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COMPARATIVE STUDY OF HOLLOW CONCRETE COLUMN WITH ORDINARY COLUMN

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ABSTRACT

Concrete is one which satisfies the performance criteria which can be defined in terms of strength, durability, permeability, shrinkage etc. due to virtue of this concrete, it can be used in many important applications like in the construction of power plants, roads, buildings, bridges etc.

The hollow reinforced concrete columns are desirable to employ in constructions, especially in seismic zones because of minimizing the superstructures' weight and subsequently the seismic response. The using of hollow columns reduces the loadings transferred to foundations; hence smaller foundations are required. Therefore, hollow columns are an economic choice in areas where the concrete cost is comparatively high. Finally, the hollow columns allow easy to access different services like pipes for electric wiring and plumbing

Keywords: *Hollow column, strength, Ductility, Exposure, Specific gravity.*

I. INTRODUCTION

Concrete is one which satisfies the performance criteria which can be defined in terms of strength, durability, permeability, shrinkage etc. due to virtue of this concrete, it can be used in many important applications like in the construction of power plants, roads, buildings, bridges etc.

The hollow reinforced concrete columns are desirable to employ in constructions, especially in seismic zones because of minimizing the superstructures' weight and subsequently the seismic response. The using of hollow columns reduces the loadings transferred to foundations; hence smaller foundations are required. Therefore, hollow columns are an economic choice in areas where the concrete cost is comparatively high. Finally, the hollow columns allow easy to access different services like pipes for electric wiring and plumbing

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II. OBJECTIVE

The objective of this study is to investigate the following properties:

- To study the strength properties of concrete such as compressive strength.
- To investigate the properties of fresh concrete such as Workability.
- To compare the strength properties of concrete column for solid section & for hollow section.

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III. ADVANTAGES

1. It reduces quantity on concrete.
2. Self weight of column get reduced.
3. Economy achieve in construction
4. Useful in earthquake region.

IV. METHODOLOGY

For developing concrete mix, it is important to select proper ingredients, evaluate their properties and understand the interaction among different materials. Concrete will normally contain not only Portland Cement, Aggregate and Water, but also Supplementary Cementing Materials.

The main ingredients of Concrete are as follows:-

- Cement.
- Fine aggregates.
- Course aggregate.
- Water.

Cement

Among the chemical constituents of cement, the most important ones are C_3A, C_3S, C_2S& C_4AF. The C_3A portion of cement hydrates more rapidly, thereby reducing the workability of fresh concrete. It also adsorbs the chemical admixtures quickly which leads to reduction in availability of those admixtures for comparatively slower setting components of cement viz., C_2S and C_3S. This further affects the workability of fresh concrete and also its rate of retention of workability.

Regarding particle size distribution, it may be noted that finer particles hydrate faster than coarser particles and hence contribute more to early age strength concrete; however, at the same time, the faster the rate of hydration may lead to quicker loss of workability due to rapid and large release of heat of hydration.
Cement used and tested in laboratory and its results are as follows;

Brand Name : Ultra tech
Cement : 53 Grade O.P.C.
Conforming IS Codes IS: 12269-1987

Table 1- Cement Properties

Sr. No.	Description of Test	Results	As per IS: 12269-1987
01	Fineness of cement (residue on IS sieve No. 9)	3 %	> 10%
02	Specific gravity	3.06	3.15
03	Standard consistency of cement	31 %	-
04	Setting time of cement a) Initial setting time b) Final setting time	 35 minute 458 minute	 > 30 minute < 600 minute
05	Soundness test of cement (with Le-Chatelier'smould)	6 mm	10 mm

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06	Compressive strength of cement: a) 3 days b) 7 days	44.70 N/mm^2 54.47 N/mm^2	> 27 N/mm^2 > 37 N/mm^2

Fine Aggregate

River sand is used as a fine aggregate. The sand particles should also pack to give minimum void ratio, as the test result show that higher void content leads to requirement of more mixing water.

Table 2- Characteristic tests on fine aggregates (sand) (IS: 383, IS: 2386).

1. Specific gravity
2. Bulk density
3. Free moisture content
4. Bulking due to moisture.
5. Water absorption
6. Clay, fine silt, and fine dust content
7. Fineness modulus (Coarse sand has higher fines modulus)

Table 3- Physical properties of Fine Aggregate (sand)

Sr. No	Property	Results
1.	Particle Shape, Size	Round, 4.75mm down
2.	Fineness Modulus	2.83
3.	Silt content	3.2%
4.	Specific Gravity	2.62
5.	Water absorption	1%
6.	Bulking of sand	4.15%
7.	Bulk density	1786 Kg/m^3
8.	Surface moisture	Nil

Coarse Aggregate

The properties such as moisture content, water absorption, etc., would help in adjusting the quantity of mixing water for the concrete mix. The strength properties of CA such as aggregate abrasion value, aggregate impact value, compressive strength, aggregate crushing value (10% fine value) etc. Would determine the limits of strength of concrete which can be achieved with a given aggregate and these limits need to be investigated for creating database for rational design of concrete.

Locally available crushed stone aggregates with size 4.75 mm to 20 mm and of maximum size 20 mm are used. The test results are as follows¬:

Table 4- Physical properties of Coarse Aggregate .

Sr. No	Properties	Results
1.	Particle shape, Size	Angular, 20mm,10mm down
2.	Fineness modulus of 20mm aggregates	7.4
3.	Specific gravity	2.66
4.	Water absorption	0.5%
5.	Bulk density of 20mm aggregates	1609 Kg/ mm^3

6.	Bulk density of 10mm aggregates	1585 Kg/mm^3
7.	Surface moisture	Nil

Water
Water is an important ingredient of concrete as it actively participates in the from concrete mix design consideration, it is important to have the compatibility between given cement and chemical and mineral admixtures along with the water used for mixing.. The strength of cement concrete comes mainly from the binding action of the hydrated cement gel. The requirement of water should be reduced to that required for chemical reaction of an hydrate cement as the excess water would end up in only formation of undesirable voids (and/or capillaries) in the hardened cement paste in concrete.

From concrete mix design consideration, it is important to have the compatibility between given cement and chemical and mineral admixtures along with the water used for mixing. It is generally stated in the concrete codes and also in the literature that the water. Water confirming to the requirements of IS-456: 2000 is suitable for making concrete. In the present work, available tap water is used for concreting.

V. METHODOLOGY

Aim of Experimental Work
The primary aim of this experimental program is to study the strength properties of column by imparting hollow cavity in core of column section. The concrete in core section does not impart much more strength. So to check strength of column by imparting such cavity in core section. The concrete mix selected for this is M20.

Investigation of concrete properties
Compressive strength of concrete done by Compressive strength test.

Casting of concrete specimens
Column mould of 230 x 230 x 750 mm is used for casting the specimens for crushing strength.

Concrete mix design

Step 1: Target strength for Mix Proportioning
= +1.65s
For M20, s =4
= Characteristic strength of concrete at 28 days
=20 MPa (Given)
=20+1.65 x 4=26.6 Mpa

Step 2: Selection of water cement ratio
IS 456, 2000.
For Mild exposure, Maximum Nominal size of aggregate 20 mm and RC work
Maximum free water cement ratio=0.55
Adopt water cement ratio=0.5 (based on experience)
< 0.55 O.K.

Step 3: Selection of water content
Degree of workability = Compaction factor = 0.8
Slump = 25 mm
maximum water content for maximum nominal size of aggregate is 186 kg.
Maximum water content =186 litre (for slump 25 mm) ie. C.F.= 0.8

Step 4:Calculation of cement content
water cement ratio= 0.5
0.5

Cement content = 372kg
IS 456 2000,
Minimum cement content
for mild exposure condition= 300 kg/
for RCC 372 kg/ > 300 kg/ O.K.

Step 5: Proportion of volume of coarse aggregate and fine aggregate content

IS 10262-2009,
For Nominal Maximum size of aggregate 20 mm and zone of coarse aggregate and fine aggregate of Zone II = 0.62

Approximate value for aggregate volume for water cement ratio is 0.5= 0.62
volume of coarse aggregate per unit volume of total aggregate = 0.62
Volume of fine aggregate per unit volume of fine aggregate =1-0.62= 0.38

Step 6: Mix calculation

The mix calculation per unit volume of concrete shall be as follows:
volume of concrete= 1
volume of cement =0.1181
volume of water =0.186
volume of all in aggregate= a- (b+ c)
=1-(0.1181+0.186) =1-0.3041
= 0.6959 m3

Mass of coarse aggregate= (volume of all in aggregate)X(Specific gravity of Coarse Aggregate) X(Volume of Coarse Aggregate) X 1000
=0.6959 x 2.65 x 0.62 x 1000
=1143.4 kg

Mass of fine aggregate=(volume of all in aggregate)X (Specific gravity of Coarse Aggregate)X(volume of Fine Aggregate) x 1000
=0.6959 x 2.6 x 0.38 x 1000
=687.55 kg

Step 7: Mix proportions for trial Number 1:

Cement= 372 kg
Water =186 kg
Fine aggregate=687.55 kg
Coarse aggregate= 1143.4 kg
water cement ratio= 0.5
Mix proportion=1**:**1.848**:**3.07

RCC design of column

Given data:

Load P = 550 KN
Grade of concrete = M20
Grade of steel = Fe500

By using formula

P = 0.4 x fck x Ac + 0.67 x Fy x Ast
$550 \times 10^3 = 0.4 \times 20 \times (0.99 \times Ag) + 0.67 \times 500 \times (0.01 \times Ag)$
$550 \times 10^3 = 11.27 \times Ag$
Hence, Ag = 48802.12 mm^2

For finding out sides of column

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$a = \sqrt{Ag}$
$a = \sqrt{48802.12}$
a = 220.91 mm
a ≅ 230 mm

sides of column = 230 x 230
load carrying capacity of adopted column size,

P = 0.4 x fck x Ac + 0.67 x Fy x Ast
P = 0.4 x 20 x (0.99 x 230 x 230) + 0.67 x 500 x (0.01 x 230 x 230)
Hence, P = 596.18 KN >550 KN

VI. TEST RESULTS AND DISCUSSION

Compressive strength of concrete at 28 Days

Table 5- Compressive strength of concrete

Load P in KN	C/S Area	Comp. Strength in (N/mm^2)	Av. Comp. Strength in (N/mm^2)
442	22500	19.64	19.65
449	22500	19.95	
436	2500	19.37	

Load carring capacity of solid column

Table 6- Compressive strength of conrete

Column no.	C/S Area	Crushing Load in (KN)	Av. Crushing Load in (KN)
1	52900	587	586
2	52900	591	
3	52900	580	

Load carring capacity of solid column

Table 7- Compressive strength of conrete

Column no.	C/S Area	Crushing Load in (KN)	Av. Crushing Load in (KN)
1	50936.50	540	565.66
2	50936.50	565	
3	50936.50	592	

Discussion

From the above crushing strength result we can discussed that ,The load carrying capacity of hollow column are reduced 3.6% than solid column but Hollow column are also satisfied the design load requirement.

V. CONCLUSION

The research dwells upon material, construction and strength of concrete as a new approach in construction Industry. The hollow concrete column is one of the recent technology for construction in earthquake prone area.

A average crushing load carring capacity of solid column are 586 KN, where as for hollow column was 565.66 KN which approximately 3.6% less than solid column. But this hollow column satisfied the design load carring capacity which was 550 KN.

Scope for Future Work

- Reduce self weight of structure.
- Economical design of structure.
- Saving in construction cost by reducing quantity of material required.
- Construction work in Earthquake prone area.

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