

REDUCTION AND OPTIMIZATION OF STRESS AT THE BOUNDARY OF A FIXED BEAM BY USING SIMPLE SUPPORT

Himanshu Bindal
B.Tech Automotive Design,
Mechanical Department,
UPES Dehradun

himanshubindal01@gmail.com

Prakhar Rastogi
B.Tech Automotive Design,
Mechanical Department,
UPES Dehradun

prastogi367@gmail.com

Ishan Sharma
B.Tech Mechanical,
Mechanical Department,
UPES Dehradun

sharmaishan1508@gmail.com

ABSTRACT

Stress analysis on a beam for hat cross-section with fixed ends was done. Only top and lower flanges were fixed without fixing the web, statically making the ends fixed. It was found that stress at edges was far superior to that at the middle for a uniformly distributed loaded beam. This paper presents a FEA study for reducing the stress at the beam ends by providing simple support along with fixed flanges. The simple support is provided at the lower flanges of hat cross-section beam. The support length was varied along the length of beam at both the ends. Optimized length of flange was found for minimized stress in the beam.

Keywords

Flange; web; supports; FEA; beam.

1. INTRODUCTION

A beam is a bar which is subjected to forces and couples lying in plane of longitudinal axis of the bar. All forces act in direction perpendicular to the member's longitudinal axis [1]. It can be subjected to various loading conditions along with various types of supports. During analysis it is generally seen that the solution of a given boundary conditions does not meet the value in practice. In other words, at boundary it is rare to see the edge loading conditions satisfying the stress systems [2].

2. DESIGN METHODOLOGY

A hat cross-section contains three flanges in which two are below and one is above. There are two webs as shown in fig. 1. In the beam there are many possible ways of making the beam fixed at both the ends. One method is fixing all the edges and other is fixing both the flanges. There can be other possible ways of making ends fixed but this study focuses on only these cases only. Though both cases are statically equivalent, but there was a difference in the stresses that were induced at the fixed edges. The variation was checked using FEA. For reducing the stress at the fixed flanges simple support was provided along with fixed support. The variation in stress was analyzed against length of simple support along the beam axis. The curve pattern was understood and region where most decrement in stress was identified. Finally the length of support for minimal stress was selected.



Fig. 1 Hat cross-section

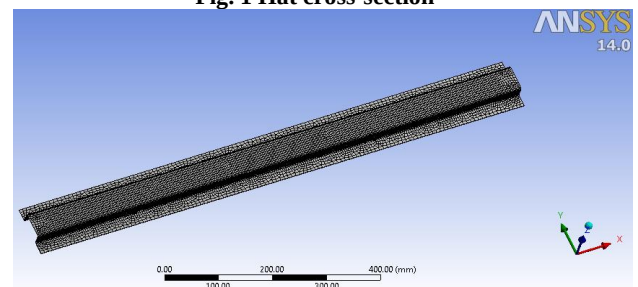


Fig. 2 Meshing

3. VARIATION IN STRESS FOR STATICALLY EQUIVALENT BOUNDARY CONDITIONS

3.1 Load calculation

Load (P) = 176 N

Length of beam (L) = 1000 mm

Width of upper flange (W) = 50 mm

Fillet radius (R) = 3 mm

Effective width of upper flange (W') = $W - 2*(R)$ = 44mm

Effective area (A) = $L * W'$ = 44,000 mm²

Pressure = P / A = 0.004MPa

In loading condition a uniform pressure of 0.004 MPa is applied which will act as uniformly distributed load as shown in fig. 3.

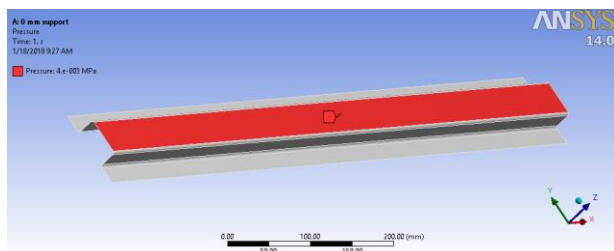


Fig. 3 Loading

The FEA study on beam subjected to fixed supports as shown in figure 4(a) and 4(b) with all edges fixed and only flanges fixed respectively shows that the maximum stress with support 1 was about 19 MPa and with support two was around 90 MPa as shown in figure 5(a) and 5(b).

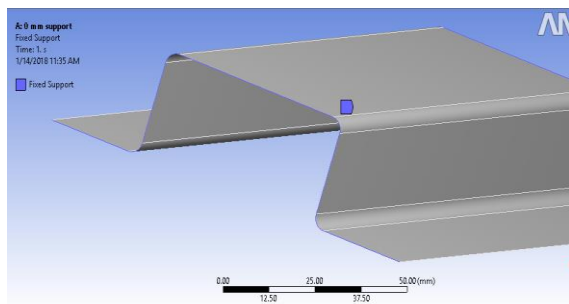


Fig. 4 (a) Support 1: All edges fixed

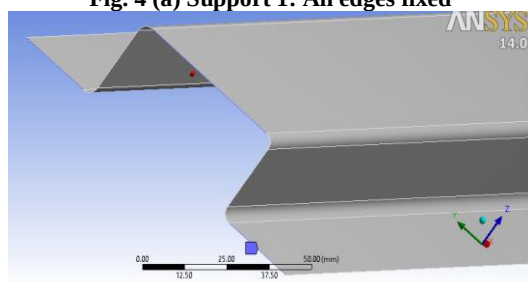


Fig. 4 (b) Support2: Only flanges fixed

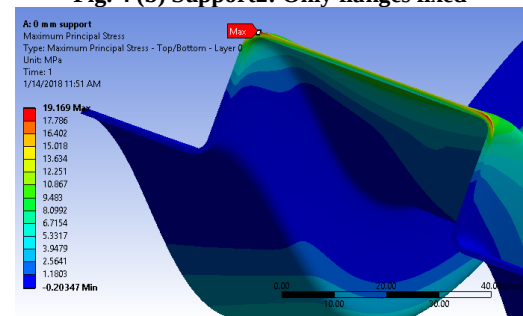


Fig. 5 Maximum Stress (a)

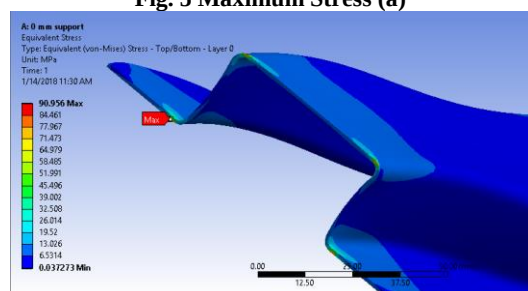


Fig. 5 Maximum Stress (b)

4. STRESS VARIATION WITH VARIATION OF SIMPE SUPPORT LENGTH

To reduce the stress on fixed ends in case of support 2 the beam was supported by simple support. The length of this support was varied from 0mm to 50mm along the longitudinal axis.

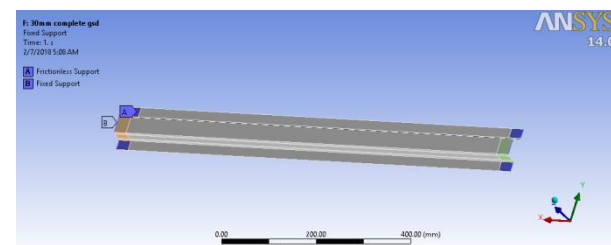


Fig. 6 Simple support

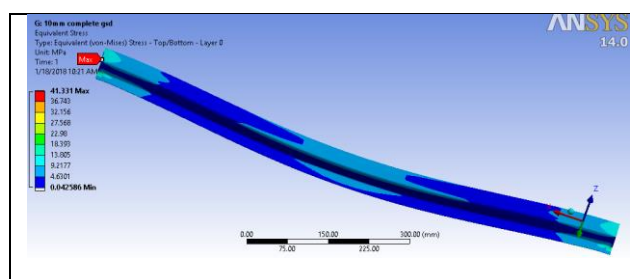


Fig. 7: 10 mm support Maximum Stress= 41.33MPa Location of maximum stress: 0mm

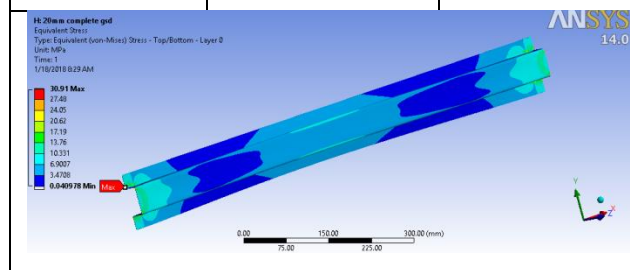


Fig. 8: 20 mm support Maximum Stress= 30.91MPa Location of maximum stress: 0mm

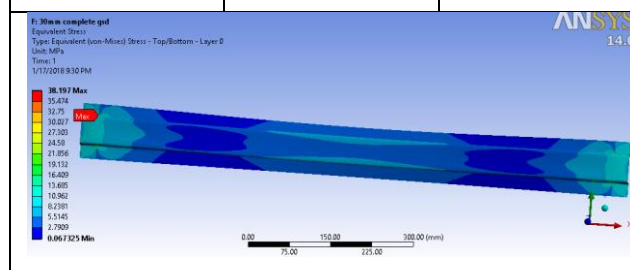


Fig. 9: 30 mm support Maximum Stress= 38.19MPa Location of maximum stress: 30mm

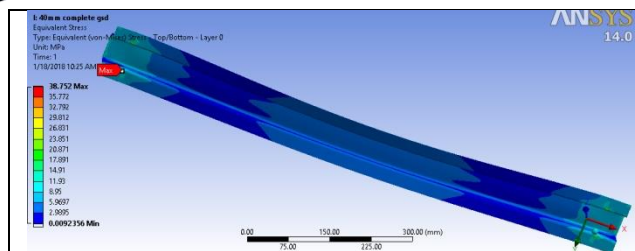


Fig.10:30 mm Maximum Stress= 38.75MPa Location of maximum stress: 40mm

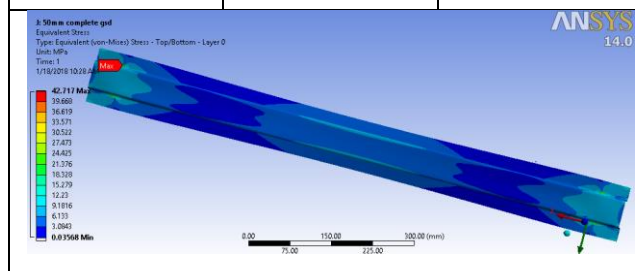


Fig.11:50 mm Maximum Stress= 42.71MPa Location of maximum stress: 50mm

The FEA study showed that as the support length changed, the point of maximum stress changed from fixed end to the simple support end.

5. RESULTS

Support length	Maximum Stress	Location of maximum stress
0 mm	90.95	0 mm
10 mm	41.33	0 mm
20 mm	30.91	0 mm
30 mm	38.19	30 mm
40 mm	38.75	40 mm
50 mm	42.71	50 mm

Fig. 12 Stress, support length and location of max. stress

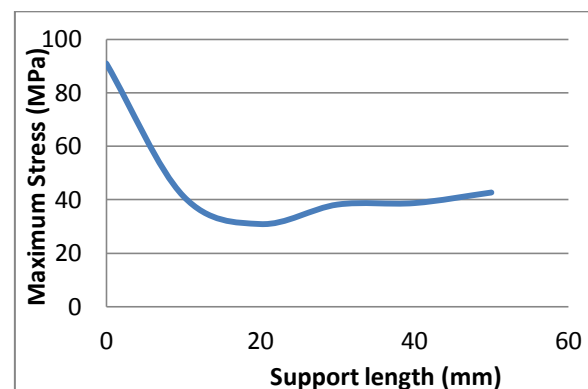


Fig. 13 Stress vs support length

It was found from the FEA study that as length of support was increased first the maximum stress decreased from 90.956 MPa to 30.91 MPa from support length of 0mm to 20mm respectively, then from 20mm to 30mm there was a small increment in the maximum stress. Later after 30mm support the stress was almost constant. It was also observed that the point of maximum stress was shifted from fixed support to the end of support while altering support length from 0mm to 50mm.

6. CONCLUSION

As the support length went towards bigger simple support length the share of vertical reaction given provided by the fixed support reduced thus directing the point of maximum stress from fixed support towards the simple support end. In region of 20mm support almost equal share of vertical load was supported by the fixed support and the simple support thus optimizing the stress in beam. Thus support length of 20mm is best the fit for the above boundary conditions.

7. REFERENCES

- [1] Schaum's Outline of Theory and Problem of Strength of Materials, 4th Ed. , by William A. Nash, McGraw-Hill, 1998, p-122.
- [2] Theory of Elasticity, 2nd Ed. , by S. Timoshenko and J. N. Goodier, McGraw- Hill, 1934, p-123.