

An Experimental Investigation on Concrete by Partial Replacement of Coarse Aggregate with Sea Shell and Cement with Animal Bone Powder

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Abstract— The most commonly used material in construction industry is Concrete. Now a days the use of concrete for modern infrastructure is in high demand. Cement is the main constituent of concrete plays a vital role in concrete production. In India, the cement consumption has grown well with a growth rate of about 6.1% every year (annually). Hence, an alternative material to partially replace cement was initiated to complete the needs of local community. Animal bone powder which has same chemical composition same as of cement can be replaced with cement. Due to continuous utilization of natural materials like coarse aggregate and fine aggregates for making concrete we are facing different problems like lack of availability of these materials, because of their high demand and in some areas restriction from the local government for the extraction of the natural materials. Due to this the price of natural materials are increasing rapidly, due to high price of natural materials ultimately the cost of construction is high. To overcome this problem many researchers are finding the replacement for cement and coarse aggregate. Through the various study it is found that waste materials from sea like sea shells having properties similar to coarse aggregate can be used in production of concrete. we bought sea shells at very cheap price from coastal area. Here coarse aggregate is partially replaced to sea shell in percentage to coarse aggregate by 10%. Similarly the replacement for cement is made by the animal bone powder. The waste quantity of animal bones has impacted the environment which are unusual to see all over the world. The primary aim of the research is to investigate the effects of varying dosage replacement of cement by animal bone powder (ABP) in the normal concrete production. The bone samples collected from M.I. Industries Thane Mumbai, we found that After cleaning and drying, the bone samples burned in the Furnace. The average required energy to burn the animal bone obtained at a temperature of 340°C. The burnt bone was allowed to cool before grinding in a hammer mill and sieving. There were four proportions prepared to start from 0% (as control specimen), 5%, 10%, 15% dosage increment by weight of bone powder, and evaluated the normal concrete strengths of M-30 grade concrete. The laboratory test results indicated the chemical analyses of bone powder composed similar compounds of oxide in cement but slightly lesser in content. Likewise, the effects of replacing animal bone on the properties of cement such as consistency and setting time remained within the acceptable limits of the Standard Specifications. As we know the lack of natural materials hence we can use these two materials as partial replacement of coarse aggregate and cement, hence we form a new concrete. On the other hand, the results of compressive strength, flexural strength, and the tensile strengths significantly declined from the control specimen during the dosage increment of the replacement made. Therefore, the

optimum dosage of bone powder indicated 10% by weight to replace cement content in normal concrete mix production.

Keywords: Steel Slag, Eco-Sand, replacement of aggregates, strength comparison

I. INTRODUCTION

Concrete plays main role in modern construction and it is a very high in demand. Comprising of natural materials as coarse aggregate, River sand as fine aggregate and a potable water and to bind all this natural material a man-made material as binder is used called as cement. In concrete the main constituent is coarse aggregate which almost cover (70-75%) to total concrete. The main advantage of concrete using in construction is its cost effectiveness, durability, outstanding compressive strength, fire resistant, and also it can bear from natural calamities hence it is very useful in construction. On the other hand, the quantity of animal bone waste has highly increased over time to time due to the dynamic population growth of cattle animals. It causes severe disposal problem and continues to accumulate at rising rates, which if not adequately managed, the bone will create increasing environmental issues. For that reason, utilization of the bone as a sustainable material in concrete production would help to preserve natural resources and maintain ecological balance. So in this research we are using the waste product as the replacement in the making of concrete and analysing the results of their strengths as compared to the conventional concrete. cement is replaced by the animal bone powder and coarse aggregate is replaced by sea shell respectively of interest.

A. Scope of the Project:

The project aim is to compare the strengths of conventional concrete and concrete with partially replaced material. By conducting compressive strength test, flexural strength test, Tensile strength, water absorption test and thus comparing the results obtained with normal conventional concrete using M30 grade of concrete.

1) Scope:

Animal bone powder is partially replaced to cement and sea shell with coarse aggregate shows economical, technical and energy saving benefits. To analyse its properties for concrete which is to be used for construction a study of all strength such as compressive strength, Flexural strength & Tensile strength are to be checked.

A The major aim of this research work is to make a concrete by partially replacing cement and coarse aggregate with animal bone powder and sea shell made.

Study may be done for higher grades of concrete because of their properties.

II. METHODOLOGY

A. Materials Collection and Properties

1) Cement

The manufacturing process of PPC Cement is done by burning calcareous and argillaceous materials by partial fusion at a very high temperature of about 1450°C. The Portland Pozzolana Cement (PPC) been used in this investigational study . Ultratech PPC Cement and it was conforming to IS:1489-199155

Here, in this project PPC is used because it makes concrete more impermeable, denser, as compared to OPC. The strength for long term is more in PPC compared to OPC.

2) Physical Properties

Sr.no	Test Conducted	Results Obtained	Requirement as per IS
1	Specific Gravity	3.15	-
2	Normal Consistency	32%	-
3	Setting Time	initial 30 final 600	Min 30 Max 600
4	Fineness(kg/m3)	332	300
5	Soundness(mm) Le-chatelier test	10	10.0mm max

Table 2.1.1: physical properties of PPC cement

3) Chemical Composition Properties of PPC

S. NO	Characteristic	Required value
1	Total loss on ignition (%by mass)	Not more than 5.0
2	Magnesia (% by mass)	Not more than 6.0
3	Insoluble residue (% by mass)	Not more than $\frac{x+4(1000 - x)}{100}$
4	Sulphuric anhydride %	Not more than 3.5%
5	Total chloride content %	Not more than 0.10%

Table 2.1.2: chemical properties of PPC cement

B. Coarse Aggregate

Coarse aggregate is crushed rock which is available easily . The requirements follow IS 383-1970. And the test is carried conforming to IS2386 (part 1) 1963. The maximum size of C.A is 20 mm which is used and the physical properties are as follows.

1) Physical properties of Coarse Aggregate

Sr.no	Tests	Coarse aggregate (12.5mm down size)
1	Specific Gravity	2.67
2	Bulk Density Loose compacted	1360 kg/m3 1600 kg/m3
3	Fineness modulus	7.11
4	Moisture content	Nil

Table 2.2.1: Physical properties of Coarse Aggregate

2) Fine Aggregate

Fine aggregate are also available locally. we have used the natural river sand in this project work. as it fills the space between coarse aggregate and cement. River sand is known as fine aggregate and it is locally available. The river sand cleaned and washed and screened at site to remove waste

materials and tested as per the procedure given in IS: 2386-1963 and the test results fill the requirement of IS 383-1970.

IS sieve size	Percentage passing	Requirements for Zone 2 as per IS 383-1970	Remark
10mm	100	100	Samples of sand satisfy grading requirements for zone Fineness modulus 3.75 Specific Gravity = 2.63 Bulk density Loose = 1450kg/m3 Compacted = 1710kg/m3 Moisture content = nil
4.75mm	99.1	90-100	
2.36mm	94.3	75-100	
1.18mm	81.0	55-90	requirements for zone Fineness modulus 3.75 Specific Gravity = 2.63 Bulk density Loose = 1450kg/m3 Compacted = 1710kg/m3 Moisture content = nil
600	46.4	35-39	
300	4.2	8-30	
150	0.2	0-10	

Table 2.3.1: physical properties of fine aggregate

1) Physical Properties of Fine Aggregate

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150	0.2	0-10	

Table 2.3.1: physical properties of fine aggregate

D. Water

For preparation and curing of concrete potable water is used having pH value 7 as per IS 456-2000.

E. Animal Bone Powder

Animal bones are found in large quantities in abattoirs in almost every town in India. Some of these bones are disposed in landfills with inherent danger of pollution and other nuisance value. Therefore, utilizing these BP as a partial replacement of cement in concrete production will enhance national development. The cost of bone powder when compared with ordinary portland cement is lower due to availability of animal bones in large quantities as waste products. Bones can be converted to bone powders (BP) and used in concrete as an additive to enhance the mechanical and durability properties of the mix. The procedure adopted for preparation of the ABP includes; collection of cow bones 1st from slaughter houses which was used as partial replacement of cement by weight as adhesive through suppliers. We bought the bone powder from M.I. Feed industries thane, Mumbai.

1) Physical properties

The bone powder have bulk specific gravity nearing to cement .and average water absorption (less than 3 percent)

Table 3.5.1 shows typical physical properties of ABP.

Property	Value
Specific Gravity	1.95 – 1.98
Unit Weight, Kg/m ³ (lb/ft ³)	1600 – 1920 (100 – 120)
Absorption	Up to 3%
Fineness Modulus	3.81
Moisture Content	3.35

Table 2.5.1: Typical Physical Properties of ABP.

2) Chemical properties

Chemical properties of animal bone powder are studied and its chemical compositions are determined in terms of simple oxides which is calculated from elemental analysis. Following table shows the lists of compounds present in Animal bone powder

Constituent	Composition (%)
CaO	40 – 52
SiO ₂	10 – 19
FeO	10 – 40 (70-80% FeO , 20-30% Fe ₂ O ₃)
MnO	5 – 8
MgO	5 – 10
Al ₂ O ₃	1 – 3
P ₂ O ₅	0.5 – 1
S	< 0.1
Metallic Fe	0.5 - 10

3) Steel slag Aggregate

Sea shell is the waste product from coastal regions. The thought of replacing to coarse aggregate is unique concept. Because of their mechanical strength, stiffness, porosity, wear resistance and water absorption capacity using of sea

shell in construction industry is good. Following table shows the properties of sea shells.

S.no	Property	Value
1	Specific Gravity	2.63
2	Water Absorption	1.04%
3	Flakiness Index	8.0%
4	Elongation Index	4.45%
5	Impact Strength	19.0%
6	Crushing Strength	18%

Table 2.5.4.: Sea shell

III. MIX PROPORTION

Cement = 443.45kg/m³
 Water = 186kg/m³
 Coarse aggregate = 995.69kg/m³
 Fine aggregate = 786.69kg/m³
 W/C ratio = 0.42

IV. EXPERIMENTATION AND TESTS RESULTS

The main research of this experimental investigation is to study the strength related properties of concrete with the use of animal bone powder and sea shell. In this experimental study. Investigation is done by replacing natural materials by aquatic waste and animal waste product. It is found from the past researche that optimum replacement level of animal bobe powder for cement is 0 to 15% by means of weight. So, in all the mixes coarse aggregate was replaced with 10% of sea shell. The strength related properties such as compressive strength, flexural strength, tensile strength was studied. As per IS Code three specimens are to be tested for each mix and each test. The entire tests for concrete were conducted as per specifications required.

A. Test Result

1) Compressive Strength

The wooden cubes having size (150mm x 150mm) have been tested and the compressive test results are listed in the Table 4.1.1

$$Formula = \frac{P}{A^2}$$

2) Flexural Strength

The flexural strength test for beam having size (150 X 150 X 750 mm) has been carried out and the results are noted below in the Table 4.1.2.

$$Formula = \frac{P \times L}{B \times d^2}$$

3) Tensile Strength

The Split Tensile strength tests are done on cubes, and these cubes are placed on diagonal planes by applying compressive forces along two opposite edges & using formula = 0.5187 X $\frac{P}{s^2}$ results are noted in Table 4.1.3

Mix Combination	7days strength (Mpa)	28days strength (Mpa)
Control mix	20.65	30.19
ABP 5% and Sea shell 10%	20.86	30.97
ABP 10% and Sea shell 10%	21.66	32.89
ABP 15% and Sea shell 10%	21.02	31.90

Table 4.1.1 Compressive Strength



Chart 1: Bar chart of Compressive strength

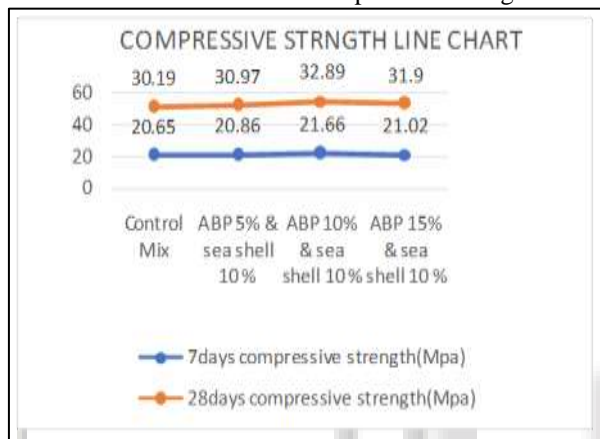


Chart 2: Line chart of Compressive strength

– Flexural strength

Mix Combination	Ultimate Load (KN)	Flexural strength at 28days strength (Mpa)
Control mix	31.10	4.16
ABP 5% and Sea Shell 10%	30.2	4.02
ABP 10% and Sea Shell 10%	31.76	4.29
ABP 15% and Sea Shell 10%	30.5	4.04

Table 4.1.2.: flexural strength

– Tensile Strength

Mix Combination	Load on Cubes which is placed Diagonal (KN)	Tensile strength at 28days strength= $0.5187 \times P \sqrt{S2}$ (Mpa)
Control mix	720.48	16.65
ABP 5% and Sea Shell 10%	739.92	16.94
ABP 10% and Sea Shell 10%	756.34	17.58
ABP 15% and Sea Shell 10%	742.62	17.09

Table 4.1.3: Tensile Strength

V. CONCLUSION

Following conclusions can be made from the experimental results obtained in this investigation

- 1) Addition of ABP and Sea shell the slump of the concrete is lower as compared to conventional concrete..
- 2) The presence of ABP in concrete fill All the voids which sometimes may remain within makes the concrete workable.
- 3) Optimum level of replacement of ABP is found as 10%. Initially the strength of concrete is increased up to 10%.
- 4) Optimum level of replacement for sea shell is found as 10%. Strength is increased due to its shape.
- 5) The combination, 10% replacement of ABP and 10% replacement of Sea shell is fixed for study and it gave compressive strength of above 30Mpa for concrete mixes M30, flexural strength and tensile strength were also found to be comparatively good.
- 6) In comparison to Conventional concrete, the strength at 28days is increased by 9.6 % by partial replacement of sea shell by 10% & animal bone powder by 10%, in concrete mix having w/c ratio 0.42 and aggregate to cement a/c ratio 4.04
- 7) The increased strength for the replacement of coarse aggregate by sea shell up to 10% is due to shape, size and surface texture of sea shell aggregates, which provide better adhesion between the mixture of concrete
- 8) From the test results obtained it may be concluded that Animal bone powder 10% and Sea shell 10 % combination is the optimum and most suitable for areas not exposed to marine conditions

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