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Investigation of Coconut Shell as a Replacement of Coarse Aggregate in Concrete

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Abstract - The three basic needs of man are food, clothing and shelter. Civil Engineer has relevance with all basic needs of man directly or indirectly. Cement concrete is one of the most important and relatively cheap construction material, which contain cement, coarse aggregates and fine aggregates. In developing country like India use of concrete is more which results in increasing demand as well as rates of raw material for concrete so there is need of find some alternatives to these material. now researchers has progressed a lot in developing the method of constructing shelter Now a days most of the research have focused on use of the waste material in concrete according to their properties. In this study, M 20 grade of concrete was produced by replacing by coconut shell. 8 cubes and 8 cylinders were casted and their compressive strength and tensile strength were evaluated at 28 days. The compressive strength and tensile strength of concrete reduced as the percentage replacement increased. Concrete produced by 0%, 10%, 15%, 20% replacement of coarse aggregate by coconut shell attained 28 days compressive strength and split tensile strength. The results showed that coconut shell concrete can be used in concrete construction. Its utilization is cost effective and eco-friendly.

Keywords: sand, cement, coarse aggregate and coconut shell, coarse aggregate.

1. INTRODUCTION

Concrete is widely used as construction material for various types of structures due to its durability. For a long time it was considered to be very durable material requiring a little or no maintenance. Many environmental phenomena are known significantly the durability of reinforced concrete structures. We build concrete structures in highly polluted urban and industrial areas, aggressive marine environments and many other hostile conditions where other materials of construction are found to be nondurable. Many of the non-decaying waste materials will remain in the environment for hundreds, perhaps thousands of years. The non- decaying waste materials cause a waste disposal crisis, thereby contributing to the environmental problems. However, the environmental impact can be reduced by making more sustainable use of this waste. Its aim is to reduce, reuse, or recycle waste, the latter being the preferred option of waste disposal.

1.1 COCONUT PRODUCTION IN INDIA

India ranks third on world coconut map and in recent times became the largest producer of coconut with the production of 16.9 billion nuts from acreage under plantation of about 1.89 million hectares. Even though India is among the largest producer of coconut with a distinction of having the highest productivity of 7779 nuts per hectare as against 3630 nuts per hectare in Indonesia and 3859 nuts per hectare in Philippines, the per capita annual availability of coconut estimated to have been 10 nuts only which is quite low compared to 222 of Philippines, 145 of Sri Lanka and 55 nuts of Indonesia.

1.2. Coconut Shell

The coconut shells were sun dried for 5 days before being crushed manually by using hammer. The coconut shells were crushed using hammer to a size such that it passes through a 12 mm sieve and retained on 4.75 mm sieve. Crushed shells were washed to remove fibers, mud etc. After washing, these shells were soaked in water for 24 hours and removed from water and then kept for 2 hours at room temperature before using them in preparation of concrete mix.

Fig.1 Graded coconut shell

Table -1: Physical properties of coconut shell

Sr. no.	Physical property	Test result
01.	Maximum Size (mm)	12.5
02.	Fineness modulus	6.48
03.	Specific Gravity	1.56
04.	Bulk Density(kg/m^3)	510-600
05.	Water Absorption (%)	23
06.	Aggregate Crushing Value (%)	2.49
07.	Aggregate Impact Value (%)	8.55

08.	Moisture Content (%)	4.2
09.	Shell Thickness(mm)	3-6

2. Mix Design

Concrete mix design: M 20 grade of concrete was designed by IS 10262-1982 method. The natural coarse aggregate were replaced as 0%, 10%, 15%, 20%. The test results were analyzed and compared with conventional concrete. Due to high water absorption of coconut shell, they were presoaked in water for 24 hours, prior to mixing. Batching and Mixing: weigh Batching was practiced with the help of electronic weigh balance. Batching was done as per mix proportions. Mixing was done by manually. Placing and Compaction cubes are cleaned and oiled to prevent the formation of bond between concrete and moulds. Place the fresh concrete in cubes in three layers, tamping each layer 25 times. The entrapped air in concrete is removed by table vibrator. Demoulding after placing fresh concrete in moulds, it was allowed to set for 24 hours. It was marked with some permanent identification mark. Concrete cubes are now kept in curing tank for 28 days. After 28 days, concrete cubes were removed from curing tank to conduct tests on hardened concrete

Fig. 2 Concrete mix of coconut shell concrete

3. RESULTS AND DISCUSSION

3.1 Compression test

Compressive strength is defined as resistance of concrete to axial loading. Cubes were placed in Universal Testing Machine (U.T.M), and load was applied. The readings on dial gauge were recorded and compressive strength was calculated. Compressive Strength = Maximum load/ Cross sectional area The maximum compressive strength of 31.75 N/mm2 was attained at 0% replacement, while the minimum strength of 9.75 N/mm2 at 20% less than 20 N/mm2. The strength decreased as the percentage replacement increased. As the coconut shell increased, the surface area increased, thus requiring more cement for proper bonding. Since cement content was constant, there was no extra bonding and strength reduced.

4. Durability

4.1Sulphate Attack

Sulphate are generally found in ground water and sub-soil. Sea water also contains large quantity of sulphates. Sulphate can be naturally occurring or could be as a consequence of industrial waste disposal. Calcium, sodium, magnesium and ammonium sulphates (increasing order of hazard) are harmful to concrete as they can lead to increase in the concrete volume and consequent cracking. Calcium sulphate reacts with calcium aluminate present in cement hydrates forming an expansive ettringite. Sodium sulphate reacts with calcium hydroxide and forms expansive gypsum in presence of aluminates and may in turn lead to the formation of ettringite. Magnesium sulphate reacts with cement compounds decomposing the cement itself and subsequently producing gypsum and ettringite.

Fig. 3 Cubes kept for acid attack

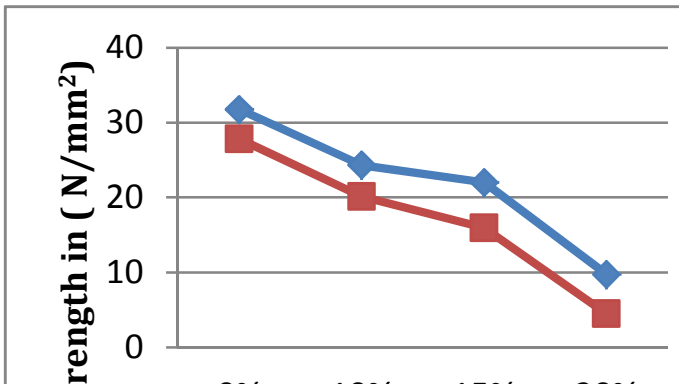

Fig. 4 Graph showing comparison for effect of sulphate attack on regular concrete and coconut shell concrete

The result obtained from compressive test after 28 days sulphate attacked. The graph shows the comparison of compressive test results of coconut shell concrete concrete after water curing and sulphate attack. From these graph and results it has been concluded that, percentage replacement of coarse aggregate by coconut shell increases then the strength difference increases between water cured cubes and sulphate attacked cubes. The 10% replacement is as same 0% replacement then the 10% replacement is suitable for sulphate attack.

4.2 Acid attack

Concrete structures are also used for storing liquids, some of which are harmful for concrete. In industrial plants, concrete floors come in contact with liquids which damage the floor. In damp conditions SO_2 and CO_2 and other acid fumes present in the atmosphere affect concrete by dissolving and removing part

of the set cement. In fact, no Portland cement is acid resistant. Concrete is also attacked by water containing free CO_2. Sewerage water also very slowly causes deterioration of concrete

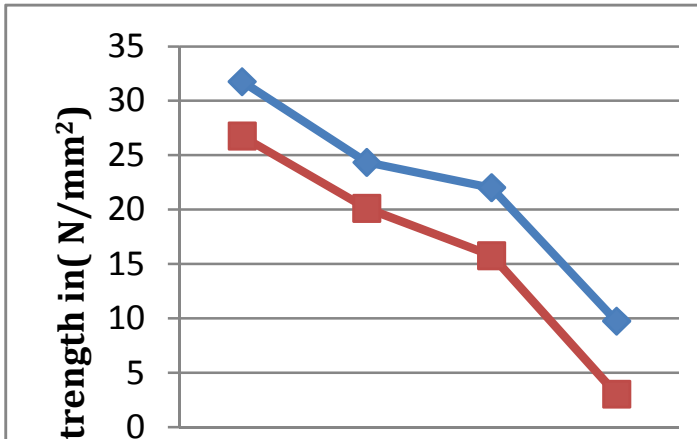

Fig. 5 Graph showing comparison for effect of acid attack on regular concrete and coconut shell concrete

The results obtained from compressive test after 28 days acid attack maintaining pH 2 to 3. The graph shoes the comparison of compressive test results of coconut shell concrete after water curing and acid curing. Brawn line indicates the strength after acid attack and blue line indicates the strength after water curing. From these result and graph it has been concluded that, percentage replacement of coarse aggregate by coconut shell increases then the strength difference increases between water cured cubes and acid attacked cubes.

5. CONCLUSIONS

The following conclusions drawn from the experimentation done for carry out the work:

A. Conventional concrete is more durable than coconut shell concrete but both concrete show similar trend in sulphate as well as acid attack.
B. Though the conventional concrete having more strength but coconut shell concrete also reaches to the characteristic strength. i.e. 20 N/mm^2
C. The percentage replacement increases with the decreasing strength of concrete, 10% replacement is optimum.

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