International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 04 | Apr 2019 www.irjet.net p-ISSN: 2395-0072

"Experimental Investigation of Steel Beam with Trapezoidal Corrugated Web Beam"

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Abstract - *Lateral buckling may occur in beam where its compression flange is free to displace laterally. The investigation represents the experimental buckling behaviour of steel section with trapezoid web. A steel beam with plain web and corrugated web are tested. A moment carrying capacity steel beam with plain web is studied and compared with moment carrying capacity of beam with trapezoidal corrugated web having 45^0 corrugation. The specimen tested under one point point loading for its behaviour. From the study, it is found that the steel beam with trapezoidal corrugated web section having higher resistance to lateral buckling compared to that of section with plain web. It is also found that the corrugation angle influence to resistance to lateral buckling.*

Keywords: Steel beam, Trapezoidal corrugated web, Moment carrying capacity, Lateral buckling.

1. INTRODUCTION

Now a day's building and civil infrastructures are becoming larger and higher, the demand for horizontal structure members, which are suitable for long spans so structural steel require high strength but steel member also have many weaknesses, such as less resistance to bucking, excessive deflection, fatigue strength, vibration. To overcome these disadvantages various types corrugated web beam are developed. Some of advantages to use corrugated web beam are stability against asymmetrical loads because the shear bucking strength in-plane and Out-of- plane load is greater than I-section beam. Especially for the main frames of single storey steel buildings the use of corrugated web beams, mainly with sinusoidal corrugation, has been increased very much during the last years. Due to the thin web of 2 or 3 mm, corrugated web beams afford a significant weight reduction compared with hot rolled profiles or welded I sections. Buckling failure of the web is prevented by the corrugation.

Steel structure building are becoming more and more popular due to their many advantages such as the better satisfaction with the flexible architectural, durability, strength, design, low inclusive cost and environmental protect as steel is manufacture to precise and uniform shapes. In construction application, the web is usually carry most of the compressive stress and transmits shear in the beam while flanges support the major external loads. Therefore, web is usually investigated by comparing the thickness and the shape. It can decrease the cost and materials without weakening the load-carrying capability of the beam. The corrugated web is proposed to compare with the common plane web. There are different type of corrugated web were propose such the horizontal corrugated web of one arc corrugation, two arcs corrugation and vertically corrugated web, In this thesis, the study of vertically corrugated web beam, will be investigated while ordinary plane web beams were also test to develop the benchmark result. Corrugated beam with web opening is commonly used where large web openings are provide along the beams.

1.1 I-Section

An I-beam, also known as H-beam. I-beams are widely used in the construction industry and are available in a variety of standard size.

Fig-1: I-Section

I-beams may be used both on their own, or acting compositely with another material, typically concrete. A beam under bending sees high stresses along the axial fibres that are farthest from the neutral axis. To prevent failure, most of the material in the beam must be located in these regions. Comparatively little material is needed in the area close to the neutral axis. This observation is the basis of the I-beam cross-section; the neutral axis runs along the center of the web which can be relatively thin and most of the material can be concentrated in the flanges.

1.2 Trapezoidal Corrugated Web

Today the corrugation process is carried out using the process of roll forming. This modern process is highly automated to achieve high productivity and low costs associated with labour. The corrugations are described in terms of pitch (the distance between two crests) and depth (the height from the top of a crest to the bottom of a trough). It is important for the pitch and depth to be quite

uniform, in order for the web to be easily stackable for transport, and to overlap neatly when joining two sheets.

Fig-2: Corrugated Web Sheet

2. STATEMENT OF PROBLEM

Due to their lightweight and superior load carrying capacity, corrugated web steel beams have gained popularity in the last few decades. The aims of this report are to study experimental response of trapezoidal corrugated web from pre buckling stage until ultimate failure.

- To examine the closed behaviour of steel beam with trapezoidal corrugated wed.
- To carry out experimental investigation in trapezoidal corrugated web beam with different shape.
- To compare the performance of trapezoidal corrugated web beam with plain web.

3. LITERATURE REVIEW

Elgaaly et al. (1997) carried out experimental and analytical studies on bending strength of steel beams with corrugated web. Parametric analytical studies were performed to examine the effect of the ratio between the thicknesses of flange and web, the corrugation configuration, the panel aspect ratio, and the stress-strain relationship to the ultimate bending moment capacity of steel beams with corrugated web.

Watanabe and Kubo (2006) presented test and numerical analysis results of CW girders with four different trapezoidal corrugation configurations under pure bending. A predicting method of the ultimate strength considering local flange buckling was also proposed based on the parametric analysis of corrugated web girders. However corrugated web beams have some weaknesses due to geometric characteristics. First,the local buckling strength of the flange can be smaller than that of plane web beams, because the largest outstand of a flange in corrugated web beams is larger than that of plane web beams. Second as a result of web eccentricity, additional in-plane transversal moment occurs in flanges.This moment reduces the flexural strength of corrugated web beams. Third, only flanges, except for the web, contribute to the flexural strength of corrugated web beams, due to the accordion effect of corrugated web. Various significant results were achieved by the mentioned studies. However,a considerable uncertainty still exists regarding the a certain value which reflect the effect of using corrugated web instead of plane web on the flexural capacity of steel I beams. Therefore, an experimental study on the effects of corrugated web on the flexural failure mechanism expected to occur in steel beams presented in this paper.

4. METHODOLOGY

Methodology gives the planed execution for the entire research work. There are two basically functioning of methodology on primary and secondary basis. In the primary methodology consist selection of study area, objective, literature survey etc. as well as in secondary methodology consist of model designing and from the result getting to the conclusion.

For proposed work experimental work is chosen as methodology.

- **Primary**

1. Defining the objective.

   Objective are decided to plan the study over the trapezoidal corrugated web beam which leads to the result and conclusion.

2. Literature survey

   Various literature are to be undertaken to give brief idea about the selected study area and its detailed facts.

3. Study of area

   The study of area is selected from various literature which leads the project for conclusion depending upon the objectives

- **Secondary**

4. Experimental investigation of trapezoidal corrugated web beam.
5. Result and discussion

   The experimental result on the structural behaviour on steel beam with plain web, trapezoidal corrugated web. Data represent include the load vs deflection curves

4.1 DESIGN CONSIDERATION

PARAMETER SELECTION

1. Web thickness (t_w) – 4mm, Corrugation angle (θ) – 45^0
2. Corrugation plate length (b) – 50 mm.
3. Corrugation web width (h) – 50mm
4. Corrugation web depth (h_w) – 300 mm

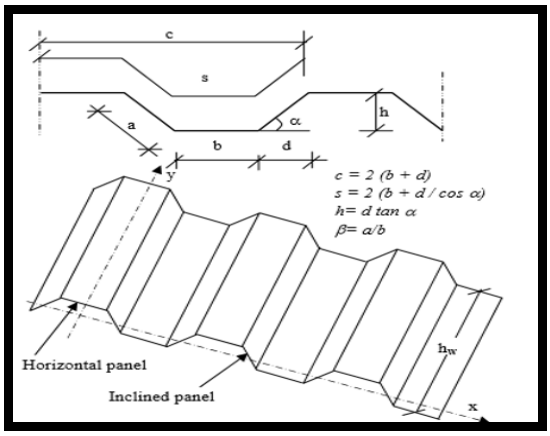

Fig- 3: Parametre selection

In experimental method the test is carried on plain web and trapezoidal corrugated web beam having corrugated angle 45. This method is used to identify the behaviour of trapezoidal corrugated web beam and plain web beam. The testing will carry on Universal Testing Machine(UTM). The specimen tested under one point loading as shown in fig. The size of corrugated web beam is having thickness of plate =4mm , length of plate=1000mm, width of plate= 300mm, deflection angle=45, a= 50mm,

The test is carried out with maximum loading capacity of 400KN. Load will applied at mid of the web beam. Linear variable Displacement Transformers (LVDT) will installed to measured displacement at every applied load. Test will stop when failure occurred. Relationship between load applied and deflection as shown in figure.

5. Result

This chapter presents the experimental results on the structural behaviour of steel beams with plain web, trapezoidal corrugated web with various aspects. Data presented include the load versus deflection curves, shear stress distribution.

The load-deflection is the important factor to evaluate the behaviour of the simply supported beams. Loads were applied at mid point distance from the supports at a uniform rate till the ultimate failure of the specimens occurred. The mid span deflection is to be taken o the displacement of span along y direction after applying the load of from 0-100kn on both plain web and trapezoidal corrugated web with 45 degree corrugation angle. Below figures shows the deflection of both the beam with same loading condition.

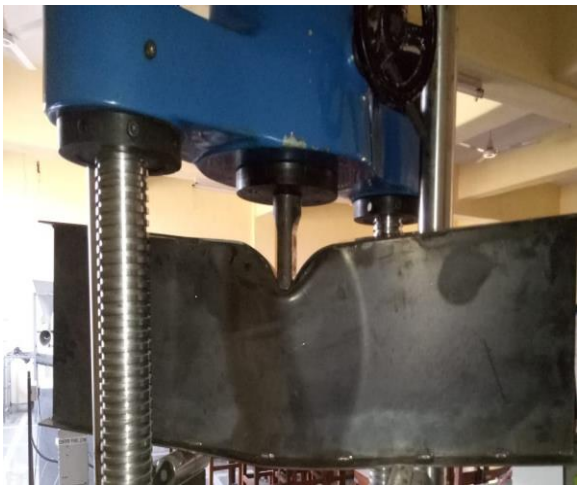

Fig-4: Failure of plate

Fig-5: Load vs Deflection (TCWB)

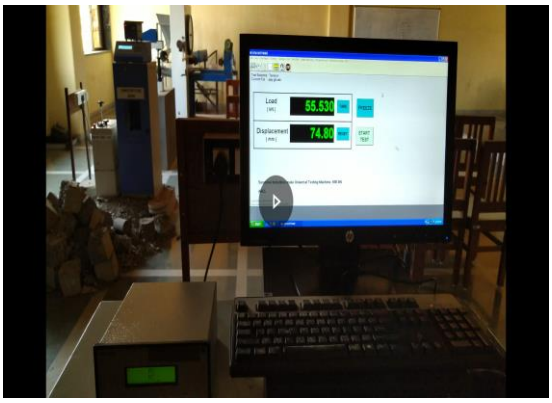

Fig-6: Load vs Deflection (PWB)

The specimen plain web beam failed at load 55KN with central deflection of 77.40mm. The other specimen that is trapezoidal corrugated web beam of 45 degree angle failed at load 46KN with 9mm deflection. It is observed that the beam having corrugated web has less deflection and higher load carrying capacity than the plain web beam.

6. CONCLUSIONS

After experiment or testing, it is observed that

- The trapezoidal corrugated beam has more load carrying capability as compared with plane web beam as and also greater than the trapezoidal web beam.
- The corrugation reduces the torsional buckling failure to local buckling
- Specimen with corrugated web, local buckling is predominant, failure occurs under the load.
- Due the corrugation there is no failure in shear zone.
- It is concluded that the beams with trapezoidal corrugated web with 45^0 corrugation angle gives better performance based on the load carrying capacity, shear stress distribution and von misses stress distribution along the web.
- Load carrying capacity of the beam can be improved by using corrugation of beam which also less uses of the material of web which is useful for the application for many constructions.
- Steel beam with trapezoidal corrugated web section have higher resistance to lateral torsional buckling. Compared to that of section with flat web. Higher value of moment of inertia about minor axis for the section with thicker corrugation contributes to the higher resistance to lateral torsional buckling.

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