Comparison of analytical critical buckling load for castellated beam

[1]Bhavik A. Patel, [2]Satyen D. Ramani
[1]PG Student, Department of Civil Engineering,[2]Asst. Professor, Department of Civil Engineering,
[1,2]SAL Institute of Technology and Engineering Research, Ahmedabad, Gujarat, India

Abstract-The paper present parametricstudy of castellated beam with rectangular and circular web opening. The study consider the web buckling capacity of castellated beam with slender cantilever beam and simply supported beam either with circular opening rectangular opening and no opening. Analysis is carried out by using finite element software ANSYS APDL. It was observed that circular opening perform better than rectangular opening.
Keywords: Web opening, Web buckling, Circular opening, Rectangular opening, ANSYS APDL, Critical load

I. INTRODUCTION

Castellated beam are I-section beam with web openings regularly spaced along the length of member. Castellated beam manufactured from steel hot rolled I-section member of the web is cut according to pattern, after that the obtained halves are shifted and re-welded (Fig. 1).

Castellated beam have been utilized broadly as a part of late times. Web opening in beam is utilized as a water driven and ventilation funnels and electric links. The impact of castellated shaft is that general building stature is lessened by abatement in the floor to roof tallness for each story level. There are constrained hypothetical and exploratory examination performed on castellated beam. The development of results were performed of configuration techniques for web shafts and expository studies were attempted by utilizing non-direct limited component investigation. The principle iniative for creating and utilization of such areas is to diminish the expense of material by utilize more compelling cross sectional shapes produced using standard profile in blend with stylish and compositional outline contemplations.

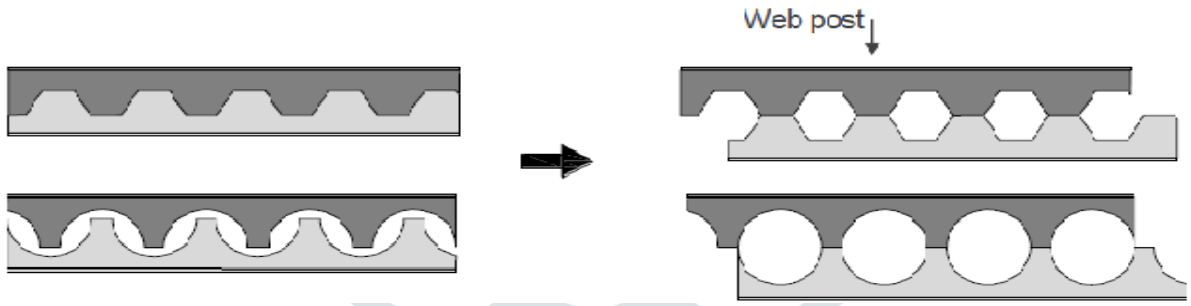

Fig.1 –Standard fabrication method of castellated beam

A castellated beam have a few restrictions additionally, push focus happens close to the web opening and decreased the heap conveying limit of shaft. Stress fixation is lessens by cut at close to the nonpartisan pivot where the anxiety are little. The significant disservice of castellated pillar is the opening in web is changes the anxiety appropriation inside part.

The depth of opening increase, stress concentration increase at the hole corners and at load application point[(1)].The investigation of Vierendeel mechanism in castellated beam with circular web opening is presented by chung et al.[(2)]. Size of beam is increase, deflection of beam is decreasing. As the web opening move towards the center of beam, stress decreasing and hence deflection is reduces[(3)]. Ultimate load carrying capacity and stiffness decrease with increase in opening area.[(4)]. At web opening the interaction between bending and shear is found to be weak, circular opening perform good than another opening [(5)].

II. Design of Beam

The study consider the lateral buckling of beams with doubly symmetric I-section. ISMB 200 section is selected for parametric study which dimension is shown in figure 2. The study involves slender cantilever beams and simply supported beams either with no opening circular and rectangular opening. The values of young modulus and Poisson's ratio is 2.1×10^5 N/mm^2 and 0.3 respectively.

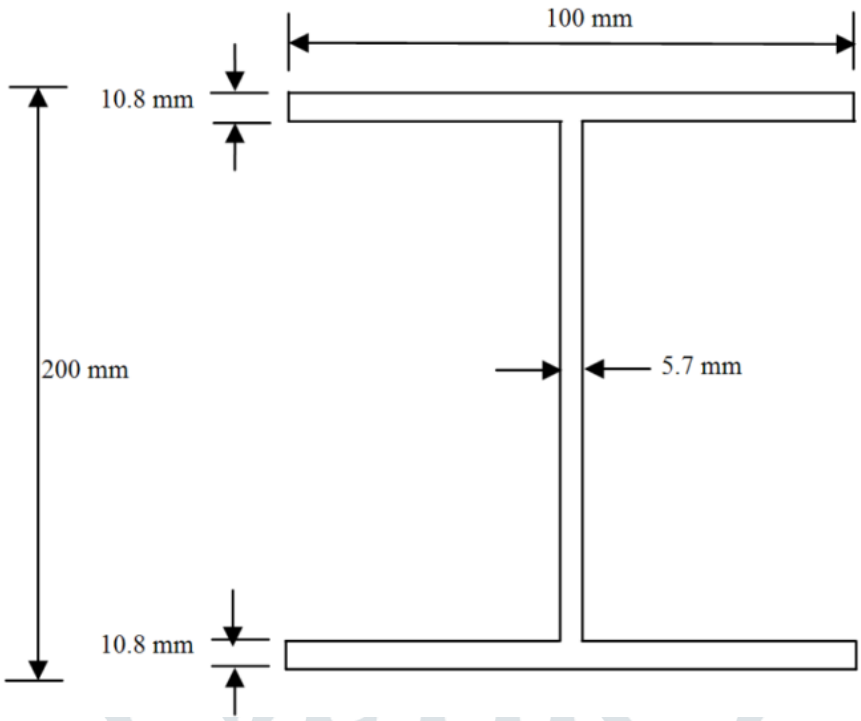

Fig.2–Properties of ISMB 200

III. Parametric Study and result comparison

a) **Cantilever Beam**

The section of cantilever beam of ISMB 200 are length L=2000mm, web thickness and flange thickness is shown in figure2, overall depth of web d=178.4mm. The location of openings are shows in figure 3. They are either circular or rectangular. Section is studied with following set of opening:

- No opening
- One opening
- Three rectangular opening
- Six rectangular opening
- 3 circular opening

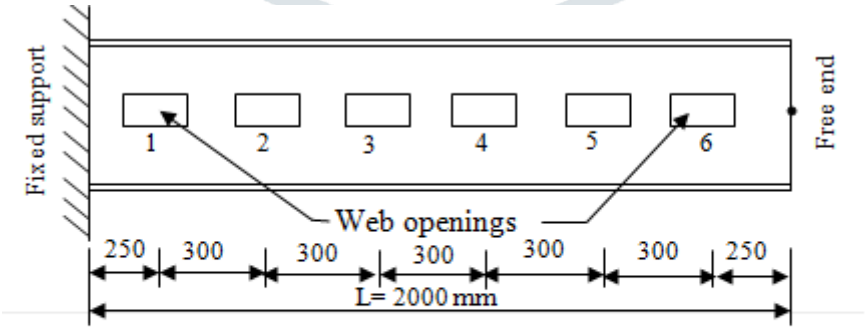

Fig. 3 Location of opening in cantilever beam

Table 1 Comparison of critical buckling load for cantilever beams

Specimen	Size of opening(mm)	Location of openings	Pcr (ANSYS) (N) (Paper)	Pcr (ANSYS) (N) (Analysis)	% Difference
1	200×100	1	80755	81369.8	7.6
2	200×100	3	79290	72926	8.02
3	200×100	6	81443	80848	0.73
4	200×100	1,3,6	81200	77147.2	4.99
5	200×100	1,2,3,4,5,6	75363	80128.8	6.3
6	200×100	-	80640	72306.3	10.33
7	100 dia.	1,3,6	75690	74032.5	2.1

Result from ANSYS is shown in figure 4

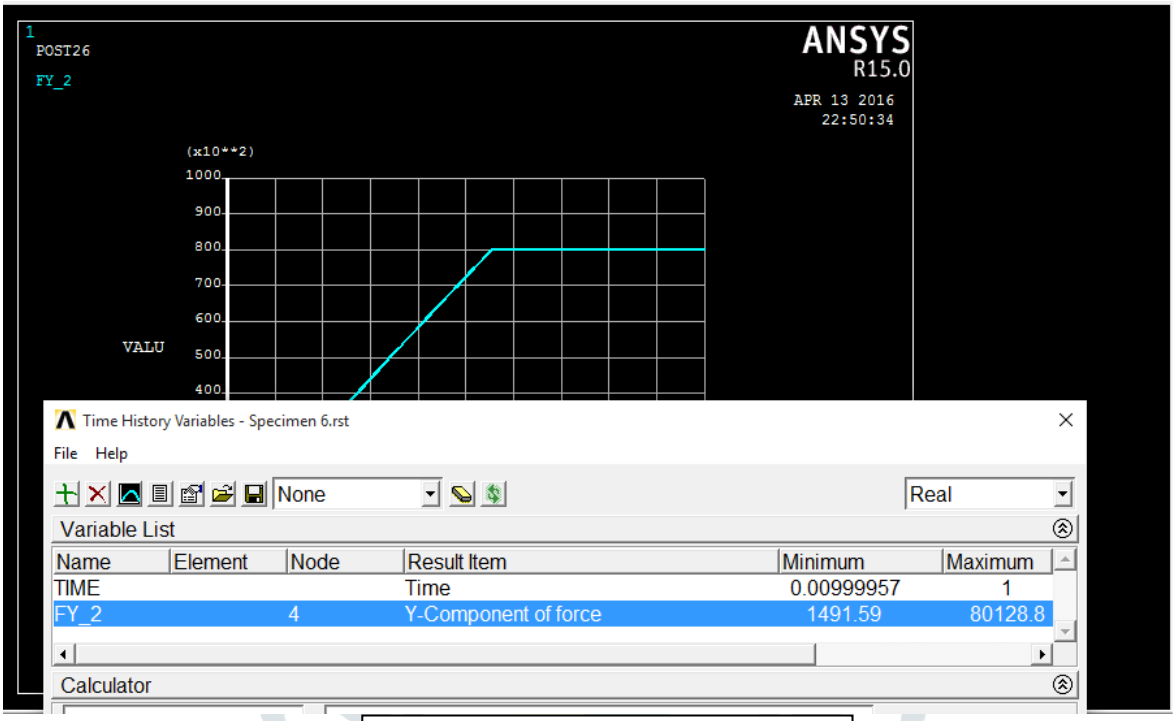

Fig. 4 ANSYS result for cantilever beam

b) Simply supported beams

The section of simply supported beam of ISMB 200 are length L= 3800mm, web and flange thickness, web depth and flange width shows in figure 2. Six location for the opening over the half left of the span are depicted in figure 5, numbers from support to mid-span. Opening are either circular or rectangular, and numbers of openings are change. Section is studied with following set of opening:

- One opening
- Three rectangular opening
- Six rectangular opening

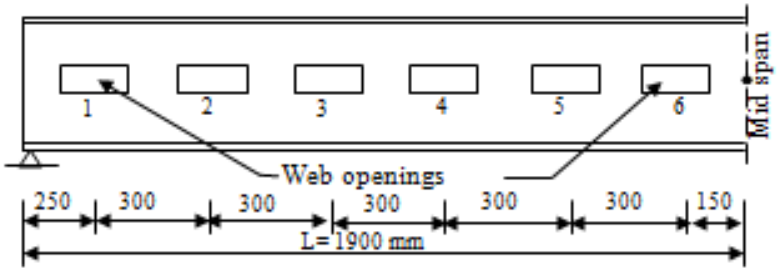

Fig. 4 location of web opening in simply supported beam

Table 2 Comparison of Critical buckling load for simply supported beam

Specimen	Size of opening(mm)	Location of openings	Pcr(ANSYS) (N) (Research Paper)	Pcr (ANSYS) (N) (Analysis)	% Difference
1	200×100	6	56994.30	63221	10.9
2	200×100	1,3,6	52450.35	56648	8
3	200×100	1,2,3,4,5,6	49985.25	54108	8.25

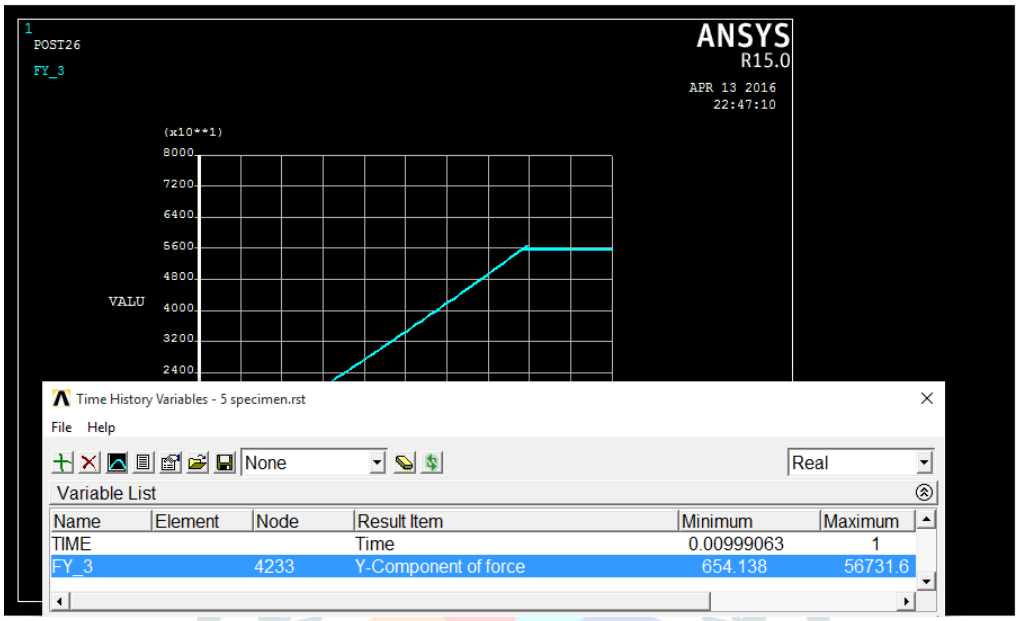

Fig. 4 ANSYS result for simply supported beam

IV. CONCLUSION

It was observed that as the location of opening changes from fix support towards the free end, the displacement is going to be decrease. At web opening, the interaction between bending and shear is found to be weak. In other words the opening can be placed in a "neutral zone". Result from study is compared and error is up to ten percentage, validated ANSYS APDL result with paper is acceptable for future work.

VI.REFERENCES

[1] M.R.Wakchaure, A.V.Sagade, (July2012) "Finite Element Analysis of Castellated beam" International Journal of engineering and Innovative Technology Volume 2

[2] Chung KF, liu TCH, Ko ACH, (2001) "Investigation on Vierendeel mechanism in steel beam with circular web opening" , Journal of construction Steel Research

[3] Sharda P. Siddh, prof. P.D.Pachpor,(July 2011) "Finite Element Analysis of steel beam with different web opening shape", International Journal of science and advanced Technology

[4] Samadhan G. Morkhade, LaxmikantM.Gupta, (2015), "An experimental and parametric study on steel beam with web openings", Int J AdvStructEng 7:249-260

[5] Samadhan G. Morkhade, LaxmikantM.Gupta(2015), "Parametric study of steel beams with web opening", Int J AdvStructEng.