

A Stress Analysis for the Upper Arm of the Pivot Table (Nova)__v1

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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. The structure is made of A-36 steel with an allowable of ~24 ksi. This analysis is to determine the stress under a full size PVC block.

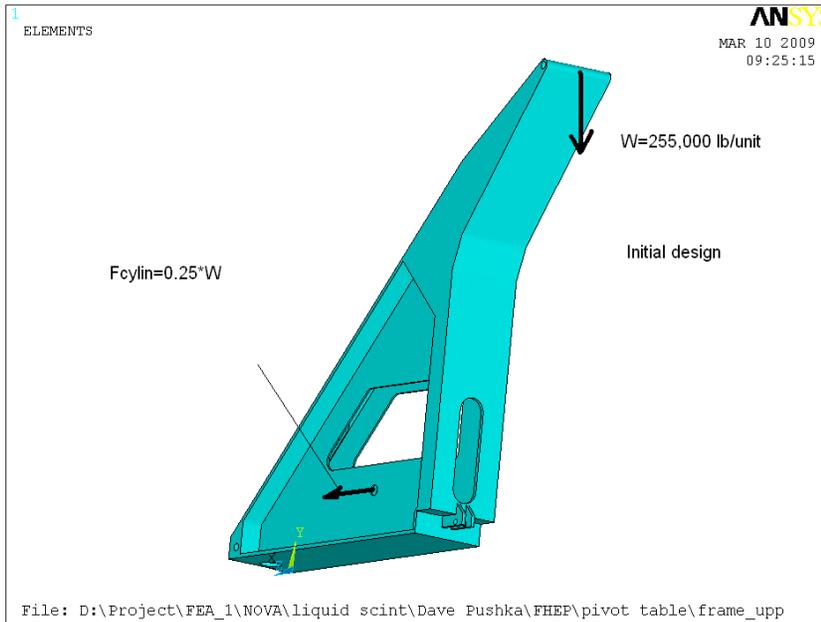


Fig 1 The upper arm Structure

Modeling

A solid model (Fig 1) of the structure is created by D. Pushka through IDEAS and then imported into the ANSYS (Para solid format). The analysis is done by ANSYS. Fig 2 is a ANSYS FEA model with a half structure due to the symmetry with the following conditions:

- The gravity load from the table is applied on the top housing area as $W/2=255,000/2=127,500$ lb.
- The cylinder reaction (F_{cylin}) is estimated based on the earlier study⁽¹⁾. It is ~25% of the vertical load W .
- 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.
- The 3-D 10 nodes tetrahedral structure solid element (solid 187) is used with an element size of ~1" (~ 2 millions degree of freedom).

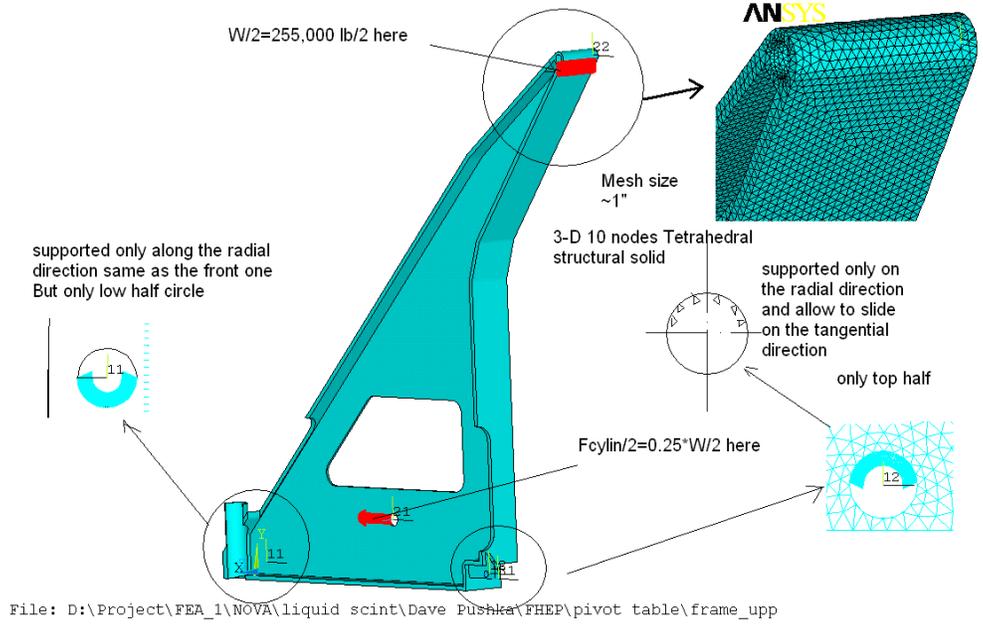


Fig 2 FEA Model (half structure)

Result & Discussion

The calculation starts with the initial design. The result reveals a very high stress around the front housing area. To reduce that, we've increased the bracket width to the 8" wide. Then, the model was iterated based on several different offset distances. The result is summarized in Table 1 & Fig 3. The 4" offset distance gives a least stress. It is primarily due to its center location between the side plate and web such that the vertical weight is more evenly distributed around the pin hole. The stress for the upper portion of structure stays very much flat. The buckling calculation indicates that safety factor is SF=11.6, which is sufficient.

Table 1 Summary of the Calculation Result

Case	Offset distance (see Fig 4)	Bracket housing area Location 1 (psi)	Top portion Location 2 (psi)	Peak stress (local stress) psi	SF (buckling)
1	Initial design	73,241	17,258	73,241	
2	0"	24,550	17,318	27,009	
3	1"	22,281	17,338	24,654	
4	2"	20,211	17,302	23,347	
5	4"	16,836	17,314	24,595	11.6

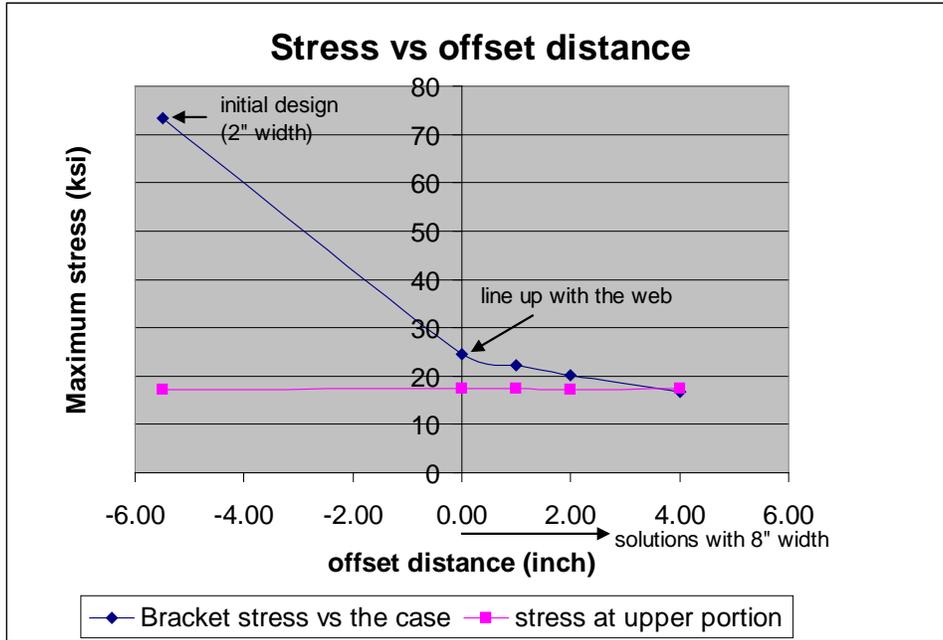


Fig 3 Stress vs offset distance

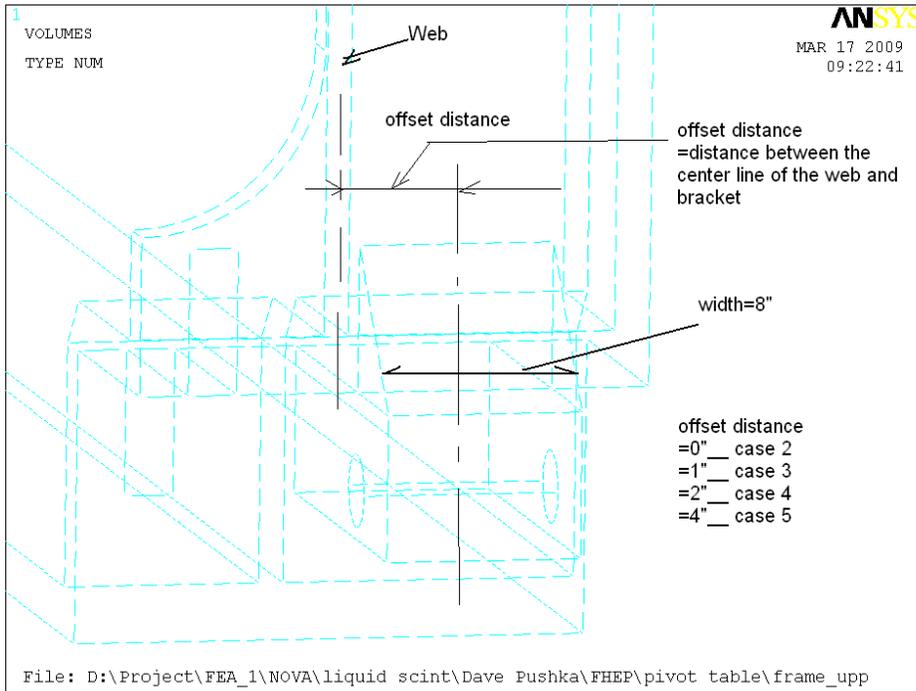


Fig 4 The off-set distance

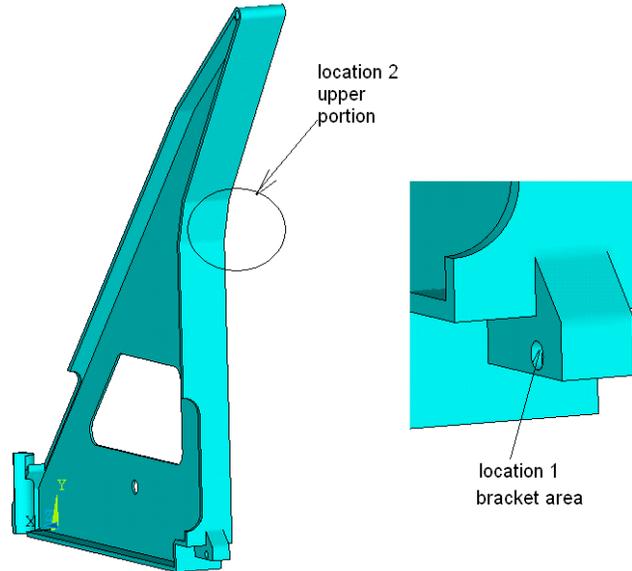


Fig 5 The high stress area _ location 1 & 2

Reference

1) Ang Lee," A Stress Analysis for a Pivot Table Used in FHEP (Nova)__v1, Nova-doc-3646-v1, March 6, 2009

Appendix A: The stress plot

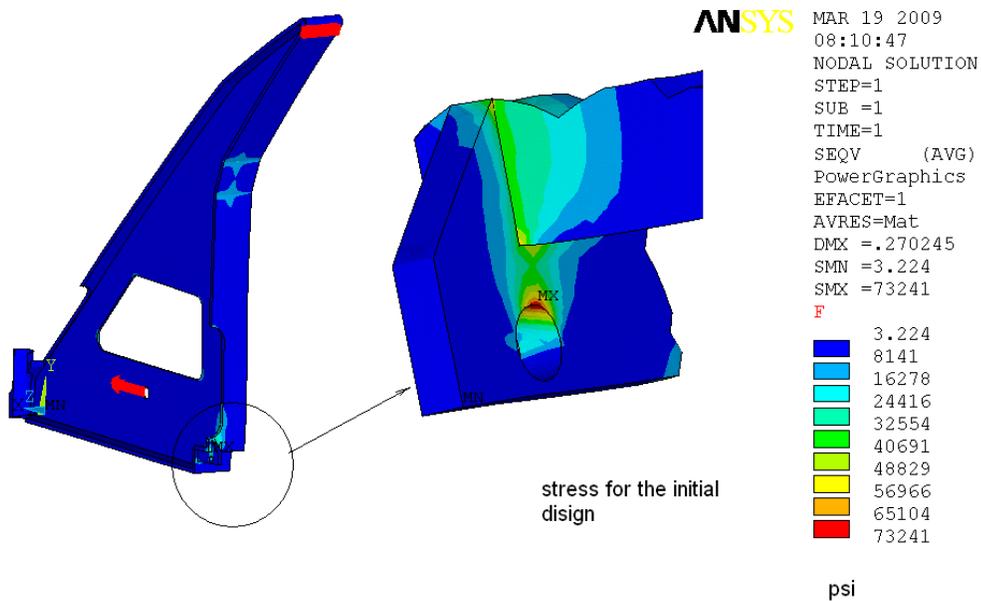


Fig A-1a The stress for the initial design (case_1)

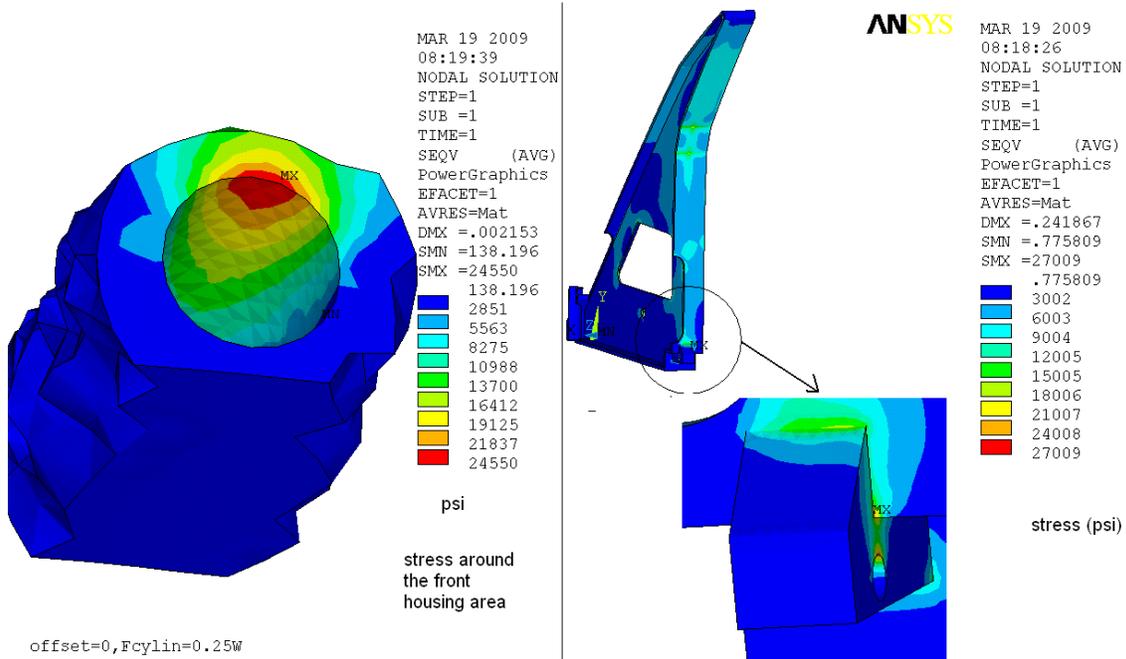


Fig A- 2a The stress for the case 2 (offset distance=0'')

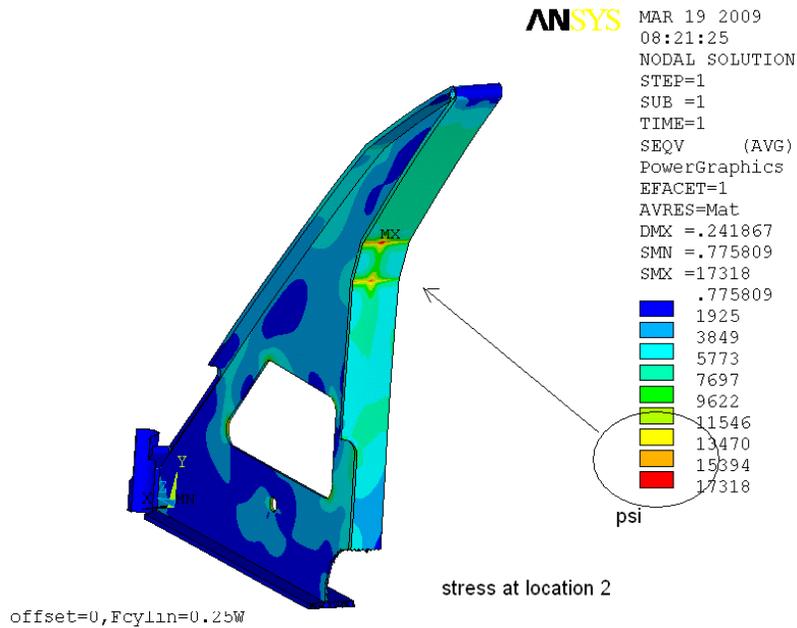


Fig A-2b The stress at the upper portion for the case 2 (offset distance=0'')

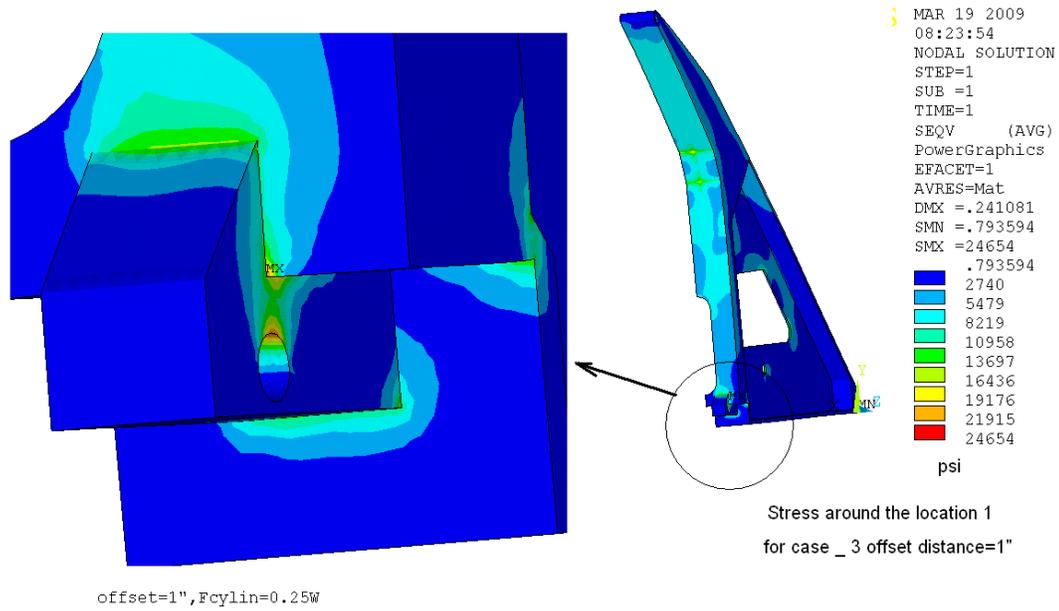


Fig A-3a The stress around the bracket area for the case 3 (offset distance=1")

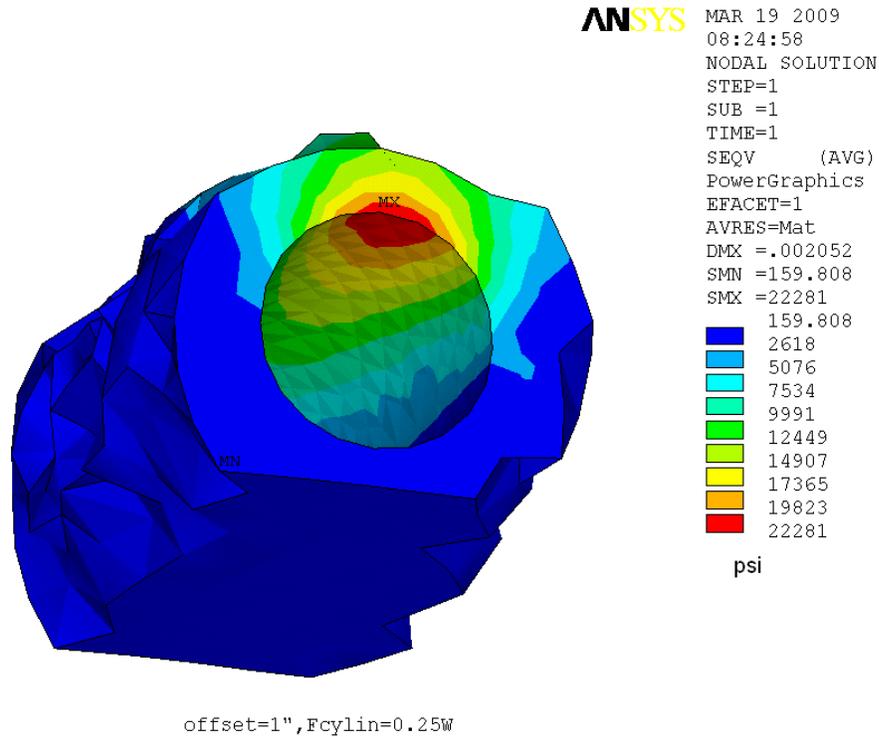
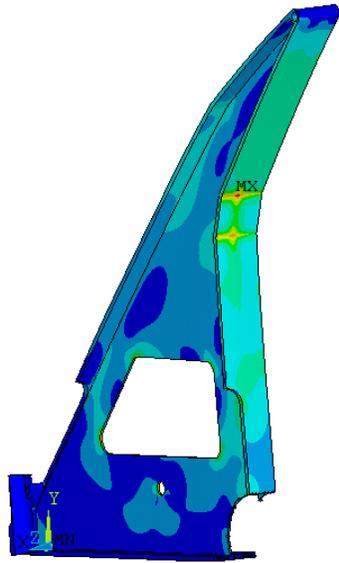


Fig A-3b The stress around the front housing for the case 3 (offset distance=1")

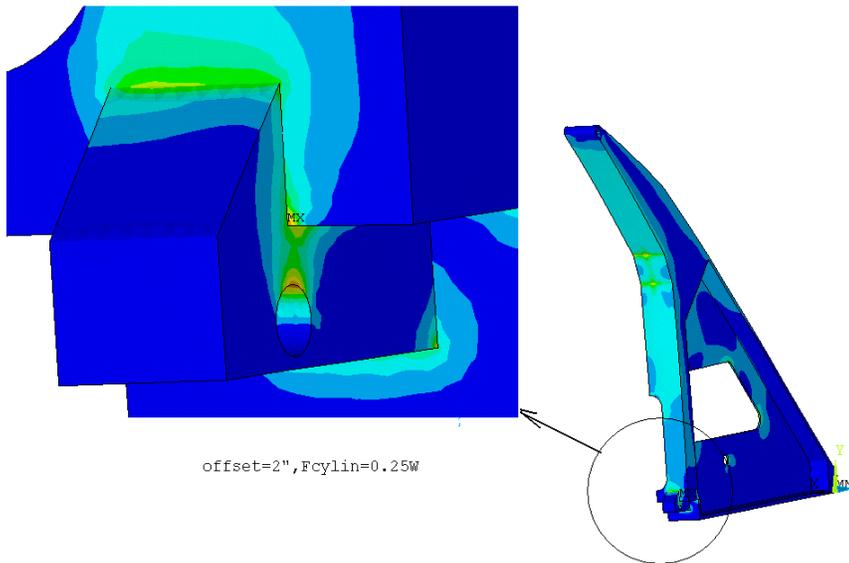
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 08:25:53
 NODAL SOLUTION
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 SUB =1
 TIME=1
 SEQV (AVG)
 PowerGraphics
 EFACET=1
 AVRES=Mat
 DMX =.241081
 SMN =.793594
 SMX =17335
 .793594
 1927
 3853
 5779
 7705
 9631
 11557
 13483
 15409
 17335
 psi



offset=1", Fcylin=0.25W

Fig A-3c The stress at upper portion for the case 3 (offset distance=1")

ANSYS MAR 19 2009
 08:28:37
 NODAL SOLUTION
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 SUB =1
 TIME=1
 SEQV (AVG)
 PowerGraphics
 EFACET=1
 AVRES=Mat
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 SMN =.825745
 SMX =23347
 .825745
 2595
 5189
 7783
 10377
 12971
 15565
 18159
 20753
 23347
 psi



offset=2", Fcylin=0.25W

Fig A-4a The stress around the bracket area for the case 4 (offset distance=2")

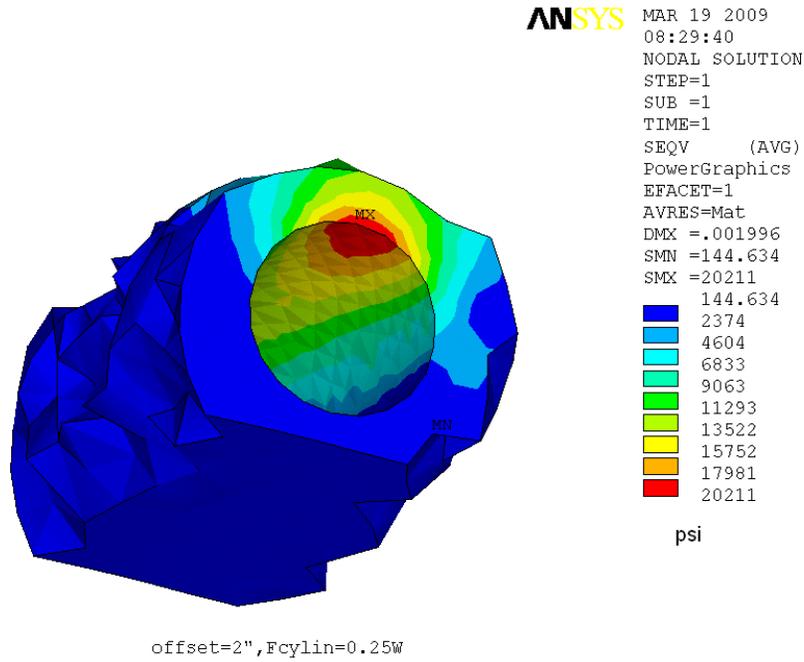


Fig A-4b The stress around the front housing for the case 4 (offset distance=2")

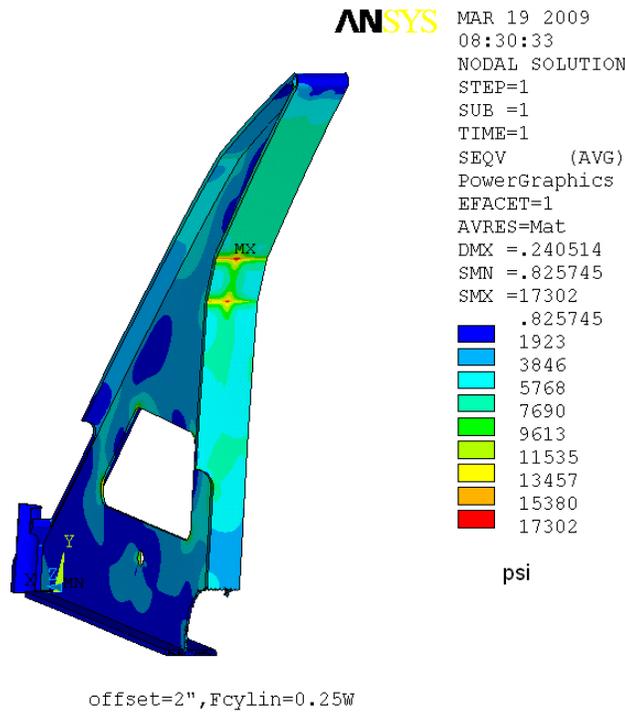


Fig A-4c The stress at upper portion for the case 4 (offset distance=2")

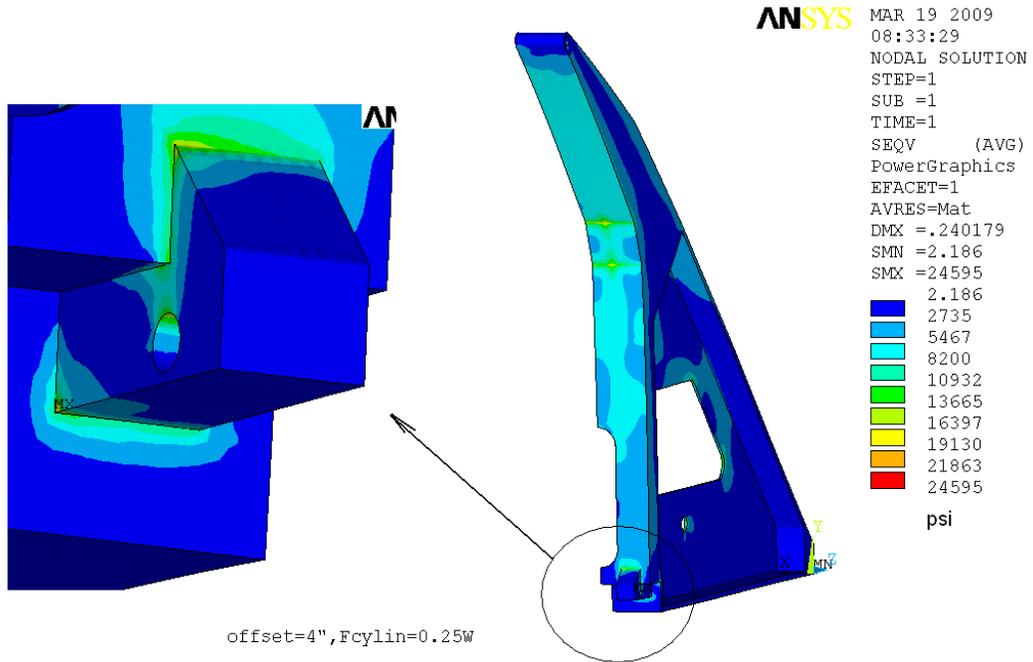


Fig A-5a The stress around the bracket area for the case 5 (offset distance=4")

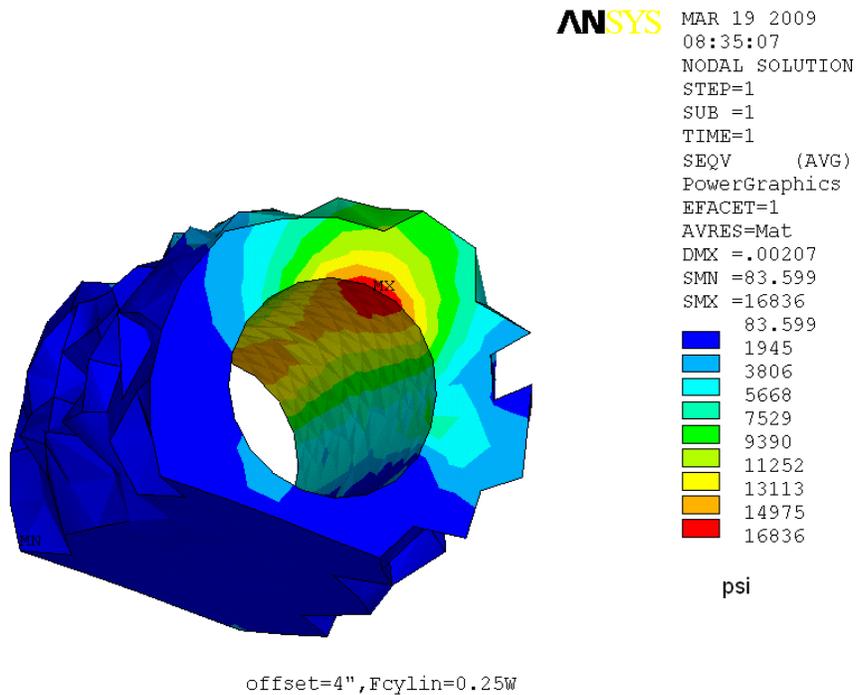


Fig A-5b The stress around the front housing for the case 5 (offset distance=4")

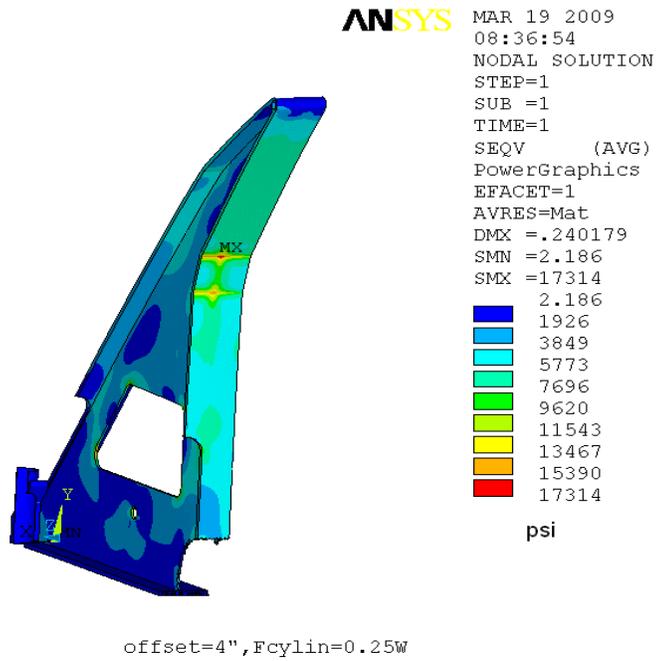


Fig A-5c The stress at upper portion for the case 5 (offset distance=4")

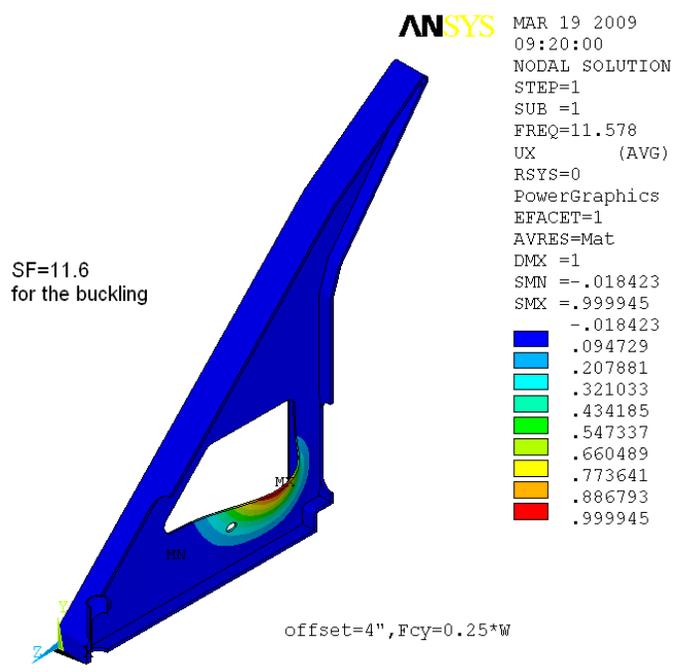


Fig A-6 SF of buckling for the case 5 (offset distance = 4")

