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Experimental Investigation of Concrete in Partial Replacement of Coarse Aggregate and Cement by Sea Shell and Prosopis Juliflora Ash

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Abstract – The Concrete is heavily used as construction materials in Modern society. With the growth in urbanization and industrialization and its demand is increased day by days. In order to minimize the negative impact of concrete, the use of waste materials. Our project deals with the partial replacement of coarse aggregate and cement by sea shell and prosopis juliflora ash. The substituent to coarse aggregate and cement by sea shell and prosopis juliflora ash at level of 10%, 20% and 30% is to be studied for masteries and strength properties 100% cement concrete mix is of M25 and water cement ratio is 0.48.the strength will be tested during the period of 7 days 14 day 28 days respective. We will compare the replace concrete with the conventional concrete about the strength and durability of the concrete.

Index Terms – Cement, coarse aggregate, fine aggregate, sea shell, prosopis juliflora ash.

1. INTRODUCTION

Every year the seafood industry produces over 100 million pounds (45.3 million kg) of \ waste that is strictly from shellfish and crustaceans (Skaggs, n.d.). Much of the waste that is generated from the industry is simply sent to landfills. With landfill space diminishing quickly, ways to recycle materials are becoming more sought for. Many of the seashells like oysters and conch shells are particularly interesting for recycling within the concrete and construction industries. The chemical makeup of these shells demonstrates strength properties that will help bind and strengthen concrete when added as aggregate. This chemical makeup is specifically focused on the calcium carbonate ($CaCO_3$), which makes up 95% of the shell (Yoon, 2002). If the shell strength could be put to use instead of waste, then it would greatly diminish the seafood industries impact on the environment, while simultaneously stimulating the construction industry. Due to the physical and chemical properties of conch and oyster shells, they may be a suitable substitute for aggregates. The crushed shells would be beneficial to the waste industry along with the construction industry. When the shells get crushed they can be substituted for all different types of aggregates depending on the size of the specimen. Oyster shells are a viable option because they contain a large amount of calcium carbonate (Kakisawa, H., & Sumitomo, T., 2012). This can help improve the strength in the concrete. Also the calcium carbonate can help improve resistance against heat and chemicals. The conch shells may increase strength in the concrete due to the uniquely weaved pattern they contain. These two shells can benefit the construction industry and the environment if it is successful. The benefits to the construction industry and the environment could be groundbreaking. The concrete production industry is estimated to be at $30 billion a year (About Concrete, If the shells can save even a small amount of current materials, it would have a huge effect on the industry. Once industry leaders find an alternative like this, it would not be difficult to market it to them. The cost savings and positive environmental impact would sell the product itself. The removal of discarded seashells from the waste stream entering landfills could provide significant savings in the long run. The substitution of shells for aggregate in concrete mix proportions the potential to lower costs and make the concrete industry more environmentally sustainable.

In addition, operations associated with aggregate extraction and processing are the principal causes of environmental concerns. In light of this, in the contemporary civil engineering construction, using alternative materials in place of natural aggregate in concrete production makes concrete as sustainable and environmentally friendly construction material. Different alternative waste materials and industrial byproducts such as fly ash, bottom ash, recycled aggregates, foundry sand, china clay sand, crumb rubber, glass were replaced with natural aggregate and investigated properties of the concretes. The basic constituents of concrete are cement, water and aggregate (and selected additives). Cement is produced by heating limestone and clay to very high temperatures in a rotating kiln. Cement is produced by grinding the resulting clinker to a fine powder. Water reacts chemically with cement to form the cement paste, which essentially acts as the "glue" (or binder) holding the aggregate together. The reaction is an exothermic hydration reaction. The water cement ratio is an important variable that needs to be "optimized". High ratios produce relatively porous concrete of low strength, whereas too low a ratio will tend to make the mix unworkable.

In the recent years, growing consciousness about global environment and increasing energy security has led to increasing demand for renewable energy resources and to diversify current methods of energy production. Among these resources, biomass (forestry and agricultural wastes) is a promising source of renewable energy. In the current trends of energy production, power plants which run from biomass have low operational cost and have continuous supply of renewable fuel. It is considered that these energy resources will be the CO2 neutral energy resource when the consumption rate of the fuel is lower than the growth rate. Also, the usage of wastes generated from the biomass industries (sawdust, woodchips, wood bark, saw mill scraps and hard chips) as fuel offer a way for their safe and efficient disposal. Wood wastes are commonly preferred as fuels over other herbaceous and agricultural wastes as their incineration produces comparably less fly ash and other residual material. A major problem arising from the usage of forest and timber waste product as fuel is related to the ash produced in significant amount after the combustion of such wastes. It is commonly observed that the hard wood produces more ash than softwood and the bark and leaves generally produce more ash as compared to the inner part of the trees. The characteristics of the ash depend upon biomass characteristics (herbaceous material, wood or bark), combustion technology (fixed bed or fluidized bed) and the location where ash is collected. As wood ash primarily consists of fine particulate matter which can easily get air borne by winds, it is a potential hazard as it may cause respiratory health problems to the dwellers near the dump site or can cause groundwater contamination by leaching toxic elements in the water.

2. LITERATURE COLLECTION

1.A Partial Replacement for Coarse Aggregate by Sea Shell and Cement by Lime in Concrete P.Sasi kumar, C.Suriya kumar, P.Yuvaraj, B.Madhan kumar, Er.K.Jegan mohan.

This paper reports the exploratory study on the suitability of the cockle shells as partial replacement for in concrete. In developing countries where concrete is widely used, the high and steadily increasing cost of concrete has made construction very expensive. The high cost of conventional building materials is a major factor affecting housing delivery in world. This has necessitated research into alternative materials of construction and analyzing tensile and compressive strength characteristics of concrete produced using by sea shells as substitutes for conventional coarse aggregate with partial replacement using M20 grade concrete. The main objective is to encourage the use of these products as construction materials in low-cost building. In this research work experiments have been conducted with collection of materials required and the data required for mix design are obtained by sieve analysis and specific gravity test. Sieve analysis is carried out from various fine aggregates (FA) and coarse aggregates (CA) samples and the sample which suits the requirement is selected. Specific gravity tests are carried out for fine and coarse aggregate. 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 In this project we tried to replace the cement and coarse aggregate partially by lime and 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. So we conclude that the cement and coarse aggregate replaced with lime and sea shell at 10% in concrete is suitable for construction. Moreover it reduces the construction cost by reducing the cost of cement and coarse aggregate and it also reduces the environmental pollution due to lime and sea shell.

2. Swaptik Chowdhury, Mihir Mishra, Om Suganya, The incorporation of wood waste ash as a partial cement replacement material for making structural grade concrete.

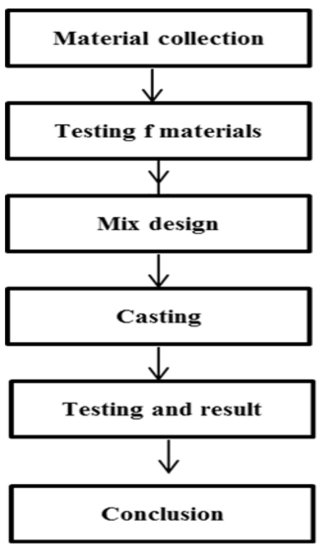
With increasing industrialization, the industrial byproducts (wastes) are being accumu- lated to a large extent, leading to environmental and economic concerns related to their disposal (land filling). Wood ash is the residue produced from the incineration of wood and its products (chips, saw dust, bark) for power generation or other uses. Cement is an energy extensive industrial commodity and leads to the emission of a vast amount of greenhouse gases, forcing researchers to look for an alternative, such as a sustainable building practice. This paper presents an overview of the work and studies done on the incorporation of wood ash as partial replacement of cement in concrete from the year 1991 to 2012. The aspects of wood ash such as its physical, chemical, min- eralogical and elemental characteristics as well as the influence of wood ash on properties such as workability, water absorption, compressive strength, flexural rigidity test, split tensile test, bulk density, chloride permeability, freeze thaw and acid resistance of concrete have been discussed in detail.

3.K .Naveen, D .Naresh, Ch.Chandrasekhar, Evaluation Of Wood Ash As Partially Replacement To Cement Etavenimadhavi.

The objective of this research work is to reduce the cost of the construction. Now a days the industrial wastes are rapidly increasing. To utilize such materials and to reduce such type of waste in environment. The cement is replaced by the wood ash. Wood ash limited to the grain size of less than 90 micrometer is added to cement by weight percentage of 0%, 5%, 10%, 15%, 20%, 25% and 30% by the method of replacement by weight.

The samples were hydrated at different time intervals ranging from one hour to 4 weeks. From this research the results are 6 much better as compared to ordinary Portland cement. The wood ash exhibits an appreciable amount of pozzolanic properties. The water requirement increases with the increase with WA addition. In between 10%- 20% wood ash sample shows higher degree of hydration and compressive strength than conventional concrete. The optimum replacement percentage of wood ash is therefore in between 10%-20% for construction industry.

3. METHODOLOGY



4. MATERIALS

The material used for this experimental work are cement, fine aggregate, coarse aggregate, water, sea shell and prosopis juliflora ash.

4.1 Cement:

Cement is a binder that sets and hardens and can bind other materials together. Ordinary Portland Cement (OPC) 53 grade is used. Cement is a binder that sets and hardens and can bind other materials together. A powdery substance made by claiming lime and clay, mixed with water to form mortar or mixed with sand, gravel and water to make concrete

4.2 Fine aggregate:

Aggregate which passed through 4.75 mm IS sieve and retained on 75 micron IS sieve is termed as fine aggregate. The specific gravity of fine aggregate was 2.6.

4.3 Coarse aggregate:

Angular shape aggregate which passes through 20 mm sieve and retain on 10mm are used as coarse aggregate in this project work. The specific gravity of coarse aggregate was 2.64 and fineness modulus of 7 was found out12.5mm.

4.4 Prosopis juliflora ash:

Prosopisjuliflora ash is the residue powder left after the combustion of wood, such as burning wood in a home fireplace or an industrial power plant. ProsopisJuliflora Ash from the biomass power plant unit in the state of Tamilnadu, India was selected to evaluate its suitability as ash for OPC replacement. The Wood Ash (WA) was obtained from open field burning with average temperature being 700C. The material was dried and carefully homogenized. An adequate wood ash particle size was obtained by mixing wood ash and cement together for a fixed amount of time.

4.5 Seashell

Seashell is a waste obtained near the seashore area as the result of disintegration of dead animals. Seashell consists of three layers outer, intermediate and inner layer .Outer layer is made up of calcite material whereas inner layer is otherwise known as nacre which is made up of calcium carbonate. Since 95% of calcium carbonate present in seashell, it has the strength nearly equal to coarse aggregate. The sieve analysis for seashell is executed to find out its size. The analysis is done with 500 grams of seashell bymanual sieve shaker for about 15 minutes with the sieve dishes are arranged from 40mm to 1.18 mm

OXIDE	PERCENTAGE
Sio2	1.60
Al2o3	0.92
Cao	51.56
Mgo	1.43
Na2o	0.08
K20	0.06
H2o	0.31
Loi	41.84

Table 1 Chemical Composition of Sea shell

5. PROPERTIES OF MATERIALS

5.1GENERAL

The materials that are used such as cement, fine aggregate, coarse aggregate. This property of materials is very useful in calculating the mix ratio.

5.2 SPECIFIC GRAVITY OF COARSE AGGREGATE

The container is dried thoroughly and it's weight W_1 grams. Take 200grams of the coarse aggregate and it's weighed again with container W_2gams. The sufficient water is added to cover the coarse aggregate half full and is screwed on the top. It is shaking well and stirred thoroughly with the glass rod to remove to entrapped air.

After the air has been removed container is completely filled with water up to mark. The outside of the container is completely filled with up to mark is dried with a cloth and weighted W_3grams.The container is cleaned thoroughly. The container is completely filled with water up to top. The outside of the container is a dried with a clean cloth and it is weighted W_4grams.

5.3 SPECIFIC GRAVITY OF FINE AGGREGATE

The pycnometer is dried thoroughly and taken it's weighed as W_1gram.Take one third part of sand in pycnometer, weighed it as W_2gram.The pycnometer is filled with water up to the top. Then it's shaking well and stirred thoroughly with the glass rod to remove the entrapped air. After the air has been removed, the pycnometer completely filled with water up to the mark. Then outside of the pycnometer is dried with a clean cloth and it's weighed as W_3grams.The pycnometer is cleaned thoroughly. The pycnometrer is completely filled with water up to top. Then outside of the pycnometer is dried with a clean cloth and it's weighed as W_4gram.

5.4 SPECIFIC GRAVITY OF CEMENT

The Flask should be free from the liquid that means it should be fully dry. Weight the empty flask(W1).Fill the cement on the bottle up to half of the flask (about 50gm) and weight with its stopper (W2). Add Kerosene to the cement up to the top of the bottle. Mix well to remove the air bubbles in it.Weight the flask with cement and kerosene(W3). Empty the flask. Fill the bottle with kerosene up to the top and weigh the flask(W4).

5.5 Water Absorption Test

This test is performed in order to determine the water absorption capacity of the aggregates used. Here about 300 grams of the various aggregates are taken separately and immersed in water for about 24 hours. These aggregates are then kept in oven at a temperature of 100 to 110 C° for a time period of 6 hours and then sample is weighted. The change in weight is noted. As per code the limiting value for the water absorption is 2%. The results of the aggregates tested are 1% for sand, 0.5% for 20mm aggregates and 0% for seashell

TEST	VALUES
Specific gravity of coarse aggregate	**2.67**
Specific gravity of fine aggregate	**2.51**
Specific gravity of cement	**2.91**
Specific gravity of sea shell	**2.50**
Specific gravity of prosopis juliflora ash	**2.48**
Water absorption for coarse aggregate	**0.5%**
Water absorption for fine aggregate	**1%**
Initial setting time for cement	**27 min**
Final setting time for cement	**535 min**

Table 2 Test values

5.6 SLUMP CONE TEST

Clean the internal surface of the mould and apply oil. Place the mould on a smooth horizontal non- porous base plate. Fill the mould with the prepared concrete mix in 4 approximately equal layers. Tamp each layer with 25 strokes of the rounded end of the tamping rod in a uniform manner over the cross section of the mould. For the subsequent layers, the tamping should penetrate into the underlying layer. Remove the excess concrete and level the surface with a trowel. Clean away the mortar or water leaked out between the mould and the base plate. Raise the mould from the concrete immediately and slowly in vertical direction. Measure the slump as the difference between the height of the mould and that of height point of the specimen being tested.

5.7 COMPRESSIVE STRENGTH OF CONCRETE CUBES

For compressive strength test, cube specimens of dimensions 150 x 150 x 150 mm were cast for M20 grade of concrete. Vibration was given to the moulds using table vibrator. The top surface of the specimen was levelled and finished. After 24 hours the specimens were demoulded and were transferred to curing tank wherein they were allowed to cure for 7 and 28days

5.8 SPILT TENSILE STRENGTH OF CONCRETE CYLINDERS

For Split tensile strength test, cylinder specimens of dimension 150 mm diameter and 300 mm length were cast. The split tensile strength of concrete is determined by casting cylinder of size 150mmx300mm.the cylinders were tested by placing them uniformly. Specimens were taken out form curing taken at age of 28 days of moist curing and tested after surface water dipped down form specimens. This test was performed on universal testing machine (UTM).

The magnitude of tensile stress (T) acting uniformly to the line of action of applied loading is given by formula.

$T_{sp} = 2P/\Pi dl$

S.NO	%REPLACEMENT OF SEA SHELL AND PROSOPIS JULIFLORA ASH	7 DAYS (N/mm2)	14 DAY (N/mm2)	28 DAY (N/mm2)
1	conventional	16	21.33	23.11
2	10%	16.59	20.44	23.55
3	20%	19.25	23.22	29.62
4	30%	17.32	21.47	25.92

Table 3 COMPERSION STRENGTH

Fig 1. COMPERSION TESTING FOR CUBE

S.NO	%REPLACEMENT OF SEA SHELL AND PROSOPIS JULIFLORA ASH	7 DAY (N/mm2)	28 DAYS (N/mm2))
1	conventional	1.723	2.234
2	**10%**	1.785	2.275
3	**20%**	1.900	2.455
4	**30%**	1.755	2.256

Table 4. .SPLIT TENSILE TEST

Fig 2.SPLIT TENSILE TEST FOR CYLINDER

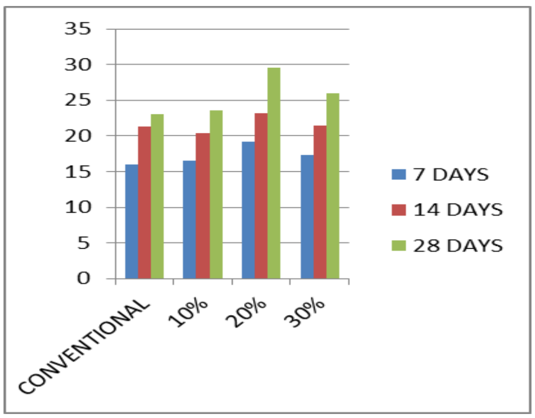
Fig 3. PROSOPIS JULIFLORA ASH

Fig 4. SEA SHELL

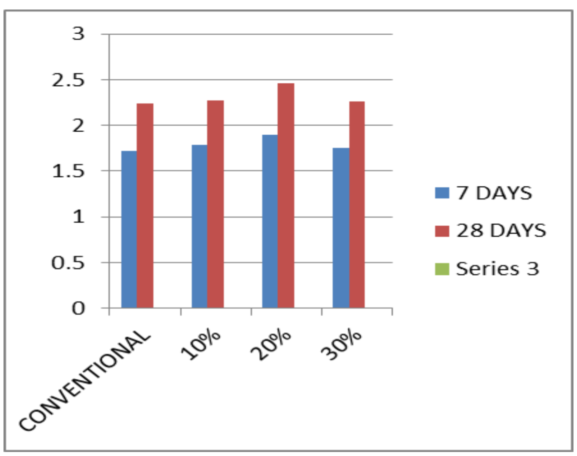
Fig 5. CUBE MOULDING

Fig 6.CYLINDER MOULD

Graph 1: COMPRESSIVE STRENGTH



Graph: 2 SPILT TENSILE STRENGTH



6. RESULT AND DISCUSSION

The above chart shows that compressive and tensile strength of concrete at 7 days and 14 days decreases gradually as the percentage of replacement increases. However, replacement by 10% and 20% is found to be more than the conventional concrete and 30% replacement is found much slightly lower than expected.

7. CONCLUSION

In this project we tried to replace the cement and coarse aggregate partially by prosopis juliflora ash and seashell (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 seashell. So we conclude that the cement and coarse aggregate replaced with prosopis juliflora ash and sea shell at 20% in concrete is suitable for construction. Moreover it reduces the construction cost by reducing the cost of cement and coarse aggregate and it also reduces the environmental pollution due to prosopis juliflora ash and seashell.

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