AN EXPERIMENTAL INVESTIGATION ON PARTIAL REPLACEMENT OF CEMENT BY RICE HUSK ASH

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***Abstract*: The scope of this project was to determine the usefulness of rice husk ash in the development of economical partial replacement of cement. The cost materials will be decreased by reducing the cement content by using waste material like rice husk ash .the work presents a study on the development of mechanical properties up to 28 days of partial replacement of cement and ordinary concrete with rice husk ash , from a rice paddy milling industry (Perambalur). Trials are conducted to assess the optimum percentages of RHA for partial replacement of fine aggregate with various percentages of RHA(0%,10%,20% ,30%,40% by weight of cement)water/ cementicious ratio from 0.35 ordinary concrete and water/powder ratio from partial replacement of cement were used to make concrete specimens 7day, 14 day, and 28 day results are compared with those of partial replacement of cement by RHA. The Fresh concrete property of passing ability, filling ability are using slump cone test .The hardened properties of partial replacement of fine aggregate (Cube, Prism ,Cylinder, Beam) are tested for Compressive strength, Split tensile strength, and Flexural strength.**

***Keywords*: material cost is reduced, development of mechanical properties**

1. INTRODUCTION

In the growing environmental consciousness at all of especially associated with concrete, and natural resources problems, sustainable development and sustainable construction throughout the global. Building are one of the maximum construction for a significant portion of the green house emission engineering approach to concrete mix design. This requires concrete durability, conservation of material, use of materials, and recycling of concrete. Waste and supplementary ,cement, RHA and metakaolin Portland cement. These materials can improves the concrete cracking in mass concrete and are less energy and CO2 by-products of the rice milling industry. During milling, broken rice and bran and rest of the 22% is received as volatile matter and the balance 25% of the weight is concerned with burning process. The usage of RHA in concrete minimize with the waste disposal problem caused by the rice milling industry is decreases the demand for cement in the construction industry production and lesser the environmental pollution caused in factories. Hence RHA not only improves the concrete provides economic and environmental benefits. The utilization production in India. This RHA as a partial replacement of cement as it contains around 85%-90% amorporous silica RHA as partial replacement of cement but very little weight of partial replacement of cement, and no work has been done in replaced cement.

1.1 CEMENT DEMAND

Cement is the main constituent of concrete. it can be defined as a material having adhesive and cohesive properties which make it capable of bonding mineral fragments into a compact mass.the main ingredient of cement production is lime stone.world consumption of cement is forecast to increase throughout the next 15 years taking the annual volume up from 2005. According to the global cement to 2021 world production and consumption of cement is high and a continuation of the annual underlying expansion which has seen year on year growth in almost ever year since the 1970 . due to increase in population and lack of incredients of cement there is a some demend in the cement manufacturing.

1.2 RICE HUSK ASH

Rice husks are the byproducts of rice paddy milling industries. For rice growing countries, rice husk have more attention due to environmental pollution and an increasing interest in conservation of energy and resources. For developing countries where rice production is abundant, the use of rice husk ash to substitute for cement is attractive because of its high reactivity. As the production rate of rice husk the amount of RHA generated yearly is about 20 million tons worldwide. In addition the properly treated ashes have been shown to be active within cement paste. RHA concrete is the special type of concrete that are produced by unusual techniques. RHA contains about 75%of organic volatile matter which burns up and balance 25% of weight husk is converted into ash during firing process, it is highly reactive in nature and obtained by combination process. It is a part of waste ashes. The land fills of waste is a problem of environmental effects because these waste ashes are not used in any work without construction. It also become eco-friendly The laboratory test has been done is compressive strength, split tensile strength, and flexural strength. . This would achieve unseemly expulsion issues. Among all dares to reuse this thing, cement, and strong gathering ventures are the one rise husk in a prevalent way Rice husk debris (RHA) fillers are gotten from rice husks, which are typically seen as agrarian waste and an environmental risk. Rice husk, when expended in outside the rice plant, yields two sorts of flotsam and jetsam that can fill in as fillers in plastics materials. The rice paddy preparing adventures give the outcome rice husk. As a result of the extending place of environmental defilement and the idea or practically factor have made utilizing rice husk. The clarifications for the use of rice husk as a possibility for concrete in strong gathering are explained in the going with zones. To have a fitting idea on the introduction of rice husk in concrete, a point by point concentrate on its properties must be finished. Around 100 million tons of rice paddy make reactions are gotten the world over. They have a low mass thickness of 90 to 150kg/m3. This results in a more vital estimation of dry volume. The rice husk itself has an unforgiving surface which is harsh in nature. These are therefore impenetrable to normal.

1.5. APPLICATIONS OF RHA

The rice husk ash is a green supplementary material that has applications in small to large scale. It can be used for water proofing. It is also used as a admixture to make the concrete resistant against chemical penetration it is mainly used in concreting the foundation, industrial factory flooring, bathroom floors etc.

1.6 REQUIREMENTS OF RICE HUSK ASH

Rice husk constitutes about 20% of weight of rice and its composition is as follows: cellulose(50%), lignin(25%-30%), silica(15%-20%), and moisture(10%-15%). Bulk density of rice husk is low and lies in the range 90-150kg/m3..... Every 100kg of husks burnt in a boiler for example will yield about 25kg of RHA.

2. LITERATURE REVIEW

Chandrasekhar et al(2003),the chemical composition of rice husk is found to vary from one sample to another due to the differences in the type of paddy, crop year, climate and geographical conditions. Here are samples of variation in chemical properties of RHA from various research works

Biu et al ,(2005),Rice husk ash (RHA) has been used as a highly reactive pozzolanic material to improve the microstructure of the interfacial transition zone (ITZ) between the cement paste and the aggregate in high- performance concrete . Rice husk ash has been reported to improve the properties of concrete or cement paste due to pozzolonic reaction and its role as a micro-filler.

kondraivendhan,(2012), It is often thought that the first function(pozzolonic reaction) is most important. The partial replacement of cement by rice husk ash in cement paste and mortar would provide micro-structure improvement, pore filling effect and better packing characteristics of the mixer

Ujene and Achuenu (2013), [Nigeria] carried out research to determine the compressive strength of across Nigeria. To ensure uniformity of the data, the research is restricted to percentage replacement of 10%, 20%, and 30% of cement with local binders using design strengths of 25 Mpa and 30Mpa at 7, 14 and 28 days curing. From the result, you can see that the maximum compressive strength was obtained at 20% replacement. Note that this research is aimed at high strength concrete, and micro-silica(MS) has been added.

Abalaka and okoli (2013), [Nigeria] carried out test on strength development and durability of concrete containing pre- soaked rice husk ash. The aim of the research was to determine the optium ordinary Portland cement (OPC) replacement with RHA resulting from the reactivity RHA on durability properties (coefficient of water absorption and sorptivity) of concrete at the age of 90 days.

Zareei et al(2017)[iran] evaluated the durability and mechanical properties of rice husk ash as a partial replacement of cement in high strength concrete containing micro silica. The research presented resulted from various ratios of rick husk ash (RHA) on concrete indicator through 5 mixture plans with proportions of 5,10,15,20 1nd 25% RHA by weight of cement in addition to 10% micro-silica(MS). This was compared with a reference mixture wait 100% Portland cement. Tesets results indicated the positive relationship between 15% replacement of RHA with increase in compressive strength and durability properties generally gain with addition up to 20%, beyond that is associated with slight decrease in strength parameters by about 4.5 %. The chemical properties of RHA used for the research is given below; strength however came at 10% partial replacement. This is in contrast with two previous results.

Bolla et al (2015), [india] carried out a research on the effect of partial replacement of cement with RHA on concrete. The cement has been replaced by rice husk ash accordingly in the range of 0%, 5%, 10%, 15% and 20% by weight of cement for mix. Concrete mixtures were in terms of compressive strengths with the conventionall concrete. These tests were carried out to evaluate the mechanical properties for the test results of 7, 14, 28 days for compressive strengths. The cement used for this test was grade 53, and cube sizes 150mm*150mm*150mm were used.

Dahiya et al (2015),[india] carried out partial replacement of grade 42.5 portland cement with 20% RHA. In their resilts, they discovered that the initial setting time increased from 30 minutes to 60 minutes. The concrete samples were cast using 150mm*150mm*150mm mould, and the target strength was M20. The compressive strength of M20 (0%RHA) concrete at 3,7 and 28 days are 14.50, 20.50 and 30.70 respectively. In the highlight of his research, water dmand increased from 0.6 to 0.8 to achieve a slump 75mm-100mm, but strength gain was almost the same at 20% replacement.

Naveen et al (2015)(india) carried out a research on the effect of RHA on compressive strength of concrete. He worked on target strengths of M30 and M60. The summary of his mix design for M30 concrete is given below; in this section, we are going to present some research works that have been carried out by various scholars on RHA.

Emmanuel and Akaangee (2015), [Nigeria] collected 4.7kg of RH and weighed it using Sartorius-2 weighing scale. 1.085kg of rice husk ash was obtained after an open burning of the rice husk in a local furnace for two hours at a temperature range of 600 degree celcius to 700 degree celcius. The finely divided ash was left to cool for 24 hrs inside the furnace. It was then grounded for four minutes to obtain a finer particles size with the aid of a disc-mill, sieved manually using a 45 micro meter sieve to ensure proper fineness of the ash.

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3. MATERIAL PROPERTY

3.1-CEMENT

Cement is a fine powder ,which when mixed with water undergoes chemical change and thereafter allowed to set and harden is capable of uniting fragments or masses of solid matter together to produce a mechanically strong material. cement is a finely pulverized material which by itself is not a binder, but develops the binding property as a result of hydration.

Raw materials used for the manufacture of cement consist mainly of lime, silica, alumina and iron oxide. These oxides interact with one another in the kiln at high temperature to form complex compounds. The relative starts proportion of these oxides composition are responsible for influencing the various properties of cement in addition to rate of cooling and fineness of grinding.

3.2 AGGREGATE

Aggregate are a granular material used in construction. the most common natural aggregates of mineral origin are sand, gravel and crushed rock. aggregates are produced from natural sources extracted from quarries and gravel pits and in some countries from sea-dredged materials. secondary aggregates are usually by- products from other industrial processes, like blast or electric furnace slags or china clay residues.According to size the aggregates are classified as:

Fine aggregate

Coarse aggregate

3.2.1 FINE AGGREGATE

It is the aggregate most of which passes 4.75mm IS sieve and contains only so much coarser as is permitted by specification. According to source fine aggregate may be according to size the fine aggregate may be described as coarse sand, medium sand and fine sand.IS specifications classify the fine aggregate into four types according to its grading as fine aggregate of grating zone-1 to grating zone-4.the four grating zones become progressively finer from grating zone-1 to grating zone-4. 90 to 100% of the fine aggregate passes 4.75mm IS sieve and 0 to 15% passes 150 micron IS sieve depending upon its grating zone.

3.2.2 COARSE AGGREGATE

It is the aggregate most of which is retained on 4.75mm IS sieve and contains only so much finer materials as is permitted by specification. According to size coarse aggregate is described as graded aggregate of its nominal size i.e. 40mm,20mm,16mm and 12,5mm etc. A coarse aggregate which has the sizes of particles mainly belonging to a single sieve size is known as single size aggregate.

3.3 RICE HUSK ASH

RHA generally refer to an agricultural by-product burning husk under controlled temperature of below 800 C. The process produces about 25% ash containing 85% to 90% amorphous silica plus about 5% alumina, which makes it highly pozzolanic. " study conducted by Mehta [14] indicated that concrete with RHA required more water for a given consistency due to its absorptive character of the cellular of the RHA particles. In an investigation rice husk ash obtained from indian paddy when reburnt at 650 C for a period of 1 hour transformed itself into an efficient pozzolanic material rich in amorphous silica content (87%) with a relatively low loss on ignition value(2.1%) [15]. There are two ways to burn rice husk ; controlled and uncontrolled methods. initially rice husk was converted into ash by open heap village burning method at a temperature, ranging from 300C to 450C [16]. When the husk was converted to ash by uncontrolled burning below 500C, the ignition was not completed and considerable amount of unburnt carbon was found in the ash [17]. RHA possibly compensate the problem of recycling huge quantity of husk waste to be land filled due to lacking of knowledge about its commercial benefits. Here, RHA locally obtained lengan located in Isfahan. Then it was burned in laboratory mill under the temperature of 600C for 5 hours.

3.4 WATER

Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, the quality and quantity of water is required to be looked into very carefully. In practice, very often great control on properties of cement and aggregate is exercise, but the control on the quality of water is often neglected. Since quality of water affects the strength, it is necessary to go into the purity and quality of water.

PRELIMINARY TEST

The preliminary test is taken for the fine aggregate, cement, coarse aggregate and also

4.1 TEST ON FINE AGGREGATE

4.1.1 Grading of fine aggregate

Soils having particles larger than 0.075 mm sieve are termed as coarse grained soils. Coarse grained soils are classified mainly by sieve analysis. The grain size distribution curve gives an idea regarding the graduation of soil whether the soil is well graded or poorly graded. In mechanical soil stabilization the main principle is to a few soils in such a proportion that a desired grains size distribution is obtained for the design mix. Hence for proportioning the selected soils, the grain size distribution of each soil should be known.

4.1.2 .Specific gravity of fine aggregate

Specific gravity of aggregate is used of in the design calculation of concrete of mixes. With the specific gravity of each constituent known its weight can be converted in to converted in to solid volume and hence a theoretical yield of concrete per unit volume can be

4.1.3 Bulk density of fine aggregate
The bulk density of an aggregate gives valuable information regarding the shape and grading of aggregate. The parameter of density is also used in concrete mix design for converting the proportion by weight into proportion by volume when batching equipment's is not available at the site.

4.2.1 SIEVE ANALYSIS OF COARSE AGGREGATE
The maximum size of aggregate is fixed based on sieve analysis. This influences the requirement of sand and water in concrete and also the spacing between the reinforcement. The sample is brought to an air dry condition before weighing and sieving condition. This is achieved by drying at room temperature. The air dry sample is weighed and sieved on the appropriate sieves starting with largest at the top. Each sieve is separately over a clean tray until not more than.

4.2.2Bulk density of coarse aggregate; The bulk density of an aggregate gives valuable information regarding the shape and grading of aggregate. The parameter of density is also used in concrete mix design for converting the proportion by weight into proportion by volume when batching equipment's is not available at the site.

Physical properties of coarse aggregate

Table NO: 1 physical properties of coarse aggregate

S .no	Characteristics	Value
1	Type	Crushed
2	Specific gravity	2.80
3	Maximum size	20mm

MIX DESIGN DEFINITION
Mix design is the process of selecting suitable incredients if concrete and determines their relative proportion with the object of certain minimum strength and durability as economically as possible.

5.1.1 OBJECTIVES OF MIX DESIGN
a. the first objective is to achieve the stipulated minimum strength.
b. the second objective is to make the concrete in the most economical manner .cost wise all concrete depend primarily on two factors , namely cost of materials and cost of labour . labour cost , by way of form works ,batching ,mixing ,transporting and curing is namely same for good concrete .There are attention is mainly directed to the cost of materials . since the cost of cement is mainly times more than the cost of there ingredients, optimum usage of cement is sought for by designing the mix .

STEP 1; MEAN STRENGTH
Fck = fck + 1.65 S
= 20+ (1.65*4)
= 26.6 N/mm2

STEP 2;CEMENT CONTENT
Cement =water content / water cement ratio
=185 kg/m3/0.45
= 411.11 kg/m3
Air content = 2 %
=1-0.02
=0.98

STEP 3;DETERMINATION OF FINE AGGREGATE
0.98 = (W+ C/SG + (1/abs vol *FA/SG)*1/1000
0.98=(185 + 411.11/3.15 + (1/0.315* FA/2.68))*1/1000
FA = 544.21 kg/m3

STEP4;DETERMINATIONOFACOARSEAGGREGATE
0.98= (W+C/SG +(1/abs vol *CA/SG))* 1/1000
0.98=(185 + 411.11/3.15 + (1/0.685 * CA/2.65) *1/1000
CA = 1202.7 kg\m3

Table 2 Mix Ratio

CEMENT	FINE AGGREGATE	COARSE AGGREGATE	WATER
411.11	544.21	1202.7	185
1	1.328	2.92	0.45

5. FRESH CONCRETE TEST
1. slump test
2. compaction factor test
3. flow table test

4. vee bee consist meter test

5.1 SLUMP CONE TEST

The internal surface of the mould is thoroughly cleaned and freed from superfluous moisture and adherence of any old set concrete before commencing the test.The mould is placed on a smooth, horizontal rigid and non-absorbent surface.The mould is then filled in four layers each approximately 14 of the height of the mould.Each layer is tamped 25times rod taking care to distribute the strokes evenly over thecross section. After the top layer has been rodded, the concrete is struck off level with a trowel and tamping rod.The mould is removed from the concrete to subside. This subside is referred as slump of concrete.The pattern of slump indicates the characteristics of concrete in addition to the slump value. If the concrete slumps evenly it is called tru slump. one half of the cone slides down,it is called shear slump. in case of shear slump, the slump value is measured as the difference in height of the mould and the average value of the subsidence. Shear slump also indicates that the concrete is non- cohesive and shows the characteristic of segregation.

5.2 TEST FOR COMPACTION FACTOR,The sample concrete to be tested is placed in the upper hopper up to the brim. The trap door is opened so that the concrete falls into the lower hopper .Then the trap- door of the lower hopper is opened and the concrete is allowed to fall in to the cylinder. In the case of a dry- mix it is likely that the concrete may not fall on opening the trap –door.In such a case, a slight poking by a rod may be required to set the concrete in motion. The excess concrete remaining above the top level of the cylinder is then ct off with the help of plane plades.The outside of the cylinder is wiped clean the concrete is filled up exactly upto the top level of the cylinder.It is weighed to the nearest 10 grams. This weight is known as “weight of partially compacted concrete’’.The cylinder is emptied and then refilled with the concrete from the same sample in layers approximately 5cm deep.the layers are heavily rammed are preferably vibrated so as to obtain full compaction. The top surface of the fully compacted concrete is then carefully struck off level with the top of the cylinder and weighed to the nearest 10 gm. This weight is known as “weight of fully compcted concrete’’

6.HARDENED CONCRETE TEST

Experiments were conducted to determine the compressive strength, split tensile strength, flexural strength and modulus of elasticity of concrete.

6.1. TESTS ON HARDENED CONCRETE

1.compressive strength
2. split tensile strength
3. flexural strength

TESTING DETAILS

S.NO	Type of test	Properties studied	Sizes of specimen
1.	Concrete strength related properties	Compressive strength	150*150*150mm in cube
2	Concrete strength	Split tensile strength	150mm diameter and 300mm height for cylinder
3	Concrete strength	Flexural strength	750*150*150mm for prism

7.2 COMPRESSIVE STRENGTH TEST

Compressive strength on concrete was done according to the IS 516:1959. Cubes of size 150*150*150 mm were cast in a mix ratio of 1:1.42:1.61 and with a water cement ratio 0.35 for reference concrete. Freshly prepared concrete was filled in the cube moulds in three demoulded after 24 hours and after these specimens were cured for 7days and 28days. The specimens were taken from the curing tank 24 hours before the test. It was allowed to dry at room temperature. Compressive strength is measured in UTM (Universal Testing Machine) i.e. maximum load at which the failure occurs is measured and the compressive strength is determined by the formula

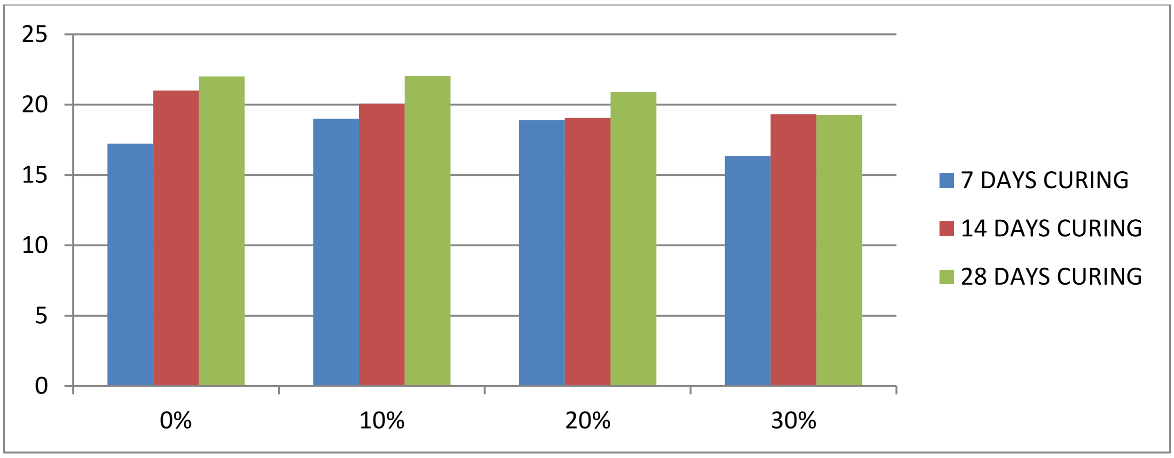

Fig 1. COMPRESSIVE STRENGTH BAR CHART

7.5 FLEXTURE STRENGTH TEST

A beam specimen should be cast for determining the flextural strength of concrete. The standard specimen sizes are 750mm*150mm*150mm. A UTM can be used for the test. The testing machine may be set to any reliable type of sufficient capacity for the test. Permissible errors should not be greater than +0.5% to _0.5%. The bed of machine should be provided with two steel rollers, of 38mm diameter, on which the specimen is supported. Rollers are placed at a centre to centre distance of 600mm for the 150mm specimen and at 400mm for the 100mm specimen.The test specimen should be cast and cured for 28 days and tested for maximum load . flexural strength or modulus of rupture (fb) should be calculated using the formula given below
Fb=(3pa)/(bd2) depth (in mm) of the specimen at the point of failure.

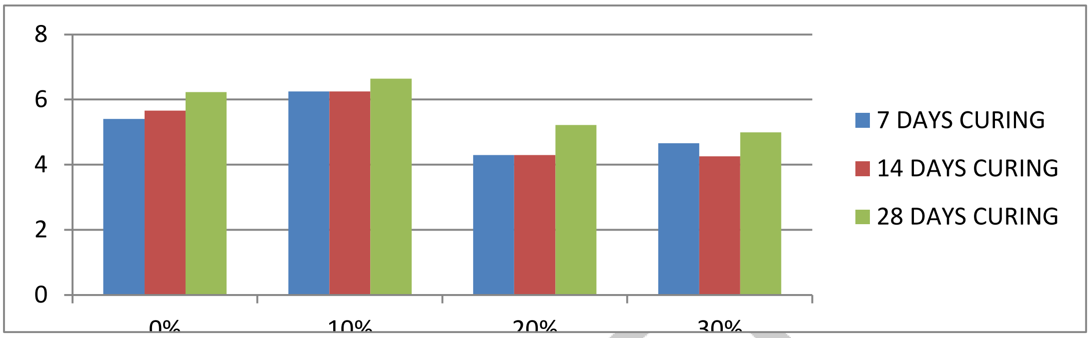

Fig 2.FLEXURAL STRENGTH BAR CHART

7.2.4 SPLIT TENSILE STRENGTH TEST

A cylindrical specimen is used in this test. This test is also is also known as split tensile test. The test specimen shall consist of concrete cylinder of daimater 150mm and 300mm height. The universal testing machine (UTM) is used for finding tensile strength of concrete. The specimens should be kept in dry condition for 24 hrs before testing. The metal strip of size 12mm*3mm is centre along the centre of the lower axis perpendicular to the loading direction.The second metal strip is then shock and increased continuously at a rate to produce approximately a split tensile stress of 14 to 21 kg/cm2/min until failure. The specimen is loaded until failure occurs and failure load is noted. Tension can be calculated using the Following formula: T=2P/3.14*Ld

Where p=concentrated time load, L=length of cylinder ,d=diameter of the cyclinde

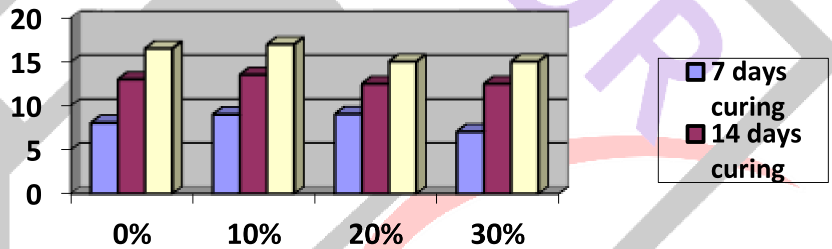

Fig 3.SPLITE TENSILE STRENGTH BAR CHART

CONCLUSION

By using this rice husk ash in concrete as replacement the emission of greenhouse gases can be decreased to a greater extent. As a result there is greater possibility to gain more member of carbon credits. RHA based sand cement block can significantly reduce room temperature. Hence air conditioner operation is reduce resulting in electric energy

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