Experimental Analysis Of CFST Sections With Tie And Self Curing Agent

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Abstract— Present paper focuses on the construction and testing of concrete filled steel tubular section. Concrete in filled Steel tubular section has gained the advantage of composite member. Generally, composite members are constructed using two or more different materials to obtain different engineering properties. Use of steel as an external mould neglects the use of shuttering panels, increases the mechanical properties of the section and neglects the water bath of the section which is often done in curing period. Water bath in one of the important method of curing for vertical structural elements. To reduce such instant, this study investigates the role of PEG400 as a self-curing agent, the percentage of PEG400 by weight of cement is 2% as the dosage of internal curing. The test results were studied for three mixes that is for M20, M25 and M30 mixes. Concrete mixes prepared using internal curing compound PEG400 with specified target strength values calculated during design mix for M20, M25, and M30 grade of concretes.

Index Terms— CFST Column, PEG400, Compressive Strength, Stiffeners, Reinforced concrete, Buckling, Workability.

1 INTRODUCTION

Concrete and steel are the most common construction materials used from 1800's to present. Both the steel and concrete are said to be heterogeneous material, manufacturing of steel and concrete utilizes different mineral ores [1]-[3]. Combination of steel and concrete are said to be composite sections, which increases the load carrying capacity and other mechanical properties of the sections. Steel concrete composite sections has the advantage of using both steel and concrete, steel has high yielding capacity and concrete has tough strain capacity, using the combination of both materials increases the advantage of improving the material property [5]-[9]. Currently, composite structural elements mainly used in high rise buildings, long span bridges and other types of special structures, use of composite steel concrete sections neglects the use of steel reinforcement thereby reducing the construction cost [10]. Generally, steel concrete composite sections are classified into two group first - concrete in filled steel encased section, second – concrete encased steel infill sections. Both the type of section have unique engineering properties [12]-[14]. In concrete in filled steel encased section, the steel tube act as an external mold in which concrete are poured inside the steel tube [16]-[17].
This system improves the efficiency and workability of the construction activities. Second, in concrete encased steel infill sections hollow steel pipes are placed at the concrete core, normally this type of sections are often used in industrial buildings, the central core of the steel pipe is used to carry the cable and other wiring units. CFST sections are made in different shapes as per the end user requirement, normally CFST sections are in the form of tubular shape and also it can be made in the form of square, rectangle, etc., [18] Use of CFST sections will increases the deflection property of the section, highly deflecting material can be adopted in earthquake prone areas to prevent loss of life [20].

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2 MATERIALS AND PROPERTIES

2.1 Cement

Cement is manufactured in a controlled environment, in which all the raw ingredients are burned to a temperature of 1200 – 1500°c and then dried at room temperature to form clinkers and these clinkers are grounded with gypsum to enhance the setting time of the cement.

Table: 1 shows the properties of cement.

Particulars	Permissible values	Test values
Fineness modulus	≤10%	4.375%
Specific gravity	3.0-3.15	3.15 g/cc
Initial setting time	30min	32min
Final setting time	600min	580min
Specific gravity	3.0-3.15	3.15 g/cc

2.2 AGGREGATE

2.2.1 FINE AGGREGATE

The M- sand having fineness modules of 3.18.The specific gravity of fine aggregate is 2.37. It is found that sand with the fineness modulus below 2.5 gives the concrete a sticky consistency. Making it is difficult to compact. Sand with a fineness of about 3.0 gives the best workability and compressive strength.

Fineness modulus = 3.17

2.2.2 COARSE AGGREGATE

The crushed stone materials which are retained on 4.75mm sieve are called coarse aggregate. Locally available coarse aggregate having the maximum size of 20mm sieve is used in the present work. According to IS 383:1970, maximum 20mm coarse aggregate is suitable for concrete work. Specific gravity

of coarse aggregate G= 2.63

2.3 POLY ETHYLENE GLYCOL

Polyethylene glycol, abbreviation (PEG400) is termed in combination with a numeric suffix which indicates the average molecular weights. One common feature of PEG400 appears to be the water-soluble nature. Polyethylene glycol is non-toxic, odourless, neutral, lubricating, non-volatile and non-irritating and is used in a variety of pharmaceuticals.

2.4 Steel Tube

Concrete filled steel tube column have many excellent structural properties, such as high compressive strength, large ductility. The thickness of steel tube is 2mm.Then, composite tubular column have been gradually used widely in the world. Fe 240 mild steel is used as per IS 2062.

3 TIE BARS

Generally tie bars are called as stirrups in axially loaded structural elements, these are used to hold the main rod and distribution rods in position and transfers the shear stress which acts on the surface of the element. At present tie bars are provided in the form of horizontal bracings to distribute the load from the steel section to the concrete core. The HYSD bars are used and provided in the middle of the column with the thickness of 8mm.

4 MIX DESIGN

The mix design of M20, M25 and M30 grade concrete given below is based on the guidelines given in Indian Standard IS 10262 : 2009.

Table: 2 shows the Mix Proportions of Different grades.

Mix Proportion	Cement	Fine aggregate	Coarse aggregate	Water
Trial – 1 M-20 grade	369	646	1108.14	203
Mix ratio 1	**1**	**1.7**	**3**	**0.5**
Trial – 2 M-25 grade	406	635.55	3	0.5
Mix ratio 2	**1**	**1.5**	**2.68**	**0.5**
Trial - 3 M-30 grade	451	621.3	1066.41	203
Mix ratio 3	**1**	**1.37**	**2.36**	**0.5**

5 EXPERIMENTAL INVESTIGATION

5.1 CFST SPECIMENS

The concrete filled steel tube consists of 114mm dia (ODI) and inner dia of 110 mm and 300mm height and a thickness of 2mm. Concrete was then filled in mould in three layers, while filling the mould concrete was compacted using tamping rod of 600mm length having diameter of 110mm then the mould is kept on the plane surface in the laboratory for 24 hours and then kept for curing. For thus study 18 specimens were casted and tested to be carried out for 28 days.

5.1 CURING OF SPECIMENS BY PEG

Poly ethylene glycol (by adding 1% &1.5% of PEG-400 by weight of cement) which helps in self-curing with better hydration which reduces shrinkage cracks and hence increases the strength and is compared with that of conventional cured Concrete of the various grade. The casting of specimens are kept for curing in atmosphere.

6 RESULT AND DISCUSSION

6.1 LOAD CALCULATION FOR NORMAL CFST

When compared with normal CFST of M20 grade, the CFST value of single and double tie bar are increased up to 4.47% and 10.3% respectively. When compared with normal CFST of M25 grade, the CFST value of single and double tie bar are increased up to 6.3% and 8.4% respectively. When compared with normal CFST of M30 grade, the CFST value of single and double tie bar are increased up to 5.8% and 7.6% respectively.

Table 3: Load calculation for normal CFST

Specimen name	Grade of concrete	7 days strength(KN)	Ultimate load (KN)
Hollow specimen	-		240
CFST.N	M20	319	492
CFST.N	M25	342	536
CFST.N	M30	352	550
CFST.N.S	M20	331	514
CFST.N.S	M25	372	570
CFST.N.S	M30	375	582
CFST.N.D	M20	353	543
CFST.N.D	M25	373	581
CFST.N.D	M30	379	592

6.2 LOAD CALCULATION FOR PEG CFST COLUMN

When compared with normal PEG CFST of M20 grade, the CFST value of single and double tie bar are increased up to 5.7% and 11.4% respectively. When compared with normal PEG CFST of M25 grade, the CFST value of single and double tie bar are increased up to 8% and 13.5% respectively. When compared with normal CFST of M30 grade, the CFST value of single and double tie bar are increased up to 8.1% and 10.6% respectively.

Table 4: Load calculation for PEG CFST

Specimen name	Grade of concrete	7 days strength(KN)	Ultimate load (KN)
CFST.P	M20	254	403
CFST.P	M25	283	450
CFST.P	M30	315	490
CFST.P.S	M20	269	426
CFST.P.S	M25	308	486
CFST.P.S	M30	341	530
CFST.P.D	M20	288	449
CFST.P.D	M25	337	511
CFST.P.D	M30	355	542

6.3 COMPARISON OF TEST RESULTS

Table 5: Comparison of test results

Specimen		Ultimate load (KN)	
With curing	Without curing	With curing	Without curing
CFST.N M2O	CFT.P M20	492	403
CFST.N M25	CFT.P M25	536	450
CFST.N M30	CFT.P M30	550	490
CFST.N.S M20	CFT.P.S M20	514	426
CFST.N.S M25	CFT.P.S M25	570	486
CFST.N.S M30	CFT.P.S M30	582	530
CFST.N.D M20	CFT.P.D M20	543	449
CFST.N.D M25	CFT.P.D M25	581	511
CFST.N.D M30	CFT.P.D M30	592	542

The following graphs shows variation of strength for different grades of concrete cured at normal Temperature:

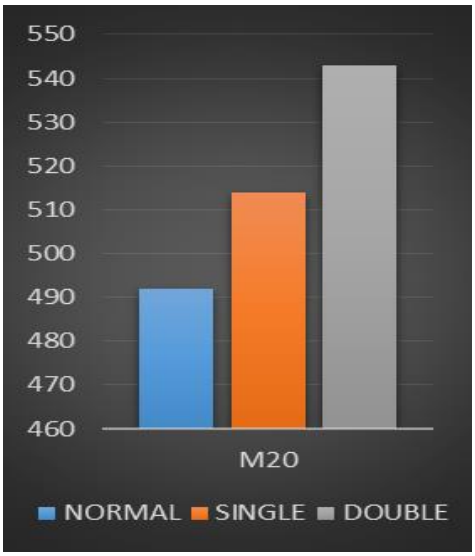

Fig 1: Comparison of normal curing column with load

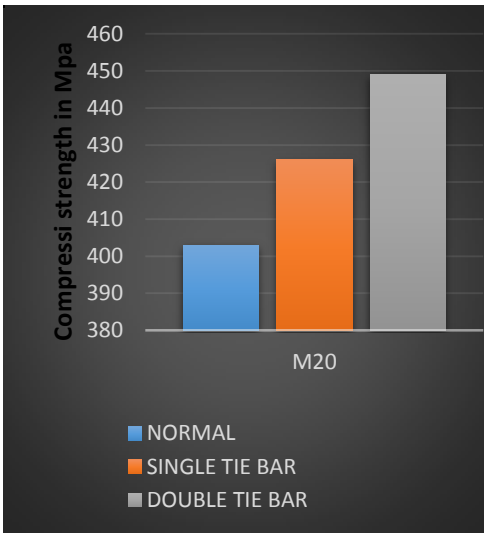

Fig 2: Comparison of PEG column with load

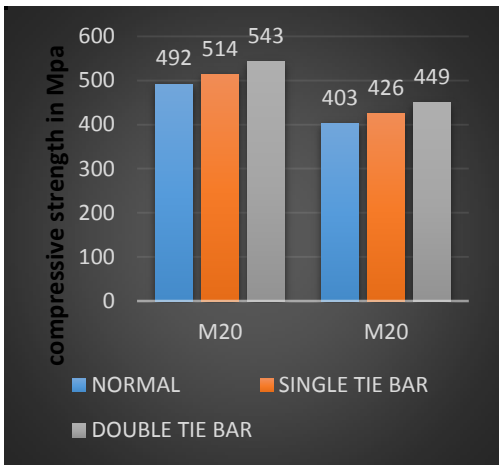

Fig 3: Comparison of curing column & PEG column

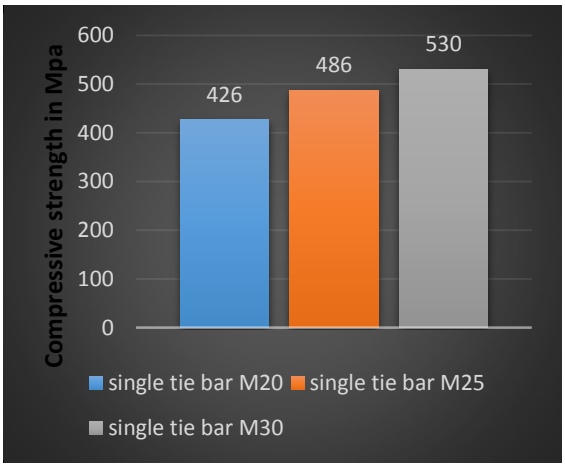

Fig 4: Comparison of single tie bar curing column

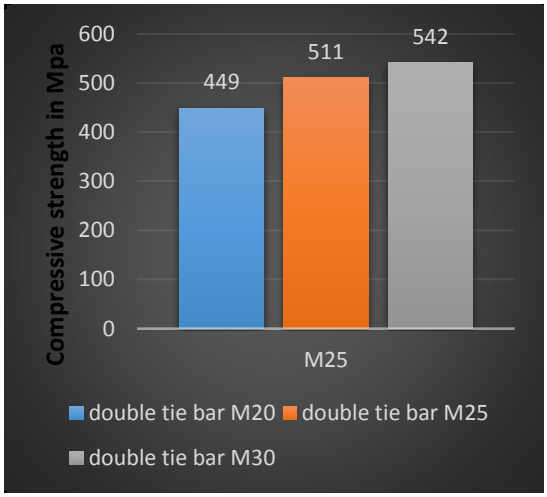

Fig 5: Comparison of double tie bar curing column

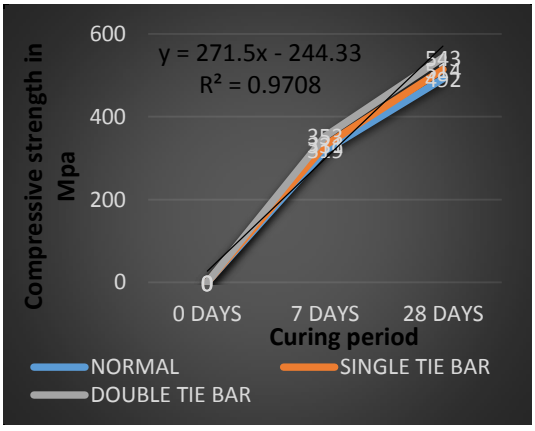

Fig 6: PEG used M20 grade 7 days and 28 days strength comparison

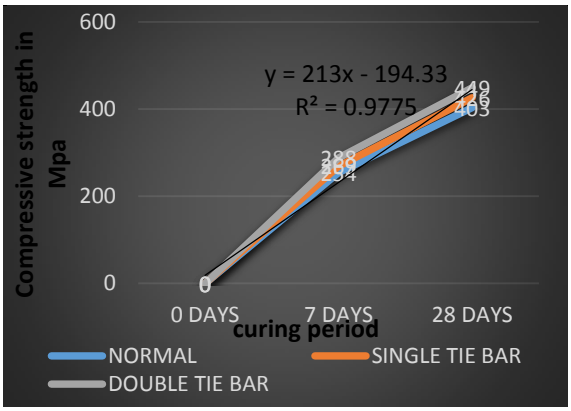

Fig 7: M20 grade 7 days and 28 days strength comparison

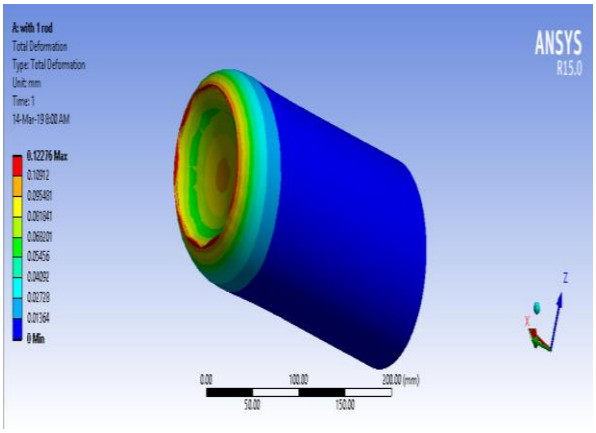

Fig 8: CFST SINGLE TIE COLUMN TOTAL DEFORMATION

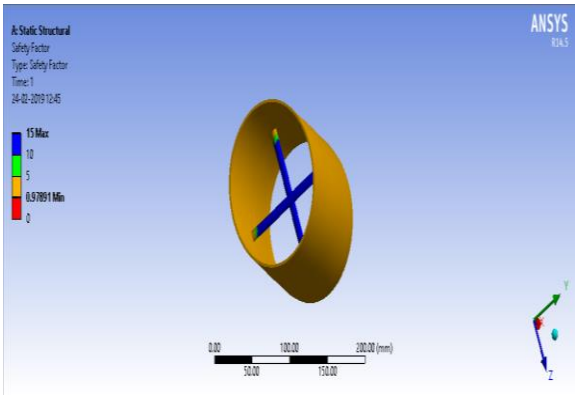

Fig 9: CFST DOUBLE TIE COLUMN TOTAL DEFORMATION

7 CONCLUSION

This work deals with increasing steel carrying capacity, so the section will reach its limit state and avoid buckling failure under higher loads. The ultimate load capacity for two cross stiffened CFST columns of M30 grade is more than for one cross stiffened CFST columns of M20 & M25 Grade and more than for unstiffened CFST columns of M20 & M25. Usage of PEG400 shows that the load carrying capacity of the concrete

member has increased up to 100 N/mm², after 28 days of test. Comparing the results of fig 6 and 7, usage of PEG 400 for M20 grade concrete in double tie bar specimen has gained the strength of 543 N/mm², whereas double tie bar specimen without PEG 400 has decreased the strength up to 100 N/mm². It is clearly shown that PEG400 can be adopted for self-curing agent in concrete filled steel tubular sections and concrete encased steel tubular sections. The buckling behavior of CFST sections are studied in Ansys software and it is shown in fig 8 and 9.

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