



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 6, June 2021

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.512

9940 572 462

6381 907 438

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Experimental Investigation of Steel Fiber on Concrete with Partial Replacement of Cockle Shell as a Coarse Aggregate

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ABSTRACT: This project presents the result on effect of steel fiber on concrete containing various percentage of cockle shell content as partial coarse aggregate replacement. Concrete mixes containing 0%, 10%, 20%, and 30% cockle shell replacement level. The steel fiber is added by various percentages such as 0%, 0.5%, 1%, 1.5% and 2% by the volume of concrete. Concrete cubes are tested at the age of 7, 14, and 21 days of curing. Tests have to be conducted on conventional concrete and concrete with partially replaced seashell as coarse aggregate of different percentages. The continuously growing construction industry has posed the possibility on depletion of natural aggregates in the future that would increase the cost of concrete material. Anticipating this issue, various types of waste materials have been investigated their potential to be used as partial coarse aggregate replacement material in concrete production such as oil palm shell, periwinkle shell, recycled coarse aggregate and others same as like that are using cockle shells as a replacement of coarse aggregate with steel fibers. Based on the concept of reduce, reuse and recycle, especially in the construction industry, it is better to consider to use cockle shell as a biodegradable material I am using cockle shells.

KEYWORDS: cockle shells, flexure, durability, tensile, deflection, steel fibers.

I. INTRODUCTION

At the end of the 20th Century that has just been left behind was very different to the world that its people inherited at the beginning of that Century. The latter half of the last century saw unprecedented technological changes and innovations in science and technology in the fields of communications, medicine and transportation and information infrastructure. The construction industry has been no exception to these changes when one looks at the exciting achievements in the design and construction of buildings, bridges, offshore structures, dams, and monuments, such as the channel tunnel and the millennium wheel. There is no doubt that these dramatic changes to the scientific, engineering and industrial face the world have brought about great communal benefits in terms of wealth, good living and leisure, at least to those living in the industrialized nations of the world. Where the shells have been used in concrete and the mix ratio are used to replacement of coarse aggregate. Finally it is found out that the replacement of coarse aggregate with cockle shells shell reduces the flexural, tensile and compressive strengths. As the cockle shell have rough surface over it. It is difficult for the mix to get along with it.

II. LITERATURE REVIEW

Tests were conducted on conventional concrete and concrete with partially replaced seashell as coarse aggregate of different percentages. These tests are carries out as per IS: 516-1959. Moulds were cast as per the standards for various tests in the form of cubes, cylinders, prisms. The concrete mix ratio of 1:1.5:3 was used for casting the moulds. Coarse aggregate is added which consists of both gravel and seashell which when mixed thoroughly forms a dry mix. The whole constituent was mixed until an even paste was obtained. The coarse aggregate for this study was a mixture of gravel and seashell at percentages of 0%, 3%, 5%, 7%, 9% and 11%. Remoulding of the cubes was done between 18 to 24 hours after casting. (Yamuna Bharathi et al, 2016)¹. In this project, cement is partial replacement with lime powder of about 10%, 20%, 30%. The coarse aggregate is partial replacement with 10%, 20%, and 30% by sea shell. The water cement ratio is maintained for this mix design is 0.5. Results show that replacement of appropriate cockle shell content able to produce workable concrete with satisfactory strength. Integration of 20% cockle shell enhanced the strength of concrete making it to be the highest as compared to any other replacement level. For each test that was



conducted, cubes and cylinders were prepared. They have concluded by saying that the project they have tried to replace coarse aggregate partially by sea shell (10%, 20%, & 30%) respectively to increase the strength of concrete. But the strength is same with the conventional concrete only at 10% and 20% replacement of aggregate by sea shell. The strength is gradually decreasing at 30% replacement of sea shell (Sasi kumar et al, 2016)². They conducted an experimental study on cockle shell ash as partial replacement for cement and as filler in concrete. The study determined the chemical composition of cockle shell ash using Fluorescence X-ray analysis. The observation on the morphology structure based on SEM analysis was also performed. The next phase involved in determining the properties such as compressive strength, tensile, modulus of elasticity, water permeability and porosity of concrete made from mixture of cockle shell ash of 5%, 10%, 15%, 25%, 50% and compared to normal concrete cured in ordinary water at the 7, 28, 90 days and up to 120 days for water permeability test. It was concluded from the study that inclusion of 5% and 10% of cockle shell ash in concrete resulted in relatively compacted morphology structure thus affecting the strength, modulus of elasticity, permeability and porosity of the concrete. (M.Boutouil et al,2013)³. The use of crushed queen scallop shells as the aggregate replacement could decrease the mechanical properties and increase the porosity because of an increase of entrapped air in concrete. Uncrushed cockle shells could replace aggregate partially up to 20% with an increase in compressive strength than normal concrete. For this purpose four different concrete mixes were produced, one of them used as reference with natural aggregates and the others prepared with 20, 40 and 60 % of crushed queen scallop shells replacing the natural aggregates. (Hector Cuadrado-Rica et al, 2016)⁴. Their study found that addition of cockle shell as partial coarse and fine aggregate replacement reduces the concrete workability due to its shape and rougher texture. However, it is motivating that the replacement of natural coarse aggregate by cockle shell at a level of 25% and fine aggregate by crushed cockle shell at a level of 10% resulted in increase of compressive strength and also to the compared to control specimen. Integration of too much of cockle shell produces harsher mix which causes disrupt the strength performance (Ramakrishna et al, 2015)⁵. Through the study, the total cementitious material content has been kept constant in all the mixes except for the variation in the percentage of natural coarse aggregate used. A control specimen was formed consisting 100% natural coarse aggregate and the other six mixes containing cockle shell as partial coarse aggregate replacement from the range of 5% to 30%. The cockle shells was integrated into concrete mix as a direct replacement for coarse aggregate on weight basis. Concrete's workability reduces as the percentage of cockle shell added as partial coarse aggregate replacement become higher. At the replacement of 30% of cockle shell, the concrete mixture which consistency is very low and difficult to be mixed exhibit very low slump. As the amount of cockle shell added is increased, this rough textured material causes the mix become harsher, more difficult to be mixed thus exhibit lower slump value. (Muthusway et al, 2012)⁶.

III. EXPERIMENTAL PROGRAM

A. Material Properties

Cement

Ordinary Portland cement of 43 grade was used for casting conforming to IS: 12269-1987. Specific gravity of cement is 3.17, normal consistency of 28%, initial and final setting time of 35 min and 535 min respectively.

Fine Aggregate

Clean and dry river sand locally available was used which was passing through IS 4.75mm sieve. Specific gravity of fine aggregate is 2.59, Water absorption is 0.53%

Coarse aggregate

Coarse aggregate passing through 12.5 mm sieve as per IS 383-1970 was used. Specific gravity of coarse aggregate (20mm) is 2.70 and (20mm cockle shell) is 2.63, Water absorption of (20mm) is 0.4% and (20mm cockle shell) is 0%. The sieve analysis of coarse aggregate is single size aggregate for both sizes.

Water

Clean portable water was used for the entire project from casting to curing of specimens

Steel Fibers

The length of steel fiber should be 20mm to 60mm and diameter or equivalent diameter should be 0.3mm to 1.2mm, length to diameter ratio was 30 to 65.

B. Mix Proportion

M30 grade concrete mix was designed as per IS: 12269-1987. The mix proportion calculated was 1:1.5:2.3 for nominal concrete and 1:1.5:2.2 for the cockle shell replacement.



Applications Of Fibers

- It improves the impact strength of concrete, limits the crack growth and leads to a greater strain capacity of the composite material Lowers the overall costs.
- For industrial projects, macro-synthetic fibers are used to improve concrete’s durability. Made from synthetic materials, these fibers are long and thick in size and may be used as a replacement for bar or fabric reinforcement.
- Adding fibers to the concrete will improve its freeze-thaw resistance and help keep the concrete strong and attractive for extended periods.
- Improve mix cohesion, improving pumpability over long distances.
- Increase resistance to plastic shrinkage during curing.
- Minimizes steel reinforcement requirements, thus resulting in reduction in size of the member.
- Controls the crack widths tightly, thus improving durability.
- Reduces segregation and bleed-water.
- FRC, toughness is about 10 to 40 times that of plain concrete.
- The addition of fibers increases fatigue strength.
- Fibers increase the shear capacity of reinforced concrete beams.

Aim And Scope Of The Project

- To find the characteristic strength of concrete with partial replacement of coarse aggregate with cockle shells.
- To study the behavior of concrete with partial replacement and conventional concrete.

Objective

- To study the compressive strength and strength development of the concrete cubed due to replacement of coarse aggregate with cockle shells.
- Reuse of waste material (Cockle shells).
- To try to obtain a more higher strength concrete.
- To obtain a more economical material compares to the ordinary one which can save cost in the construction.

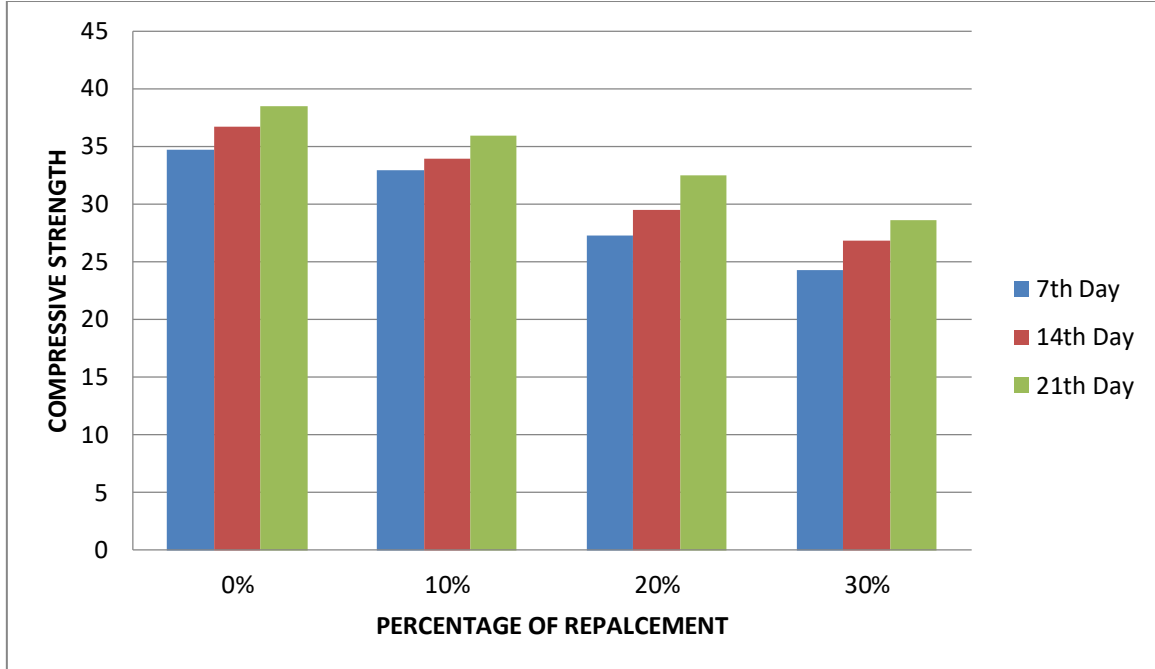
IV. EXPERIMENTAL RESULTS

Compressive strength

Cube mould of 150mm × 150 mm ×150mm were casted for finding the compressive strength of concrete. In which steel fibre and cockle shell with different hybridization ratio were added in concrete and compressive strength of cube was calculated by using compression testing machine. Compressive strength of cubes at 7th ,14th and 21th day was obtained and tabulated.

Table(1) Compressive strength of cube at 7th,14th and 21th day.

% Of Cockle Shells (Replacement For Coarse Aggregate)	7 th Day	14 th Day	21 th Day
0%	34.66	36.74	38.44
10%	32.89	33.88	35.96
20%	27.28	29.45	32.44
30%	24.21	26.87	28.64



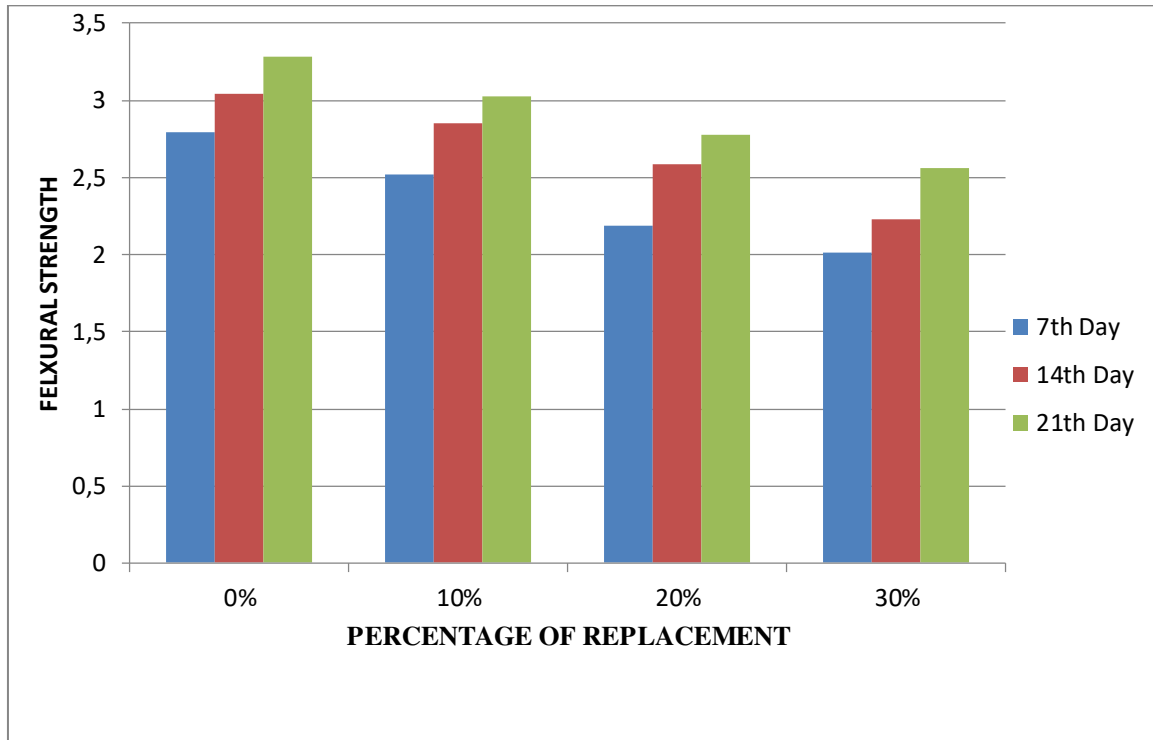
GRAPH 1 COMPRESSIVE STRENGTH

Flexural strength of Cylinder

The beam specimens were tested for flexural strength at the end of 28 days. The specimens were tested immediately on removal from the water while they were still in wet condition. The dimensions and weight of each specimen were noted before testing. The bearing surface of the supporting and loading rollers was wiped clean. The specimen was then placed on the rollers in such a way that the load will be applied to the upper most surface as cast in the mould along two lines spaced 13.3cm apart. The axis of specimen was carefully aligned with the axis of the loading device. The load was applied without shock and increasing continuously. The load was increased until the specimen failed and the maximum load applied to the specimen was recorded. Unusual fractures were recorded.

Table(2) Flexural strength of cylinder at 7th, 14th and 21th day.

% Of Cackle Shells (Replacement For Coarse Aggregate)	7 th Day	14 th Day	21 th Day
0%	2.79	3.04	3.28
10%	2.52	2.85	3.03
20%	2.19	2.59	2.78
30%	2.01	2.23	2.56



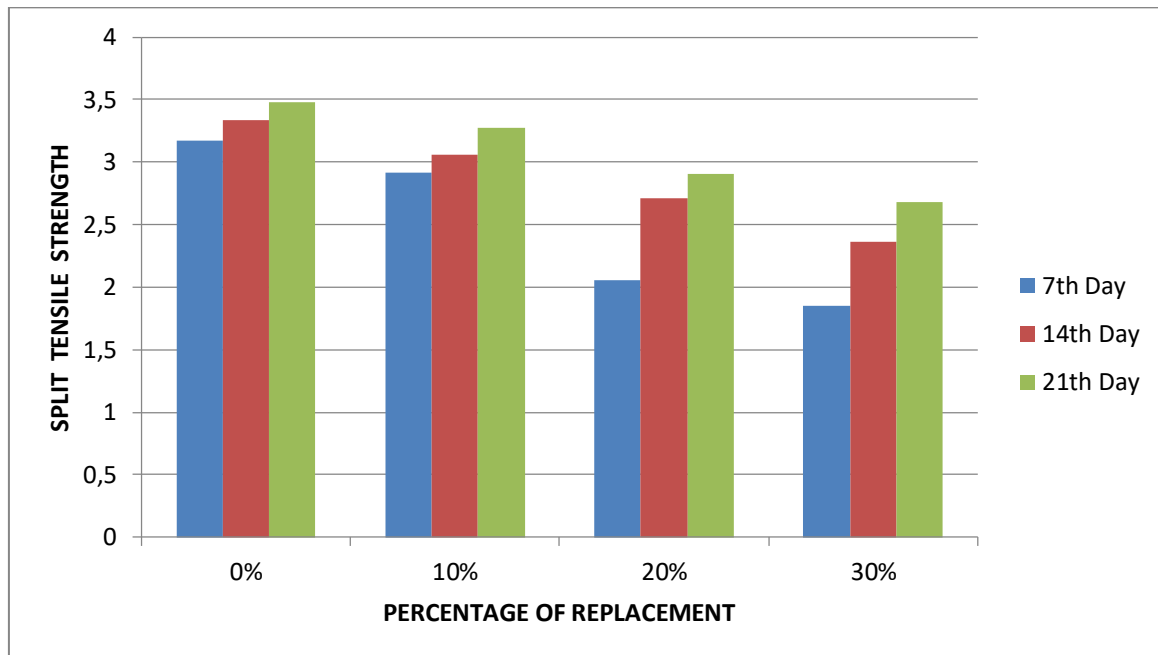
GRAPH 2 FLEXURAL STRENGTH TEST

Split Tensile Strength of beams

The cylindrical specimens were tested for split tensile strength at an age of 28 days. The specimen was tested immediately after taking out from the water. The weight of the specimen was noted down before testing. The specimen was placed on the plywood strip and aligned so that, the central horizontal axis of the specimen is exactly perpendicular to the load applying axis. The second plywood strip was placed length wise on the cylinder and the top plate was brought down till it touched the plywood. The load was applied without shock and increased continuously until the resistances of the specimen to the increasing load broke down and no greater load can be sustained. The maximum load applied was then recorded. Any unusual type of failure was noted.

Table(3)Split Tensile strength

% Of Cockle Shells (Replacement For Coarse Aggregate)	7 th Day	14 th Day	21 th Day
0%	3.17	3.34	3.48
10%	2.92	3.06	3.27
20%	2.05	2.71	2.91
30%	1.85	2.36	2.68



GRAPH 3 SPLIT TENSILE STRENGTH TEST

V. CONCLUSION

The mechanical behavior of concrete with partial replacement of seashell as coarse aggregate is investigated and presented. The following conclusions can be drawn based on the analysis of results.

- The addition of seashell as partial replacement for coarse aggregate has low compressive strength of concrete for both 7 days and 28 days.
- The flexural strength lowers with replacement of seashell.
- The workability reduces as the seashells are replaced due to their rough texture.
- This reduces the construction cost by reducing the cost of coarse aggregate and it also reduces the environmental pollution caused by cockle shells.

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