Nova-Doc-5655-v1

An Updated Analysis for the Upper Arm based on a Heavier Table and Extrusion

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Introduction

A steel upper arm, used for Nova pivot table assembly, is designed by D. Pushka as shown in Fig 1. This note is to update the calculation [1] to reflect the latest loading change as indicated by reference 2. The structure is made of A-36 steel with an allowable of ~21.6 ksi.

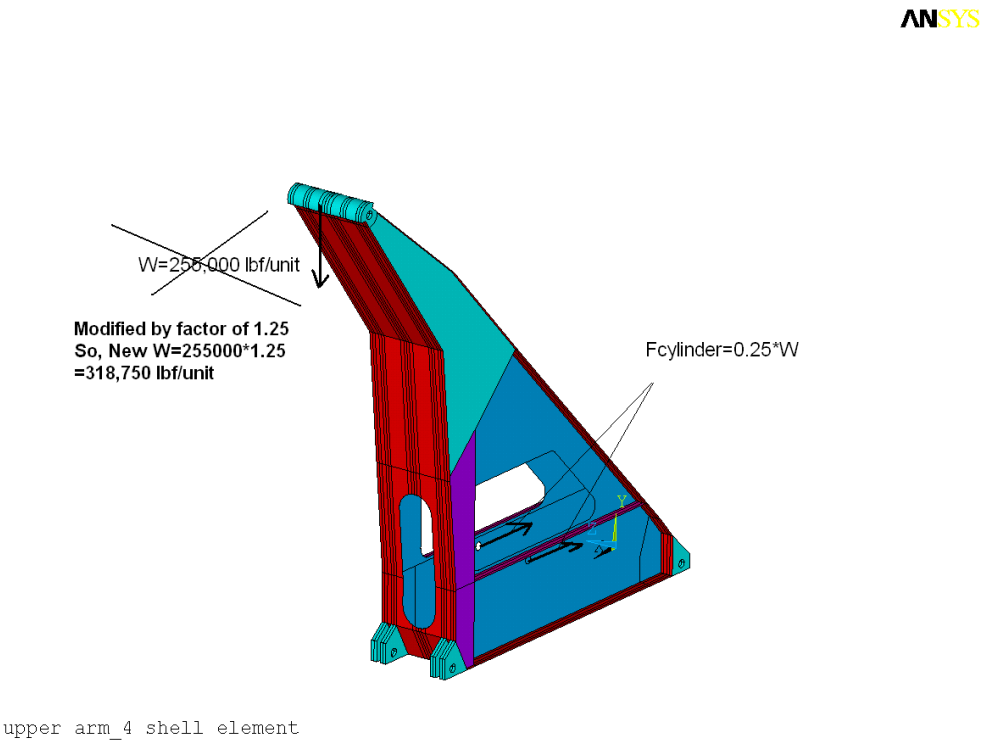


Fig 1 The Upper Arm Structure with a heavier load

Modeling

One-half structure is modeled by a shell element (shell 181) in Ansys as shown in Fig 2 with a following condition:

a) The gravity load from the table is applied on the top housing area as W/2=255,000*1.25/2=159,375 lb.

b) The cylinder reaction (Fcylin) is estimated based on the earlier study [3] . It is ~25% of the vertical load W.

c) The constraints, for both front and back housing, are shown in Fig 2. For the front one, top half is constrained along the radial direction only with free rotation along the tangential direction. The back housing is constrained in a similar fashion, except it is on the lower half.

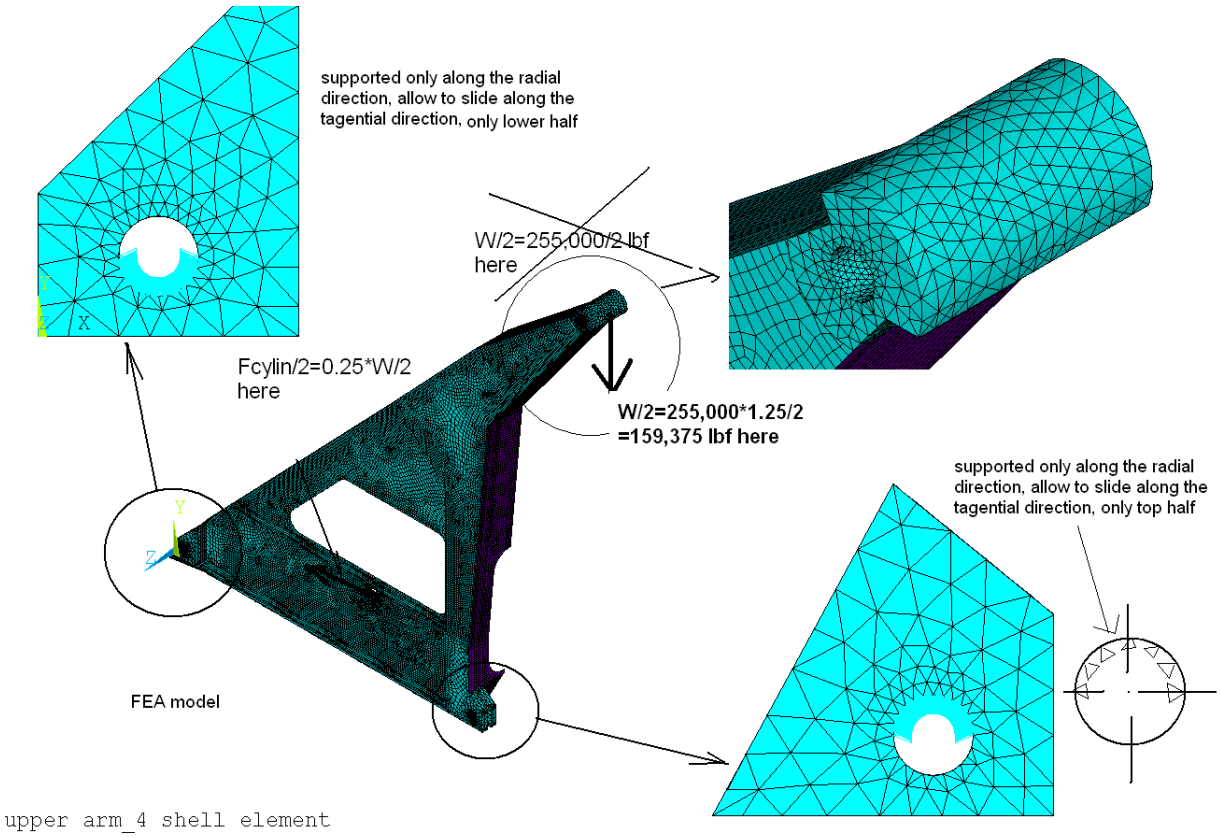


Fig 2 FEA model

Result and Discussion

a) Structure member

The calculation result is summarized in Table 1. The structure member seems adequate for a given loading case.

Table 1 Stress for the upper arm

Parts	#1_ upper reinforce-ment	#2 _ lower reinforce-ment	#3_top flange	#4_web section	# 5_ mid reinforce-ment	#6_back bracket	#7 _ the front bracket	#8 _top housing
Plate Thickness (inch)	2”	1”	2”	1”	0.5”	Solid block	Solid block	Solid block
Stress (ksi)	**12.2**	**8.1**	**20.2**	**16.75**	**14.7**	**12.25**	**20.25**	**14.8**
SF for the buckling	**SF=17/1.25=13.6***							

*Note: For the buckling calculation, we simply just scale the load by using the earlier result [(1)].

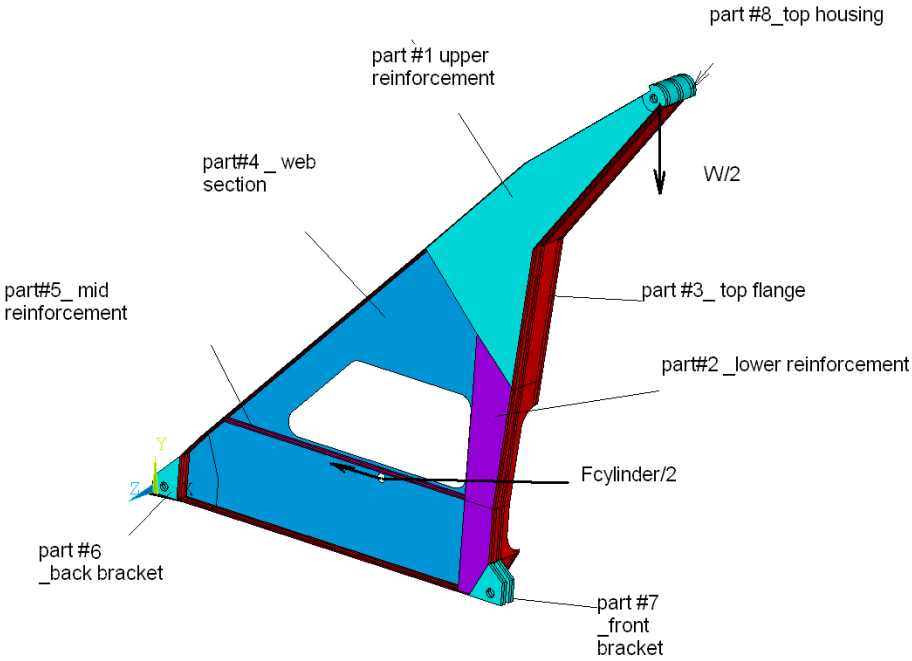


Fig 3 The description of the part

b) *Weld stress*

Most of welds are full size weld per weld drawing (3). We'll check several critical welds as:

- Front bracket area: the drawing shown is single bevel joint with size of 3/16" (view F-F). The minimum size for the partial penetration of the groove well should be at least

  te (min)=$(tp/6)^{0.5}$=$(1/6)^{0.5}$=0.408" with 1/8" additional size.--> around 0.5"

  It gives a 0.5" inch as min weld size. **It is suggested weld size for both forward and rear pin area should be rechecked and revised accordingly in the drawing.**

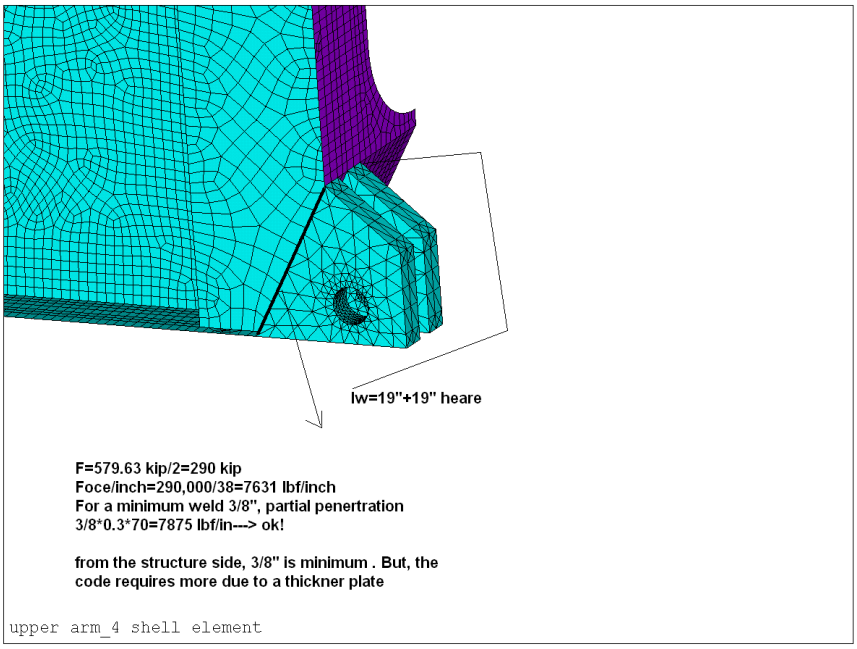


Fig 4 The weld size for forward pin area

- For the connection between Web and top flange, it is a double side,0.5" continuously fillet weld (based on conversation with D Pushka). Therefore, we've scaled the shear stress of the top flange by a factor or 1.43 (1/0.7) to estimate the shear stress on the weld connection as shown in Fig 5. The maximum seems around 11 ksi < 0.3*70. The node force summation also indicates the weld stress is fine for this region as shown in Fig 6.

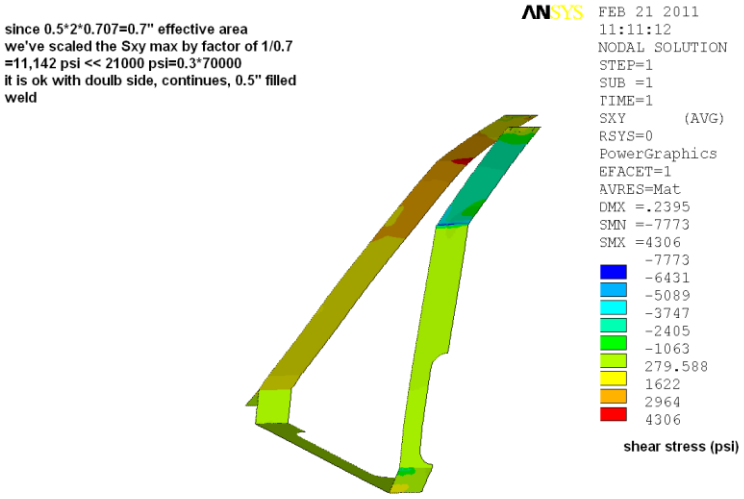


Fig 5 The shear stress plot for the top flange

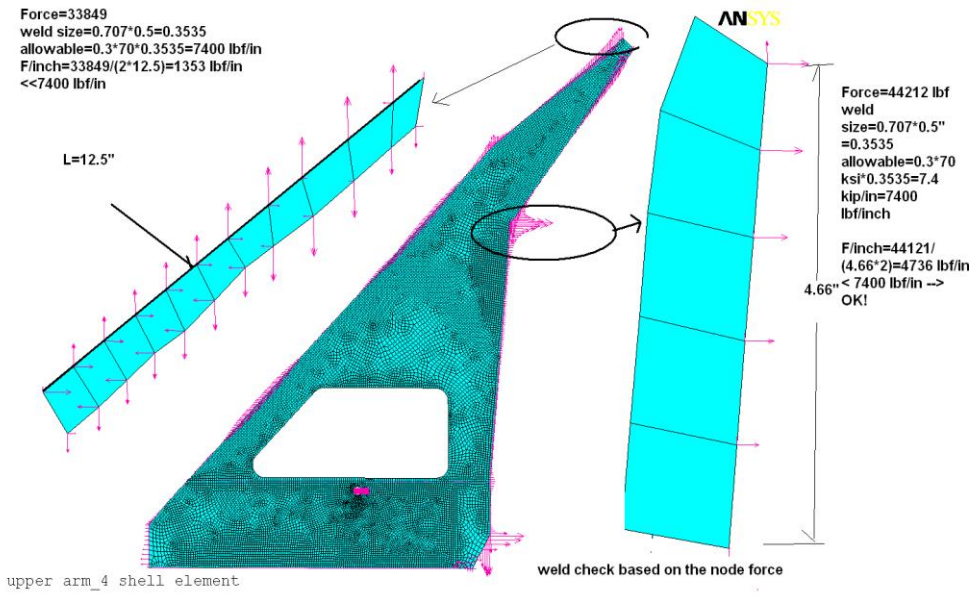


Fig 6 The node force summation result

Reference

1)Ang Lee," An Updated Calculation for the Upper Arm used in FHEP**",** Nova-doc-4217-v1,Sept 15, 2009

2) Dave Pushka," Evaluation of Design for Heavier Modules",MD-EBG-304, Jan 19, 2011

3) Ang Lee,"A Stress Analysis for the Upper Arm of the Pivot Table",Nova-doc-3666-v1,March 20, 2009

4)PPD_Weld Drawing," Nova FHEP PIVOTER UPPER FRAME ASSEMBLY WELDMENT",# 3929.220-ME-466549, OCT-26-2009

Appendix

Sterss plot

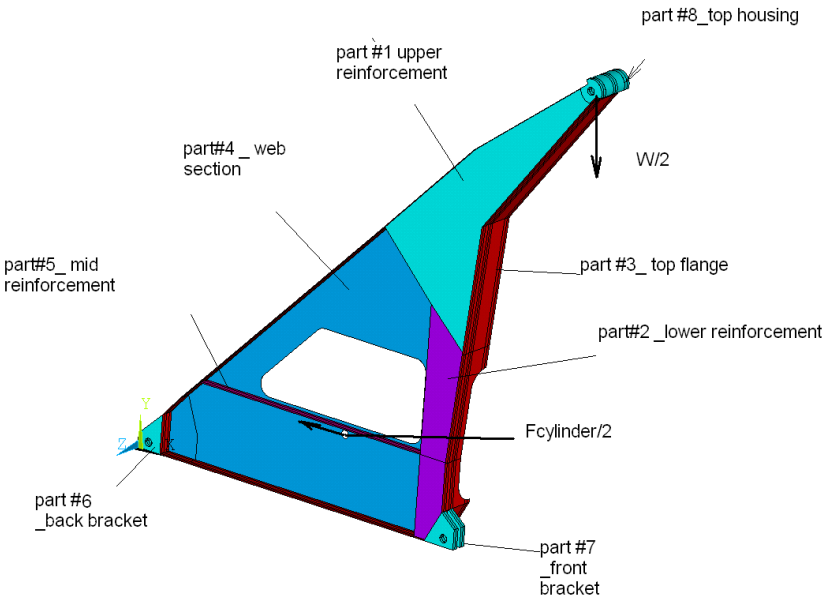


Fig A-1 The description of the parts

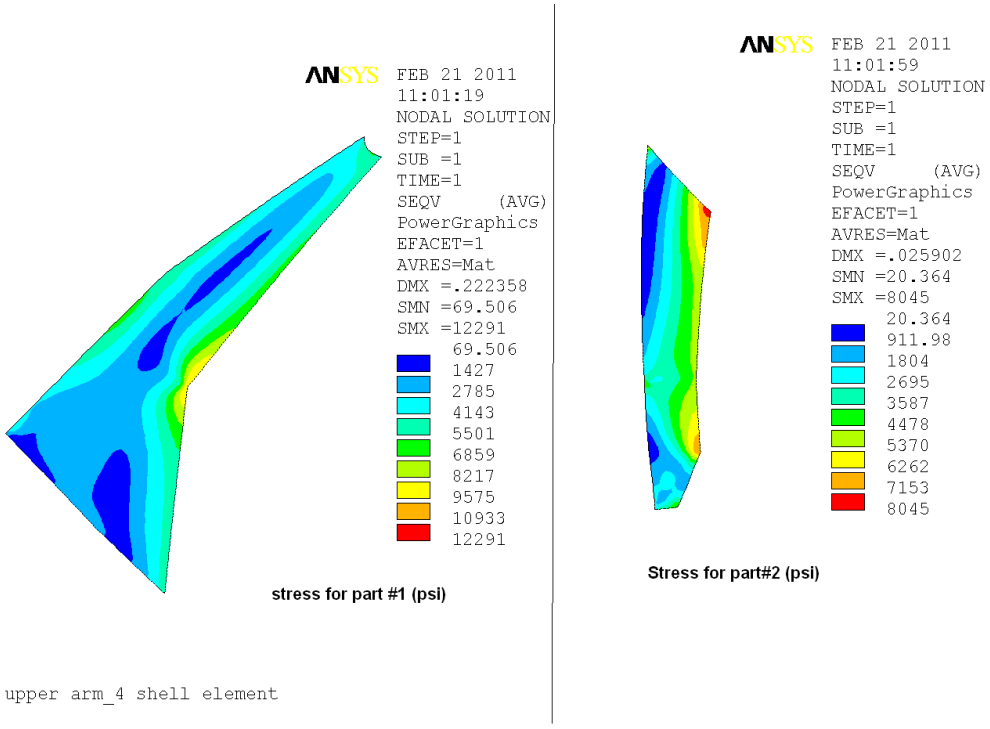
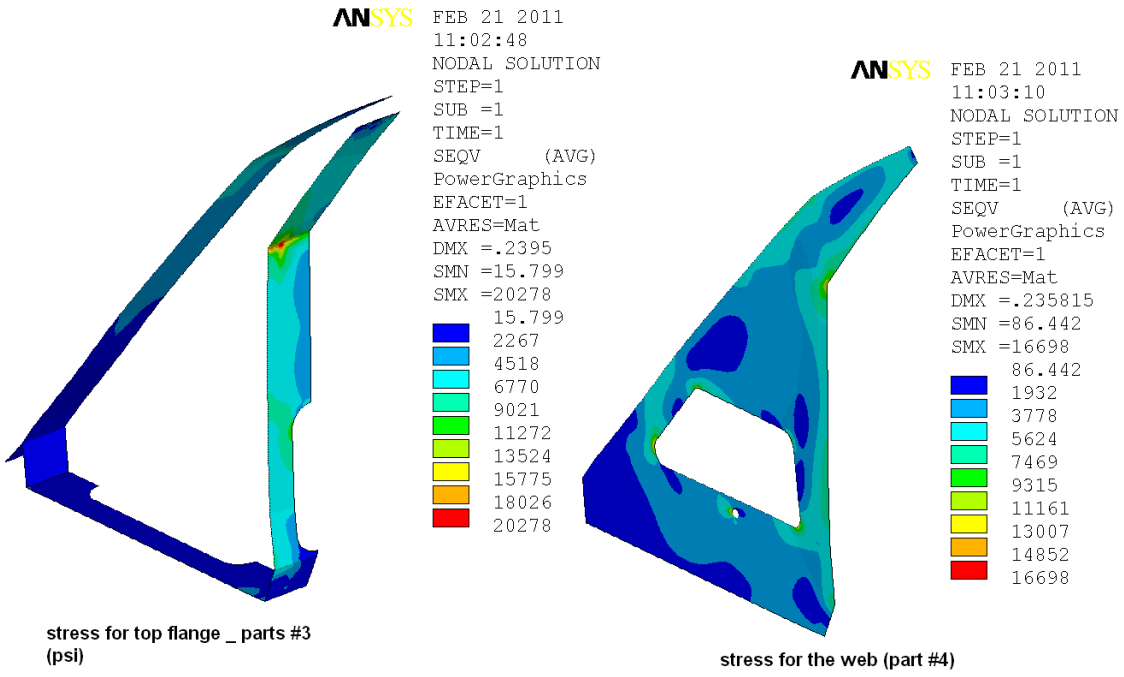


Fig A-2 Stress for part #1 and #2



upper arm_4 shell element

Fig A-3 Stress for part #3 and #4

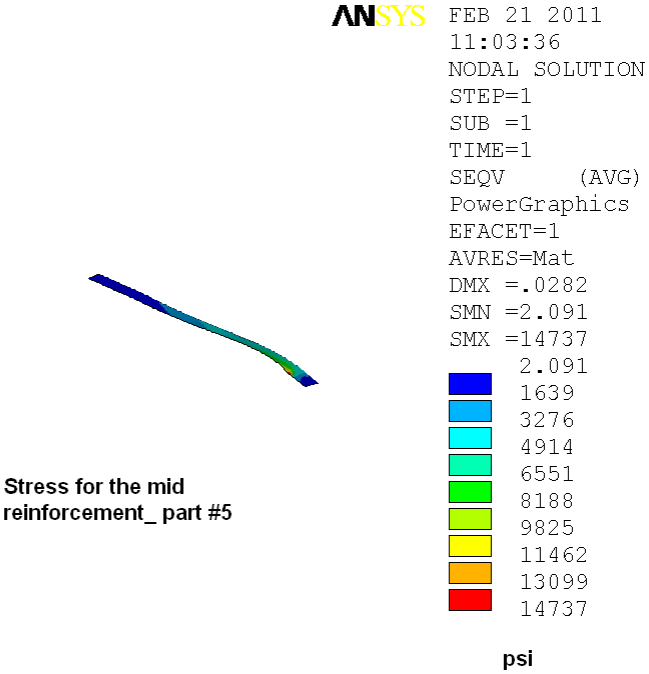


Fig A-4 Stress for part #5

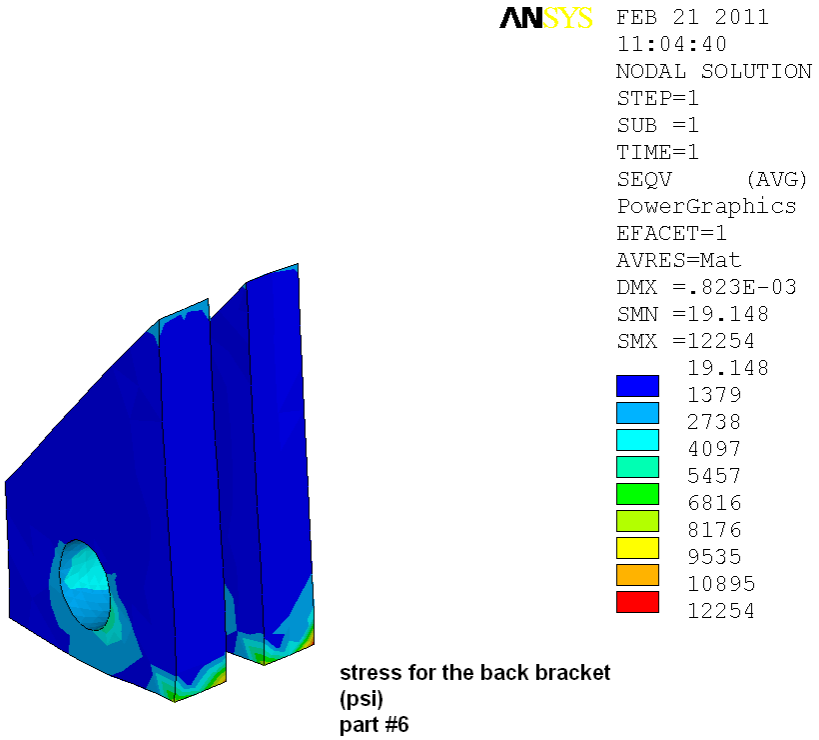


Fig A-5 Stress for the back bracket

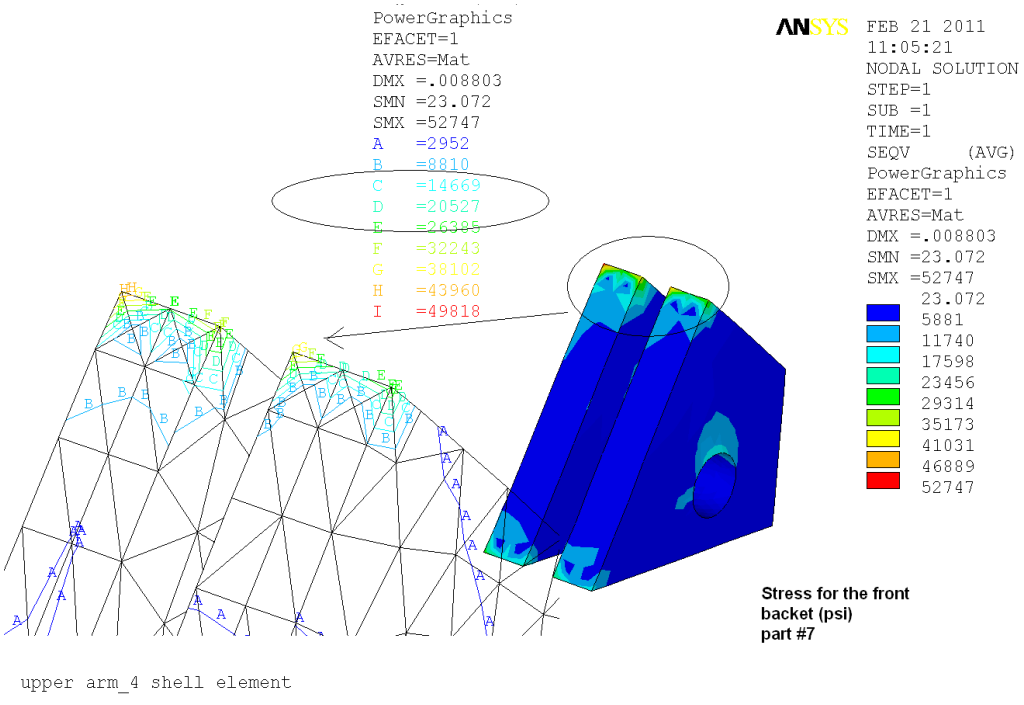


Fig A-6 Stress for the front bracket , part #7

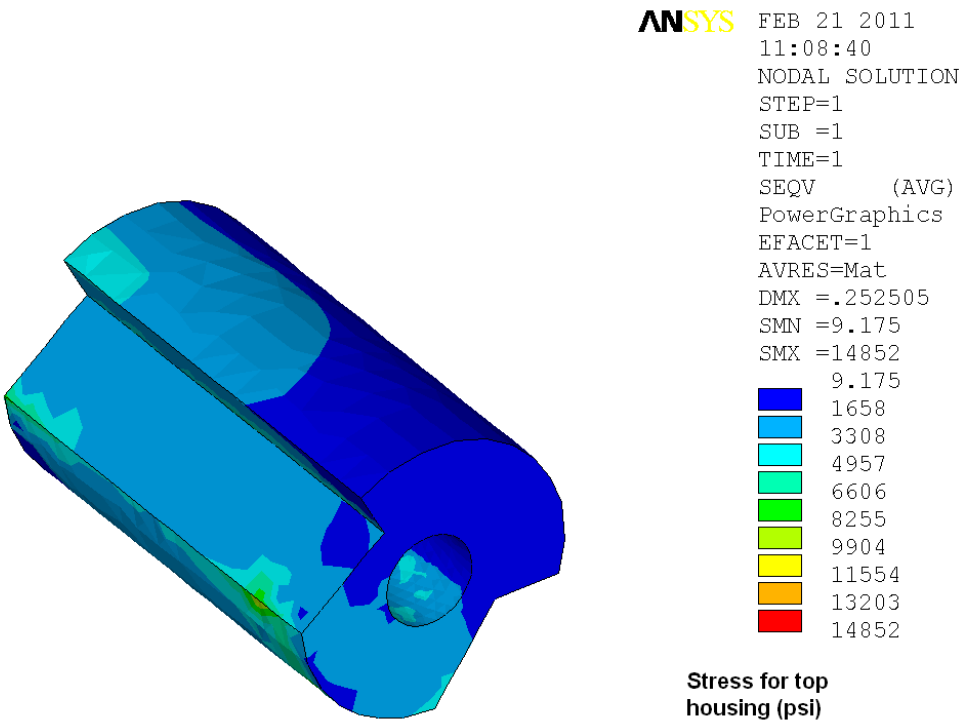
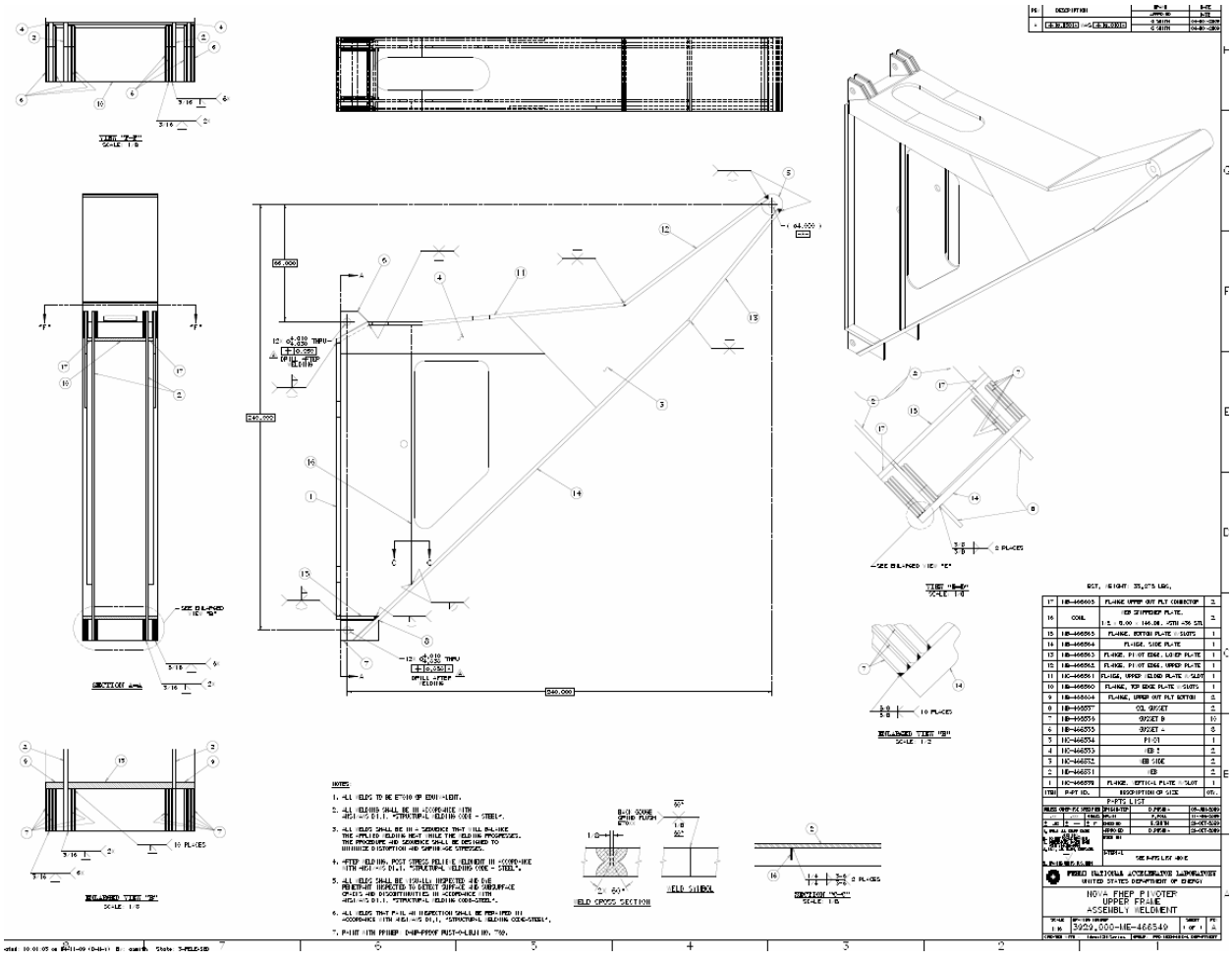


Fig A-7 Stress for the top housing

PPD weld drawing



25% weight increase:

Based on reference 2

Block weight=422,400

Table weight=204,400

Total will be=626800 lbf

Each upper arm will be 626800/2=313400 lbf/unit

Compared with initial number of 255,000/unit, 313400/255000=1.23--→ we have used factor of 1.25