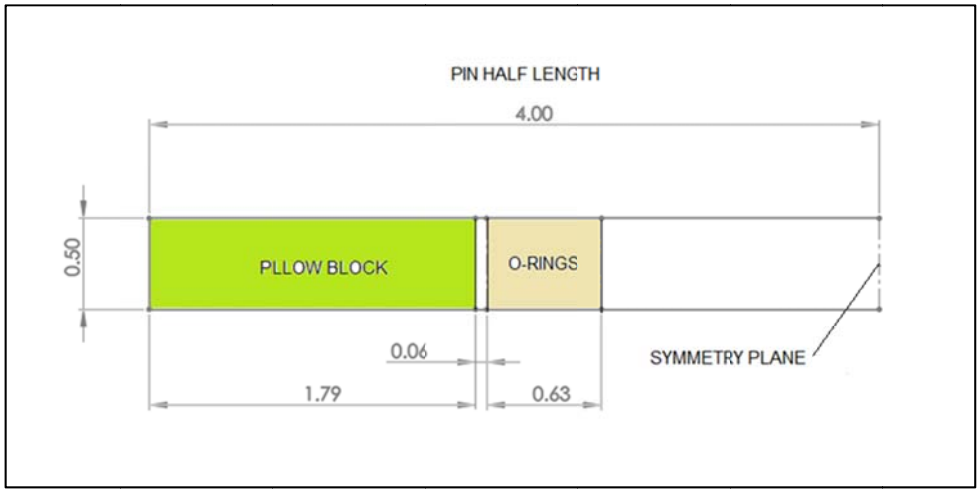

Figure 1 - Schematic of the pivot pin. The pillow block area is restrained within the bearing, allowing only rotation. The o-ring area is the location thru which the swing arm loads the pin.

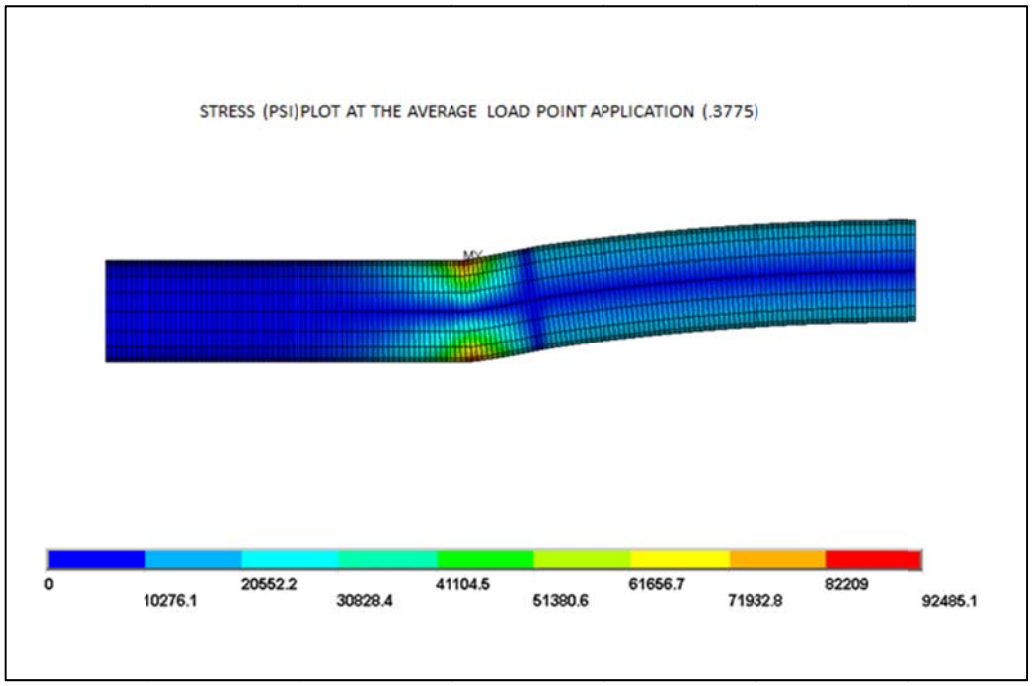

Figure 2 - Stress (psi) contour plot of the pin with the maximum dynamic reaction applied at the center (x = .3775") of the o-ring area.

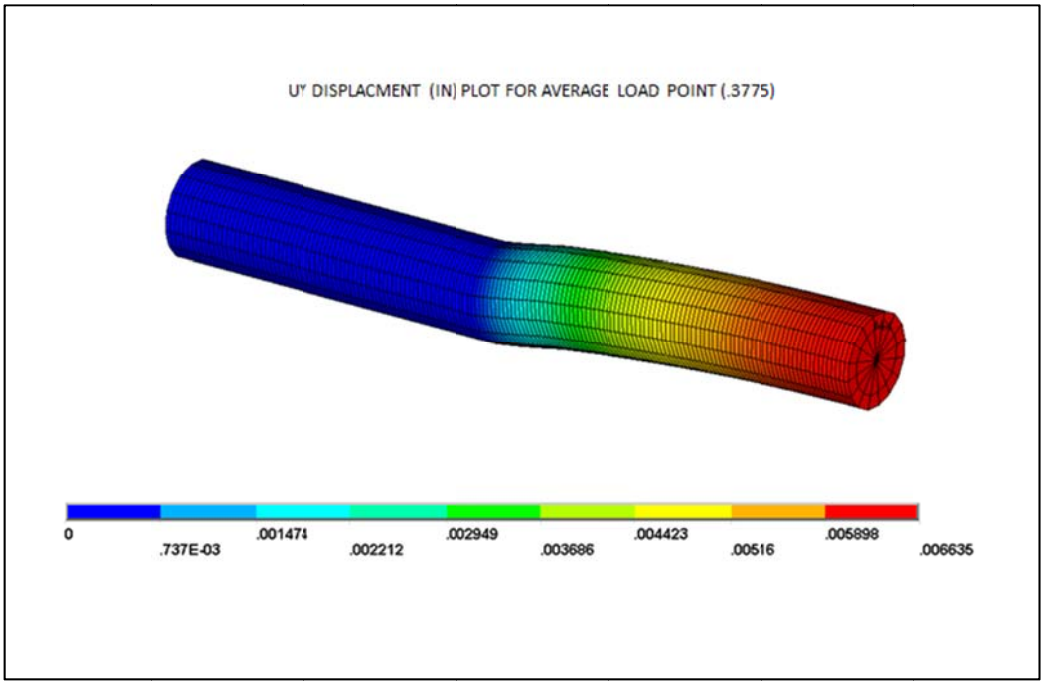

Figure 3 - Diplacement (in) contour plot for the same load case as in Figure 2.

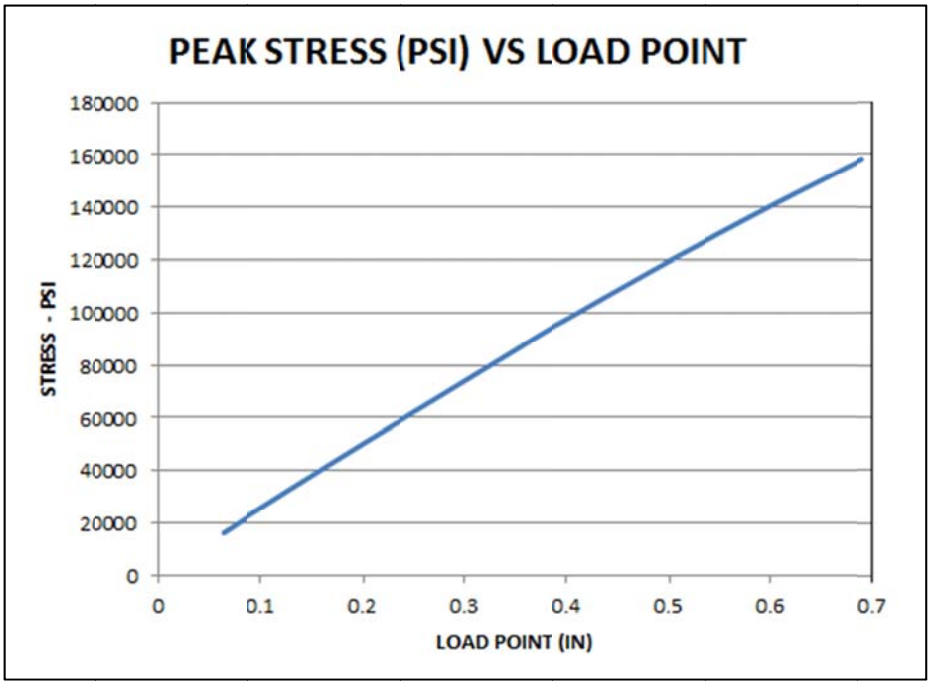

Figure 4 - Graph showing the maximum stress as a function of the load point in the o-ring area.

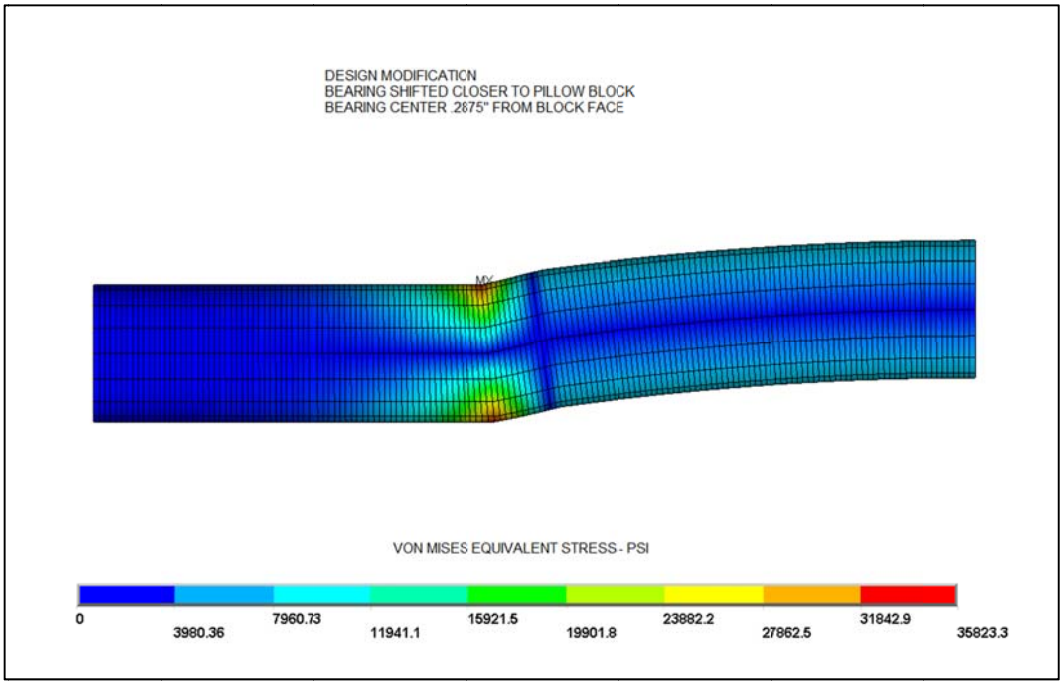

Figure 5 - Stress (psi) contour plot for the same load condition after re-design.