Experimental Investigation On The Behaviour Of Cold Formed Light Gauge Steel Beams Subjected To Cyclic Loading


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ABSTRACT
Cold formed steel structures are structural products that are made by forming plane sheets of steel at an ambient temperature into different shapes that can be used to convince structural and functional requirements. Therefore, the understanding of cold formed steel performance becomes an important issue to be studied. The aim of this paper is to study of the behavior of cold formed light gauge steel beams under cyclic loading. The effect of the cold formed beams with and without welding is tested for cyclic load and compared with its behavior under static loading. Totally four cold formed specimens are tested and its behavior are experimented and presented. Specimens are tested for cyclic loading and static loading. Deflections are measured. Load-deflection curves are plotted. Ultimate load carrying capacity, energy absorption capacity, ductility parameter and stiffness parameter are determined. The theoretical values are obtained by analyzing as per IS: 811 – 1987 and compared with the experimental results. Experimental results are compared with ANSYS Software results.

Keywords----- Cold formed light gauge steel, welding, ANSYS

I. INTRODUCTION
In construction industry one of the issue raised in adopting steel as structural member is how to reduce the weight of the component parts such as beams and girders and also to have good structural performance. This leads to the form called light gauge steel members.

Light gauge steel evolved as a building material in the 1930’s and reached large scale usage only after the Second World War. In comparison with conventional steel construction, where standard hot-rolled shapes are used, the cold-formed Light gauge steel structures are relatively new development.

Light gauge steel sections are cold-formed in rolls by rolling the material in cold condition or by bending the steel sheets or strips in press brakes, cold rolling being used for mass production while press brakes are used for economical production of small quantities of special shapes.

These are used widely in structures subjected to light or moderate loads or for the members of short span length. For such structures the use of hot-rolled shapes is often uneconomical and the stresses developed in the smallest available shape may be very low. In such conditions cold formed steel sections are lightweight materials suitable for building construction owing to their high structural performance.

The CFS (cold formed steel) members offer one of the highest load capacity-to-weight ratios among the various structural component currently on the market (also in comparison with hot-rolled steel members). The consequent lightweight of such components produces economy in production, transportation and handling, by reducing labour costs and worker fatigue. Light gauge members are connected by spot welds or by screws, rivets, bolts, etc.

Shapes which can be cold-formed are many and varied. Generally, the shape varies with its application. Engineers have learned to adopt this versatility to
advantage in design of compression members, studs, joists, beams, roof, panels and other industrial structural members. In the design of structural sections for framing members the main aim is to develop shapes which combine economy of material with versatility, ease of mass production, and provision for effective and simple connection to other structural members or to non-structural materials or both. The usual shapes of framing members are channels, zees, hat sections, tees, I sections and tubular sections as in fig. These sections, 50 to 300 mm in depth can carry substantial loads and are used as primary framing members in residential, commercial and industrial buildings up to two stories in height and roof trusses up to 15 m span.

II. EXPERIMENTAL PROGRAM

2.1 MATERIAL AND ITS PROPERTIES

The material used is cold rolled sheets named as CR Sheets with thickness 0.9 mm. From the coupon test, the properties of the material were determined. Young’s modulus of elasticity is $2 \times 10^5$ N/mm$^2$, Poisson’s ratio is 0.3 and yield stress is 211 N/mm$^2$.

2.2 DESIGN OF COLD FORMED STEEL BEAMS

The design of cold formed light gauge steel beams was made as per IS 811-1987. Area, moment of inertia, ultimate load and ultimate moment are first determined and finally check for the safety of the web and the flange, check for shear and deflection is made. The theoretical results are compared with ANSYS Results and Experimental results.

2.3 ANALYTICAL ANALYSIS

The finite element method is a numerical analysis technique for obtaining approximate solutions for the wide variety of engineering problems. Most of the engineering issues today make it necessary to obtain numerical solutions to problems rather than exact closed form solutions. The basic concept of the finite element analysis is that structure is divided into a finite number of elements having finite dimensions and reducing the structure having infinite degrees of freedom to finite degrees of freedom. Then original structure is assemblage of these elements connected at a finite number of joints called nodal points (nodes). For the finite element analysis advanced software ANSYS14 is used. In one end the specimen was strained in x, y and z directions and the other end of the specimen was constrained in y and z directions. The loads were applied along the transverse line on the upper surface of the top flange. Young’s modulus of elasticity is $2 \times 10^5$ N/mm$^2$, Poisson’s ratio is 0.3 and yield stress is 211 N/mm$^2$.

2.4 EXPERIMENTAL INVESTIGATION

The experimental investigation consists of arrangement of the specimen in loading frame. The test specimen was arranged in a manner of simply supported condition. The load was applied gradually through a jack at increment of 5kN. The cycle load first applied to a maximum of about 40kN then the specimen was unloaded with a decrement load of 5kN. The load was brought to zero. Afterwards the specimen was turned over and arrange in the position of simply supported condition and the cycle test was performed.

The load is applied axially along the centre of the beam and distributed into two point loading by the distributer ISMB 150 i.e. load applied at 1/3 distances. The dial gauge is placed at the centre of the beam. Load is applied and the corresponding deflections are determined.

The fabricated specimen is placed in the loading frame. To avoid the specimen’s failure from bearing it is placed carefully. The specimen is checked for its horizontality in both the directions. The dial gauge is placed at the centre. Load is applied and the corresponding deflections are determined and the values are noted. The specimen is loaded till failure. Ultimate load is determined. The failure modes are completely recorded and studied.

III. RESULTS-ANSYS RESULTS

3.1 I PURLIN 1. MODELLING

The experimental investigation consists of arrangement of the specimen in loading frame. The test specimen was arranged in a manner of simply supported condition. The load was applied gradually through a jack at increment of 5kN.
2. SHEAR FORCE DIAGRAM

3. BENDING MOMENT DIAGRAM

4. NODAL SOLUTION (MAXIMUM STRESS)

3.2 C PURLIN

1. MODELLING

2. SHEAR FORCE

3. BENDING MOMENT
IV. CONCLUSION

From this study, ultimate load carrying capacity, ultimate stress, ductility, stiffness and energy absorption capacity of the beams with and without joining of the specimens with weld can be dealt.

REFERENCES