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A Study On Strength Properties Of Concrete Using Seashells And Egg Shell Particles As Partial Replacement Of Coarse Aggregate And Fine Aggregate

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Abstract
Now a day's fine aggregate(sand) and coarse aggregate is very expensive, so that by using admixtures like egg shell powder and sea shells as partial replacement in fine aggregate, coarse aggregate would give better saving and environment free. Seashell contains large amount of calcium content, and the rough texture of the seashell makes suitable for the partial replacement of coarse aggregate in concrete which provides economically alternative for not only the coarse aggregate in concrete but also the materials used in concrete such as sand and cement also.Eggshell is made almost entirely of calcium carbonate ($CaCO_3$) crystals. Egg shells are the waste material and also reducing the concrete weight by partial replacement in fine aggregate .In this project I have partially replaced two types of admixtures named as egg shell powder and sea shells in cement concrete mix. Here egg shell powder and sea shells is used in cement concrete mix with a percentage variation of 5%, 10%, 15%, 20%.

Key Words: *sea shells , egg shell powder ,Coarse aggregate, Compressive strength, Fine aggregate, Flexural strength, Spilt tensile strength.*

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I. Introduction

The purpose of fine aggregate and coarse aggregate is very rapidly used in civil engineering constructions like apartments, water tanks, different types of roads etc.Fine aggregate was found from lakes, rivers, oceans etc. Will affect to the environment because it will be excavated and transported with tones of load; therefore there was a disturbance in below the layers of earth crest problem identified to the environment.The majority of coarse aggregate comes from quarries produced by various operations, including blasting, crushing, and screening. The aggregate characteristics are determined by the type of rock used to create it, which could be sedimentary, igneous, or metamorphic. So that if we partially replaced egg shell and sea shells (waste material) in fine aggregate ,coarse aggregate there was a reduced quantity of fine aggregate and coarse aggregate and the total quantity of fine,coarse aggregate will also be reduced. The main objective of this thesis is to determine the concrete strength of M25Grade by partial replacing of cement concrete from 0% to 20% with sea shells and egg shell particles . The mix design of M25 grade concrete was designed as per the method specified in IS 10262-2009.

1.1 SEA SHELLS: Materials such as bone, teeth, and seashells possess remarkable combinations of properties despite the poor structural quality of their ingredients (brittle minerals and soft proteins). Nacre from mollusk shells is 3,000 times tougher than the brittle mineral it is made of, a level of *toughness amplification* currently unmatched by any engineering material. For this reason, nacre has become the model for bio-inspiration for novel structural materials. The structure of nacre is organized over several length scales, but the microscopic brick-and-mortar arrangement of the mineral tablets is prominent. This staggered structure provides a *universal* approach to arranging hard building blocks in nature and is also found in bone and teeth. Recent models have demonstrated how an attractive combination of stiffness, strength, and toughness can be achieved through the staggered structure. The fabrication of engineering materials that duplicate the structure, mechanics, and properties of natural nacre still present formidable challenges to this day.

Fig:1.1 sea shells

EGG SHELLS: Egg shells in scientific terms refer to the outer protective covering of an egg. They are spatially curved surface structures that support external applied loads. Shells can be found in various natural structures such as eggs, plants, leaves, skeletal bones, and geological forms . The strength of egg shells can be measured using different methods such as compression, impact, and puncture. Compression is particularly useful for developing a non-destructive measurement of shell strength. If a linear relationship exists between compression force and the induced deformation of the shell, a non-destructive test could be developed to predict the force at failure .

Fig:1.2 Egg Shells

Objectives

1. To examine the mechanical properties of concrete by using egg shell powder and sea shells in concrete mix.
2. To find the optimum percentage of egg shell powder and sea shells content to be partially replaced in concrete in relation to their mechanical properties.
3. To find strength properties like compressive strength, split tensile strength, and of flexural strength of concrete.
4. To decrease the fine aggregate and coarse aggregate content in cement concrete by partially replaced with egg shell powder and sea shells.

II. Experimental Tests And Mix Design

Workability of concrete

Slump cone test was performed to determine the slump of the concrete mixes. The slump values for various mixes as shown in below table.

Table:1

EP+SS (percentage)	Slump(mm)
0	100
5	90
10	80
15	70
20	72

Slump values for different % of egg shell powder and sea shells

Mix-proportions

Grade designation - M25
Type of cement - OPC 53 grade conforming to IS 8112
Max. Nominal size of aggregate - 20mm
Exposure condition - moderate
Water-cement ratio = 0.45
Water = 250 lit
Cement content = 554kg/m³
Fine aggregate = 624kg/m³
Coarse aggregate = 1194 kg/m³

Experimental Setup

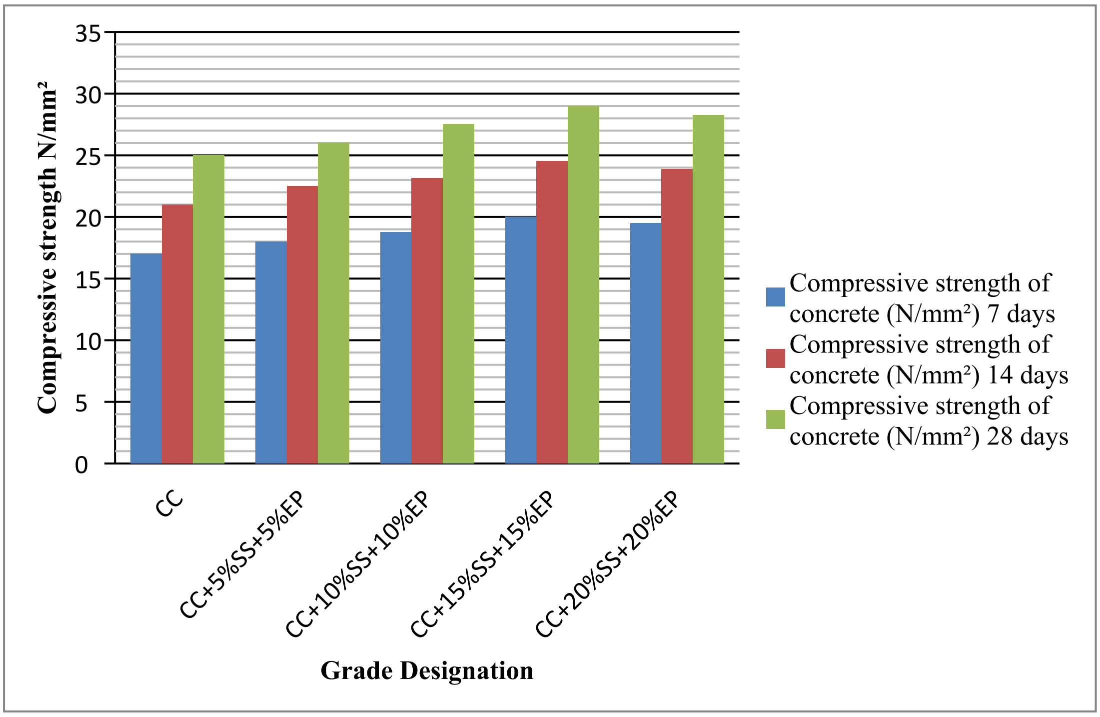
Compressive Strength

The compressive strength of a material is that value of uni-axial compressive stress reached when the material fails completely. The cubes are then tested between the loading surfaces of the compressive testing machine of capacity 2000KN in such a way that the smooth surface directly receives the load and it is applies until the failure of the load. The compressive strength is determined by the ratio of failure load to the cross sectional area of the specimen.

$$\frac{\text{failure load}}{\text{cross sectional area}} = fck$$

Table:2

Grade designation	Compressive strength of concrete (N/mm²)		
M25	7 days	14 days	28 days
CC	17	21	25
CC+5%SS+5%EP	18.00	22.50	26.00
CC+10%SS+10%EP	18.75	23.125	27.5
CC+15%SS+15%EP	20.00	24.50	29.00
CC+20%SS+20%EP	19.50	23.875	28.25



Graph:1 Compressive Strength of concrete for 7days,14days,28days

Split Tensile Strength

The resistance of a material to a force tending to tear it apart, measured as the maximum tension the material can withstand without tearing. Tested by keeping the cylindrical specimen in the compressive testing machine and is continued until failure of the specimen occurs.

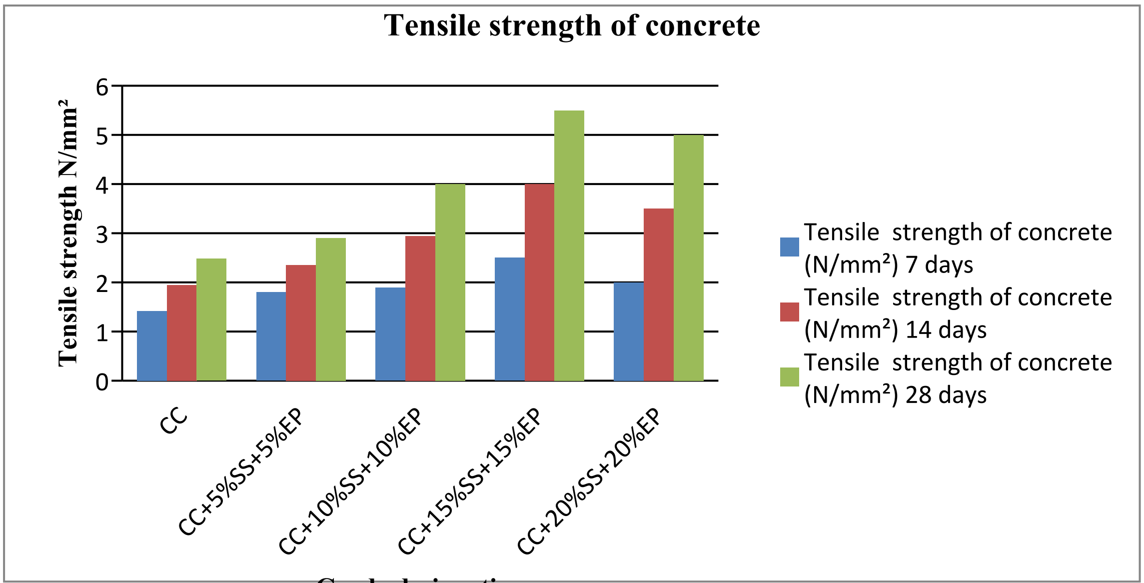
Splitting Tensile Strength shall be calculated by using the formula:

$$f_{ct} = \frac{2P}{\pi l d}$$

P = maximum load in Newton's applied to the specimen
L = length of the specimen in mm
D = cross sectional dimension of the specimen in mm.

Table-3

Grade designation	Tensile strength of concrete (N/mm²)		
M25	7 days	14 days	28 days
CC	1.42	1.95	2.48
CC+5%SS+5%EP	1.80	2.35	2.90
CC+10%SS+10%EP	1.89	2.945	4.00
CC+15%SS+15%EP	2.50	4.00	5.50
CC+20%SS+20%EP	2.00	3.75	5.00



Graph:2 Tensile Strength of concrete for 7days,14days,28days

Flexural Strength

The flexural strength may be expressed as the modulus of rupture f_b, which, if "a" equals the distance between the line of fracture and the nearer support, measured on the centre line of tensile side of the specimen, shall be calculated to the nearest 0.5kg/sq.cm as follows:

$$f_b = \frac{pl}{bd^2}$$

When "a" is greater than 20.0 cm for 15 cm specimen or greater than 13.3 cm for a 10.0 cm specimen.

When a is less than 20.0 cm but greater than 17.0cm for a 15.0 cm specimen, or less than 13.3 cm but greater than 11.0cm.

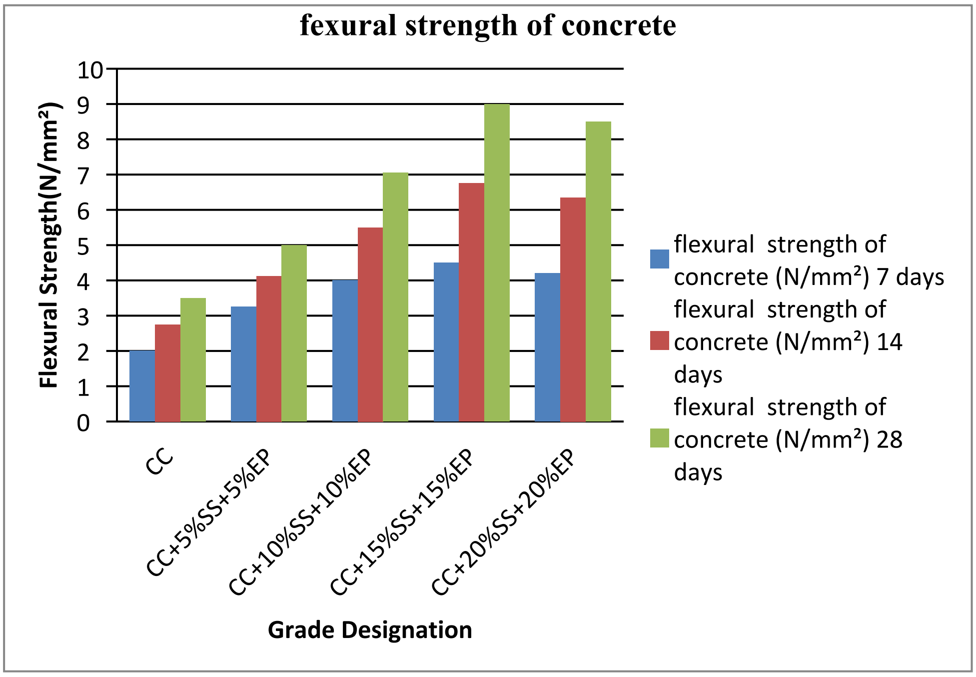
Where,
b = measured width in cm of the specimen
d = measured depth in cm of the specimen.
l = length in cm of the span in which the specimen was supported and
p = maximum load in kg applied to the specimen.

$$f_b = \frac{3p \times a}{bd^2}$$

Table:4

Grade designation	flexural strength of concrete (N/mm²)		
M25	7 days	14 days	28 days
CC	2.00	2.75	3.5

CC+5%SS+5%EP	3.25	4.125	5.00
CC+10%SS+10%EP	4.00	5.50	7.05
CC+15%SS+15%EP	4.50	6.75	9.00
CC+20%SS+20%EP	4.20	6.35	8.50



Graph: 3 Tensile Strength of concrete for 7days,14days,28days

III. Experimental Test Results And Conclusions

1. It is observed that Slump values of the concrete are decreasing as the admixtures percentage increasing. The reduction in slump with the increase in the admixture will be attributed to presence of admixture which causes obstruction to the free flow of concrete.
2. Compressive Strength enhancement ranges from 25% to 29.00% when % of admixture increases from 5% to 15% when compared to the conventional concrete at 28 days. 15% is observed as the optimum value.
3. Split tensile Strength enhancement ranges from 2.48%to 5.50% when % of admixture increases from 5% to 15% when compared to the conventional concrete at 28 days. 20% is observed as the optimum value.
4. Flexural Strength enhancement ranges from 3.5% to 9.00% when % of admixture increases from 5%to 15% when compared to the conventional concrete at 28 days. 15% is observed as the optimum value.
5.From the results it is observed that 15% is the optimum dosage of sea shells and Egg shell particles admixture increases the compressive strength, split tensile strength and flexural strength.
6. Addition of more than 15% of sea shells and Egg shell particles would result decreasing the values of compressive strength, split tensile strength and flexural strength.
7. Construction cost of the cement concrete structures like buildings, apartments, a rigid slab or culverts may be reduced by using sea shells and brick dust particles.

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