A Review on Concrete infilled Coldformed steel composite section

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Abstract

The demand for durable, aesthetic, in construction industry is ever increasing. The use of composite sections in the construction industry is popular nowadays for their advantages. The cold formed steel sections with concrete infill can prove to be quite useful for the construction industry. The cold formed sections can carry more load than the concrete sections of the similar size. The increase in strength of the sections is also the result of confinement effect produced by steel on the concrete. Previous studies reveal that such sections produce less deformations under the equivalent stress of the similar sections.

Use of cold formed section can prove to be useful in terms aesthetics, load carrying capacity, flexural strength for structural members. The life expectancy of the sections can be increased with help of these sections.

Keywords: We would like to encourage you to list your keywords in this section

1. Introduction

Steel is an alloy of iron and carbon that is widely used in construction and other various applications due to its hardness and tensile strength. Structural steel is generally divided into hot-rolled sections and cold-formed sections. Cold formed steel sections are press folded steel sections which are moulded under the high pressure and under cold state of a high capacity moulding iron. It is also theoretically and experimentally proven that the cold formed sections provide increased strength than the hot rolled sections of the same size and grade. They can be useful in construction practices due to their strength, ductility, stiffness, energy absorption capacity, easy construction procedure and overall economy. The thickness of these sheets ranges from 0.0147inch (0.373mm) to about ¼ inch (6.35mm). Cold-formed steel sections tend to be more sensitive to local buckling than the hot rolled sections. The manufacturing and transportation of these members is easy and durable than most of the construction materials. They possess high strength to weight ratio than many of the building and structural materials. The cold formed steel sections are durable and they last for long time due to high resistance to corrosion. They are recyclable and reusable products which require very less energy, time and expenses to remold them to the required shape and size. The yield strength of steel sheets used in forming cold-formed sections is at least 280 N/mm^2.

The local buckling behavior of concrete in-filled sections is enhanced by the pressure of concrete in-fill when compared to hollow box-sections. This effect allows using an increased wall slenderness and higher steel quality. In addition, the presence of the steel box-section produces an increase of concrete strength due to the confinement effect.

In the research work presented by Nimburi R. Dharmakrishna[1] in "Flexural study on cold formed steel in-filled with construction waste- Broken Tiles." The experimental work mainly focused on flexural behavior of composite beams made up of cold formed steel sections in-filled with and without concrete with optimum replacement of coarse aggregate by broken tiles. The author divided the research in three stages as

1) Designing the concrete mix M25 for the three different percentage.
2) To find the optimum percentage of coarse aggregate to replaced
3) To prepare the models of cold formed steel in-filled with concrete to find the flexural properties.

The author mitigated the risks of excessive curing to steel by adding a self-curing agent PEG400 i.e. Polyethylene Glycol 400 to cut off the extra water required for the curing of the concrete to help it attains its maximum strength. During the analysis stage author subjected the models developed on ANSYS v12 under 100KN point load. The tests were carried out on two types of models viz. composite cold formed steel section with concrete in-fill consisting broken tiles and hollow cold formed steel section to compare the characteristic properties and behavior of the sections. The result attained by the author prove that the composite sections of cold formed steel in-filled with concrete show better performance, longer durability and the sections are able to sustain loads than the hollow cold formed sections. Author could achieve the result that showed reduction in deformation by 29% in composite sections than hollow sections.

In the research work in “Performance of in-filled cold formed steel channel section beam” by Jyothi K.N., The author used the channel sections with concrete in-fiiled for the flexural testing of the concrete in-filled sections. The sections used were ‘C’ channels made up of cold formed steel sections. The author used the Australian code (AZ/NZS.4600-2005) for the determination of moment carrying capacities. As the IS code is still under revision for the CFS members the most recommended code are Euro code and Australian code/ New Zealand code. The author used 12 specimens for testing with 6 section in-filled with concrete and 6 hollow sections. The M20 grade of concrete was used with 53 grade of cement. The method used for the curing of the concrete in-filled sections was wet gunny bags for 28 days and the testing of the sections was done by two-point loading system. After the testing of the hollow and concrete in-filled sections the graphs were plotted and the result provide astonishing increase in strength up to 74.09% was found in concrete section than hollow sections. The moment carrying capacity of the composite section was observed to be increases with increase in the depth of the section. The failure of the section was observed by the cracking of the in-filled concrete and in some cases by separation of steel from concrete while the hollow section failed by inward and outward buckling.

In the report by W Leonardo Corte’s Puentes in the research work “Compressive strength capacity of light gauge steel composite columns.” The author experimented on 12 long and 14 stud columns for their axial compressive strength and confinement. The 12 long columns were experimented by loading the column under axial loads. The author to set main goal as to investigate the contribution of various component of light gauge steel composite column under the axial load testing capacity. There is no particular code for design of such composite columns in existence and it proved to be challenging to assess the design and extending to proper conclusion. According to the most codal provisions the author could select the steel section by considering the width to thickness ratio of the sections. Author selected four columns for concrete only four columns for steel sections and four columns with concrete infill and the loading was applied on the sections with 2200KN capacity compressive testing machine gradually. The steel only columns. Columns suffered through the modes of buckling at the mid-height of the sections and at the end of the section. The corresponding faces were observed to be influenced by the buckling pattern. While in the concrete in-filled sections could attain more axial compressive strength than individual column without steel and individual column without concrete. It helped in supporting the restraining effect of the concrete core resulting into the improvement of the overall sections. The author could verify that the effect of using the composite cold formed steel and concrete section could improve the overall tensile capacity of the section by 33% of the tensile capacity of the concrete sections. The columns were subjected to end buckling and the axial strength capacity of these sections was assumed with the end bearing resistance as the limit state of section.

The author performed various tests on the CECSTC (concrete filled cold formed steel tubes) sample for axial compression. The author tested section for in-filled and hollow condition. The in-filled material used was PCC with four different sections. The square and rectangular cold formed steel was used as casing for the composite sections. For the determination of axial deformation and compressive strength of sample one point load was applied on the on the different samples like PCC, Hollow, and concrete in- filled light steel gauge column with the help of UTM machine. The author tested the section under UTM for compressive strength and repeated the procedure for all sections. The failure modes observed on the sections followed bulging of the sections after the failure. The testing results indicates that the in-filled sections carried more load before failure of the section than the PCC and hollow sections. The ultimate load of the section could attain 50% more load then PCC and 65% more load than hollow sections while increase in the cross-sectional area resulted in increased load carrying capacity. After testing the square and rectangular section author could verify experimentally that the load carrying capacity of concrete in- filled column is higher than the PCC and hollow section, about 50% load more than PCC carried by concrete in-filled column and about 45% more than hollow load carried by concrete in-filled column and by observation it is also clear that as area increased the strength carrying capacity also increases. For testing of sample one point load was applied on the on the different samples like PCC, Hollow, and concrete in- filled light steel gauge column with the help of UTM machine. The author tested the section under UTM for compressive strength and repeated the procedure for all sections. The failure modes observed on the sections followed bulging of the sections after the failure. The testing results indicate that the in-filled sections carried more load before failure of the section than the PCC and hollow sections. The ultimate load of the section could attain 50% more load then PCC and 65% more load than hollow sections while increase in the cross-sectional area which resulted in increased load carrying capacity. After testing the square and rectangular section author could verify experimentally that the load carrying capacity of concrete in- filled column is higher than the PCC and hollow section, about 50% load more than PCC carried by concrete in-filled column and about 45% more than hollow load carried by concrete in-filled column and by observation it is also clear that as area increased the strength carrying capacity also increases.

2. Technical Parameters Studied by Various Authors On Cold Formed Concrete Infilled Sections

Sr no	Name of paper	Year of publishing	Deflection	Deformation	Normal stress-strain	Compressive strength	Buckling behavior
1	Flexural study on cold formed steel in-filled with construction waste- Broken Tiles.			✓	✓		
2	Compressive strength capacity of light gauge steel composite columns.	2016				✓	
3	Performance of in-filled cold formed columns	2014	✓				✓
4	Experimental study on concrete in– filled Light gauge steel hollow section	2017				✓	✓
5	Performance of in-filled cold formed steel channel section beam.	2015					

Sr no	Name of paper	Uni-axial eccentric load	Flexural strength	Bi-axial eccentric load	Thickness ratio	Depth ratio
1	Flexural study on cold formed steel in-filled with construction waste- Broken Tiles.		✓			
2	Compressive strength capacity of light gauge steel composite columns.					
3	Performance of in-filled cold formed columns	✓		✓		
4	Experimental study on concrete in – filled Light gauge steel hollow section				✓	✓
5	Performance of in-filled cold formed steel channel section beam.		✓			

3. Methodology to be adopted for research work based on Previous research

The research work focuses on the primary analysis of the light cold formed concrete In-filled sections with in fill of plain cement concrete and specimen of steel fiber reinforced concrete. 30 specimens of cold formed steel will be experimented during the project work. The 6 hollow sections of cold formed steel will be arranged for testing. The same sections of the same size will be analyzed in the ANSYS Workbench v14.5.

This research contains following four stages.

1. Procurement of the required materials along with the designated grades.
2. To prepare the concrete mix and test the respective specimens on the UTM and to record the results and observations.
3. To prepare models of cold formed steel infilled with concrete and in filled with steel fiber reinforced concrete and to find the flexural properties on ANSYS Workbench v14.5 software.
4. To compare the analytical results from the ANSYS software with the experimental results

The flexural properties of cold formed steel infilled with concrete will be analyzed by using ANSYS v14.5 software. Flexural properties like deformation, normal stress and strain, ultimate load carrying capacity and buckling of the column sections will be observed. During the analysis stage three cases will be considered.

1. Analyzing cold form steel without any concrete infill.
2. Cold formed steel infilled with conventional plain cement concrete.
3. Cold formed steel infilled with steel fiber reinforced concrete.

4. Conclusion:

According to the previous studies on the cold formed steel sections there is improvement in the capacities of the sections if they are infilled with concrete. The improvements in the sections mainly include increment in load carrying capacity of the section, tensile and flexural capacities of section. The confinement of the section may also help in the increased value of the load carrying capacity but according to the Euro codes, the increment in the ultimate load of the section is assumed to be negligible as in case of square and rectangular column sections.

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