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Structural Optimisation and Cost Effective Light Weight Composite Cold Form Steel Structures

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***Abstract*: Build up box sections are becoming increasingly popular in cold formed construction. This paper aims to develop the optimized innovative less weight composite column to replace the conventional hot rolled steel columns in aspect of weight reduction and economic design for steel and composite building to achieve this less weight concept. Column are made using cold form channel section used in the form of multi sectional alignment which is limbed with high strength bolt and ultra-lightweight concrete filled inside the CFS section to increase the stiffness and strength. This study deals with the parametric optimization of the concrete filling aspect ratio to avoid the buckling and various CFS section alignment to resist more load. The complete investigation of this research is carried on ANSYS and non- linear compressive load testing is done and results are compared with conventional type in considering the economic design.**

***Keywords*: Axial load, Cold Formed Steel (CFS), Composite column.**

1. Introduction

Cold form steel members are made from structural quality sheet steel that are formed into different shapes by roll forming the steel through a series of dies. In this process no heat is require to form the shapes hence get the name cold form steel. Cold form structure is durable, reliable and cost effective for building projects

In cold formed steel structures, the application of buildup channel section is increasing steadily. The increasing demand of CFS section as a cost effective design solution has led to development of CFS build up sections. These sections take advantage of higher load carrying capacities and may be used for longer beam spans, studs truss members, portal frame, columns etc. To obtain buildup section two or more CFS sections are joined together at interval with the help of direct welding or using bolts. For increasing structural performance light weight concrete is filled into the CFS column. This is a study of such composite 2 limbed multi section CFS column with various shape arrangement and comparing the structural performance with conventional column using ANSYS software.

Any type of structure under static or dynamic conditions can be evaluated by using ANSYS. ANSYS is the leading design software in the present engineering society. The ANSYS stands for extended Three- Dimensional Analysis of Building Systems. Designing of reinforced concrete structure. ANSYS is the better choice than STAAD pro and E-tab because of simplicity of software. Main advantage of this software is fast generation of models by the similar storey concept. Static analysis of structure means analysis of structure.

2. Cold Form Steel Channel Sections

The study of CFS members starts in early 2000s but here I'm introducing some of the new models of CFS channel section used in the form of multi sectional arrangement which is limbed with high strength bolt and ultra-lightweight concrete.

3. Analytical Study

Analytical study of composite 2 limbed multi section CFS column is done with the help of ANSYS Workbench 16.1 Software. It is used to find the best cross section which suits for axial and impact load characteristics.

Cross section of CFS Members is changed one after other and obtained the values of Total deformation, equivalent stress, strain, force reaction etc. under axial loading continues up to the failure of members. The comparison showing the graph of different cross section is as below.

- CFS-R (Cold formed steel-R)
- CFS-L (Cold formed steel-L)
- CFS-T (Cold formed steel-T)
- PCF-R (Partially concrete filled-R)
- PCF-L-W (Partially concrete filled-L-W)
- PCF-L-F (Partially concrete filled-L-F)
- PCF-T-W (Partially concrete filled-T-W)
- PCF-T-F (Partially concrete filled-T-F)
- FCF-R (Fully concrete filled-R)

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- FCF-L (Fully concrete filled-L)
- FCS-T (Fully concrete filled-T)

These various models are analysed by Displacement control method in ANSYS software under axial load.

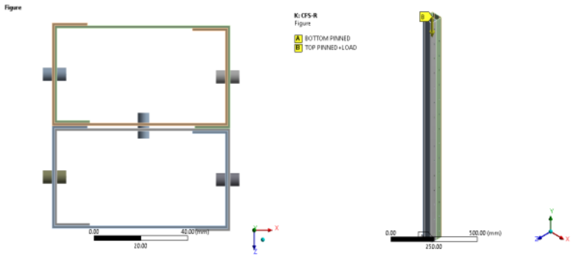

Fig. 1. Model and boundary condition diagram of CFC-R

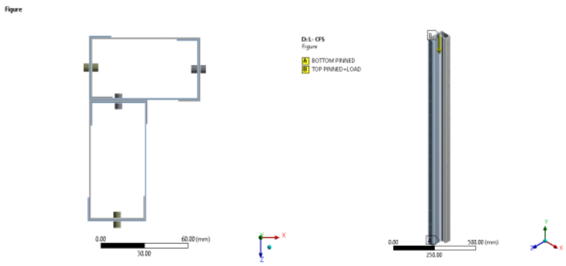

Fig. 2. Model and boundary condition diagram of CFC-L

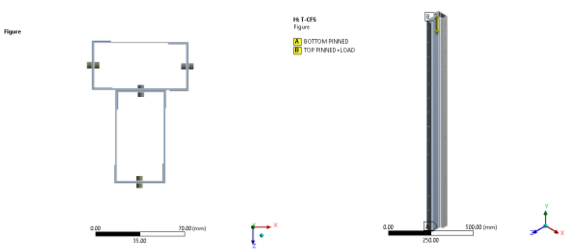

Fig. 3. Model and boundary condition diagram of CFS-T

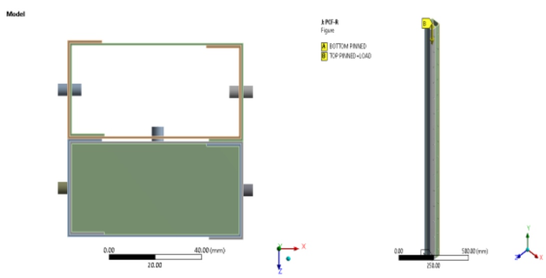

Fig. 4. Model and boundary condition diagram of PCF-R

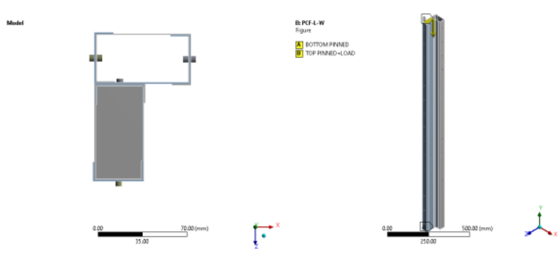

Fig. 5. Model and boundary condition diagram of PCF-L-W

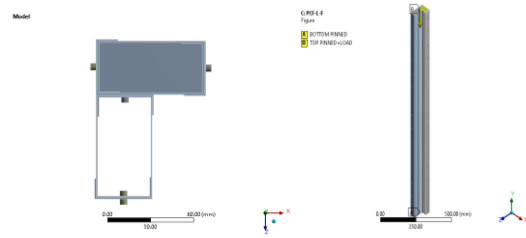

Fig. 6. Model and boundary condition diagram of PCF-L-F

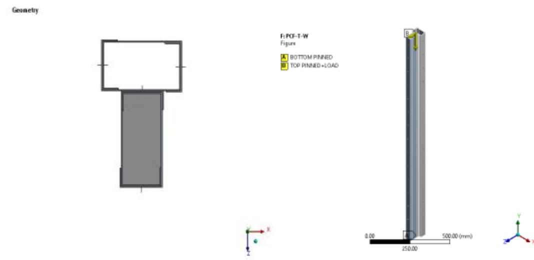

Fig. 7. Model and boundary condition diagram of PCF-T-W

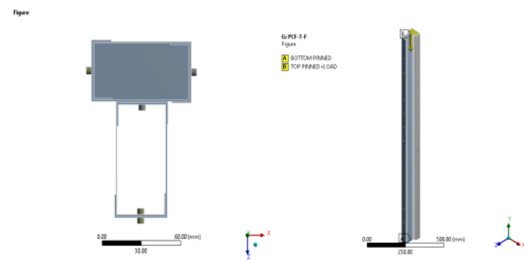

Fig. 8. Model and boundary condition diagram of PCF-T-F

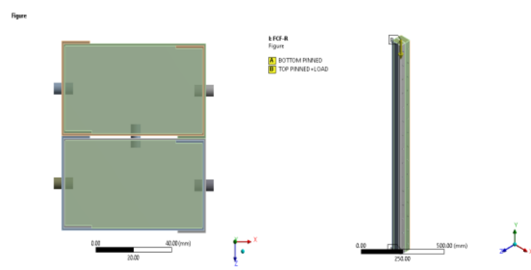

Fig. 9. Model and boundary condition diagram of FCF-R

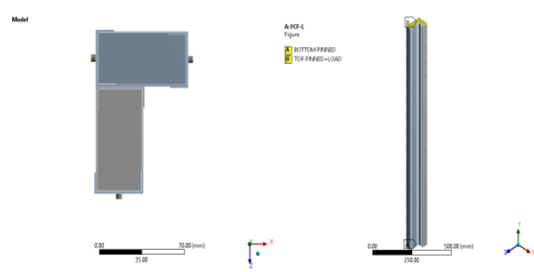

Fig. 10. Model and boundary condition diagram of FCF-L

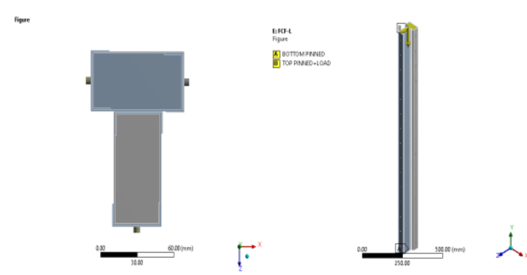

Fig. 11. Model and boundary condition diagram of FCF-T

After conducting the experiment in various models using ANSYS software the total deformations for all models are obtained. The comparison study of various shapes can be expressed by the charts and figures below.

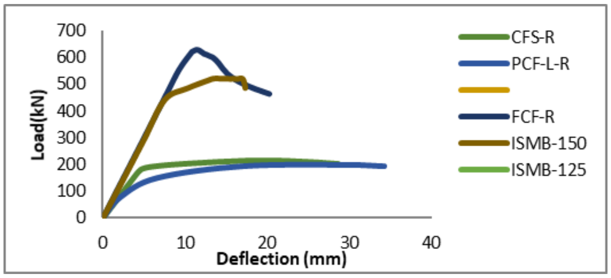

Fig. 12. Comparison chart for load in L shaped columns

From the Fig. 12 it is clear that fully concrete filled CFS column section FCF-L has more load carrying capacity than conventional steel column section ISMB 150.

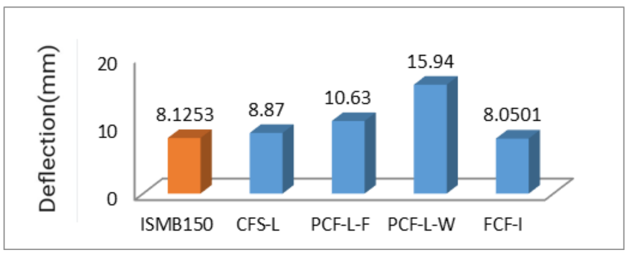

Fig. 13. Comparison chart for deformation in L shaped columns

From the Fig. 13 it is clear that fully filled concrete CFS section FCF-L has less deformation compared to other models.

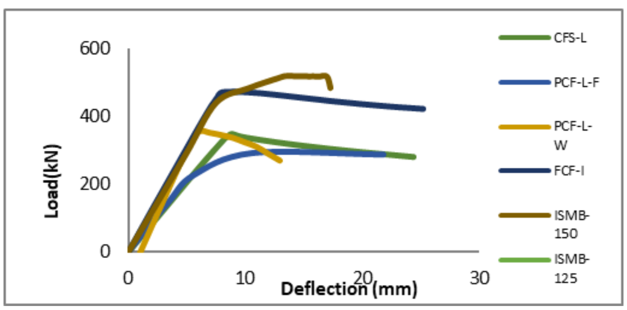

Fig. 14. Load vs. deflection graph for L shaped columns

From Fig. 14, it is clear that fully filled concrete CFS section FCF-L withstands maximum load.

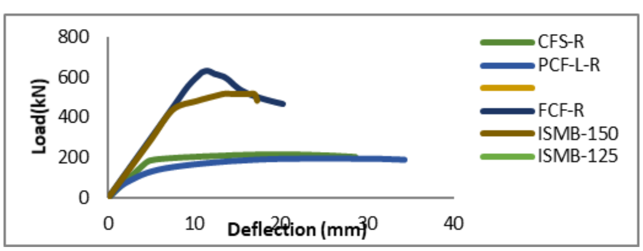

Fig. 15. Comparison chart for load in R shaped columns

From the Fig. 15 it is clear that fully concrete filled CFS column section FCF-R has more load carrying capacity than conventional steel column section ISMB 150.

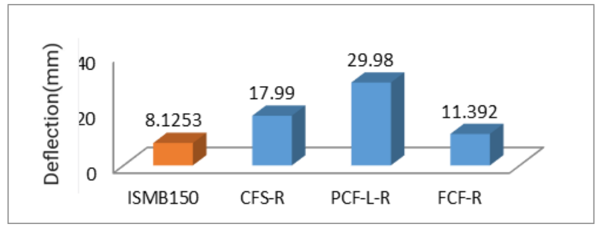

Fig. 16. Comparison chart for deformation in R shaped columns

From the Fig. 16 it is clear that fully filled concrete CFS section FCF-R has less deformation compared to other models.

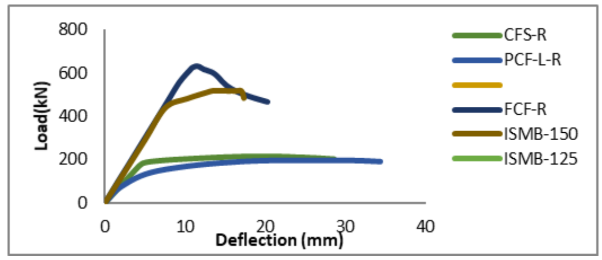

Fig. 17. Load vs. deflection graph for R shaped columns

From the Fig. 17 it is clear that fully filled concrete CFS section FCF-R withstands maximum load.

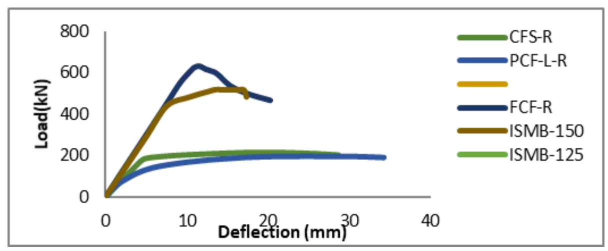

Fig. 18. Comparison chart for load in T shaped columns

From the Fig. 18 it is clear that fully concrete filled CFS column section FCF-T has more load carrying capacity than conventional steel column section ISMB 150.

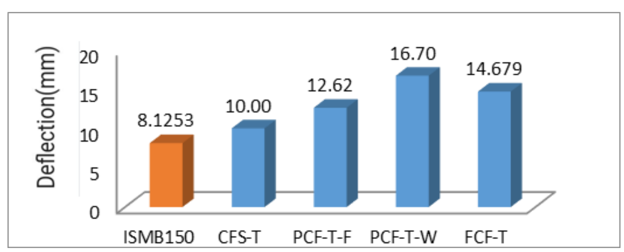

Fig. 19. Comparison chart for deformation in R shaped columns

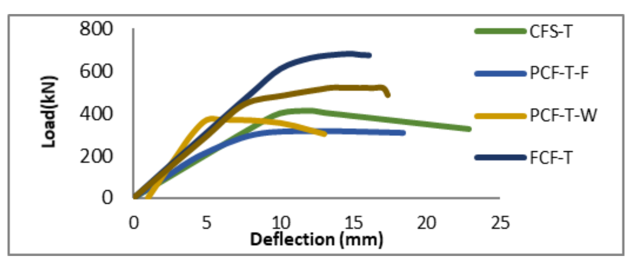

Fig. 20. Load vs. deflection graph for R shaped columns

From the Fig. 19 it is clear that fully filled concrete CFS section FCF-T has less deformation compared to other models.

From the Fig 20, it is clear that fully filled concrete CFS section FCF-T withstands maximum load.

4. Conclusion

From the research conducted above it is clear that the most apt two limbed column sections for construction is fully concrete filled CFS sections and in which section FCF-T which has two limbs joined in T shape is the best. Considering the present economic scenario, it is better to adopt composite CFS members for construction than conventional construction members.

5. Future Scope

Further researches can be conducted in order to find other various shapes of composite CFS members with many useful performances in construction field comparing to the conventional steel members.

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