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An Experimental Study on Oyster shell concrete with Oyster shell powder as replacement of Fine Aggregates.

Vatsal kathiria[1], Aakash suthar[2]
[1]Mtech student LJ University Ahmedabad, India
[2]Aakash Suthar , Assistant Professor , civil engineering department LJ University Ahmedabad, India

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ABSTRACT: The Requirements of the country are rapidly increasing with that there is an increase in the growth of industries and housing. Construction is the backbone of all industries, concrete has emerged as one of the most important material in the developing world, due to its unique properties like compressive strength, durability, Fire resistance, Thermal resistance, and impact resistance. Due to the rapid increase in the consumption of concrete the demand for sand is also increasing in countries where there is high infrastructure growth, as a result, the cost of materials increases gradually. In China, sand mining is restricted due to environmental issues. Now to overcome these scientists are performing experiments to find an alternative to sand from the environmental wastage. Oyster shell powder can be added to the concrete as a replacement for fine aggregates with substitution of 5 % to 25 % by the volume of aggregate in the mixer. Marble powder is added to the mixture as an admixture. The compressive strength test and flexural strength tests are performed and the results are compared with normal concrete to see whether it can be used in place of fine aggregate or not.

KEYWORDS: Oyster shell powder,marble powder.

I. INTRODUCTION

Practically four types of materials are used in every structure made in civil engineering that is Concrete, steel, timber, and aluminium. In which concrete is the most used material and it is used in the construction of roads, bridges, dams, sidewalks, power plants, etc. Concrete undergoes several problems such as segregation, creep, drying shrinkage honeycombing, spalling, etc. The reasons for these problems can be improper supervision, improper construction method, quality of materials, or an improper mixture of concrete. Sometimes as the number of alumina increases in concrete defects such as efflorescence is seen on the surface of the concrete. In underwater construction or in places where the temperature is very high admixture is added to concrete to increase or delay the initial and final setting time of concrete. In the present world, the construction industry is booming and due to that resources are depleting in some parts of the world, and to overcome this much research is going to find alternative components of concrete. In some parts of the world mining of sand from the river is restricted due to environmental issues. It causes erosion of the river bed and also causes failure of the river bed. So scientists are doing experiments to find alternative materials that can be used as a replacement for components of concrete.

History of concrete:-

The precursor to concrete was invented in 1300 BC when Middle Eastern builders found that when they coated the outsides of their pounded-clay fortresses and home walls with a thin, damp coating of burned limestone, it reacted with gases in the air to form a hard, protective surface. This wasn’t concrete, but it was the beginning of the development of cement. Concrete was first used by Romans from 200 to 600 BC.

By 600 BC, the Greeks had found naturally available pozzolan material that developed hydraulic properties when mixed with lime, but the Greeks were nowhere near as productive in building with concrete as the Romans. By 200 BC, the Romans were building very successfully using concrete, but it wasn’t like the concrete we use today. It was not a plastic, flowing material that can be poured into forms, but more like cemented rubble. The Romans built most of their structures by mounding stones of different sizes and hand-filling the spaces among the stones with mortar. Above ground, walls were covered both inside and out with clay bricks that also served as forms for the concrete. The brick had little or no structural value and its use was mainly cosmetic. Before this time, and in most places at that time (including 95% of Rome), the mortars commonly used were a simple limestone cement that hardened slowly from reacting with airborne carbon dioxide. True chemical hydration did not take place. These mortars were weak. The Romans knew concrete was a revolutionary material so they perform experiments by placing it inside the moulds of arches and domes and it quickly hardens reducing the troubles of builders, but as the Roman Empire collapsed the use of concrete become very rare in the 18 century it was redeveloped. Today the usage of concrete is more than steel.

History of Oyster shell:-

Oyster shells are made up when oyster secrets the proteins and minerals from the mantle extracellularly, they does not shed their shell they enlarge as they grow. Tabby is a type of concrete used in coastal areas as the availability of oyster shells is in ample amount, they are burnt and then mixed with water, sand, ash, and broken oyster shell. The labour-intensive process relies on slave labour to crush and burn the oyster shells into quicklime. The quicklime was then slaked, combined with the shells, sand, and water then poured or tamped into wood forms known as cradles, built up in layers which is the similar manner in which rammed earth is created. Tabby was used as a substitute for bricks, which were rare and expensive because of the absence of local clay. Tabby was used as concrete for floors, foundations, columns, and roofs or was made into bricks or used as "oyster shell mortar" or "burnt shell mortar". It is likely that 16th-century Spanish explorers first brought tabby. The oldest known example of tabby concrete in North America is the Spanish Fort San Anton de Carlos located on Mound Key in Florida. The earliest known use of tabby was near Beaufort, South Carolina, formerly known as Santa Elena which was the capital of Spanish Florida from 1566 to 1587.

The British tradition began later (sometimes close to, but earlier than, 1700, upon introduction of the techniques from Spanish Florida,) than the Spanish (1580), and spread far more widely as a building material, reaching at least as far north as Staten Island New York, where it can be found in the still-standing Abraham manee house erected circa 1670. Beaufort, South Carolina, was both the primary centre for British tabby and the location of the earliest British tabby in the south-eastern US. It was here that the British tradition first developed, and from this hearth tabby eventually spread throughout the sea island district. Tabby was used in the West Indies, including the islands of Antigua and Barbados.

History of Aggregates:-

Aggregates have been around since before humans walked on the face of the earth, they are formed in the fires of volcanoes and moulded by erosion, time, water, and glaciers. The first type of concrete, a mixture of gypsum and lime, was used in ancient Egypt during the building of the pyramids as a mortar between the stones. Aggregates are raw materials that are produced from natural sources and extracted from pits and quarries, including gravel, crushed stone, and sand. When used with a binding medium, like water, cement, and asphalt, they are used to form compound materials, such as asphalt concrete and Portland cement concrete. Aggregate is a landscaping term that's used to describe coarse to medium grain material. The most common types of aggregate that are used in landscaping include crushed stone, gravel, sand, and fill.

Varying in material and stone size, each type can have its purpose when it comes to landscaping projects. Aggregate is the component of a composite material thatresists compressive stress and provides bulk to the composite material. Forefficient filling, aggregate should be much smaller than the finished item, buthave a wide variety of sizes. For example, the particles of stone used to make concrete typically include both sand and gravel. The aggregate base is a construction aggregate typically composed of crushed rock capable of passing through a 20 millimetre (3⁄4 in) rock screen. The component particles will vary in size from 20 mm down to dust. The material can be made of virgin (newly mined) rock, or recycled asphalt and concrete. The base is used in roadways, as a base course for cement pads and foundations, and as backfill material for underground pipelines and other underground utilities. "Base course" refers to the sub-base layer of an asphalt roadway. Generally consisting of larger grade aggregate, spread and compacted to provide a stable base for further layers of aggregates or asphalt pavement. The aggregate base course is often referred to as ABC. They are used to provide support for railways on which the ballast and tracks are laid.

II. LITERATURE REVIEW

In thepaper [1], the effects of oyster shells as a replacement for fine aggregate for a long time

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are evaluated. In this paper, tests are performed to find compressive strength from 3 days to 1 year. Results show an increase in compressive strength when replacement is till 5 % of oyster shell and till the curing period reaches 6 months. Tests are also performed to find the elastic modulus of concrete and the result shows the value decreased by 10 to 15% as the substitution rate reaches 20 %. Drying shrinkage increases as the oyster shell substitution increases and the use of oyster shell has no effects on freezing and thawing, carbonation and chemical attack resistance and permeability resistance was approved.

In the paper [2], the soil mortar was formed by replacing sand with oyster shells. Tests are done to find compressive strength at a cement/ soil ratio of 0.1 and 0.2.oyster shell was replaced by 0 to 80 % in cement mortar. The results show that oyster shell replacement in soil mortar having a cement/soil ratio is 0.2 shows an increase in compressive strength at 20 and 40 % replacement of fine aggregates, However, the compressive strength of soil mortar at cement/soil ratio of 0.1 shows the increase in compressive strength when dosages reach 40 to 60 % replacement of fine aggregates. It is used in the viable application of breakwater and sea wall construction.

In the paper [3], the replacement of aggregates with Oyster shells is done in the production of hollow blocks. The diameter of crushed oyster shells added to hollow concrete blocks coming between 10- 25 mm is added in the coarse aggregate category and the diameter which is less than 5 mm is added in the fine aggregates category. The correspondence between grain size of oyster shell and the strength characteristics are evaluated, according to it when the diameter is between 10 to 13 mm it shows favourable results in strength as well as workability but as the diameter reaches in range of 19 to 25 mm then there is a reduction in strength. Crushed oyster shells are added to the hollow concrete blocks with 30 % and 50 % replacement of aggregates and it is seen that the compressive strength is higher compared to normal hollow concrete blocks.

In the paper [4],the physical properties of the oyster shell are as follows, the colour can be yellow, white, silver, or tan. Its colour changes due to temperature and levels of mineral concentration in the seawater. The weight of one shell ranges from 50 grams to 200 grams and its length ranges from 3 to 15 cm. They are oven Dried at 50 degrees Celsius and then crushed manually or with the mechanical jaw. The workability of concrete is based on the fineness of the oyster shell which means an Oyster shell passing through a 75 um sieve gives more workable concrete than an oyster shell passing from a 150 mm sieve. When the oyster shell is added between 10 to 20 % then there is a gradual decrease in the elastic modulus of concrete.

In the paper[5], the effects of oyster shell as replacement of sand in Control low strength concrete(CLSM). The hardened properties, durability, and engineering properties are evaluated. When the water/binder ratio was 1.3 the slump/flow of the Control low strength concrete the workability and flow ability, increased. A water Penetration Test is performed and it is seen that after the addition of oyster shell shows better results than normal CLSM, with the increase in replacement of oyster shell the density of concrete also increases. The value of drying shrinkage after the addition of oyster shell is because of its characteristics such as low rigidity of oyster shell and based on the size of fine powder of oyster shell. It also improves the resistance to chemical attacks of concrete.

III. METHODOLOGY TO OBTAIN MIX DESIGN OF M-30 CONCRETE:-

The method of calculating materials which are required to cast 18 beams and 18 cubes of M-30 grade, amount of fine aggregate to be replaced in concrete with oyster shell is given by mix design of concrete.

Concrete Mix design of M-30 grade of Concrete for 1 m^3 of concrete using IS-456:2000 and IS-10262:2019

Required data for design of M-30 grade of concrete:-

1. Grade of Concrete- M30 grade
2. Type of Cement –OPC 43 grade.
3. Maximum nominal size of Aggregates – 20 mm
4. Exposure Condition – Severe (IS-456,Table-3)
5. Minimum Cement Content – 300 Kg/m^3
6. Workability in terms of slump- 100 mm
7. Method of placing – by hand
8. Number of layers in which concrete is placed- 3 layers
9. Compaction –by temping rod of 16 mm diameter with the round end
10. Number of blows in each layer – 35 number of blows
11. Standard Deviation- 5 N/mm^2.(IS-10262-2019,Table-2)
12. Type of Coarse aggregate – Crushed angular Aggregate.
13. Minimum cement content – 450 kg/m^3 (Is-456,CL.8.2.4.2)

14. Water Content Ratio-0.55 (IS-456,Table-5)

Fine aggregate- Zone II.
Test data of materials:-
1. Specific gravity of Cement-3.16 Kg/m^3.
2. Specific Gravity of fine aggregate – 2.46 Kg/m^3.
3. Specific Gravity of Coarse aggregate – 2.73 Kg/m^3.
4. Specific Gravity of Water– 1.0 Kg/m^3.
5. Specific gravity of Marble Powder – 2.57 Kg/m^3
6. Specific gravity of Oyster shell powder– 2.21 Kg/m^3
Type of admixture-Marble powder

Summary of Materials which are used to design M-30 concrete for 1m^3.
1. Quantity of cement = 315.2 Kg/m^3.
2. Quantity of Water = 157.6 Kg/m^3.
3. Quantity of Fine Aggregates = 668.38 Kg/m^3
4. Quantity of Coarse Aggregates = 1210Kg/m^3
(20 mm- 60 % and 10 mm – 40 %)
5. Quantity of Admixture (1.1 % of Cement)= 3.46 Kg/m^3
6. Water/cement Ratio = 0.50

The materials required to cast 18 cubes of 150 X 150 X 150 mm to find the Compressive strength of Oyster shell added into concrete are found below :-
1. Size of cube(LxBxH) = 150 X 150 X 150 mm
2. Volume of cube in m^3 = 0.00375 m^3\
3. Water/cement Ratio = 0.50
4. Quantity of cement = 1.182 Kg/m^3.
5. Quantity of Water = 0.591 Kg/m^3.
6. Quantity of Fine Aggregates = 2.506 Kg/m^3
7. Quantity of Coarse Aggregates = 4.537 Kg/m^3
(20 mm- 60 % and 10 mm – 40 %)
8. Quantity of Admixture (1.1 % of Cement)= 0.0129 Kg/m^3
(Admixture is marble powder)

Now in this cubes as we replace the fine aggregates with Oyster shell powder to Compare the Compressive Strength of normal concrete and oyster shell concrete, the values for replacement of fine aggregate are given as Table 1:-

Oyster shell (%)	Amount of Fine aggregate replaced(kg/m^3)
0	2.506
5	0.1253
10	0.2506
15	0.3759
20	0.5012
25	0.626

Table1:-Amount of fine aggregate replaced in cubes

The materials required to cast 18 beams of 700 X 150 X 150 mm to find the Compressive strength of Oyster shell powder added into concrete are found below :-
1. Size of cube(LxBxH) = 700 X 150 X 150 mm
2. Volume of beam in m^3 = 0.01575 m^3
3. Water/cement Ratio = 0.50
4. Quantity of cement = 4.96 Kg/m^3.
5. Quantity of Water = 2.48 Kg/m^3.
6. Quantity of Fine Aggregates = 10.52Kg/m^3
7. Quantity of Coarse Aggregates = 19.05Kg/m^3
(20 mm- 60 % and 10 mm – 40 %)
8. Quantity of Admixture (1.1 % of Cement)= 0.0544 Kg/m^3
(Admixture is marble powder

Now in this beams as we replace the fine aggregates with Oyster shell powder to Compare the Flexural Strength of normal concrete and oyster shell concrete, the values for replacement of fine aggregate are as given in Table 2:-

Oyster shell(%)	Amount of Fine aggregate replaced(kg/m^3)
0	10.52
5	0.526
10	1.052
15	1.578
20	2.104
25	2.631

Table2:-Amount of fine aggregate replaced in beams

IV. RESULTS AND DISCUSSION :-

In this section, the values of compressive strength of cube for 7, 14 and 28 days after replacing oyster shell powder with fine aggregates from 0% to 25% are given in the Table 3,4,5 respectively.

Oyster shell %	7 days compressive strength (N/mm^2)
0	22.6
5	26.6
10	28.8
15	30.6
20	32.4
25	28

Table 3:- Compressive strength at 7 days

Oyster shell %	**14 days compressive strength (N/mm^2)**
0	28
5	30.2
10	32.8
15	34.2
20	35.5
25	32.5

Table 4:- Compressive strength at 14 days

Oyster shell %	**28 days compressive strength (N/mm^2)**
0	30.2
5	32.4
10	34.2
15	36.8
20	38.2
25	34.6

Table 5:- Compressive strength at 28 days

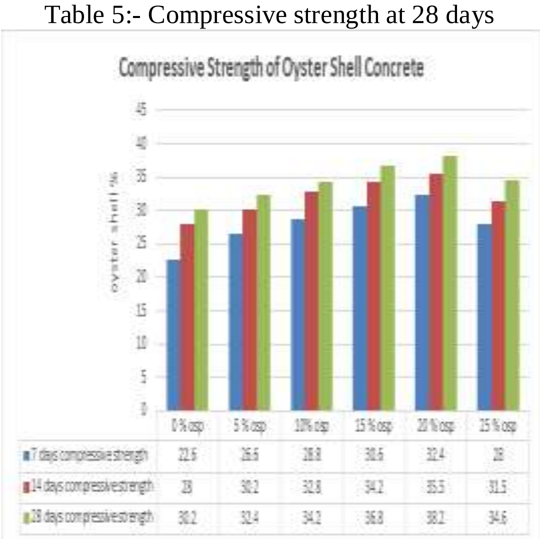

Figure:-1 Compressive strength of oyster shell concrete

The Figure 1 shows increment in compressive strength at 0 % to 25 % replacement of oyster shell at curing period at 7, 14 and 28 days.Now the flexural strength of concrete at 7, 14 and 28 days are evaluated.

The values of flexural strength of cube for 7, 14 and 28 days after replacing oyster shell powder with fine aggregates from 0% to 25% are given in the Table 6,7,8 respectively.

Oyster shell %	**7 days Flexural strength (N/mm^2)**
0	4.4
5	5.6
10	6.5
15	7.2
20	8.0
25	5.5

Table 6:- Flexural strength at 7 days

Oyster shell %	**14 days Flexural strength (N/mm^2)**
0	9.2
5	10.1
10	10.8
15	11.7
20	12.4
25	9.7

Table 7:- Flexural strength at 14 days

Oyster shell %	**28 days Flexural strength (N/mm^2)**
0	13.1
5	13.8
10	14.5
15	15.4
20	16.1
25	13.3

Table 8:- Flexural strength at 28 days

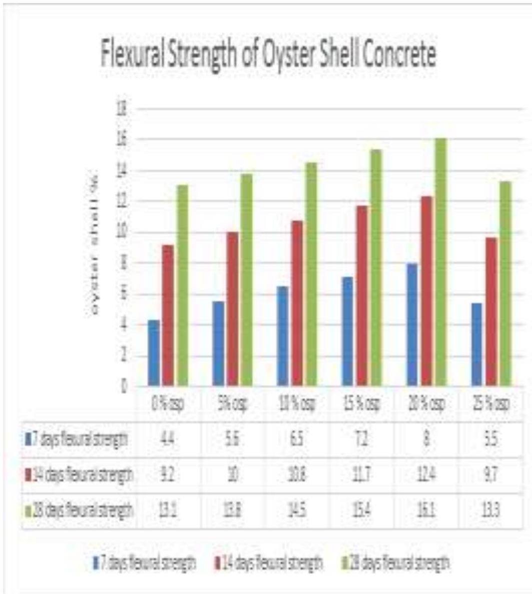

Figure:-2 Flexural strength of oyster shell concrete

The Figure 2 shows increment in Flexural strength at 0 % to 25 % replacement of oyster shell at curing period at 7, 14 and 28 days.

V. CONCLUSION

In this research when you replace fine aggregate with oyster shell powder the results shows 4% to 11 % increase in compressive strength and the flexural strength of concrete increases from 2 to 9% respectively.

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