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EXPERIMENTAL STUDYUSES OF COCONUT SHELL AND PASTIC WASTE AS A PARTIAL REPLACEMANT OF COARSE AGGREGATE

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ABSTRACT:

Global warming and environmental destruction has become the major issue in the recent years. Use of more and more environmental friendly materials in any industry in general and construction study in particular, is of paramount importance. As well as the high cost of conventional building materials is the major factor affecting housing delivery in India. This has necessitated research into alternative materials of Construction. Our present project intends to explore the most effective use of waste product such as plastic waste (HDPE), coconut shell and coconut fibre as a constituent of concrete mix replacing the coarse aggregate partially. The main objective is to encourage the use of these waste products as construction materials in low cost housing. In this study, M20 grade of concrete was used and 28 cubes were casted as well as their compressive strength and workability was evaluated at 7, 14 and 28 days. The compressive strength of concrete was reduced and increased as the percentage replacement was varied. The result showed that this concrete can be used in reinforced concrete construction. Its utilization is cost effective and eco-friendly.

Keywords- Cement, Sand, Aggregate, Coconut shell, Coconut fiber, plastic waste.

INTRODUCTION

Concrete is the widely used number one structural material in the world today. The demand to make this material lighter has been the subject of study that has challenged scientists and engineers alike. The challenge in making a lightweight concrete is decreasing the density while maintaining strength and without adversely affecting cost. Introducing new aggregates into the mix design is a common way to lower a concrete's density. Normal concrete contains four components, cement, crushed stone, river sand and water. The crushed stone and sand are the components that are usually replaced with lightweight aggregates. Lightweight concrete is typically made by incorporating natural or synthetic lightweight aggregates or by entraining air into a concrete mixture. Some of the lightweight aggregates used for lightweight concrete productions are pumice, perlite, expanded clay or vermiculite, coal slag, sintered fly ash, rice husk, straw, sawdust, cork granules, wheat husk, oil palm shell and coconut shell.

The high cost of conventional building materials is a major factor affecting housing delivery in India. In developing countries where abundant agricultural and industrial wastes are discharged, these wastes can be used as potential material or replacement material in the construction industry. This will have the double advantage of

reduction inthe cost of construction material and also as a means of disposal of wastes. It is at this time the above approach is logical, worthy and attributable.

OBJECTIVES:

1. To use the waste material effectively so that it may not harm the environment.
2. To reduce the construction cost and make it more economical.
3. To reduce the structural dead load.
4. To focus on the rural area development.
5. To know the strength variation of and study their property.
6. To find compressive strength, and flexure test after 7days 14 days, and 28 days, and check as per I.S code.

EXPERIMENTAL STUDY

Material and Methods:

1. **Cement:**

Depending upon the strength of the cement at 28 days when tested as per IS 4031-1988. Cement is classified as

a) 33 grade cement
b) 43 grade cement
c) 53 grade cement

Types of cement

- Ordinary Portland Cement
  i) Ordinary Portland Cement 33 Grade
  ii) Ordinary Portland Cement 43 Grade
  iii) Ordinary Portland Cement 53 Grade

If 28 days strength is not less than 33N/mm^2, it is called 33 grade of cement, if the strength is not less than 43N/mm2, it is called 43 grade of cement, and if the strength is not less than 53 N/mm2, it is called 53 grade of cement. But actual strength obtained by these cements at the factory is much higher than the BIS specifications.Although all materials that go into concrete mix are essential, cement is very often the most important because it is usually the delicate link in the chain. It constitutes only about 20 of the total volume of concrete mix; it is the active portion of binding medium and is the only scientifically controlled ingredient of concrete. Portland cement referred as (Ordinary Portland Cement) is the most important type of cement and is a fine powder produced by grinding Portland cement clinker. The OPC is classified into three grades, namely 33 Grade, 43 Grade, 53 Grade depending upon the strength of 28 days.

The cement as determined from various tests conforming to Indian Standard IS: 8112:1989 are listed in Table 1. Cement was carefully stored to prevent deterioration in its properties due to contact with the moisture. The various tests conducted on cement are initial and final setting time, specific gravity, fineness and compressive strength.

Table No-1. Chemical Composition of O.P.C Cement

S. No.	Characteristics	Values obtained experimentally	Values specified by IS
1	Specific gravity	3.156	3.15
2.	Standard consistency(%)	33	30
3.	Initial setting time	105(minutes)	30(Minutes)
4.	Final setting time	430(minutes)	600(Minutes)
5.	Compressive strength 3 days 7 days 28 days.	 25.2 N/mm 2 37.9 N/mm 2 47.8 N/mm	 23 N/mm2 (Min.) 33 N/mm2 (Min) 43N/mm2 (Min)

2. Sand

The aggregates most of which pass through 4.75 mm IS sieve are termed as fine aggregates. The fine aggregate may be of following types:

1. Natural sand, i.e. fine aggregate resulting from natural disintegration of rocks.
2. Crushed stone sand, i.e. fine aggregate produced by crushing hard stone.
3. Crushed gravel sand, i.e. fine aggregate produced by crushing natural gravel.

According to size, the fine aggregate may be described as coarse, medium and fine sands. Depending upon the particle size distribution IS: 383-1970 has divided the fine aggregate into four grading zones (Grade I to IV). The grading zones become progressively finer from grading zone I to IV. In this experimental program, fine aggregate was locally procured and conformed to Indian Standard Specifications IS: 383-1970. The sand was sieved through 4.75 mm sieve to remove any particles greater than 4.75 mm and conforming to grading zone II. It was coarse sand light brown in color. Sieve analysis and physical properties of fine aggregate are tested as per IS:383-1970 and results are shown in Table 2.

Table 2: Properties of fine aggregate

S.No.	Characteristics	Value
1.	Specific gravity	2.34
2.	Bulk density(kg/m3)	1.3
3.	Fineness modulus	2.62
4.	Water absorption	0.88

3. Aggregate

The aggregate which is retained over IS Sieve 4.75 mm is termed as coarse aggregate. The coarse aggregates may be of following types:-

1. Crushed graves or stone obtained by crushing of gravel or hard stone.
2. Uncrushed gravel or stone resulting from the natural disintegration of rock
3. Partially crushed gravel obtained as product of blending of above two types.

The normal maximum size is gradually 10-20 mm; however particle sizes up to 40 mm or more have been used in Self Compacting Concrete. Locally available coarse aggregate having the maximum size of 20 mm was used in this work. The aggregates were washed to remove dust and dirt and were dried to surface dry condition. The aggregates were tested as per IS: 383-1970. Specific gravity and other properties of coarse aggregates are given in Table 2. The sieve analysis of coarse aggregate was done. Table 2 the result of sieve analysis. Proportioning of coarse aggregates was done and fineness modulus was obtained.

Table 3: Properties of coarse aggregate

S. No.	Characteristics	Value
1.	Colour	Grey
2.	Size	20mm
3.	Shape	Angular
4.	Specific gravity	2.74

4. COCONUT SHELL:

- Coconut shell is the strongest part covered in coconut fruit. Coconut shell is located in between the coconut flesh and coconut husk.
- Coconut shell has high strength and modulus properties.
- It has added advantage of high lignin content. High lignin content makes the composite more weather resistance.
- Coconut being naturally available in nature and since its shells are non-biodegradable; they can be used readily in concrete which may fulfil almost all the qualities of the original form of concrete.
- It is suitable as low strength giving lightweight aggregate when used to replace common coarse aggregate in concrete production.
- It exhibits more resistance against crushing, impact and abrasion, compared to crushed granite aggregate.
- Addition of coconut shell decreases workability.

The amount of cement content may be more when coconut shell are used as an aggregate in the production of concrete compared to conventional aggregate concrete.

- **Length of coconut fibre:** Generally, the natural lengths of coconut fibres are from 60-230 mm. The lengths of fibres were measured using steel ruler and 30 pieces were randomly chosen to find out the length of coconut fibre. However, in this study chopped coconut fibres used with size of 15-35 mm.
- **Diameter of coconut fibre:** To determine the diameter of coconut fibre, micrometer was used with precision of 0.01 mm. It has been observed that diameter of coconut fibre is from 0.17-0.24 mm.
- **Natural humidity of coconut fibre:** To determine the natural humidity, fibres were at first open air-dried for 5 days and then the same fibres were dried in an oven at 80°C for 5 h. The weights of fibres were measured using electronic bench scale with a precision of 0.01 g. The natural humidity "H" was calculated using equation given below and found the natural humidity of coconut fibre is 12.2%. It can be seen that humidity percentages are nearly similar for different types of coconut fibre samples:

$$H = [(Wd–Wo)/Wo] \times 100$$

where,

W_d and W_O are the weight of air-dried and oven dried fibres, respectively.

5. PLASTIC WASTE:

- According to the report of "The Economic Times" There is a bit of plastic everywhere, in our wallets, on our dining tables and kitchens, in our cars and buses and in our phones and offices. It is nearly impossible to imagine a world without plastics. From its beginning in 1950, global plastic production has increased dramatically from 2 million tonnes to 380 million tonnes in 2015. Its sheer convenience -- lightweight and durable – has made this man-made material ubiquitous in every sphere of human existence. In the last 70 years, 8.3 billion.
- It is light, strong material that is made with chemicals and is used for making many different sorts of objects.
- We almost always take the suffocation warning on plastic bags and packages seriously, keeping plastic packaging out of reach of babies and children. But we have not been as mindful with the planet. Of the 8.3 billion tonnes of plastic produced, 6.3 billion tonnes have been discarded. Every year, nearly 13 million tonnes of plastic waste are added to oceans. Given their durability, plastics do not decompose.
- An estimate by the Ministry of Petroleum and Natural gas suggests that the annual per capita consumption in India would be 20 kgs by 2022.
- Only 60% of the total plastic waste is being recycled.
- As per CPCB reports, plastic contributes to 8% of the total solid waste, with Delhi producing the maximum quantity followed by Kolkata and Ahmedabad.
- Households generate maximum plastic waste, of which water and soft drink bottles form a large number.
- In India, around 43% of manufactured plastics are used for packaging purpose and most are of single use.
- CPCB has estimated the collection efficiency as 80.28% in 2014, out of which only 28.4% was treated. Remaining quantities were disposed in landfills or open dumps.

Physical properties of plastics:-

Specific Gravity	1.04
Density	0.945 to 0.962
Melting Point	75 – 100 degree Celsius
Softening Point	110 degree Celsius
Elongation to Break %	> 500
Fineness	< 2.36 mm

WATER

Water fit for drinking is generally considered fit for making concrete. Water should be free from acids oils, alkalis, vegetables or other organic impurities. Soft water are also produce weaker concrete. Water has two functions in a concrete mix. Firstly, it reacts with chemically with the cement to a cement paste in which the aggregates re held in suspension until the cement paste has hardened.

SPECIMEN PREPARATION

1. Grade of concrete to prepared is **M20** {1: 1.5: 3}.

i.e., 1 ratio of cement, 1.5 ratio of sand, 3 ratio of aggregrate.

2. The partial replacement of aggregate in two ratio's
   - 2.1 First ratio is coarse aggregate is replaced with 10% of coconut shell, 5% of plastic waste.
   - 2.2 While in the second case coarse aggregate is partially replaced with 8% of coconut shell, 4% of plastic waste.

3. Now preparation of specimen should be done in following steps:-
   - 3.1 Collection of coconut waste from different sources such as municipality, temples, etc.
   - 3.2 Collection of plastic waste from different sources such as curbside, drop-off, buy-back
   - 3.3 Collection of materials such as cement (OPC 43 grade), sand, aggregate (10-20mm).
   - 3.4 Water-cement ratio is 0.4-0.45 (as per IS code).
   - 3.5 10% of coconut shell and 0.5% of coconut fibre is replaced as coarse aggregate by weight.
   - 3.6 5% of plastic waste is replaced as coarse aggregate by weight
   - 3.7 Mixing process is done and then casting is done in the mould
   - 3.8 Workability check is also done after the mixing process
   - 3.9 Demoulding is done after 24 hours and then curing is done
   - 3.10 Compressive strength test is then performed after 7, 14 and 28 days respectively.
4. Similar procedure should be followed for the second ratio i.e. 8% of coconut shell and 4% of plastic waste

RESULT ANALYSIS

1. SLUMP TEST

Slump test is used to determine the workability of fresh concrete. Due to a huge slump may obtain if there is any disturbance in the process. It also mentioned that a slump more than 225mm will indicate a very runny concrete. Theapparatus& equipment used for the slump test & the procedure of the test according to IS7320-1974.

2. COMPRESSIVE TEST

According to IS: 509-1959, the testing for the specimens should be carried out as soon as possible after taking out from the curing tank. The specimen needs to get measurement before testing. The length and height of specimen is measured and recorded. The axis of specimen is aligned with the centre of thrust of the seated plate. Plate is lowered until the uniform bearing is obtained. The force is applied and increased continuously at a rate equivalent to 20MPa compressive stresses per minute until the specimen failed. Record them maximum force from the testing machine.

COMPRESSIVE STRENGTH (M20 GRADE CONCRETE)

S.no.	Mix percentage	7 Days	14 Days	28 Days
1.	Conventional Concrete	13.5 N/mm^2	18 N/mm^2	20 N/mm^2
2.	@ Coconut Shell- 10% & Plastic Waste – 5%	11.5 N/mm^2	17.5 N/mm^2	19 N/mm^2
3.	@ Coconut Shell- 8% & Plastic Waste – 4%	12.5 N/mm^2	18.5 N/mm^2	22 N/mm^2

3. FLEXURAL TEST

The beam mould of size 100X15X10 cm (when size of aggregate is less than 40mm). The specimen shall be supported on 38mm diameter roller with 1000mm span for150mm size specimen. The load shall be applied through two similar rollers mounted at the two points of the supporting span that is spaced at 40mm. The load is applied without shock at a rate of 4KN/minute for 150mm specimen. The load shall be increased until the specimen fails and the maximum load applied to the specimen during the test. The flexural test was performed on beams on universal testing machine according to IS: 516-1959. The failure load to each beam was noted for finding flexural strength.

Flexural strength of beam can be calculated by following Formula,

$$F_b = PL / bd^2$$

Where,

P = Maximum load in kN applied to the specimen

L = length of the specimen in mm

d = depth measured in cm of the specimen at the point of failure

b = measured width of the specimen in mm

COST ANALYSIS

* Cost analysis is done on the basis of DSR.

S.No.	Particulars	Quantity/no. (standard)	Rate (as per DSR)	Per	Amount (□)
1.	Cement	8 bags	285	bag	2280
2.	Sand	0.414 m^3	1200	cum	406.8
3.	Coarse aggregate	0.828 m^3	1300	cum	1076.4
	TOTAL				3853.2

Replacement of coarse aggregate (15.5%)= 0.12834 m^3

Conventional coarse aggregate= 0.69966 m^3

Rate of conventional aggregate= 0.69966X1300= □ 909.50

Total saving on coarse aggregate/m^3= □ 166.9 as per DSR

CONCLUSION

1. It reduces the dead load of the structure.
2. The compressive strengths of modified cement concrete are as equal as plain cement concrete
3. As our idea is based on the concept of utilization of waste as a construction material, therefore it will considerably reduce into the generated waste quantity.
4. It can also be used as a waste management technique.
5. Emission of CO_2 will also be reduced upto the certain extent.
6. It can also be used in the development of rural areas as coconut and plastic wastes are easily available in rural areas.
7. It will also reduce the cost of construction if concrete is produced in a huge mass.

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