Analytical Study of Effect of Size of Web Opening on Ultimate Load Carrying Capacity of Steel Beam with Trapezoidally Corrugated Web

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Introduction

I section beam are commonly using in the construction of steel structure. Normally this beam are constructed from two parallel flanges and plain web. Web portion carry maximum load and transmit shear stresses in the beam, which are responsible for local buckling in web portion. Thus, can be reduce by using corrugated web beam. Corrugated web beam offered a negligible contribution to the moment carrying capacity of the beam and the ultimate moment capacity is based on the flange yield stress (Mohammed Elgaaly et al 1997). Trapezoidally corrugated web beam commonly using in the steel structure.

Trapezoidally corrugated web beam with 30^o, 45^o angle could be achieved without decreasing load carrying capacity of beam and resisting local buckling of the web more efficiently. Corrugated web beam with lesser corrugation could sustain higher bending moment (Divahar et. al. 2018). The number of corrugations web and thickness is improving the rotation and energy absorption capacities of the structural elements (Zirakian et. al. 2016). Combination of loading situation improve the fatigue life of corrugated web girders. In addition, smaller weld size resulted in the fatigue life of analysed girder being longer (Kovesdi et al 2014). Increase the height of corrugated web with cut out and length of parallel parts increase the shear resistance of beam and local buckling is minimized (Romeijn et. al. 2009).

Gap of the Literature Review

Many researcher works on this kind of trapezoidally corrugated web beam to study load carrying capacity. Till date, trapezoidally corrugated web beam with openings has not been carried out. There are still no design specification with respect to uses of opening in trapezoidally corrugated web. In the European standard code Eurocode 3: Design of steel structures - EN 1993-1-5 (2006) no design guidelines has not been given for trapezoidally corrugated beams with openings. In modern building where water pipes, air ducts produce large depth between storeys. This study is done based on the demand for additional design specification to make openings in corrugated sheets.

Parametric Study of Web Corrugation & Openings

The following data has been used in the modelling and analysis of trapezoidally corrugated web beam with opening using ANSYS software. The beam is considered as simply supported boundary condition with point load at centre. The analysis has been performed, by using finite element method. Figure 1 shows the finite element model of trapezoidally corrugated web beam with opening. The comparison of ultimate load carrying capacity of this beams having web thicknesses as 3mm, 4mm, 5mm with plain web beam (PWB) and corrugated web beam (CWB) are as shown in Figure 2, 3 and 4 respectively.

1) Overall depth (D) = 200 mm
2) Thickness of flange = 10mm
3) Thickness of web = 3mm, 4mm, 5mm
4) Width of flange = 100 mm
5) Length = 2233 mm & 2050 mm
6) Angle of corrugation = 30^o, 45^o
7) Horizontal panel = 300 mm
8) inclined panel = 100 mm (30^o), 70.71 mm (45^o)
9) Opening = 0.5 D, 0.6 D, 0.75 D
10) Total number models = 30 Nos

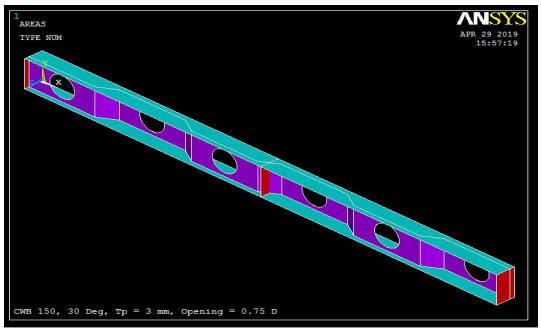

Figure 1 CWB with opening

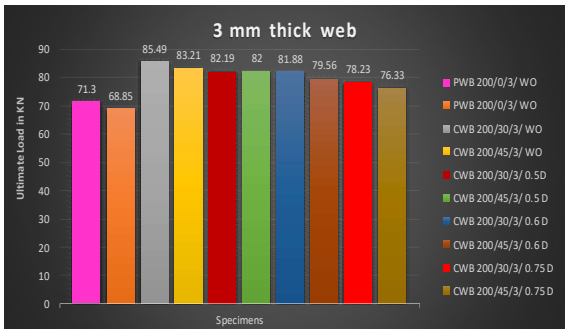

Figure 2 CWB opening with 3mm thick web

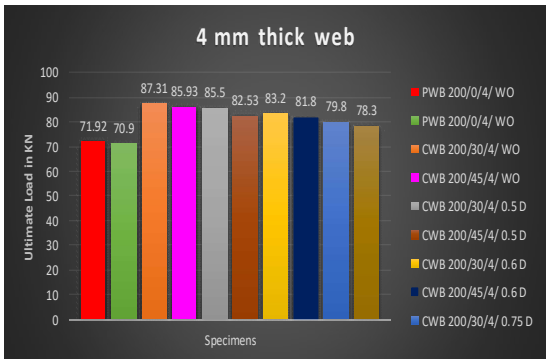

Figure 3 CWB opening with 4mm thick web

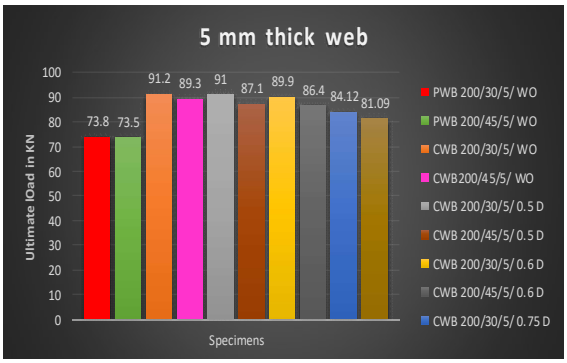

Figure 4 CWB opening with 5mm thick web

Concluding Remarks

In this investigation, effect of web opening on strength capacity and load – deflection behaviour, von misses stress distribution and flexural stiffness with corrugated web beam without opening and plain web beam has been conducted. Based on the present investigation the following conclusions has been drawn.

- Load carrying capacity of corrugated web beam with opening is more than plain web beam. Similarly self weight of CWB with opening is less than plain web beam. Increasing in the length of horizontal panel and lesser the corrugation angle increases the load carrying capacity of beam than plain web beam.
- Flexural stiffness of 200 mm depth with web opening having 30^o and 45^o corrugated web are more than the plain web beam. Flexural stiffness of corrugated web beam is more up to 0.5 D than plain web beam, but increasing the diameter of opening to 0.6 D and 0.75 D leads to decrease in flexural stiffness and come near about flexural stiffness of plain web beam.
- Von misses stresses due to load in corrugated web beam with opening is less than plain web beam. The beam with plain web is failed due buckling of web, but corrugated web with 30^o,45^o angle with opening is failed due to local buckling of flange.
- According to the load carrying capacity it is concluded that corrugated web beam with opening can be used instead of plain web beam. It is helpful to reduce the floor-to-floor height of building.

References

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