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# Experimental Investigation of Trapezoidal Corrugated Web Beam

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**Abstract - This electronic docu Trapezoidal web profile is a structural steel section made of two flanges connected to a web plate of trapezoidal profile. The ability of trapezoidal web profile to resist lateral torsional buckling is one of the most important criteria considered in the design of this steel section. Economical design of built-up beams normally requires thin webs. Now a day's light gauge elements have been used in built-up section, If the web is extremely thin, the problem of plate buckling may arise. By using thicker Plates, web stiffeners or strengthening the web can possibly reduce this risk. The use of corrugated web is a potential method to achieve adequate out of Plane stiffness and shear buckling resistance without using stiffeners. In this work, experimental investigations have been carried out to study the structural behaviour of corrugated steel beam with plain web, trapezoidal corrugated web. In this phase, experimental analysis of plain beam, with trapezoidal corrugated web, was carried out using the experimental setup.**

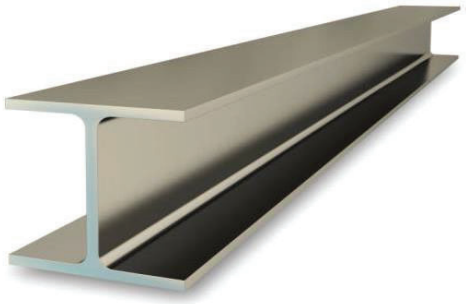
***Keywords – Corrugated beam, Steel beam, Trapezoidal corrugated beam, mid span deflection***

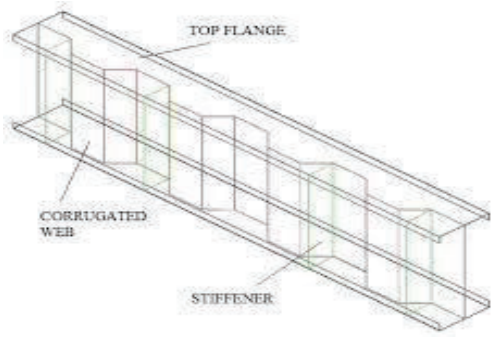
## I. INTRODUCTION

In construction application, the web is usually carrying 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. The load-carrying capability of the beam the corrugated web is proposed to compare with the common plane web. There is different type of corrugated web were proposing 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 providing along the beams.

Recently, several researches have attempted to use corrugated plates as the web of I-girders, this can overcome the disadvantages of conventional stiffened flat web such as web instability due to bending stress and also provide high fatigue resistance by minimization of the welding process. Most of the previous studies focused on the shear buckling of corrugated steel webs because the corrugated steel webs fail due to shear buckling or yielding, and three different shear buck ling modes (local, global, and interactive) are possible depending on the geometric characteristics of corrugated steel webs.

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. I-beams may be used both on their own, or acting compositely with another material, typically concrete.






### I Section steel beam and Corrugated web section

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 labor. The corrugations are described in terms



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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. The use of corrugated web beam is commonly used since it makes ducting and services work much more easily.

## II. LITERATURE REVIEW

**C.L. Chan, Y.A. Khalid, B.B. Sahari, A.M.S. Hamouda (2001)** has studied that the effect of web corrugation on the bending capacity of the beam using finite element method. Beams with plain web, horizontally corrugated web and vertically corrugated web were studied. The corrugation profiles studied was half circle corrugation. It was concluded that the vertically corrugated web provides a stronger support against the flange buckling than those with horizontally corrugated and plain webs. It was also concluded that corrugated web beams with larger corrugation radius, could sustain higher bending moment and there is 10.6% reduction.

**Jian-Guo Nie, Li Zhu, Mu-Xuan Tao, Liang Tang (2013)** has stated that shear strength of trapezoidal corrugated steel webs shows shear strength of trapezoidal corrugated steel webs is an important issue for the design of box girder bridges with trapezoidal corrugated steel webs. Eight H-shape steel girders with trapezoidal corrugated webs are firstly tested to investigate the shear behaviour of webs. An extensive parametric study based on the linear elastic buckling analysis is then conducted to derive the simplified formula for calculating the elastic shear buckling strength of trapezoidal corrugated steel webs considering three different shear buckling modes.

**Sherif A. Ibrahim (2014)** has studied that lateral torsional buckling of plate girders with corrugated webs (CWG). In this content the both theoretical and finite element analyses for un-symmetrical plate girders with corrugated webs subjected to uniform moment. A new warping constant for this un-symmetrical cross-section is derived taking into consideration the cross-sectional variation along the girder length. Trapezoidal corrugated web profile is taken into consideration in the derivation. The location of the shear centre is determined and a closed form of the warping constant is derived. Then-symmetry of the web less beam, which agrees with the case of CWG, is considered in the calculation of the lateral torsional buckling strength

**R. Divahar and P. S. Joanna (2014)** has studied that the effect of web corrugation in cold-formed steel beams with trapezoidal corrugated web. In this content the results of the experimental study on load carrying capacity of cold-formed steel section with trapezoid web. A total of six cold formed steel beams with plain webs and corrugated webs were tested. The moment carrying capacity of cold-formed steel beam with plain web is studied and compared with the moment carrying capacity of beam with trapezoidal corrugated web having $30^0$ and $45^0$ corrugations. The specimens were tested under two-point loading for its pure flexural behaviour. From the study, it is found that the cold formed steel beam with trapezoidal corrugated web section have higher resistance to lateral buckling compared to that of section with plain web. It is also found that the corrugation angles influence the resistance to lateral buckling.

**Lincy R.Divahar (2018)** has studied that the result of the experimental study of the lateral bucking behaviour of cold-formed steel section with trapezoid web. Lateral buckling may occur in an unstrained beam where its compression flange is free to displace laterally. A total study of six cold-formed steel beams with plain webs and corrugated webs are tested. The moment carrying capacity of cold-formed trapezoidal corrugated web having 30to40 degree corrugations. After the test it analyses steel beam with trapezoidal corrugated web beam have higher resistance of lateral buckling compared to that section with plain web. The average load carrying capacity of 30-degree web is 25% than the plain web. Shear web eliminated in corrugated web.

**Patil Niranjan (2022)** The literature indicates that trapezoidal corrugated web beams (TCWBs) can improve the structural efficiency of steel I-sections by increasing web stability and reducing the need for thicker web plates. The study investigates the effect of corrugation angles of 30° and 45° using finite element analysis in ANSYS. The beams are evaluated based on load–mid-span deflection behavior and stress distribution in the web. The comparison suggests that changing the corrugation angle influences the stiffness, strength, and stress distribution of the beam. Overall, corrugated web beams offer a potential material-saving and economical alternative to conventional flat-web beams while maintaining adequate load-carrying capacity.

### *A. Research Gap*

Many researchers done the study on trapezoidal corrugated web beam, as listing out the major gaps in overall literature is about the corrugation angle effect on trapezoidal corrugated web beam which effect on the strength of the beam and in its stress distribution. Also, by changing the depth of web of beam with change in corrugation angle need to study in structural behaviour of trapezoidal corrugated web beam.

### *B. Summary of Literature Review*

From the literature it is understood that, research on trapezoidal corrugated web beam is limited. As per previous research trapezoidal web profile is more effective than I-beam profile. I-beam having lowest displacement as compared to corrugated web. Corrugation of trapezoidal corrugated web reduces the torsional buckling. Load carrying capacity of trapezoidal corrugated web beam is improved by corrugation and it is better than I -beam. Hence, it is concluded that trapezoidal corrugated web which is better in comparison with I -beam.

## III. METHODOLOGY

In this chapter we have tried to focus on material required for the project and the quality of material that we are going to use during experimental work. The following point has been discussed as follows.

A. Theoretical Study.
B. Experimental Study.



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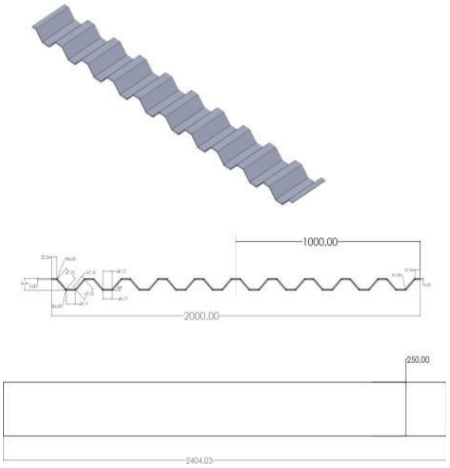
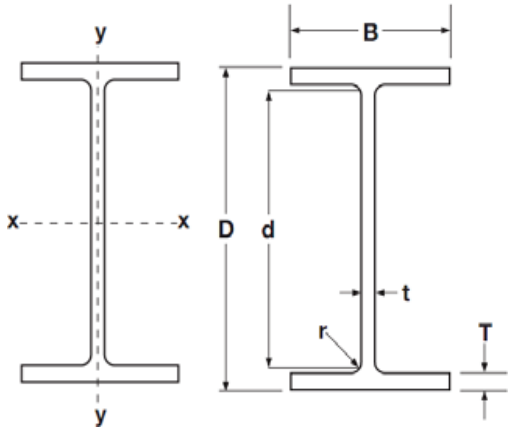
The selected parameters for study are as follows for trapezoidal corrugated web.




**Trapezoidal corrugated web beam**

1. Web thickness (tw) - 5mm
2. Corrugation angle (θ) - 45°
3. Corrugation plate length (b) -50mm
4. Corrugation web width (h) -50mm,35.35mm
5. Corrugation web depth (hw) -250mm
6. Length of flange and web – 2000mm




**I-section Beam.**

The selected parameters for study are as follows for Plain beam.

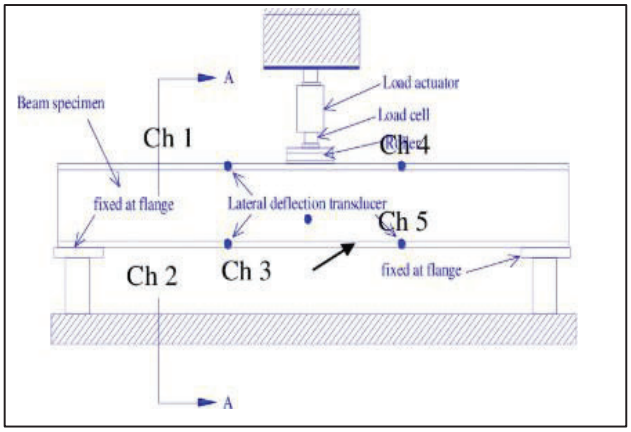
1. Web thickness (tw) - 5mm
2. Flange thickness (tf) - 5mm
3. Length of flange and web -2000mm
4. Corrugation angle (θ) - 0°
5. Web depth (hw) -250mm

## IV. EXPERIMENTAL INVESTIGATION

This chapter present the summary of the experimental work conducted in the present investigation. The details of experimental work carried out on the trapezoidal corrugated web beam and plain beam. The experimental investigation includes material testing, fabrication of test specimens, test setup and testing procedure. The main objective of experimental work is to examine the behaviour of trapezoidal corrugated web beam and plain beam under one-point loading.

The program involved fabrication of different group of varying parameters trapezoidal corrugated web beam and plain beam. In this study two specimen were investigated, having same aspect ratio, angle of corrugation 45-degree, web slenderness, corrugation width and depth, web stiffeners with 2000mm length.

Trapezoidal corrugated web specimen fabricated by using software model design. For trapezoidal corrugated web steel plates of size 2000mm long of 25mm thickness were cut by means of cutting machine to make flanges and webs of desired shape and size, the webs being cut to desired depth and width. Then the trapezoidal corrugated web is joint with the flange by using gas welding with copper wire. The view of the beam with after being welded to the bottom flange the unstiffened trapezoidal corrugated web after the preliminary welding.




**Experimental Setup.**

## V. RESULTS AND DISCUSSION

The failure pattern of the test specimens is found when tested under one point loading. It is observed that the beams with plain web failed earlier as compared with corrugated. Plain Beam was able to take 44.65KN load and that of corrugated beam was 90.1KN. and the specimens with $45^0$ trapezoidal corrugated web, failure occurred due to further loading, then the specimens with.

| Sl. No | Specimens | Ultimate Load (kN) | Deflection (mm) |
|---|---|---|---|
| 1. | Beam with Plain Web | 44.65 | 12 |
| 2. | Beams with $45^0$ Corrugate Web | 90.11 | 54 |



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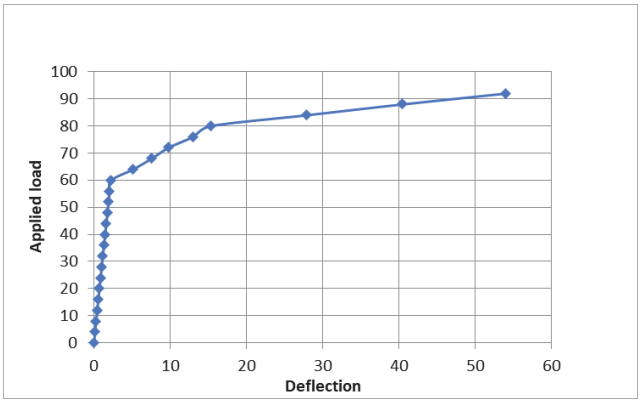
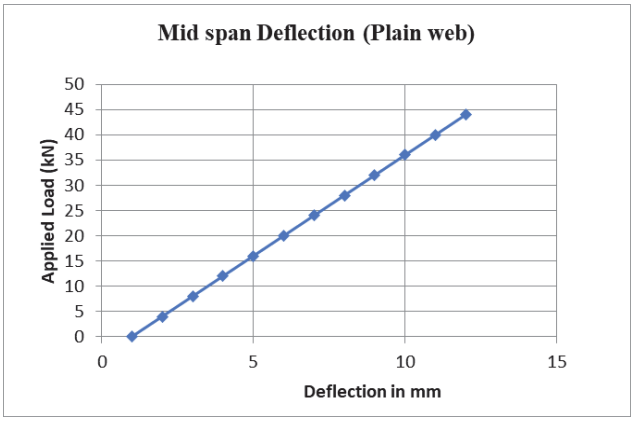



**Mid span Deflection (TCWB45)**




**Mid span Deflection (Plain web)**

## VI. CONCLUSION

The following conclusions could be made from the experiments conducted on the structural behaviour of plain web, trapezoidal corrugated web in which Corrugated beam was found to be stronger than as plain beam. In the beams with trapezoidal corrugated web having an angle of web is $45^0$ has more strength than the plain web beam and the failure was typically in the form of flexural cracks originating from the bottom of the specimen and extending towards the top of the specimen. The majority of cracks were formed between the zone of point loading and some cracks was also observed near the end supports due to which deflection is more in trapezoidal corrugated web beam.

Major Conclusions can be made by this experimental work are as follows.

1. The ultimate strength of the trapezoidal corrugated web beam is higher than plain web beam.
2. Steel beams with plain web failed by buckling of web and it is eliminated by using steel beams with trapezoidal corrugated web.
3. Steel beams with trapezoidal corrugated web having corrugation have higher moment carrying capacity and lateral buckling resistance, when compared with steel beams with plain web.

*a) Formatting:* Insert one hard return immediately after the last ***ACKNOWLEDGMENT*** (HEADING 5)

The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g.” Avoid the stilted expression “one of us (R. B. G.) thanks ...”. Instead, try “R. B. G. thanks...”. Put sponsor acknowledgments in the unnumbered footnote on the first page.

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