EXPERIMENTAL STUDY ON CONCRETE FILLED STEEL TUBULAR COLUMNS

SUBMITTED BY

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ABSTRACT

Concrete filled steel tubular columns are being widely used in civil engineering. The addition of quarry dust by replacing aggregate in concrete is to improve the compressive strength of CFSTs. CFSTs is one of many composite elements used at present in civil engineering. Different approaches and design philosophies were adopted in different design codes for it. This interaction between components of CFST elements is reached because of different material properties, such as poisson's ratio, modulus of elasticity etc. The test results are presented in diagrams, tables. Previous researches of other investigators are summarized. Differences and similarities in behavior of solid concrete and composite elements and hollow members with different number of concrete core layers are discussed.

Key words: *Quarry dust, compressive strength test, Flexural strength test, Split tensile strength test.*

1.INTRDUCTION

1.1 GENERAL

In civil engineering, the merits or selection of a building material are based on factors such as availability, structural strength, durability and workability. Concrete filled steel tubes is an innovative idea, for beams and columns including hollow steel elements with an infill of concrete that are suitable as replacement for reinforced concrete beam and column in small to medium sized building. The use of concrete filled steel tubes in the construction industry continues to be economical alternative to the traditional construction methods. The concrete filled steel tubular column system has many advantages compared with the ordinary steel or the reinforced concrete system.

1.2 CFST

Concrete filled steel tubular columns consist of a steel tubes filled with concrete. The concrete core adds stiffness and compressive strength to the tubular column and reduces the potential for inward local buckling. The steel tube acts as longitudinal and lateral reinforcement for the concrete core helping it to resist tension, bending moment and shear and providing confinement for the concrete.

1.3 OBJECTIVES

- To study a comparison on behavior of concrete filled steel tubular column with partial replacement of waste materials in concrete.
- To effectively utilize the waste material in construction industry.
- To determine the effective percentage of replacement of waste material in concrete.
- To decrease the cost of construction by replacing costliest materials.
- To reduce the self weight of the structure.
- To increase the load carrying capacity of the structure.

1.4 ADVANTAGES OF CFST

- A concrete filled steel tubular member utilizes the compressive strength of the concrete, with the steel tube providing the required tensile capacity, use of CFST members has become increasingly popular in construction of building structures because of their structural benefits such as reduced cross section, high strength and improve fire resistance as well as greater apparent stiffness and excellent seismic resistant structural properties, such as high ductility.
- Depth of steel beam is reduced to support a given load. For a storey heights, foundation costs, paneling of exteriors, heating, ventilating and air-conditioning spaces, thus reducing the overall cost of building.
- Steel beam acts as permanent and integral formwork.

1.5 APPLICATIONS OF CFST

- The CFST concept can lead to 60% load saving of steel in comparision to a structural steel system. In CFST member concrete core delays the local buckling and forces the steel tube to buckle outwards rather than inwards as well as increase significantly the ductility of the section, resulting in a higher flexural strength.
- CFST members can be used as seismic structure when applied to high raised bridge pier. This is because seismic forces can be reduced owing to the lightweight of CFST members hollow cross-section.

2. LITERATURE REVIEW

Varma AH, Ricles JM, Sause Retal this study investigates the axial load behavior of concrete-filled steel tubular columns with the width t thickness ratios between 40 and 150, and proposes an effective stiffening scheme to improve the mechanical properties of square cross-sectional CFST columns. Results in this study demonstrate that the proposed stiffening scheme can significantly enhance the ultimate strength and ductility of CFST square columns.

3. MIX DESIGN

Table 1 - Mix design for M_{20} grade concrete

Water	cement	Fine aggregate	Coarse aggregate
186	371kg/m^3	612.70kg/m^3	1228.773kg/m^3
0.5	1	1.65	3.303

4.EXPERIMENTAL WORK

4.1 CEMENT

The most common cement is used is ordinary Portland cement. The type-I is preferred according to IS:267-1976, which is used for general concrete structures. Cement is fine, grey powder. In the present work OPC cement 43 grades was used for casting cubes and cylinders for all concrete mixes. In Portland cement concrete constituents about 10% volumes of the concrete mix and is an active portions of building medium.

4.2 WATER

Water is the important ingredients of concrete as it actively participates in the reaction with cement. Portable water is generally considered satisfactory. In the present investigation tap water used for mixing and curing purposes.

4.3 FINE AGGREGATES

The sand is used for experimental works was conformed to grading zone-III sieve analysis of the fine aggregate as per IS 383-1970 are results are provided. The sand was first sieved through 4.75mm sieve. The results of testing carried out for aggregate is provided.

4.4 COARSE AGGREGATES

The material which retained on BIS test sieve number 480 is termed as coarse aggregate. The broken stone is generally used as a stone aggregate. A common maximum size for coarse aggregates in structural concrete is 1.5 inches.

4.5 QUARRY DUST

The quarry dust is taken from the quarry industry which is available locally and as a replacement of ordinary river sand this can be used as an alternative material for the construction. The quarry dust is simply taken quarry industry which is available locally.

5. TEST ON CEMENT

5.1 FINENESS TEST

100 grams cement is taken in a standard IS sieving no 90µ. The air which get lump is broken down and the material is sieved continuously for 15 minutes using sieve shaker. The residue left on the sieve is weighted.

Fineness modulus of content = 1.87

5.2 CONSISTENCY TEST

300 grams of content is taken and a paste with a weight quantity of water is prepared. The paste is filled in the mould within 3 to 4 minutes. The mould is shocked well. A standard plunger of 10 mm diameter and 50 mm long is attached to the Vicat apparatus. Then the needle used for plunger size 10 mm diameter and 50 mm long.

Consistency of cement = 33%

5.3 INITIAL SETTING TIME

A net paste with 0.85 time of the water required is prepared to gives standard consistency. The time at which the water is added and it is noted. Then the vicat mould is filled with the cement paste in 3-5 minutes. The needle is gently lowered to the surface of the paste and it is quickly released until needle fails to pierce the block for 5 to 7 mm measured between the timing will give the initial setting time. The needle used for 1mm square. Using amount of water is 123ml.

Initial setting time = 50 minutes

Final setting time = 590 minutes

5.4 SPECIFIC GRAVITY TEST

The dry specific gravity bottle is weighted as W_1 grams. The bottle is filled with distilled water and weighted W_2 grams. The specific gravity bottle is dried and filled with kerosene and weighted as W_3 grams. Some of the kerosene is poured out and introduced with and weighted quantity of cement as W_4 grams. 100 grams of weight of cement is taken as W_5 grams.

W_1 = 0.624

W_2 = 0.675

W_3 = 1.544

$W_4 = 1.506$

Specific gravity of kerosene $= \dfrac{W_3 - W_1}{W_2 - W_1}$

$= 0.80$

Specific gravity of cement $= \dfrac{(W_2 - W_1)}{(W_2 - W_1) - (W_3 - W_4)} = 3.14$

Specific gravity of quarry dust = 3.06

6. FRESH CONCRETE TEST

Concrete slump test is to be determine the workability or consistency of concrete mix prepared at the laboratory or the construction site during the progress of the work. Compaction factor of fresh concrete is done to determine the workability of fresh concrete by compacting factor test as per IS : 1199-1959. The Apparatus Used Is Compacting Factor Apparatus. Finally the vee bee consistency test is used to find the compatibility of freshly mixed concrete. The test changes the shape of the concrete from cone to cylinder using vibration. The slump values, compaction factor value and the vee bee consistency values are indicated in table

Table – 2 Fresh concrete test values

	Slump values in (mm)	Compaction factor	Vee bee consistometer (sec)
For 0%	54	0.91	11
5%	46	0.9	15
10%	42	0.87	21
15%	31	0.84	27
20%	23	0.79	33
25%	14	0.71	35

7. RESULTS

Table – 3 flexural strength & split tensile strength after 28 days in N/mm^2

Replacement of aggregates	% of replacement	Prism			Avg	Cylinder			Avg
		1	2	3		1	2	3	
Conventional concrete	-	6.0	6.25	6.5	6.25	2.98	2.54	2.83	2.78
Quarry dust	25%	4.75	5.25	5.5	5.17	2.55	2.82	2.41	2.59

Table – 4 Young's modulus values

Cylinders	specimens	Youngs modulus	Average
Conventional concrete	1	32501.62	33134.55
	2	33767.48	
Quarry dust	1	37243.64	34934.6
	2	32625.54	

8. CONCLUSION

From the above result it can be observed that the partial replacements are a very attractive proposition for composite columns. However, the success of the method defends on several factors.

- The test results show that the use of waste materials from various industries gives the effective utilization of recycled aggregate and its gives an innovative and best performance.
- The youngs modulus values are quarry dust is higher than the convensional concrete.

9. REFERENCE

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