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Strengthening of Concrete by using Oyster Shell and Marble Powder

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***Abstract*: Concrete is one of the most commonly used materials in the field of construction. The main ingredients of concrete mix are aggregate, sand, cement and water. Usually, fine aggregate and cement used for concrete mix is river sand and ordinary Portland cement. Since excessive excavation of river sand causes erosion and failure to river beds which is becoming a serious environmental problem, to overcome this issue oyster shell is introduced to replace the river sand.**

The key point of this research was to develop a high performance concrete by replacing river sand with oyster shell and experimentally determine the effect of shell with the concrete. On this research the differences in the concrete properties with river sand and oyster shell will be determine and compared. Further, metakaolin and marble powder is to be used to add strength and give better workability to the concrete. This experiment is to be carried out using several tests which include initial tests for cement, fine aggregate and coarse aggregate, workability, compressive, tensile and flexural test etc.

***Keywords*: Marble powder, Metakaolin, Oyster Shell, and workability.**

I. INTRODUCTION

A. General

The requirements of the country are rapidly increasing with increase in the growth of the industries. Construction industry being the back bone of all other industries, concrete has emerged as one of the most important material in the developing world. Being in the chart of highest consumed, concrete production relies on the availability of cement, sand and coarse aggregate in a concrete mix the most commonly used fine aggregate is natural sand obtained from. Due to the rapid increase in the consumption of concrete the demand of natural river sand is rapidly increasing in countries of high infrastructure growth.

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Due to the shortage of this natural river sand, the growth rate of construction field is adversely affected in almost all part of country. The physical and chemical properties of oyster shells, makes it a suitable substitute for aggregates. These crushed shells benefit the waste industry and the construction industry at same time.

Because of the amount of the calcium carbonate content in oyster shell, they are considered a good option. The transformation of pure limestone gives out marble. A large quantity of powder is generated (about 20% of total marble quarried) during the cutting operation, which produces waste in million tons. The huge dust particles which are released into the atmosphere, becomes chief contributions to a pollution.

Metakaolin, the new material in the field of concrete which is effective in reducing sulphate attack, developing strength and improves the air-void. In recent years materials like fly ash, silica fume, rice husk ash etc are being used as partial replacement of cement for advancing HSC with enhanced workability, strength etc with reduced porousness.

Due to rapid infrastructural growth in evolving world the requirement of natural aggregates are very large which results in supply scarcity. To resolve this issue, natural sand is partially replaced with oyster shell and cement with marble powder and metakaolin which is proved effective and economical. It also contributes to the concrete industry's constant search for materials which can be partially replaced and at same time reduced the waste disposal problem.

a) Scope Of The Project

The research on concrete mix by replacing fine aggregate with different percentage of oyster shell and keeping the constant replacement amount of cement with marble powder dust and metakaolin, which is intended for distinctive compressive strength of 30 N/mm^2. The study is conducted to find axial compressive strength and reduce full dependence on natural aggregate.

b) Objectives of The Project

The main aim of the project is:

To lower the reliance on natural aggregate as the primary source of aggregate and use locally available oyster shell as a construction material. To reduce the cost in construction and contribute to clean environment by utilizing the waste properly.

B. *Materials* Used

a) Cement

Cement is a composition of calcium silicate sand aluminate sand alumina ferrite. It is obtained by merging fixed proportions limestone, clay and other minerals in its required ration, which is mixed and heated at temperature range of 1500˚C.

This process gives out clinker where a small amount of gypsum is added and a fine powder is produced called ordinary Portland cement. The cement when mixed with sand and water forms a paste and slowly sets to form a concrete mass. 53 Grade cement was used for this experiment. The specific gravity, initial setting time and fineness were determined by carrying out he the test in the lab.

b) Fine Aggregate

If the aggregate passes through IS Sieve 4.75 than it is classified as fine aggregate. These are added to concrete to increase workability and to give a homogenous mix. Normally the sand obtained naturally from river is preferred and used as fine aggregate. For the study, locally available river sand was used. Various physical properties were determined by conducting a test as per IS 383(part-III)-1970.

c) Coarse Aggregate

The aggregate of size between 20mm to 4.75mm is considered as coarse aggregate. For the study the test was carried out on 20mm size aggregate. They were considered as per IS 2386 – Part I.

d) Oyster Shell

Because of its physical and chemical properties, oyster shells are considered as suitable replacement of aggregates. The crushed oyster shell are found to be beneficial to the waste industry and construction industry. Depending upon the size of specimen the crushed shell can be substituted for different size of aggregate. The high amount of calcium carbonate on shell makes it suitable. This helps in improving the strength of the concrete and calcium carbonate content contributes to the resistance of heat and chemicals.

Fig. 1. Oyster shell

e) Marble Powder Dust

Re-using the wastes from industries has environmental, economical and technical advantage. These benefits can be seen from two different perspectives, one from the point of waste producer and the other from the user part. Marble powder being one of the basic pollutants, reusing these waste in some parts as replacement with cement, contributes in lowering the pollution risk.

Fig. 2. Marble powder

f) *Metakoalin*

Metakoalin a valuable admixture for concrete is a pozzolanic product which has many specific features. They are available in many different varieties. Metakoalin also provides special reactivity. Partial replacement of 8-20% (by weight) of ordinary Portland cement by metakoalin gives favorable engineering properties.

Fig. 3. Metakaolin

g) Water

The most essential ingredients of concrete mix is water as it actively hydrates in reaction with cement. It contributes to the strength such that giving cement a paste. The amount and type of water requires proper care. Water used should be free from impurities. Sea water shall not be used. Ordinary portable water available in university campus was used

II. TESTING OF MATERIALS

A. Cement

For the study of Ordinary Portland Cement (OPC) of grade 53 as per IS 12269 was used for experimental work. The specific gravity, initial setting time, fineness test were carried out in lab. Physical properties of cement is shown in table below:

Table-I: Properties of Cement

S.No	Particulars	Values
1	Grade	OPC 53 Grade
2	Specific gravity	3.25
3	Initial setting time	32 min
4	Fineness	2%

B. Fine Aggregate

The sand used was locally available river sand. Test was carried out to determine its different physical properties as per IS 383 (Part III)-1970. The type of sand used was river sand (<4.75mm) with fineness modulus 3.2 and the value of specific gravity as 2.645. The table below shows the properties of fine aggregate.

Table- II: Properties of Fine Aggregates

Sl. No.	Particulars	Values
1	Specific gravity	2.645
2	Fineness modulus	3.2
3	Water Absorption	1.046%
4	Moisture Content	0.251%

C. Coarse Aggregate

The aggregate whose size varies in the range of 20mm and 4.75mm are considered as coarse aggregate. Test were conducted on the aggregate to determine the different physical properties as per IS 383 (Part III)-1970.

Table- III: Properties of Coarse Aggregate

Sl. No.	Particulars	Values
1	Specific gravity	2.68
2	Fineness modulus	7.018
3	Impact value	34.5%
4	Water absorption	0.5%

D. Oyster Shell

Table- IV: Properties of Oyster Shell

Sl. No.	Particulars	Values
1	Specific gravity	2.62
2	Fineness modulus	2.21
4	Water Absorption	1.098%
5	Moisture Content	0.272%

Table-V: Mix Proportion

So the required mix design is 1: 1.065: 2.45.

III. RESULTS AND DISCUSSION

A. General

Charts are drawn with results showing the difference in strength within 30 % of oyster shell concrete mix. The difference in strength between the two is also recorded.

B. Compressive Strength Test Report

Compressive strength of is considered to be the outstanding property of concrete. The data presented here shows the compressive strength of oyster shell concrete were comparatively M30 higher than that of reference here mix .For all the days of wing .In this studies a significant oyster shell rise has been detected in concrete mix of 30% oyster shell with admixture 30% oyster shell(OS3O) together with from the above figure it is observed that OS20 gives the compressive strength higher than other concrete mixes with oyster powder as well as conventional concrete for all curing days. The possibilities of this is more voids present in concrete mix. The result clearly shows that the use of admixtures in conjunction with granite is necessary for utilizing the full potential benefits of oyster shell powder. In this study it also shows the decrease in strength with increase in water cement ratio.

Table- VI: Compressive Strength Result

Designation of mix	Compressive strength (N/mm^2)		
	7 day	14 day	28 day
OS0	26.25	27.89	31.22
OS10	28.72	32.12	33.34
OS20	29.21	32.84	37.21
OS30	27.43	28.63	32.52
OS40	25.78	26.89	30.92

Table- VII: Comparision of Compressive Strength

Designation of mix	Percentage increase in compressive strength %		
	7 day	14 day	28 day
OS10	9.41	15.17	6.79
OS20	11.28	17.75	19.19
OS30	4.50	2.65	4.16
OS40	-1.82	-3.72	-0.97

From the results it is clear that when we replace fine aggregate by oyster shell and with 10% each marble powder & metakaolin replacement for cement, the compressive strength increases upto30% river sand replacement. Also we get the maximum compressive strength at 20% fine aggregate replacement.

Fig. 4. Testing of Cube Specimen

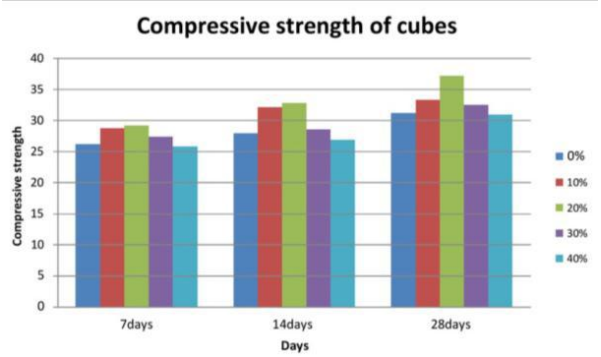

Fig. 5. Variation of compressive strength for cubes

C. Split Tensile Strength Test Report

The tensile strength of concrete is a distinctive property and is of considerable importance. The difference of split tensile strength with duration of curing is shown here. The test specimen, cylinder of 100mm have been tested at the duration of 1,14 and 28 days. It is shown in figure that OS20 shows higher strength than all the concrete mixes. The decreased with 30% increase in oyster shell in the mix is also shown in the figure. The strength reduction can be due to the unfilled micro voids present it the concrete mixes as the amount of oyster shell increases.

Table- VIII: Split Tensile Test Result

Designation of mix	Split Tensile Strength (N/mm^2)	
7days	28 days	
OS0	2.54	4.36
OS10	2.71	4.46
OS20	3.16	4.73
OS30	2.90	4.67
OS40	2.44	4.30

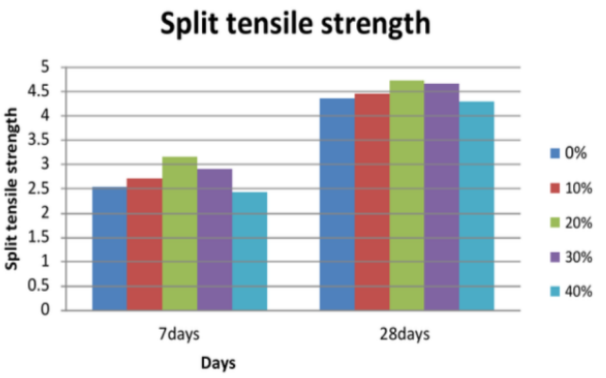

Fig. 6. Variation of Split tensile strength for cylinder

Table- IX: Comparision of Split tensile strength

Designation of mix	Percentage increase in Split tensile strength %	
7days	28days	
OS10	6.69	2.98
OS20	24.44	11.01
OS30	14.17	9.22
OS40	-4.09	-1.81

From the results it is clear that when we replace fine aggregate by oyster shell and with 10% each marble powder & metakaolin replacement for cement tensile strength increases up to 30% river sand replacement.

Also the maximum split tensile strength is achieved at 20% fine aggregate replacement.

D. Flexural Strength Test Report

The ability of the material to withstand load under deformed condition is known as flexural condition. It is also known as bend strength , modulus of rapture of fracture strength. The highest stress experienced by the moment of rapture within the material is known as flexural strength. The difference of flexural strength with duration of curing is shown here. The specimen of 1000mm length, 150mm width, 200mm thickness, beam have been checked with curing duration of 28 days. It is shown in the first figure that OS20 and 0S30 clearly shows flexural strength value higher than conventional concrete.

Fig. 7. Testing of beam specimen

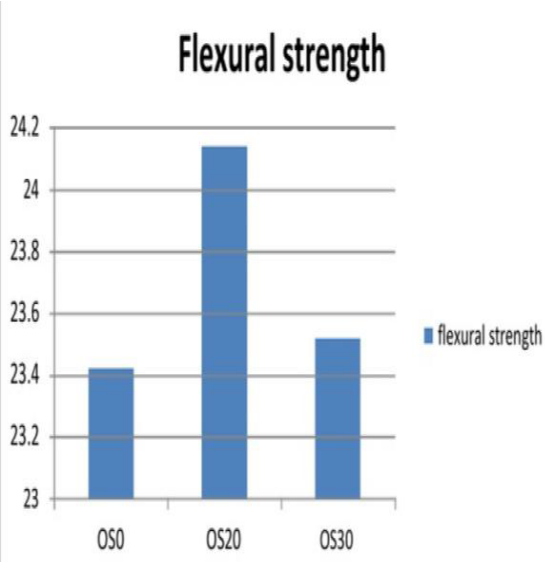

Fig. 8. Variation of Flexural strength for beam

Table- X: Flexural Strength Result

Designation of Mix	Flexural load (kN)	Flexural strength (N/mm^2)	Deflection (mm)
OS0	70	23.42	15.2
OS20	81.5	25.74	12.3
OS30	75.3	23.52	13.8

From the results it is clear that when we replace fine aggregate by oyster shell and with 10% each marble powder & metakaolin replacement for cement there is an flexural strength rise up to 30% river sand substitution.

Also we get the maximum flexural strength at 20% fine aggregate replacement.

IV. CONCLUSION

The research study on high performance concrete prepared with oyster shell powder as fine aggregate and small part of cement (10%) substituted with each marble powder dust and metakoalin under water curing is carried out to find out the mechanical properties like compressive, split and flexural strength for M30 grade concrete. The concrete specimen were prepared with water cement ratio of 0.38. The result of test clearly shows the beneficial effects of the mechanical properties of concrete. The concrete with 20% oyster shell was found highest than other percentage of oyster powder shell and CC. Hence, on comparison with OS20 with control concrete the following conclusions were made. The mechanical property of concrete i.e., compressive strength 4-19% higher than that of CC, split tensile strength 2-11% higher than that of CC and flexural strength, which is also higher than CC. with the increase in the days of curing the strength was also increased. Thus, this experimental study proves that the property of concrete could enhance the utilization effect of oyster shell powder obtained from the river bed replacing river bad. The behavior of oyster shell aggregate with metakoalin and marble powder in concrete possess good strength properties like cement produced by using river sand.

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