Experiments on Partial Replacement of Coconut Shell as Coarse Aggregate in Concrete

Palak Patel
Department of Structure Engineering
Darshan institute of engineering and technology, Rajkot, India

Dr. N. K. Arora
Principal
Lukhdhirji Engineering Collage, Morbi, India

Shraddha R. Vaniya
Assistant Professor
Department of Structure Engineering
Darshan Institute of Engineering And Technology, Rajkot, India

Abstract

In the construction, the cost of building materials are rising day by day.the use of alternative material is a partial replace of coarse aggregate in solving part of natural aggregate. The various waste materials are used such as coconut shell, cockle shell, periwinkle shell, foundry sand etc. so here in my project I will use coconut shell waste as replacement of coarse aggregate by different percentage for making concrete of different grade like M-20. Concrete made from coconut shell waste as coarse aggregate will be studied for compressive strength, tensile strength and flexural strength. the percentage replacement will be 0%, 10%, 20% and 30% with natural coarse aggregates and replacement of 10% various size of coconut shell in concrete. the replacement 10% of coconut shell and added coir fibre on high temperature. I will prepare cubes, cylinders, beams and finally slump test, tensile strength test, compressive strength test, split tensile strength test and flexural strength test will be conducted to obtain the results. A large no. of trial mixes are required to select the desired optimum replacement of coarse natural aggregate by coconut shell waste material.

Keywords: Coconut Shell, Coarse Aggregate, Light Weight Concrete, Light Weight Material, Compressive Strength, Split Tensile Strength, Flexural Strength

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I. INTRODUCTION

Concrete is the widely used first number of structural material in the world today. Infrastructure developed across the world created demand for different construction materials. Different waste materials and industrial by products such as fly ash, recycle aggregates, foundry sand, bottom ash, glass ware and coconut shell were replaced with natural aggregate. Using the alternative materials in place of natural aggregate in concrete as sustainable and environmentally friendly construction materials. In India demand of construction aggregate in 2010 was 2210 million metric tons.(in 2015 it will be expected as 3330 million metric tons and after 2020 it will be more than 5075 million metric tons.

II. DESCRIPTION OF MATERIALS

A. Cement:

Ordinary Portland cement grade 53, conforming to I.S.12269-1987 was used. The physical property of cement is shown as per table 1.

Table – 1
Basic Result Of Ordinary Portland Cement (OPC)

TEST		*RESULT*
Initial setting time		*185 min*
Final setting time		*320 min*
Compressive strength	*3 days*	*27.08 N/mm^2*
Soundness		*4.9 mm*
Fineness (90 um sieve)		*1.7 %*
Standard consistency		*30.50 %*

B. Coarse Aggregate:

as coarse aggregate in concrete consist 35 to 70% of volume of the concrete.an aggregate with specific gravity more than 2.55 and absorption less than 1.5%.the physical properties of coarse aggregate is shown in table 2.

Table – 2
Sieve Analysis Of Coarse Aggregate (20mm)

Sieve size (mm)	*Weight retain (gms)*	*Cumulative weight retain (gms)*	*Cumulative percentage weight retain (%)*	*Cumulative percentage weight passing*
40	*0.0*	*0.0*	*0.0*	*100*
20	*315*	*315*	*6.3*	*93.7*
10	*4475*	*4790*	*95.8*	*4.2*
4.75	*120*	*4910*	*98.2*	*1.8*

Table – 3
Test Value of Coarse Aggregate (20 Mm)

Coarse aggregate	*Aggregate Impact value*	*12.4*
	Aggregate Crusher Value	*14.3*
	Aggregate Abrasion Value	*16.3*
	Specific Gravity	*2.85*
	Water Absorption	*0.94%*
	Gradation	*Falls in 20 mm size*
	Combined Flakiness Index, Elongation Index	*22.9 %*

C. Coconut Shell:

Table – 4
Physical Properties of Coconut Shell

TEST	*RESULT*
Sp. Gravity	*1.12*
Water absorption (%)	*24.03%*
BulkDensity(kg/m3)loss	*522.31*
Bulk Density(kg/m3)compacted	*649.23*

D. Coir Fiber:

Table – 5
Physical Properties Of Coir Fibre

TEST	*RESULT*
Sp. Gravity	*0.74*
Water absorption (%)	*68.69*

E. Fine Aggregate:

The fractions from 4.75 mm to 150 microns are termed as fine aggregate. Locally available natural river sand conforming to grading of IS: 383 1970 with specific gravity 2.77 was used as fine aggregate.

Table – 6
Sieve Analysis of Fine Aggregate.

Sieve size (mm)	*Weight retain (gms)*	*Cumulative weight retain (gms)*	*Cumulative percentage weight retain (%)*	*Cumulative percentage weight passing*
10	*0*	*0*	*0*	*100*
4.75	*118*	*118*	*5.9*	*94.10*
2.36	*68*	*186*	*9.3*	*90.7*
1.18	*296*	*364*	*24.10*	*75.9*
600 micron	*332*	*694*	*40.70*	*59.3*
300 micron	*874*	*1568*	*84.40*	*15.6*
150 micron	*146*	*1714*	*91.70*	*8.3*

Table – 7
Test Value Result of Fine Aggregate

Fine aggregate	*Specific gravity*	*2.55*
	Gradation	*Fall in Zone II*
	Moisture content	*1.4%*
	Fine modulus	*2.56*
	Silt content	*0.78%*

III. WORKABILITY TESTS

A. Slump Cone Test:
Slump test is the most commonly used method of measuring workability of concrete which can be employed either in laboratory or at site of work. It is not a suitable method for very wet or very dry concrete. It does not measure all factors contributing to workability, nor is it always representative of the placability of the concrete. However, it is used conveniently as a control test and gives an indication of the uniformity of concrete from batch to batch. Repeated batches of the same mix, brought to the same slump, will have the same water content and water cement ratio; provided the weights of aggregate, cement and admixtures are uniform and aggregate grading is within acceptable limits. Additional information on workability and quality of concrete can be obtained by observing the manner in which concrete slumps. Quality of concrete can also be further assessed by giving a few tamping or blows by tamping rod to the base plate. The deformation shows the characteristics of concrete with respect to tendency for segregation. The size of slump cone mould is
Bottom diameter: 20 cm, Top diameter: 10 cm and Height: 30 cm
In slump test of fresh concrete, the each layer of concrete was compacted 25 times with the help of steel rod 0.6m long and 16mm in diameter. The slump cone is removed carefully in the vertical direction without affecting the shape of concrete slump.

IV. TESTS FOR CONCRETE

A. Test for Compressive Strength of Concrete Cubes:
Compression test is the most common test conducted on hardened concrete, partly because it is an easy test to perform, and partly because most of the desirable characteristic properties of concrete are qualitatively related to its compressive strength. The cube specimen is the sizes 150x150x150 mm are used for compression test. These specimens are tested by compression testing machine after 7 days,14 days and 28 days curing. .The compressive strength test on hardened concrete will be performed on a 2000 KN capacity compression testing machine.
Compressive strength=maximum load/area

=P/A

B. Test for Split Tensile of Concrete Cylinder:
The tensile strength is one of the basic and important properties of the concrete. The tensile strength test on hardened concrete is performed on a 400 KN capacity testing machine. Specimen of concrete cylinder is 150 mm diameter x 300 mm height. In the splitting tension test a 150 mm x 300 mm concrete cylinder is subjected to compression loads along two axial lines which are diametrically opposite. In these tests in general a compressive force is applied to a concrete specimen in such a way that the specimen fails due to tensile stresses developed in the specimen. Direct tension test of concrete are seldom carried out, mainly because the specimen holding devices introduce secondary stresses cannot be ignored. The steel plates were placed at the top and bottom between the platens of testing machine and the cylinder. The test consists of applying a compressive line load along the opposite generators of a concrete cylinder place with its axis horizontal between the compressive platens.
The measured splitting tensile strength fc, of the specimen shall as below.

$Fc=2p /\pi\, l\, d$

Where p= Maximum load in Newton applied to specimen,
l= Length of the specimen,
d=Cross sectional dimension of the specimen.

C. Test for Flexural Strength of Concrete Beams:
Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending size of concrete beam specimen is 100 mm breadth x 100 mm depth x 500 mm length or 150 mm breath x 150 mm depth x 700 mm length. The flexural strength is expressed as modulus of rupture in Mpa and is determined by standard test methods third point loading or centre point loading. In the central point loading, maximum fibre stress will come

below the point of loading where the bending moment is maximum. In case of symmetrical two point loading, the critical crack may appear at any section, not strong enough to resist the stress within the middle third, where the bending moment is maximum. It can be expected that the two point loading will yield a lower value of the modulus of rupture than the centre point loading. I.S. 516-1959, specifies two points loading.
The flexural strength of the specimen shall be expressed as the modulus of rupture fb, which, if "a‟ equals the distance between the line of fracture and the nearer support, measured on the centre line of the tensile side of the specimen, in cm, shall be calculated to the nearest 0.5 kg/sq cm as follows.

$Fb = pl / (bd^2)$
Where b = measured width in cm of the specimen,
d = measured depth in cm of the specimen at
the point of failure,
l = length in cm of the span on which the
specimen was supported,
p = maximum load in kg applied to the
specimen

D. Test for Durability of Concrete Cube:

The durability of cement concrete is defined as its ability to resist weathering action, chemical attack, abrasion. Durability of concrete is the important factor for any structures. Durability of concrete is direct effect the service life of the structure. Along service life is considered synonymous with durability. As durability under one set of conditions does not necessarily mean durability under another, it is customary to include a general reference to the environment when defining durability.

V. RESULTS

The mix proportion for M 20 is and W/C ratio of 0.48 was casted. Slump test was tested when the concrete in fresh concrete. The cubes, beams and cylinders were tested for compressive strength, split tensile strength and flexural strength. These tested were carried out at age of 7 days, 14 days and 28 days.

A. Workability Test Results:

1) 1slump Test:

Table – 8
Islump Test

Slump(mm)	
conventional	*72*
10% CS	*66*
20% CS	*60*
30%CS	*52*
40%CS	*46*
50%CS	*37*

B. Strength Results:

2) Compressive Strength Test Results:

Table – 9
Compressive Strength Test Results

Compressive strength(N/MM^2)			
	7 days	*14 days*	*28 days*
conventional	*20.53*	*24.00*	*27.58*
10% CS	*18.14*	*21.05*	*23.46*
20% CS	*16.83*	*18.92*	*20.95*
30% CS	*15.63*	*17.30*	*18.94*

40% CS	*13.51*	*15.04*	*17.06*
50% CS	*11.05*	*13.54*	*15.48*

1) Effect of Size of CS In Concrete:

Table - 10

Compressive strength(N/mm^2)			
	7 days	*14 days*	*28 days*
10%CS(8 mm size of CS)	*19.85*	*21.82*	*22.67*
10%CS(10 mm size of CS)	*18.17*	*20.12*	*21.23*
10%CS(12.5 mm size of CS)	*17.67*	*19.56*	*20.11*

1) Comparison of replace of CS and added coirFibre and replace of CS and added coir fibre On high temperature.

Table – 11

Compressive strength(N/mm^2)			
	7 days	*14 days*	*28 days*
10% CS+ added 2% coir fiber	*20.02*	*21.67*	*23.25*
10% CS+ added 2% coir fiber(oven 125·c)	*15.60*	*18.02*	*19.71*
10% CS+ added 2% coir fibre(oven 150·c)	*12.99*	*15.93*	*17.11*
10% CS+ added 2% coir fibre(oven 200·c)	*11.31*	*12.73*	*14.37*

3) *Flexural Strength Test Results:*

Table – 12

Flexural strength(N/MM^2)			
	7 days	*14 days*	*28 days*
conventional	*2.88*	*3.01*	*3.91*
10% CS	*2.71*	*3.06*	*3.58*
20% CS	*2.06*	*2.87*	*3.20*
30% CS	*1.85*	*2.41*	*2.9*
40% CS	*1.59*	*2.08*	*2.57*
50% CS	*1.26*	*1.92*	*2.1*

1) Effect of Size of CS In Concrete:

Table - 13

Flexural strength(N/mm^2)			
	7 days	*14 days*	*28 days*
10%CS(8 mm size of CS)	*2.81*	*2.97*	*3.20*
10%CS(10 mm size of CS)	*2.76*	*2.94*	*3.15*
10%CS(12.5 mm size of CS)	*2.71*	*2.90*	*3.11*

1) Comparison of replace of CS and added coir fibre and replace of CS and added coir fibre on high temperature.

Table - 14

Flexural strength(N/mm^2)			
	7 days	*14 days*	*28 days*
10% CS+ added 2% coir fibre	*2.78*	*3.16*	*3.66*
10% CS+ added 2% coir fibre(oven 125·c)	*2.43*	*2.83*	*3.05*

10% CS+ added 2% coir fibre(oven 150·c)	*2.22*	*2.50*	*2.9*
10% CS+ added 2% coir fibre(oven 200·c)	*2*	*2.18*	*2.38*

4) *Split Tensile Strength Test Results:*

Table - 15

Split tensile strength(N/MM^2)			
	7 days	*14 days*	*28 days*
conventional	*1.62*	*2.02*	*2.55*
10% CS	*1.55*	*1.77*	*2.17*
20% CS	*1.2*	*1.58*	*2.06*
30% CS	*1.05*	*1.19*	*1.86*
40% CS	*0.89*	*1.05*	*1.3*
50% CS	*0.69*	*0.96*	*1.07*

1) *Effect of Size of CS in Concrete:*

Table - 16

Split tensile strength(N/mm^2)			
	7 days	*14 days*	*28 days*
10%CS(8mm size of CS)	*1.71*	*1.85*	*2.05*
10%CS(10mm size of CS)	*1.63*	*1.71*	*2.00*
10%CS(12.5mm size of CS)	*1.60*	*1.63*	*1.93*

2) Comparison of replace of CS and added coir fibre and replace of CS and added coir fibre on high temperature.

Table - 17

Split tensile strength(N/mm^2)			
	7 days	*14 days*	*28 days*
10% CS+ added 2% coir fibre	*1.79*	*1.97*	*2.38*
10% CS+ added 2% coir fibre(oven 125·c)	*1.59*	*1.77*	*2.03*
10% CS+ added 2% coir fibre(oven 150·c)	*1.29*	*1.58*	*1.77*
10% CS+ added 2% coir fibre(oven 200·c)	*1.06*	*1.16*	*1.28*

3) Compressive strength with acid attack of M 20 and % of CS

Table - 18

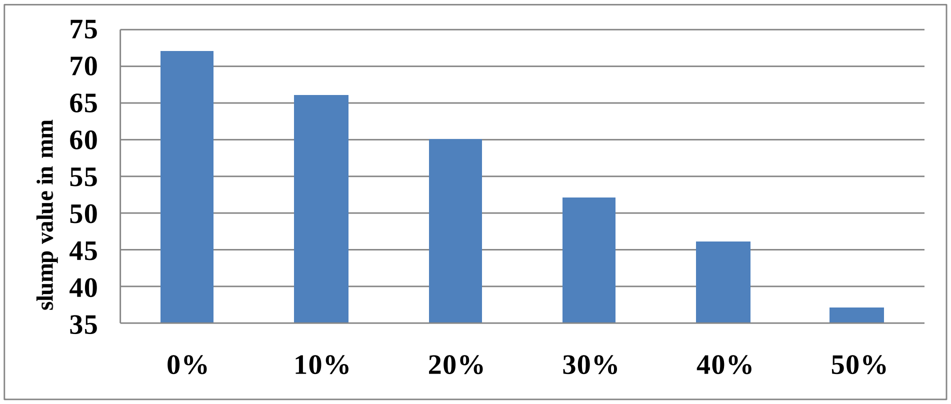
Compressive strength with acid attack(N/MM^2)		
	H_2SO_4	*HCl*
0% CS	*40.64*	*38.82*
10% CS	*27.58*	*32.8*
20% CS	*22.48*	*26.21*
30% CS	*17.47*	*21*
40% CS	*12*	*15.01*
50% CS	*9.13*	*11.13*

4) Comparison Of Compressive Strength With Acid Attack Of 10 % CS And 10% CS Of Various Sizes

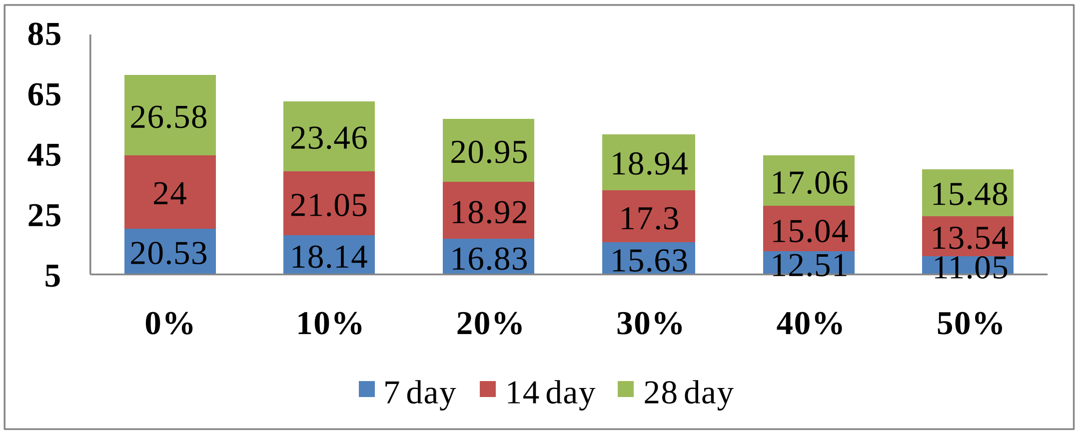
Table - 19

Compressive strength with acid attack(N/MM^2)		
	H_2so_4	*Hcl*
10% CS	*27.58*	*32.8*
10% CS(8 mm size)	*27.89*	*33*
20% CS(10 mm size)	*27.61*	*32.13*
30% CS(12.5 mm)	*26.58*	*31.8*

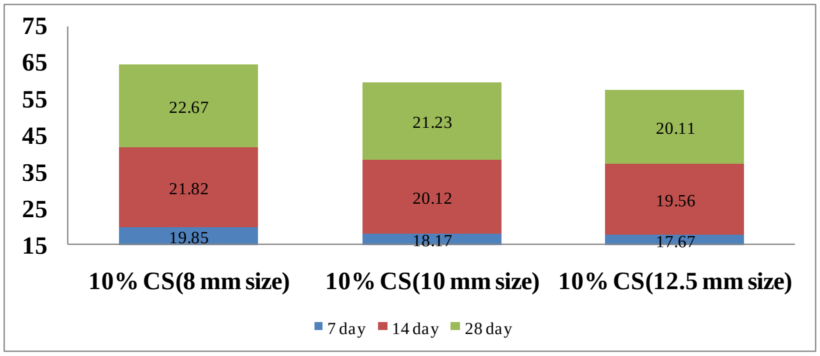
C. Bar Charts:



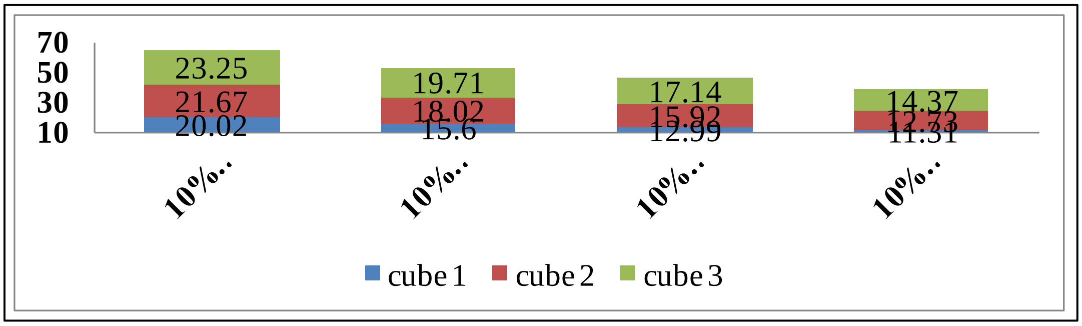
Graph 1: Slump Test Results For Conventional And % Cs



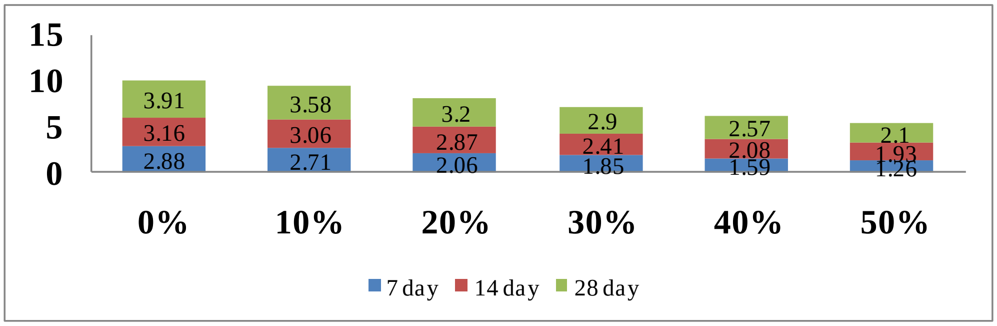
Graph 2: Compressive Strength Results For M 20 And % CS



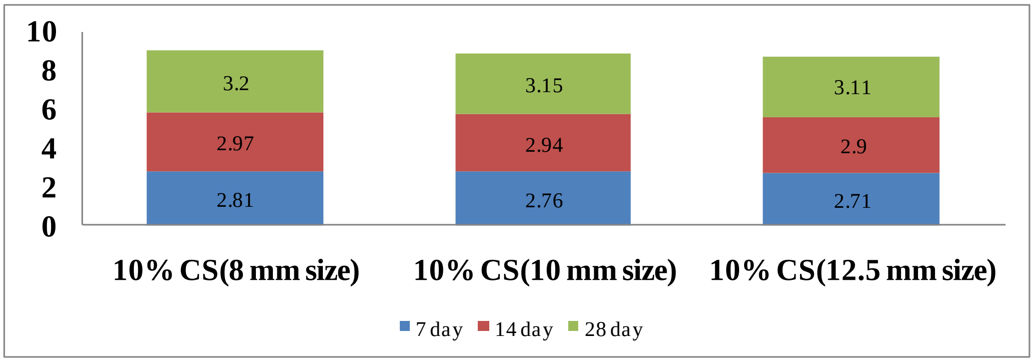
Graph 3: Compressive Strength Results Of Various Size Of CS



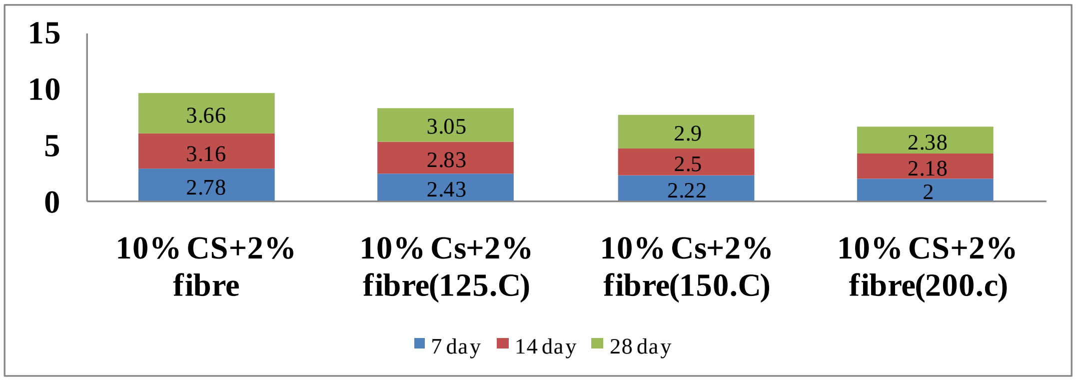
Graph 4: Compressive Strength Results Of % CS+Added Fibre In Concrete On High Temperature



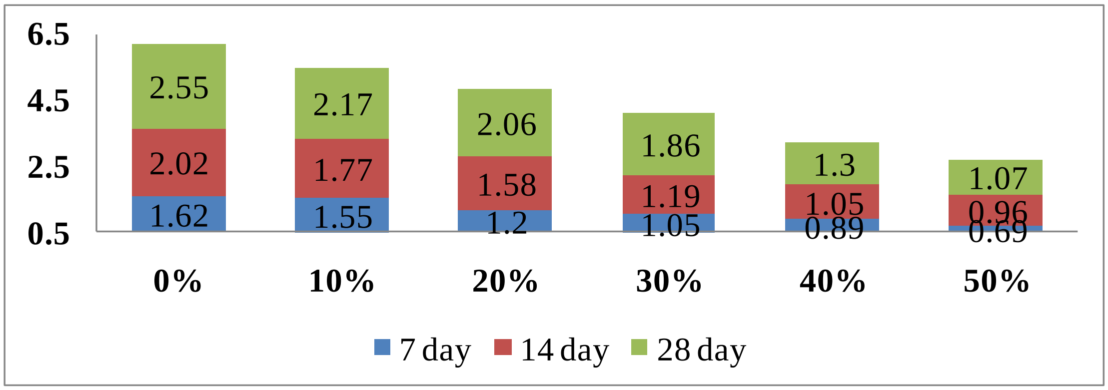
Graph 5: Flexural Strength Results Of M 20 And % CS



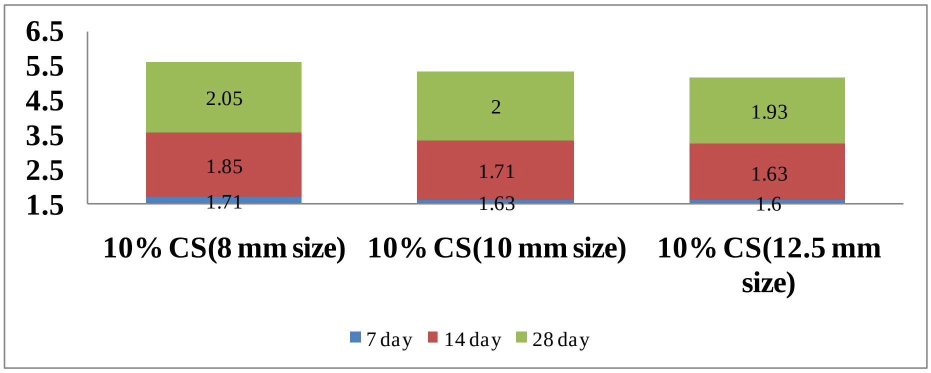
Graph 6: Flexural Strength Results Of Various Size Of CS



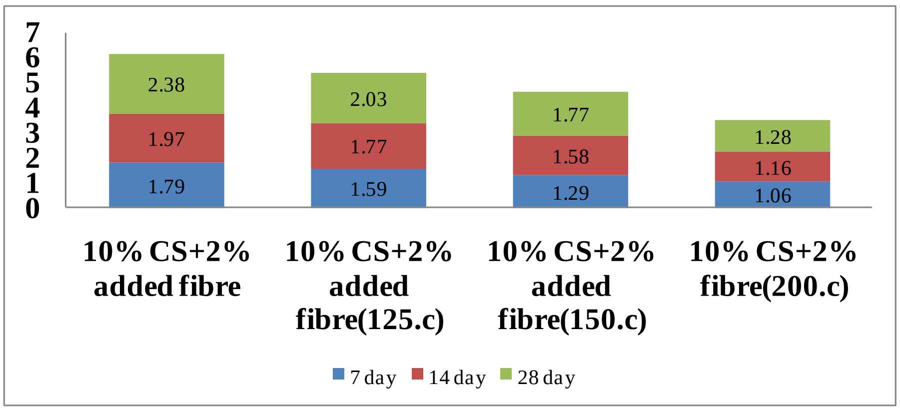
Graph 7: Flexural Strength Results Of %Cs And Added Fibre On High Temperature



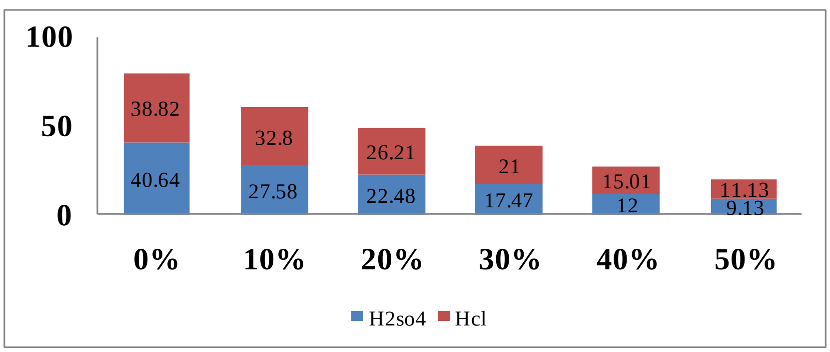
Graph 8: Split Tensile Results Of M 20 And % CS



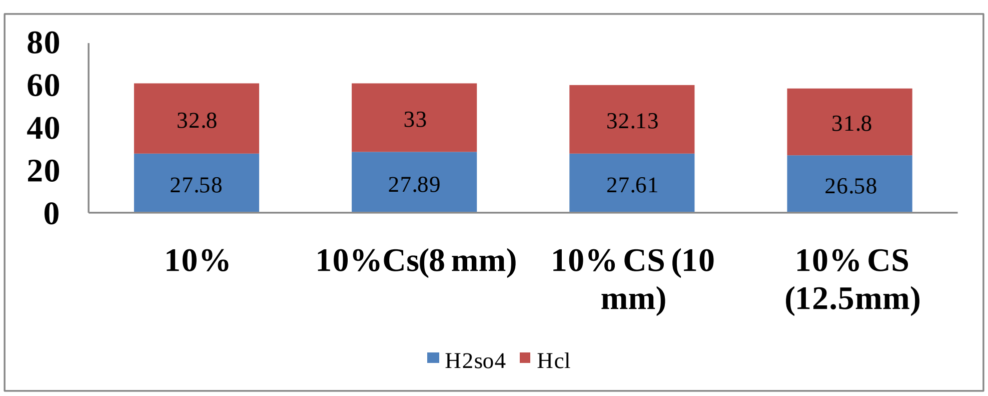
Graph 9: Results For Split Tensile Strength Of Size Of CS In Concrete



Graph 10: Result For Split Tensile Strength Of % CS And Added Fiber In Concrete On High Temperature



Graph 11: Compressive Strength with Acid Attack Results of M 20 and % CS



Graph 12: Compressive Strength With Acid Attack Results Of 10 % CS And 10% CS Of Various Sizes

VI. CONCLUSION

The experiments were performed to replaced CS as coarse aggregate in concrete of M 20 grade. The check the effect of size of Cs in concrete.i will used the various sizes of 8 mm,10mm and 12.5 mm in replaced 10% of CS.after 10% CS and added coir fibre in concrete on different tempreture.the following conclusions were obtain base on results.

1) The addition of Cs increases as decrease the workability.
2) The percentage of Cs increase as deceased compressive strength, split tensile strength and flexural strength as compared to conventional concrete.
3) The replacement of CS up to 20% as to good result of compressive strength as compared to conventional concrete.
4) The various sizes (8 mm, 10 mm and 12.5 mm) of 10% replace Cs in concrete .the sizes of Cs increase as decrease the split tensile strength, flexural strength and compressive strength.
5) Replacement of 10% CS and added fibre in concrete. After the replacement of 10% CS and added fibre in concrete on different high temperature. By observing that replaced cs and added fibre in concrete to increase flexural test, split tensile strength and compression test as compared to Cs and added fibre on different high temperature.
6) The result shows compressive strength of percentage replaced of Cs concrete in H_2SO_4 and Hcl solution curing are partially greater then the normal water curing.

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