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Experimental Investigation of Industrial by - Products Concrete Filled Mild Steel Tubular Columns with GFRP Wrapping

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Abstract: Concrete filled steel tubular columns are becoming widely used in engineering. Composite structural members provide a cost-effective alternative to traditional structural steel or reinforced concrete columns. The use of composite columns in different areas of construction is becoming an attractive solution. Concrete-filled steel tube columns provide high strength, high ductility, and high stiffness. In addition to these advantages, the steel tubes surrounding the concrete columns eliminate permanent formwork which reduces construction time. Glass fibre reinforced polymer (GFRP) - confined concrete filled tubular composite columns have been recently introduced as a wrapping technique for structural steel columns. These techniques are becoming very attractive trend for industrial and high-rise buildings. The aim of the project is to study the axial behaviour of mild steel tubular column wrapped with GFRP sheets using vinyl ester resin and to find the load–deformation relationship of CFT columns. The experimental investigation also involves the replacement of cement and the fine aggregates with the 40% of fly ash and 50% of copper slag respectively, further it incorporates addition of silica fume at 6% and steel fibre at 0.5% which is to be maintained constantly for all mixes recommended for confined concrete tubular section. At M30 grade of concrete with constant water cement ratio, tests are to be conducted to find the axial compression behaviour of stubbed columns, effect of using a GFRP retrofitting system, ductility factor, and confinement ratio. A eleven stub columns are to be casted totally, consisting of M30grade of concrete mix will be considered for the investigation. Finally, the experimental results will be compared with the analytical results obtained from Ansys software.
Key Words: Glass Fibre Reinforced Polymer, Vinyl Ester, Square Stainless Steel, Copper Slag, Steel Fibre

I. INTRODUCTION

Composite sections are becoming popularly increasing in construction. Harnessing the strengths of two different materials to form a composite section can be beneficial in terms of both structural performance and cost. In recent years mild steel members have become popularly increasing in architectural and structural applications. Typical application of mild steel in tubular construction includes pedestrian bridges.

The term 'composite column' refers to a compression member in which the steel and concrete elements act compositely. The role of the concrete core in a composite column is not only to resist compressive forces but also to reduce the potential for buckling of the steel member. The steel tube reinforces the concrete to resist any tensile forces, bending moments and shear forces, and offers confinement to the concrete.

Composite columns can buckle in local or overall modes, but this investigation is focused on the cross-section resistance of short composite columns, where only local buckling effects were exhibited.

The principal disincentive for the utilisation of mild steel for structural elements is the low initial material cost, but considered on a whole-life basis; cost comparisons with other metallic materials become more favourable. Concrete infilling on mild steel tubes maintains the durable and aesthetic exposed surface, but will lead to reduced column sizes and material thickness, both of which have clear economic incentives.

II. CONCRETE FILLED TUBULAR COLUMNS

Concrete stubbed tubes are increasing usage in the modern constructions throughout the world. Experimental studies on concrete-filled steel tubes have been on-going for many decades. From a structural point of view, hollow sections exhibit high torsional and compressive resistance about all axes when compared to the open sections. Use of composite columns can result in significant savings in column size, which ultimately can lead to considerable economic savings. The role of concrete core in a composite column is not only to resist compressive forces but also to reduce the potential for buckling of steel member. The mild steel is a corrosive material; significantly, this means that the surface can be treated any protective coatings. It maintains the durable and aesthetic exposed surface.

A review of available experimental studies shows that the main parameters affecting the behaviour and strength of concrete-filled columns are: the geometrical parameters, such as the slenderness, the D/t ratio and the initial geometry of the column; the mechanical parameters, such as the strength of the steel and concrete, the loading and boundary conditions and the degree of concrete confinement.

III. LITERATURE REVIEW

A. General

The following section deals with the comprehensive literature review regarding the papers published on the concrete filled tubular columns by using various metals under different cross sections and the concrete made up of different materials like fly ash, silica fume, copper slag and lime stone. Several researches have been conducted on the concrete filled tubular columns under monotonic loading conditions and also using different admixtures regarding the load carrying capacity, failure mode of columns and other related parameters. Some of the literature have been reviewed and discussed.

B. Reviews On Literatures

Sakthieswaran Natarajan & Ganesan Karuppiah (2014), the investigation on effect of addition of fly ash, copper slag, steel fibre, and polypropylene fibres on compressive strength of concrete and to determine the hierarchical order of mix variables in affecting the strength. While fly ash and copper slag used as partial replacement of cement and fine aggregate respectively, and the fibres are used as addition to the mixes. That the amount of cement replaced by fly ash is varied from 40% to 60% (by weight), the amount of fine aggregate replaced by copper slag varied from 30% to 50% (by weight), Amount of silica fume as 6%, and the water binder ratio of 0.35, amount of super plasticizer varied from 2 to 2.2% by weight of the binder content respectively. Analytical part was performed by method of cluster analysis using MAT LAB software, experimental and analytical results were compared. Concluded that increases in fly ash-cement ratio, copper slag-fine aggregate ratio strength of the concrete also increases, addition of both fibres to reduce the strength, replacing 40% of cement by fly ash and 50% of fine aggregate by copper slag with 0.5% of steel fibres gives the higher strength.

Bedage S D & Shinde D N (2015), the investigation deals with comparison between experimental and analytical study of concrete filled steel tubes under axial compression. The method of finite element analysis was used in ABAQUS 6.13.1, different cross sections like circular, square and rectangular was used. Three different types of grades were adopted such as M20, M30, and M40. Concluded that the analytical results obtained by ABAQUS are in good agreement with the experimental values. The confinement pressure is more effective for circular concrete filled columns, Circular specimens are failed in length while square and a rectangular specimen fails at ends during the time of testing.

Wei Hua & Hai-Jun Wang (2014), the experimental study on RC columns, hollow steel tube columns, concrete filled steel tubular (CFT) columns, and reinforced concrete filled steel tubular (RCFT) columns. The load carrying capacity confined effect, ductility ratio, and failure mode of test columns are investigated. Difference between CFT and RCFT are compared. Mechanical characteristics of columns are discussed. Concluded that the CFT columns has lost strength after the maximum compressive strength, Avoid shearing failure due to the provision of reinforcing bars, Reinforcement has effectively increase the shear bearing capacity of columns, strength, rigidity, and ductility of RCFT are improved. The greater width-thickness ratio better confined effect and filled concrete has effectively resisted local buckling of steel tubes.

Richard Liew J Y & Xiong M X (2014), the investigation on behaviour of tubular columns in-filled with ultra-high strength concrete at ambient and elevated temperatures, basis mechanical properties of high strength materials was studied, stub columns under concentric loading condition, beam under moment, and slender beam-columns under concentric and eccentric compression were tested, concrete cube and cylinder specimens were used to find compression and split tensile strength of concrete. Concluded that the test results were compared with the predictions using a modified Eurocode 4 approach. Failure of UHSC filled steel tube columns with low steel contribution ratio, confinement effect is ignored, full plastic moment resistance is achieved, at high temperature strength reduction in the concrete filled columns are less when compared to the normal concrete strength.

Sundarraja M C & Sriram P (2014), the investigation on strengthening of corroded (damaged) square hollow steel tubular sections subjected to compression with suitable wrapping of CFRP composites, the wrapping was used as lateral strips with varying number of layers and provide proper spacing of 20mm to 70mm, Concluded that the horizontal wrapping style of narrow strip of

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CFRP fabrics was improved the external confinement pressure of HSS tubular columns, failure modes of the columns, axial stress-strain behaviour, enhancement in the load carrying capacity, effect of distribution of CFRP layers was to be studied. In the corroded HSS columns confined by CFRP sustained higher load and larger axial deformation, the load carrying capacity of 70mm spacing wrapping column was more strength when compared to 50mm spacing.

C. Motivation Study From The Reviewed Literature

The reviewed literature shows that the concrete filled tubular columns depends on various factors loading condition, stress-strain relationship, width to thickness ratio, slenderness limits, confinement effect, local buckling etc.,. The reviewed literatures clearly showed there is lack of experimental studies on increases strength of columns retrofitted with glass fibre reinforced plastic (GFRP) in mild steel tubes. So far, GFRP laminates was used as an external wrapping of the mild steel tubular columns and the normal concrete was used in all the places, since they are largely available waste material through industries and by the nature. The use of fly ash of proportion 40% and use of copper slag of proportion 50% was referred from Sathieswaran Natarajan (2014) investigation on the cement with fly ash and fine aggregate with copper slag which produced a durable and good compressive strength of concrete. The silica fume of 6% with their extraordinary performance in filling the voids in concrete with other pozzolanic materials and steel fibre was used 0.5% of by weight which improves the tensile strength of concrete.

D. Further Possibilities

1) Cement can also be replaced with metakaolin, GGBS, talcum powder and silica fume instead of fly ash.
2) Fine aggregate can also be replaced with marble powder, green sand and bottom slag instead of copper slag.
3) Stainless steel, Aluminium and PVC sections are also be used instead of mild steel section.
4) Circular, rectangular, triangular, trapezoidal shapes can be used instead of square section.
5) Slender column can also be used instead of short column.

IV. RESULTS AND DISCUSSIONS

After having a detailed literature review, the following work was proposed. It is clear that lot of research work has been done in steel concrete composite structures, especially in concrete filled tubular columns. In future it was to carry out an experimental investigation on concrete filled mild steel square tubular columns with varying number of layers of GFRP composites. Totally eleven tubular specimens are going to be casted. Among these, one is to be tested without concrete and rest of the specimens are filled with concrete both of the specimens calculating to its axial compressive loading.

Five specimens are required for one mix. The inner concrete core is made up of replacement of cement and the fine aggregates with the fly ash and copper slag, further it incorporates addition of silica fume and steel fibre which is to be maintained constantly for all mixes. Tests are to be conducted for axial compressive strength of CFT columns, stress-strain behaviour, and load – deformation relationships are evaluated. Finally, the experimental results will be compared with the analytical results obtained from Ansys software.

REFERENCES

[1] Bedage S D & Shinde D N (2015), “Comparative study of concrete filled steel tubes under axial compression”, International Journal of Engineering Research Vol. 3 Issue. 3 pp.465-471.
[2] By Brian Uy (2000), “Strength of concrete filled Steel box columns incorporating local buckling”, Journal of Structural Engineering Vol. 3, pp. 341-352.
[3] Bambach M R (2011), “Design of hollow and concrete filled steel and stainless steel tubular columns for transverse impact loads”, Elsevier Vol. 49, pp. 1251-1260.
[4] By Hanbin Ge & Tsutomu Usami (2004), “Cyclic tests of concrete-filled steel box columns”, Journal of Structural Engineering Vol. 10, pp. 1169-1177.
[5] Chithira K & Baskar K (2013), “Experimental study on circular concrete filled steel tubes with and without shear connectors”, Techno-Press Ltd Vol. 16, No. 1 pp. 99-116.
[6] Dennis Lam & Leroy Gardner (2008), “Structural design of stainless steel concrete filled columns”, Elsevier Vol. 64 pp. 1275-1282.
[7] Hsuan-The Hu M, Chiung-Shiann Huang & Ming-Hsien Wu (2003), “Nonlinear anaylsis of axially loaded concrete-filled tube columns with confinement effect”, Journal of Structural Engineering Vol. 10, pp. 1322-1329.
[8] Kheyroddin A, Naderpour H & Ahmadi M(2014), “Compressive strength of confined concrete in CCFST columns”, Journal of Rehabilitation in Civil Engineering Vol. 2-1, No.2014 pp. 106-113.
[9] Kenji Sakino, Hiroyuki Nakahara & Shosuke Morino (2004), “Behavior of centrally loaded concrete-filled steel tube short columns”, Journal of Structural Engineering Vol. 2, pp. 180-188.
[10] Lanhui Guo, Shijun Yang & Hui Jiao (2013), “Behaviour of thin walled circular hollow section tubes subjected to bending”, Elsevier Vol. 73 pp. 281-289.
[11] Lam D, Gardner L & Burdett M (2008), “Behaviour of concrete filled stainless steel elliptical hollow sections”, Innovative design of steel structures Vol. 15, No. 6, pp.151-161.

[12] Mohammed Yousuf, Brain Uy, Zhong Tao & Alex Remennikov (2013), "Transverse impact resistance of hollow and concrete filled stainless steel columns", Elsevier Vol.82, pp.177-189.

[13] Qingli Wang & Yongbo Shao (2013), "Compressive performances of concrete filled square CFRP-steel tubes (S-CFRP-CFST)", Techno-Press Ltd Vol. 16 No. 5 pp. 455- 480.

[14] Richard Liew J Y, Xiong M X & Xiong D X (2014), "Design of high strength concrete filled tubular columns for tall buildings", International journal of High-Rise Buildings Vol.3, No. 3, pp. 215-221.

[15] Rui Wang, Lin-Hai Han & Chuan-Chuan Hou (2012), "Behavior of concrete filled steel tubular (CFST) members under lateral impact: Experiment and FEA model", Elsevier Vol. 80, pp. 188-201.

[16] Sakthieswaran Natarajan & Ganesan Karuppiah (2014), "Hierarchical order of influence of mix variables affecting compressive strength of sustainable concrete containing fly ash, copper slag, silica fume, and fibres", The Scientific World Journal Vol. 2014 pp. 1-11.

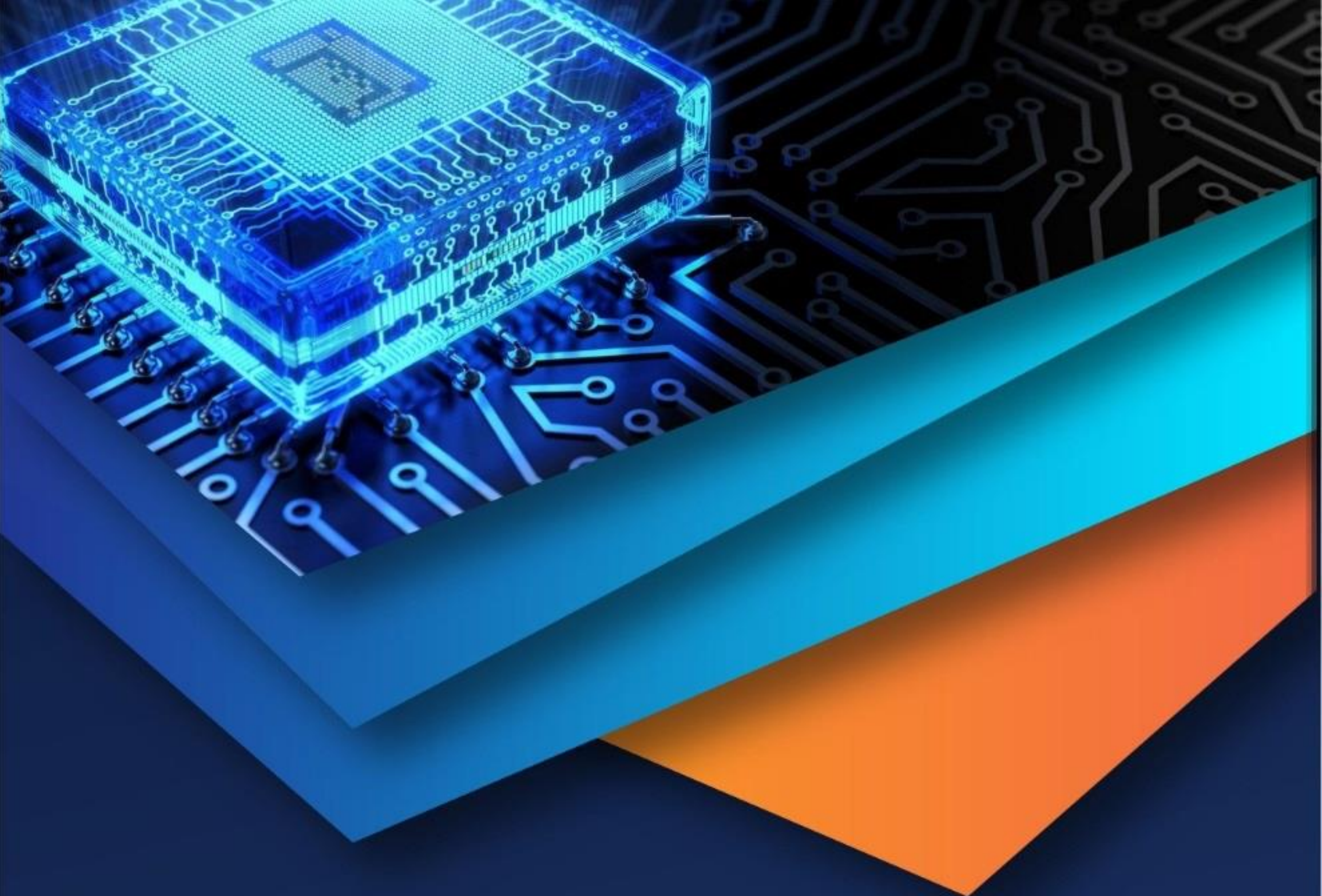
[17] Sundarraja M C & Sriram P(2014), "Investigation on corroded HSS Tubular members under compression strengthened with CFRP composites", Archives of Civil Engineering Vol. 1, pp.145-159.

[18] Wei Hua, Hai-Jun Wang & Akira Hasegawa (2014), "Experimental study on reinforced concrete filled circular steel tubular columns", Techno-Press Ltd Vol. 17 No. 4 pp. 517- 533.

[19] Xu Chang, Zong Liang Ru, Wei Zhou & Yong-Bin Zhang (2012), "Study of concrete filled stainless steel-carbon steel tubular (CFCT) stub columns under compression", Elsevier Vol. 63 pp.125-133.

[20] Zeghiche J & Chaoui K (2008), "An experimental behaviour of concrete-filled steel tubular column", Elsevier, Vol. 61, pp. 53-66.

[21] Eurocode 4: Design of composite steel and concrete structures, Part 1.1: General rules and rules for buildings. Brussels, Commission of European Communities, March; 1992.



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