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Experimental Investigation on RCC Short Hollow Circular Columns with Mineral Admixtures

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Abstract- **Concrete is the most frequently used material in the construction material worldwide. High elevation bridges with very large size columns are constructed to accommodate high moment and shear demands. In particular, bridge piers designed in accordance with old design codes may suffer severe damage during seismic events, caused by insufficient shear or flexural strength, low ductility and inadequate reinforcement anchorage. Many parameters may influence the overall hollow column response such as: the shape of the section, the amount of the longitudinal and transverse reinforcement, the cross section thickness, the axial load ratio and finally the material strength of concrete and reinforcement. This paper focuses on circular hollow cross sections and investigates the columns behavior under a state of compression. The experimental results have been compared with solid sections on the behavior of the hollow column strength of concrete M20 grade concrete mix designed as per I.S. 10262-1982 method.**

Index Terms- Short Columns, Glass Fiber and Fly ash.

I. INTRODUCTION

The concrete mixes have been prepared as per the nominal mix 1:1.4:2.8 by keeping Silica fume content as 7.5% and glass fibre content as 2% by weight of cement to all the mixes. The super plasticizer dosage of 1% by weight of binder is used. The steel fiber content is varied as 0, 0.75, 1.0, 1.25 and 1.5% by volume of concrete. The workability of fresh concrete has been determined by conducting the Slump test. The strength of hardened concrete has been determined by conducting Compression test on hollow circular cylinders at 28 days. The results of tests conducted shows that admixtures and fibres reduce the structural cracks, drying shrinkage cracks, etc., and the following points are noted. Limited crack growth and cost effective because admixtures are very low in price and easily available one. Self weight of the column is less than the solid short column. Workmanship and time of construction is less. Hence it is clearly proved that the hollow sections shows economical in construction and reduce the self weight of the structure. In seismic areas, the construction of bridge piers under safe due to effective earthquake hazard risk reduction.

II .MATERIALS AND METHODS

The cement used in this experimental study is ordinary Portland cement of 43 grade of Juary brand of specific gravity 3.15 and initial setting time of 37 minutes. The coarse aggregate is of hard broken granite stone obtained from a local quarry of well graded from 10mm to 20mmwith specific gravity of 2.67. The fine aggregate is local river sand of maximum size 4.75mm with a specific gravity of 2.70 and gradation Zone II. A standard quality silica fume having most particle size smaller than 1 micron, obtained from an authorized supplier at Salem has been used. Super plasticizer named Conplast SP- 430 has been used with a dosage of 1.0% by weight of binder is used for all the mixes. Steel Fibres obtained by cutting drawn wires, and fibres with different types of crimps, indentations, and shapes to increase mechanical bond are also being produced. In this work, 0.4mm diameter galvanized iron wire is cut into pieces of straight fibres having aspect ratio 100 has been used. The fibre content varies from 0.75 to 1.5% by volume of concrete. The glass fibres used as the commercial name called " CEMFIB" and mixed with water before adding into the concrete in order to avoid balling effect. A standard quality fly ash having most particle size smaller than 1 micron, obtained from an authorized supplier at Salem has been used. The water used here is potable with PH7.10.

Objectives: The main objective is to assess the compressive strength of reinforced concrete hollow circular column sections with addition of silica fume, glass fibre, steel fibre and fly ash.

Scope: The grade of concrete selected for study is M_{20} with designed mix ratio 1:1.4:2.8 on weigh batching. The materials are mixed in dry condition and wet mix is done in a pan mixer for suitable duration.

III. EXPERIMENTAL PROGRAMME

The experiments conducted on different mix ratios with different specimens as follows

- PCC solid column with conventional mix.
- PCC solid column with 8% silica fume replace cement.
- PCC solid column with 20% fly ash replacing cement.
- PCC Solid Column with 0.50% steel fibre
- PCC Solid Column with 0.20% glass fibre.
- PCC hollow column with conventional mix.
- PCC hollow column with 8% silica fume replace cement.
- PCC hollow column with 20% fly ash replacing cement.
- Hollow Column with 0.50% steel fibre
- Hollow Column with 0.20% glass fibre.
- RCC solid column with conventional mix.
- RCC solid column with 8% silica fume replace cement.
- RCC solid column with 20% fly ash replacing cement.
- RCC Solid Column with 0.50% steel fibre
- RCC Solid Column with 0.20% glass fibre.
- RCC hollow column with conventional mix
- RCC hollow column with 8% silica fume replace cement.
- RCC hollow column with 20% fly ash replacing cement.
- RCC Hollow Column with 0.50% steel fibre
- RCC Hollow Column with 0.20% glass fibre.

Casting of specimens: The various ingredients are mixed in the specified proportions as shown above and filled in the moulds. The specimens are compacted by using hands. After 24hrs the specimens are demoulded and kept immersed in water for curing. The details of specimens are,

1. Solid column diameter 150mm and height of the column is 450mm.
2. Hollow column outer diameter 150mm and inner diameter 100mm with height as 450mm.

Reinforcement details:
Main rods - 8mm diameter - 6 Nos @ 78mm spacing - Fe 415
Lateral ties - 6mm diameter - 5 Nos @ 75mm spacing - Fe 415

Figure1. Compression testing for specimens

Figure 2. Failure of hollow columns under direct compression

Testing of specimens for Compressive strength at 28 days

The ingredients are thoroughly mixed in pan mixer and the specimens were casted in cylindrical moulds manually and compacted well by suitable vibrators for dense concrete.

For each test three specimens were casted and a total number of specimens are as follows. PCC solid columns 15 Nos , PCC hollow columns 15 Nos, RCC solid columns 15 Nos and RCC hollow columns 15 Nos were casted for testing. The specimens are demoulded after 24 hours and immersed in water tank for water curing. After 28 days of curing cylindrical specimens in water immersion it is taken out and dried in an oven and they are placed in the compression testing machine in order to find the compressive strength of the specimens. The results are tabulated in tables as follows.

Table 1. Results of compression strength at 28 days for PCC columns

S.No	Description	Comp. Strength at 28 days in N/mm^2	
		Solid	Hollow
1	Conventional concrete	13.58	11.14
2	8% silica fume replace cement	14.75	11.78
3	20% fly ash replacing cement.	12.09	11.98
4	0.50% steel fibre	20.37	17.82
5	0.20% glass fibre	11.88	10.83

Table 2. Results of compression strength at 28 days for RCC columns

S.No	Description	Comp. Strength at 28 days in N/mm^2	
		Solid	Hollow
1	Conventional concrete	15.84	12.09
2	8% silica fume replace cement	13.58	12.73
3	20% fly ash replacing cement.	12.49	12.41
4	0.50% steel fibre	19.80	18.47
5	0.20% glass fibre.	13.58	13.24

Chart 1. 28 Days compressive strength of PCC Solid and hollow columns.

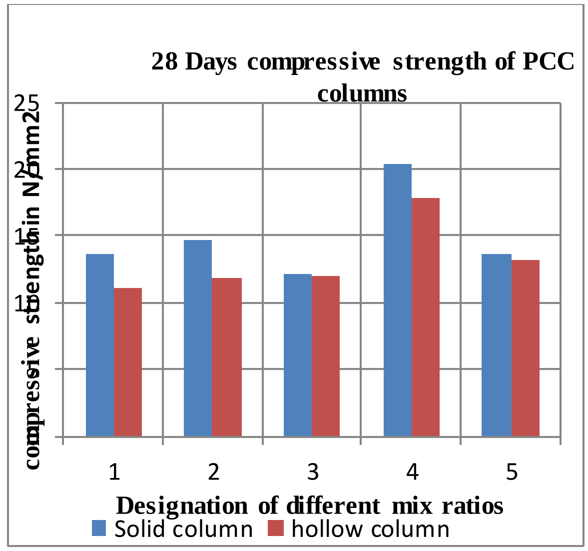
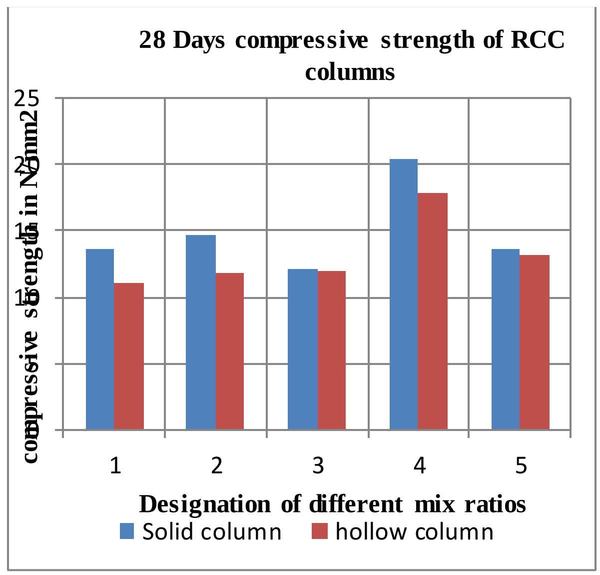


Chart 2. 28 Days compressive strength of RCC Solid and hollow columns.



IV. ANALYSIS OF RESULTS

In case of PCC columns the results shows that the solid columns having more strength than hollow columns in all the cases except only in case of fly ash addition and glass fibre addition the hollow column gives more or less gives same strength as of solid column.

In case of PCC columns addition of silica fume and steel fibres gives more strength than conventional concrete both in solid and hollow columns and addition of fly ash and glass fibre shows reduced strength compare with conventional concrete.

In case of RCC columns the results shows that the solid columns having more strength than hollow columns in all the cases except only in case of fly ash addition and glass fibre addition the hollow column gives more or less gives same strength as of solid column.

In case of RCC columns addition of silica fume and steel fibres gives more strength than conventional concrete both in solid and hollow columns and addition of fly ash and glass fibre shows slightly reduced strength compare with conventional concrete.

V. CONCLUSIONS

In PCC the compressive strength of concrete hollow sections increases with addition of mineral admixtures and fibers that will shows due to reduction of voids in concrete.

In PCC compressive strength of concrete solid sections decreases with addition glass fibre due to reaction of alkali content in cement concrete and the addition of fly ash does not implies additional strength as already having fly ash in the manufacturing of cement.

In case of RCC the compressive strength of RCC concrete hollow sections increases with addition of mineral admixtures and fibres that will shows due to cylindrical behaviour of hollow sections.

In case of RCC the compressive strength of RCC concrete solid sections decreases with addition glass fibre due to reaction of alkali content in cement concrete and the addition of fly ash does not implies additional strength Both the concrete

The behavior of concrete hollow sections similar in both plain and reinforced concretes that shows that addition of reinforcement does not plays a vital role.

A considerable strength improvement in RCC.concrete but both the cases the failure section is nearby supports and need further investigations.

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