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An Analysis on Strength and Durability of Concrete by Partial Replacement of Cement by Endocarp Ash

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ABSTRACT: Cement is widely used in the construction field more tonnage of cement is produced every year from every factory. For manufacturing of huge cement quantities natural resources are necessary. Preserving the natural resources and high rising costs of building construction in developing countries have been sources of concern to government and private developers.

This study investigated has done on coconut endocarp. The endocarp is directly dumped in the environment and cause environmental problem. Waste can be used to produce products by using admixture or not. So that natural resources are used more efficiently and the environments are used more efficiently and the environment is protected from waste deposits. Coconut endocarp is partially decomposable when it is buried in ground and remaining portions will not be decomposed naturally even after 30 years. Hence it is decided to reuse the ash of coconut endocarp ash in concrete and study the behavior of the same.

The project deals with the replacement of cement by coconut endocarp. In my project the properties of Fine Aggregate, Coarse Aggregate and Coconut Endocarp Ash are obtained through various tests. The design mixes in various properties are different in weight percentages of coconut endocarp ash. Such as 2%, 4%, 6%, 8%, 10% were added in the cement composites in M20 concrete. Water-cement ratio is 0.55 is added into cement composites to maintain their workability.

Compressive strength test is evaluated of the concrete cubes for 7, 14, 21, 28 days of curing condition. Results of physical properties (density, moisture content, water absorption) and mechanical properties compressive strength are presented. The process is mainly preserving the natural resources and scarcity of resources and reduction in construction cost is assured.

KEYWORDS: Cement, coconut endocarp ash, fine aggregate, coarse aggregate and water.

I. INTRODUCTION

DEVELOPMENTS IN THE WORLD:

The construction industry relies heavily on conventional materials such as cement and sand for the production of concrete. Due to rising in the cost of materials has stuck the development of shelter and infrastructural facilities in developing countries. There arises the need for engineering consideration of the use of cheaper and locally available materials to meet desired need enhance self-efficiency, and lead to an overall reduction in construction cost for sustainable development.

The Coconut Palm is found in all tropical and subtropical regions 25 degrees north and south of the equator. Its distribution includes most of the world's tropical islands and coastal regions. Rarely its range extends outside the tropics, where it will flower, but fruits fail to develop normally it is originated in the coastal areas of Southeast Asia (Malaysia, Indonesia, Philippines).

ENVIRONMENTAL EFFECT ON PRODUCTION PORTLAND CEMENT

In the production of Portland cement must contain appropriate proportions of lime, silica, alumina and iron compounds. The raw materials are broken up and blended in the mixing proportions and fed into the upper end of the kiln.



The mixture passed through the kiln at controlled ratios by the slope of the kiln and then speed at which the kiln rotates. Heat produced by the combustion of powdered coal, fuel oil or gas is forced into the lower end of the kiln, producing high temperatures of around 1650 to 1900 degree C. During this process, several reactions occur which result in the formation of Portland cement clinker. The clinker is cooled and then broken up. During this operation, a small amount of gypsum is added to regulate the setting time of the cement. The production of clinker is very energy intensive and, furthermore, large amounts of CO_2 , a greenhouse gas, is emitted during the calcinations of limestone used as a source of lime, resulting in approximately 0.9 tone of CO_2 emission for every tone of Portland cement produced. The impact is significant in India with the current annual production of about 100 million tons of cement, and the consequent release of over 90 million tons of CO_2 .

COCONUT ENDOCARP

Coconut endocarp is a hard bio mass separated from coconut during the extraction of the coir fiber. Due to organic nature it should be burnt to ash, which may be used as an alternative for fly ash / ground granulated blast furnace slag (GGBS). It would be the ideal admixture for partial replacement of cement.

II. LITERATURE REVIEW

Shamsul Baharin Jamaludian., (2012) Development and properties of coconut fiber reinforced composite cement with the addition of fly ash. Effectiveness utilization of agricultural wastes and industrial wastes in the composite cement has been studied in terms of physical and mechanical properties. Twenty weight percent of fly ash and 80 weight percent of sand were added in the composite cement. Different weight percentages of coconut fiber (3, 6, 9, 12, and 15 wt. %) were added in the composition as reinforcement for cement composites. Water to cement ratio ranging from 0.55 to 0.70 was added into the cement composites accordingly to maintain their workability. Then the cement composites were cured in water for 7, 14, and 28 days. Results for physical properties (density, moisture content, and water absorption) and mechanical properties (compressive strength and modulus of rupture) are presented.

U. Johnson., (2012) utilization of oil palm kernel shell as lightweight aggregate in concrete. It is seen from the results that OPKSC has comparable mechanical properties and structural behavior to normal weight concrete (NWC). Recent investigation on the use of crushed OPKS shows that OPKSC can be produced to medium and high strength concrete. Sustainability issues combined with higher ductility and aggregate interlock characteristics of OPKSC compared to NCW has resulted in many researchers conducting further investigation on the use of OPKS as LWA.

Ishak ahmad., (2012) Effect of Chemical Treatment on Mechanical and Water-Sorption Properties Coconut Fiber-Unsaturated Polyester from Recycled PET. Surface treatment of coconut fiber caused a significant increase in the tensile properties with the optimum treatment of 0.5% silane on the 5% alkaliized coconut fiber/polyester composites. Chemical treatments on the fiber improve fiber/matrix adhesion especially for silane on alkaliized fiber treatment.

S.C. Maiti and Raj, K. Agarwal, 2009 also discussed about the use of silica fume as a partial replacement of cement to produce a high performance concrete. Silica fume (5-10% by weight of cement) is essential to produce high strength abrasion resistant concrete. This highly reactive material is a byproduct of ferrosilicon industries with fineness greater than $15000 \text{ m}^2/\text{kg}$. This material is being imported from Australia and Norway, and is available through Indian suppliers.

MATERIALS

In general, concrete is a mixture of cement, fine aggregate, coarse aggregate, coconut endocarp ash and water. To modify the properties of concrete, admixtures are added during the preparation of concrete. The mixture eventually hardens into a stone like material. Cement and water are two ingredients that chemically react, the gravel and sand give strength.

CEMENT

The natural cement is obtained by burning and crushing the stones containing clay, carbonate of lime and some amount of carbonate of magnesia. The clay content in such stone is about 20 to 40 percent. The natural cement is brown in colour and its best variety is known as Roman cement. The natural cement resembles very closely eminent hydraulic lime. It sets very quickly after addition of water. It is not as strong as artificial cement and hence it has limited use in practice.



The artificial cement is obtained by burning at a very high temperature a mixture of calcareous and argillaceous materials. The mixture of ingredients should be intimate and they should be in correct proportion. The calcined product is known as clinker. A small quantity of gypsum is added to the clinker and it is then pulverized into very fine powder which is known as the cement.

Ordinary Portland cement is referred to use in ordinary concrete construction. Zuari cement 53 grade has used this investigation as per IS codes: 12269 – 1987.

AGGREGATES

STANDARD SAND

Ennore sand grade I, grade II, and grade III is used as per the test confirmed to IS 650-1991. In figure 5 shows the materials of standard.

Standard sand grade I – 2mm passing 1mm retained (1mm-2mm) Standard sand grade II – 1mm passing – 500 micron retained (500 micron – 1mm)

Standard sand grade III – 500 microns passing – 90 microns retained (90 microns – 500 microns)

FINE AGGREGATE

The river sand obtained from Cauvery river karur. The sand is free from salt, silt, clay and organic impurities. The fine aggregates complying with the requirements of any grading zone I, II, III is suitable for concrete but the quality of concrete produced will depend upon a number of factors including the proportions. But the grading zone IV not recommended by most specifications.

When concrete of high strength and durability is required fine aggregates conforming to any one of the four grading zones, may be used. But the concrete mix should be properly designed. As the fine aggregates grading becomes progressively finer, that is from grading zones I to IV, the ratio of fine aggregate to coarse aggregate progressively reduced. The most suitable fine to coarse ratio to be used for any particular mix will, however depend upon the actual grading particle shape and surface texture of both fine and coarse aggregates.

COCONUT ENDOCARP ASH

The coconut endocarp is obtained from nearby Karur, district, and Tamilnadu. The coconut is burnt to ash by using furnace. The sample is maintained at 500⁰C to 550⁰C for 4 to 5 hours.

COARSE AGGREGATE

It is expected that our country is likely to face acute shortage of common building materials like brick, cement, coarse aggregates and etc. there is therefore an urgent need to tackle the situation by materials to tackle the situation.

The scarcity of materials and high costs are likely to hamper many construction projects and development programmers. It will therefore be necessary to lay greater emphasis on the growth of such industries which utilize local raw material resources for producing building materials at lesser costs by resorting to more scientific methods of production

The aggregate are the important constituents in concrete. They give body to the concrete, reduce shrinkage and effect economy. Earlier aggregates were considered as chemically inert materials. But now it has been recognized that some of the aggregates are chemically active and also that certain aggregates exhibit chemical bond at the interface of aggregate and paste. The mere fact that 70-80% of the volume of the compact. Their impact on various characteristics and properties of concrete is un-doubt fully considerable.



BATCHING AND MIXING OF MATERIALS

Batching of materials was done by weight. The percentage replacements of aggregates by coconut endocarp were 0%, 2%, 4%, 6%, 8% and 10%. This was done to determine the proportion that would give the most favorable result. The 0% replacement was to serve as control for other sample.

CASTING OF SAMPLES

The size of formwork adopted was 150 x 150 x 150mm. The concrete was mixed, placed and compacted in three layers. The samples were demolished after 24 hrs. and kept in a curing tank for 7, 14, 21 and 28 days as required.

TESTING OF SAMPLES

All tests were carried out at the materials testing laboratory. The cube was placed in between the teeth and the universal testing machines before the load was applied. The load was increased until fracture occurs. The fracture load was noted.

The compression test on cube was carried out with the universal testing machine. The sample was weighed before being put in the universal testing machine. The load was applied and increased until failure. The machine automatically stops when failure occurs, and then displays the load and the compression strength was evaluated. Part of the cube was cut off, shaped, measured and placed on the machine. Load was then applied until failure and the crushing load was noted. The compressive strength of each sample was determined as follows;

Compressive strength = $\frac{\text{Crushing load (N)}}{\text{Effective Area (mm}^2\text{)}}$

WATER

Water is used for mixing and curing, clean and free from injurious amounts of oils, acids, alkalis, sugar, organic materials of other substances that may be deleterious to concrete or steel. Portable water is generally considered for mixing concrete. The pH value of water 6 – 8 should be in concrete. The pH value for water shall generally not less than 6.

III. METHODS

TESTS ON FINE AGGREGATE

FINENESS MODULUS OF FINE AGGREGATE

Using the sieve analysis results, a numeral index called the Fineness Modulus (FM) is often computed. The fineness modulus is the sum of the total percentages retained than each of specified series of sieves, divided by 100. The specified sieves are 1.18 mm, 2.36 mm, 10 mm, 4.75 mm, 150 mm, 300 mm, and 600 mm. The higher the fineness modulus. The sieves of the sizes conforming to IS 460-1962 shall be used. The balance or scale shall be such that it is readable and accurate to 0.1 % by weight of the test sample.

For fine aggregate used in concrete, the fineness modulus generally ranges from 2.3 to 3.10. The test of fine and coarse aggregate, cement test is conducted in Quality Control Laboratory.

SPECIFIC GRAVITY OF FINE AGGREGATE

Specific gravity of fine aggregate is the mass of fine aggregate in air divided by the mass of an equal volume of water at temperature of 4 degree C. An aggregate with a specific gravity of 2.50 would thus be two and one half times as heavy as water.

BULK DENSITY (UNIT WEIGHT)

IS 2386 (PART 3): 1963

The bulk density of an aggregate is the mass of the aggregate divided by the volume of particles and the voids between particles.



TESTS ON COARSE AGGREGATE

FINENESS MODULUS OF COARSE AGGREGATE

The aggregate crushing value gives a relative measure of the resistance of an aggregate to crushing under a gradually applied compressive load. It is the percentage by weight of the crushed material obtained when the test aggregates are subjected to a specified load under standardized conditions, and is a numerical index of the strength of the aggregate used in road construction. Aggregate with lower crushing value indicate a lower crushed fraction under load and would give a longer service life to the road and hence a more economical performance. Weaker aggregates if used would get crushed under traffic load and produce smaller pieces not coated with binder and these would be easily displaced or loosened out resulting in loss of the surface / layer. In short the aggregates used in road construction must be strong enough to withstand crushing under roller and traffic.

The apparatus for the standard aggregate crushing test as per IS 2386 part – I consist of the following: the aggregate sample the material for the standard test consists of aggregates sized 10mm to 12.5mm. The aggregates should be in surface dry condition before testing. The aggregates may be dried by heating at 100^o - 110^o C for more than 4 hours and cooled to room temperature before testing if necessary.

Sieve the material through 12.5mm and 10 mm IS sieves. The aggregates passing through 12.5mm sieve and retained on 10mm sieve comprise the test material. Take about 3.25kg of this material. Pour the aggregates to fill about just more than 1/3rd depth of the measuring cylinder. Compact the material by giving 25 gentle blows with the rounded end of tamping rod.

SPECIFIC GRAVITY OF COARSE AGGREGATE

Specific gravity of a coarse aggregate is the mass of fine aggregate in air divided by equal volume of water at temperature of 4 degree C. Specific gravity of aggregate is useful in mix design and for calculating voids content in aggregate.

TESTS ON CEMENT

FINENESS OF CEMENT- TYPES OF CEMENT ZUARI 53 GRADE.

SIEVE TEST

Fineness of cement is carried out of check proper grading of cement. It should be checked with the sieve no.9. The fineness of cement as represented by specific surface expressed as total surface area in square centimeters per gram of water the fineness by weight should not be more than 10%.

CONSISTENCY OF STANDARD CEMENT PASTE

The Vicat apparatus with plunger conforming to IS 5513 – 1969. This method of test covers the procedure for determining the quantity of water required to produce a cement paste of standard consistency.

The standard consistency of a cement paste is defined as that consistency which will permit the Vicat plunger to a point 5 to 7 mm from the bottom of Vicat mould. Prepare a paste of weighed quantity of cement with a weighed quantity of water, taking care that the time of gauging is not less than 3 minutes, not more than 5 minutes, and the gauging shall be completed before and any sign of setting occur. The gauging time shall be counted from the time of adding water to the dry cement until commencing to fill the mould. Fill the Vicat mould with this paste, making it level with the top of the mould; shake the mould slightly to open air.

The temperature shall be while performing the above operation. Place the mould along with the base plate under the rod bearing the plunger, lower the plunger gently to touch the surface of the test block and quickly release, allowing it to sink into the paste. This operation shall be carried out immediately after filling the mould.

DETERMINATION OF INITIAL AND FINAL SETTING TIME

The initial setting time of cement is the time period available between the moment of addition of water to the cement and the commencement of initial setting of cement. The cement paste or mix must be mixed and placed in



position during this period before commencement of setting action. If the paste or mix is disturbed, reshaped or compacted after commencement of setting action, the final strength attained setting will be less.

Weight 400gm of cement places it in a glass through. Calculate the amount of water required i.e. 0.85 times of the weight of water required to produce a paste of standard consistency. Add the calculated amount of water, start the stop watch, mix thoroughly and fill up the Vicat mould completely. The surface should be smoothed off level with the top of the mould. Place the test block, confined in the mould and resting on the glass plate, under the rod fix the initial setting needle to the moveable rod. Lower the initial setting needle gently until it touches the surface of the block, and release quickly. Note the penetration of the needle. If the needle pierces completely, wait for a while and then release the needle at a fresh place, repeating at intervals till the needle fails to pierce the block for about low standard consistency of cement paste is defined as that consistency which will per meter measured from the bottom of the mould.

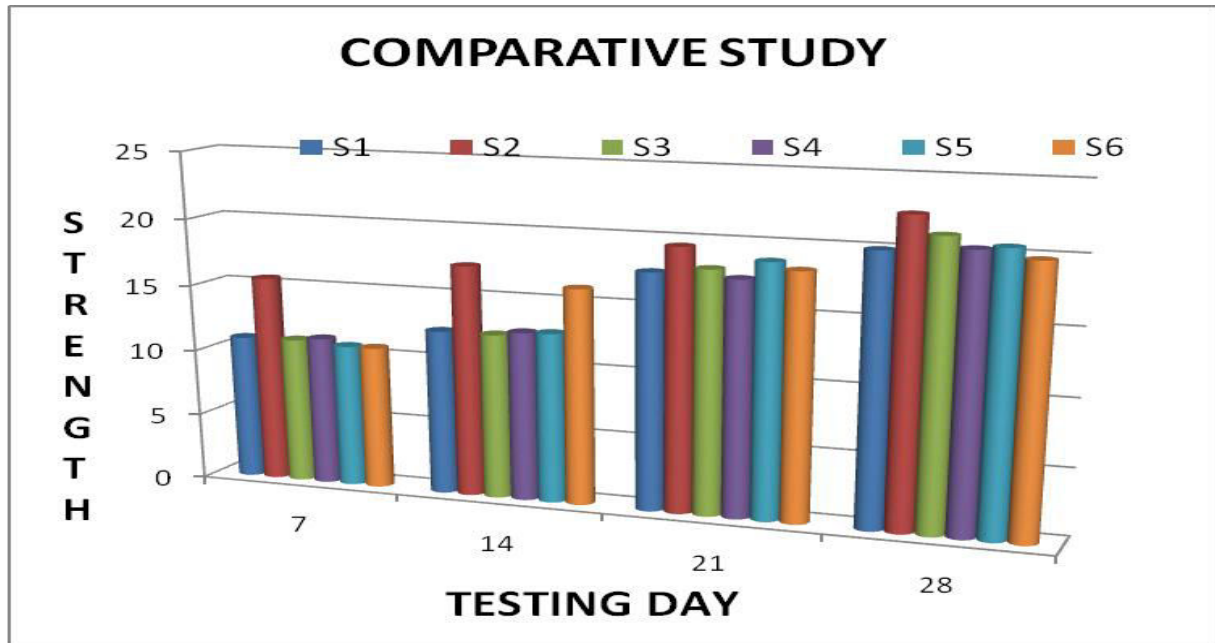
TABLE: COMPARATIVE STATEMENT SHOWING THE COMPRESSIVE STRENGTH OF MORTAR CUBE:

MIX	AVERAGE	COMPRESSIVE STRENGTH		
		14 th DAY	21 st DAY	28 th DAY
CURING	7 th DAY			
CONVENTIONAL MORTAR CUBE	10.89	12.37	17.63	20.00
CEMENT + COCONUT ENDOCARP (2+98%)	15.56	17.33	19.56	22.52
CEMENT + COCONUT ENDOCARP (4+96%)	10.96	12.37	18.07	21.19
CEMENT + COCONUT ENDOCARP (6+94%)	11.19	12.67	17.48	20.37
CEMENT + COCONUT ENDOCARP (8+92%)	10.74	12.74	18.81	20.59
CEMENT + COCONUT ENDOCARP (10+90%)	10.74	16.15	18.30	19.85

Figure 7 it has been noted that 28 days cured specimens having compressive strength of 20.00 N/mm² without coconut endocarp ash (conventional concrete). When 2% of coconut endocarp ash and 98% of cement is added then result is 22.52 N/mm² with an increase of 2.52 N/mm². When 4% of coconut endocarp ash and 96% of cement is added then result is 21.19 N/mm² with an increase of 1.19 N/mm². When 6% of coconut endocarp ash and 94% of cement is added then result is 20.37 N/mm² with an increase of 0.37 N/mm². When 8% of coconut endocarp ash and 92% of cement is added then result is 20.59 N/mm² with an increase of 0.59 N/mm². When 10% of coconut endocarp ash and 90% of cement is added then result is 19.85 N/mm² decreasing up to 0.15 N/mm².



FIG: TEST RESULTS IN CEMENT MORTAR CUBE USING COCONUT ENDOCARP ASH AND CEMENT OF COMPARATIVE RESULT



From the above fig indicators the relationship between days of curing in X axis and compressive strength in Y axis. Compressive strength of cement mortar cubes are tested on the following dates 7th, 14th, 21st and 28th days. It has noted that for comparative statements of tall results.

IV. CONCLUSION

From the research there exists a high possibility for partial replacement of cement with coconut endocarp ash in concrete. Also partial replacement of ordinary Portland cement with ash of coconut endocarp is acceptable up to 10 percentages by mass. It is one of the effective disposals of sustained solid waste and reuses the same effectively.

The cement mortar cubes is prepared in C.M 1:3 using standard Ennore sand as reference conventional mortar cube and six mix proportions of coconut endocarp ash and cement were 0%+100%, 2%+98%, 4%+96%, 6%+94%, 8%+92%, 10%+90%, by replacing as a part of cement. Water cement ratio is 0.55.

The partial replacement of ordinary Portland cement with coconut endocarp ash is well development especially in India. The cost of coconut endocarp ash is low due to availability of coconut in large quantities as agricultural farm wastes in southern parts of India. The utilization of coconut endocarp ash is will promote waste management at little cost, reduce pollution by these waste and increase the economic base of the farmer when such waste are sold there by encourages more production.

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