ABSTRACT

Cold-Formed Steel (CFS) members are widely used in residential, industrial and commercial buildings as the primary load bearing structural elements due to their advantages such as higher strength to weight ratio over other structural materials. Cold-formed steel members are often made from thin steel sheets and hence are more susceptible to various buckling modes. The current cold-formed steel sections such as C and Z-sections are commonly used because of their simple forming procedures and easy connections, but they suffer from certain buckling modes.

Under flexure, cold formed open cross-section exhibits three modes of instabilities: local, lateral-torsional buckling and distortional buckling. In the design codes, effective widths of the plate elements are considered to calculate moment capacity of beam. The present Indian code of practice for design of cold formed steel members is under revision. Generally, codes provide design criteria for C, Z and I sections. If the higher moment capacity is needed the depth of web should be larger. But thin web provided is subjected to local buckling and it has to be stiffened. An alternate method of stiffening is provided with corrugation in the web. Corrugation may be of sinusoidal, triangular or trapezoidal profile. It is therefore important to strengthen the web and to increase the moment capacity of these members. So, a study is made on an I-section with trapezoidal corrugated web of CFS.
sheet. Spot welding is used for connection between the web and the flange at the folding points and at the middle of the panel in order to avoid the welding failure.

The primary objective of this research is to investigate the behaviour and strength of the I-beam with trapezoidal corrugated web of stiffened flanges for which there are no design rules currently available. The entire investigation is divided into four distinct phases of activities.

In the first phase, six coupons were tested under tension for two thicknesses. Accurate mechanical properties including the yield strength and elasticity modulus were determined. Further, a total of 61 specimens were tested on varying parameters like corrugation angle, aspect ratio, h_w/t_w ratio and b_f/t_f ratio under two point loading and their failure modes and their moment capacity were also investigated.

In the second phase a comprehensive investigation was aimed at, to investigate the buckling and ultimate failure behaviours of I-beams with trapezoidal corrugated web subjected to two point loading using finite element analysis. Sufficiently accurate finite element models simulating the physical conditions of both buckling and section moment capacity tests were developed. Comparison of experimental and finite element analysis results showed that the buckling and ultimate failure behaviour of the sections could be simulated using appropriate finite element models. All the moment
capacity results were compared with the available design methods based on AS/NZ: 4600-2005, AISI S100-2007 and IS: 801-1975. Suitable recommendations were made for the design of I-beams with trapezoidal corrugated web.

In the third phase, as the corrugated profile varies along the length, a procedure for warping constant calculation was proposed to find the warping constant and location of shear centre and validated using the finite element model.

In the fourth phase, limitations for designing I-beams with trapezoidal corrugated web, such as, corrugation angle, aspect ratio, h_w/t_w ratio and b_f/t_f ratio were proposed, by carrying out extensive parametric study using a validated finite element model. Using the FEA results, a new design equation is proposed to determine the moment capacity of I-beam with trapezoidal corrugated web.

To summaries, this thesis demonstrates that I-sections with trapezoidal corrugated web can perform well as economically and structurally efficient flexure members. Structural engineers and designers can make use of the new design rules to design the I-sections with trapezoidal corrugated web depending on the type of applications.