Experimental Analysis of Trapezoidal Corrugated Steel Web Beam For Its Stress And Deflection: A Review

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Abstract- *The objective of the project is to show efficiency of the corrugated web beam as compare to I-beam. Now a day's weight optimization is very efficient tool for obtain maximum efficiency, some of failure modes of the I-section beam are Bending failure by yielding, Bending failure by lateral torsional buckling, Bending failure by local buckling, Shear failure, Vibration. There are various shapes such as corrugation along horizontal direction and vertical direction, one arc and two arc sinusoidal along vertical direction and horizontal direction, trapezoidal corrugated shape for horizontal direction of web. Strength of the beam can be increased by using different shapes of corrugation for beam which also optimize the material of web and is useful for the application for many construction. There are various methods of fabrication such bending and welding, hot rolling and cold rolling. Experimental analysis will be carry out by using UTM to find the failure modes of corrugated web beam. Verification of testing will be carry out by using various software's such as ANSYS.*

Keywords- Trapezoidal corrugated beam, ANSYS.

I. INTRODUCTION

I - section beams are widely used in construction industry such as bridges, slender structure etc. and is available in variety of standard sizes. An I-beam, also known as H-beam, W- beam (for "wide flange"), Universal Beam (UB), Rolled Steel-Joist (RSJ),or double-T ,is a beam with an I- or H-shaped cross-section. The horizontal elements of the "I" are known as flanges, while the vertical element is termed the "web". I-beams are usually made of structural steel and are used in construction. The method of producing an I-beam, as rolled from a single piece of steel, was patented by Alphonse Halbou of the company forges de la Providence in 1849. There are two standard I- beam forms: Rolled I-beam, formed by hot rolling, cold rolling or Extrusion (depending on material).

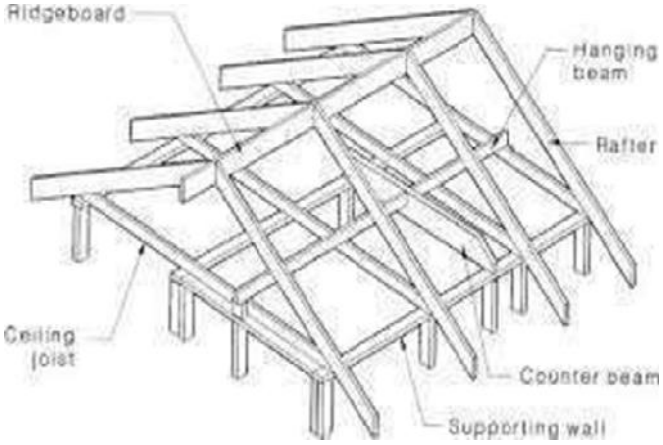

Fig. 1 Application of I Section Beam

Design of I-section beam may be governed by any of the following criteria

- Deflection-the stiffness of I-beam will be chosen to minimize deformation.
- Vibration-the stiffness and mass are chosen to prevent unacceptable vibration, particularly in setting sensitive to vibration, such as offices and libraries.
- Bending failure by yielding -where the stress in the cross section exceeds the yield stress.
- Bending failure by lateral torsional buckling -where a flange in compression tends to buckle sideways or the entire cross section buckle torsionally.

II. STATE OF DEVELOPMENT

The project deals with experimentation and analysis of trapezoidal corrugated web beam and I-section beam so number of papers are available which describes the limitations of using I section beams, benefits of built up section, accordion effect, various shapes that can be used as web, design consideration in trapezoidal corrugated web and also effect of corrugation angle into strength of beam.

Jian Jiang et. al (May 2015) This paper presents theoretical and experimental investigations on the local stability of compression flanges of H-beams with corrugated webs. Firstly, a simplified model of the flange plate considering the rotational restraint from webs is established. A formula for calculating the critical buckling stress of flanges is deduced. After verifying the proposed theoretical model against finite element analyses using ANSYS, parametric studies are carried out to investigate the influence of the tension flange, beam length and corrugated web on the resistance of compression flanges against local buckling. Secondly, experiments are carried out on three groups of corrugated web beams. The finite element modelling of the test specimens is validated against the available experimental results of their ultimate load- bearing capacity. The influence of the initial geometric imperfection of compression flanges and residual stresses on the critical buckling stress of compression flanges are studied using the FE model. It is concluded that initial imperfections may reduce the critical buckling stress by 28% while residual stresses may lead to a reduction of 14%. Finally, a correction factor of 70% is suggested for the critical outstand-to-thickness ratio of flanges to account for these two effects on the stability of steel beams with corrugated webs.

Mohammadi et. al. (May 2015) In this paper, an analytical equivalent model for the mechanical properties of the trapezoidal corrugated core is presented. A complete set of analytical formulations is derived based on energy approach for elastic modulus in different directions, transverse and in-plane shear modulus, in-plane Poisson's ratio and mass density of the equivalent model. The proposed approach is general and is able to model different corrugation geometry. To validate the precision and accuracy of the derived formulations, the obtained results are compared with the literature and the finite element simulations. A set of tensile and three-point bending tests are also carried out to further evaluate the derived equations. The results indicate that the analytical relations are accurate for a wide range of geometrical parameters.

Siva Prakash V.(April 2015) flexural behaviour of cold framed steel I-beam section with different corrugated profile sheet as web.

The objective of this paper is study the behaviour of cold formed built up I –section with different corrugation web. Total three specimens are experimented with flat, trapezoidal, triangular corrugation in web. The experimental result shows that the bending capacity or flexural capacity of the corrugated web (trapezoidal, triangular) is larger than flat web. When the triangular corrugation web increases the flexural capacity also increases than the trapezoidal web and flat web. All the specimen failed due to crushing on top compression flange and local buckling.

Magnucka et. al. (Nov 2014) Devoted to the mathematical modeling of transverse shearing effect for sandwich beams with sinusoidal corrugated cores. Bending and buckling problem of two sandwich beam are find out by theoretical.

Khalid et. al.(Feb 2014) The paper is devoted to the behaviour of mild steel structural beams with corrugated web subjected to three-point bending. Semicircular web corrugation in the cross-sectional plane (horizontal) and across the span of the beam (vertical) were investigated both experimental and computationally using finite element technique. In the finite element analysis, test specimen was modelled using commercially available finite element software LUSAS and a non-linear analysis was performed. Corrugation radius of 22.5 and 4 mm thickness, with constant corrugation amplitude to cycle length ratio (H/λ) and flange thickness of 6 mm were selected as the base sizes. The plane web beams, welded and ordinary rolled, were also tested with both methods to develop the benchmark results. The comparisons between the experimental and the finite element analysis results were satisfactory. It was noted that the vertical-corrugated web beam (VCRx) could carry between 13.3 and 32.8% higher moment comparing to the plane and horizontal-corrugated web beams, for the range of corrugation radius taken. Besides that, larger corrugation radius could sustain higher bending load up to the yielding stage. This attributed to the increment of the second moment of area (I) that has influence on the direct bending stresses (σzz). In addition, reduction in weight could be achieved by using the vertical-corrugated web. This is true for the corrugation shapes and sizes taken throughout this structure

Lincy Pabraham et. al.(Oct 2013) Built-up I-sections have been extensively used whenever standard I-sections could not satisfy the moment carrying and shear capacities required. In these built up sections it has been common practice to use more steel in webs rather flanges. This results in uneconomical sections as steel is an expensive material. So introducing corrugated profile in web reduced the web instability and also the need for providing transverse stiffeners. But, even after in corrugated webs and lateral stiffeners, effects like lateral torsional buckling were observed. Thus measures other than providing conventional transverse stiffeners and corrugated webs were to be found. This paper deals with the investigation on Behaviour of encased cold formed built up I section with trapezoidally corrugated web and encased cold formed built up I section with plane web, under two point loading by varying H/T ratio of the beam specimen. The experimental results of encased trapezoidally

corrugated web and that of plane web are compared and the behaviour and failure modes are discussed. Encasing the corrugated web of steel beam with concrete could improve the resistance to transverse deflections.

Jae-Yuel oh et. al. (April 2012) Various types of composite members have been developed to utilize the combined advantages of existing reinforced concrete and steel structures, and to actively improve ductility and serviceability of structural members. One of them is the hybrid-type steel beam, in which the prestressing method is applied to a steel beam. Introducing prestress to the existing I-shaped steel beam, however, results in a very low prestress efficiency due to the large axial stiffness of the section. On the other hand, if corrugated webs are used, the prestress introduced to the main flexural-resistant elements—the upper and lower flanges—gets larger due to the accordion effect, so that it is very advantageous not only in terms of serviceability, but also of achieving the improved flexural strength. Most previous studies on steel members with corrugated webs, however, have focused on the shear buckling strength of the corrugated webs, and few studies have been conducted on the accordion effect of the corrugated webbed beam to which prestress is introduced. Therefore, this research proposed two rational and theoretical models to quantitatively estimate the accordion effect, which is induced by the introduction of prestress to corrugated webbed steel beams, and performed experiments on two steel beams with corrugated webs and one with typical wide flange section. The experimental results showed that the prestressing efficiency of steel beams with corrugated webs increased more significantly than that of the steel beam with a typical web, and it is verified that the proposed methods are very simple and provide good agreements with the experimental results.

Chan et. al.(Dec 2001) The effect of web corrugation on the beam's strength is presented in this paper. Beams with plane web, vertically and horizontally corrugated webs were investigated using LUSAS finite element package. For the horizontally corrugated case, one arc and two arcs were studied, while half-circular wave corrugation was used for the vertical type. Half of circle corrugations of 22.41 mm mean radius and 3.44 mm thickness were used throughout this study. Non-linear elastic–plastic behavior has been considered. Three different corrugation radii were taken for each type of the beam to investigate its effect on the beam's strength.

III. GAP IDENTIFICATION AND OBJECTIVES OF STUDY

Realizing the fact, I-section beam have been extensively used whenever standard I-section could not satisfy the moment carrying and shear capacities desired. To built up an I-section it has been common practice to use more steel in webs rather flanges. This results in uneconomical sections as steel is an expensive material. The strength of I-section beam against lateral-tensional buckling along the length of the beam, and local buckling of the beam cross-section can be enhanced by using corrugation along horizontal direction and vertical direction. Different shapes of corrugation as like one arc and two arc sinusoidal along vertical direction and horizontal direction, trapezoidal corrugated shape for horizon direction of web. Strength of the beam can enhance by using corrugation of beam which also optimization the material of web is useful for the application for many construction. The stress and deflection analysis of such corrugated I-section beam will be carried out for its application.

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