INCREASE IN COMPRESSIVE STRENGTH BY PARTIAL REPLACEMENT OF RICE HUSK ASH WITH CEMENT

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ABSTRACT

Dumping or removing of industrial waste is a great concern for environment. So the usage of ash on replacement of cement increase the compressive strength. In these days the Rice Husk Ash, Fly Ash plays vital role in increasing the compressive strength of concrete. In this investigation , the cubes were made by approximate replacement of 15%,20%,25% by weight of cement. The workability and durability was increased as compared with ordinary Portland cement concrete. From our results as 15% of replacement of Rice Husk Ash by weight of cement yields higher compressive strength as compared to ordinary Portland cement. By 20% of replacement of Rice Husk Ash by weight of cement yields lower compressive strength as compared to ordinary Portland cement. By 25% replacement of Rice Husk by weight of cement yields higher compressive strength at 7 days & 14 days and decrease the compressive strength at 28 days.

***Key Words**: Increasing compressive strength, Rice husk ash, Ordinary Portland cement*

1.INTRODUCTION:

1.1 GENERAL: There are number of outlining materials that are used as a piece of building advancement. Concrete is a champion among the most basic materials in the improvement business, nowadays. Concrete is the most generally utilized development material in India with yearly utilization surpassing 100 million cubic meters. With everything taken into account, strong is the mix of solid, aggregates and water.

Concrete is a composite material made out of granular materials like coarse aggregates embedded in a cross section and bound together with bond or cover which fills the space between the particles and glues them together. After some time, the bond shapes a hard cross section which ties whatever is left of the fixings together into a solid stone-like material with various occupations. Concrete is used as a piece of broad sums wherever mankind has a prerequisite for establishment. The measure of bond used general ton for ton is twice that of steel, wood, plastics and aluminum merged. Strong use in the bleeding edge world is outperformed just by that of regularly happening water. The bond business is one of the three fundamental creators of carbon dioxide, a critical ozone hurting substance (the other two being the imperativeness age and transportation endeavors). We can decrease the sullying sway on condition by extending the utilization of present day brings about our improvement industry. In India, trademark stream sand (fine aggregate) is by and large used as a piece of mortars and concrete. In any case, creating natural restrictions to the abuse of sand from riverbeds have realized an output for elective sand, particularly near the greater metropolitan zones. This has gained extraordinary strains on the openness of sand driving the improvement business to scan for an elective advancement material. To overcome from this crisis, partial supplanting of trademark sand with present day symptom is financial choice.

RHA generally referred to an agricultural by-product of 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 indicated that concrete with RHA required more water for a given consistency due to its absorptive character of the cellular RHA particles. In an investigation rice husk ash obtained from Indian paddy when reburnt at 650 °C for a period of 1 h transformed itself into an efficient pozzolanic material rich in amorphous silica content (87%) with a relatively low loss on ignition value (2.1%) . There are two ways to burn rice hush: controlled and uncontrolled methods. Initially rice husk was converted into ash by open heap village burning method at a temperature, ranging from 300 °C to 450 °C . When the husk was converted to ash by uncontrolled burning below 500 °C, the ignition was not completed and considerable amount of unburnt carbon was found in the resulting ash .

1.2 OBJECTIVE:The objective of the experimental investigations are to check the effect of use of rice husk ash concrete reinforced elements as compare to cement concrete elements in aggressive environment and normal condition are,

- To evaluate the effect of just replacing the cement by rice husk ash used in concrete and to study the compressive strength of concrete under varying percentage of rice husk ash, as well as to study, the effect of varying curing time period under different exposure condition.
- To understand the actual behavior of concrete when rice husk ash has been replaced by cement to ascertain strength of concrete which is one of the important criteria of the concrete, in different exposure conditions in different loading behavior.
- To arrive at the optimal level of replacement of rice husk ash with reference to strength
- To determine the performance of concrete by partial replacement of M sand by rice husk ash in 15%, 20%, 25% variants.
- To determine the compressive strength and split tensile strength of concrete for 7 days,14 days and 28 days curing.
- To determine the most optimized mix of rice husk ash based concrete.

1.3 SCOPE:Further research is needed to establish the long-term durability of concrete containing mineral admixtures. The microstructure properties of concrete are needed to be further researched. Other innovative low cost locally available materials that can be used, as mineral admixtures are required to be developed. Other levels of replacement of cement can be researched. Some tests relating to durability aspect such as water permeability, resistance to the penetration of Chloride ions, corrosion of steel reinforcement, resistance to Sulphate attack, durability in marine environment etc. needs investigation

The further research work can be carried out on following topics below:

- To provide economical construction material.
- Provide safeguard to the environment by utilizing waste properly.

The same experimental work can be carried out on other higher grades of Concrete.

- Flexure, shear and torsional strengths can be computed.
- Tests on durability can be computed.
- Behavior of strengths for different aspect ratio can be studied.

2.TESTING OF MATERIALS

2.1 CEMENT

The natural cement is obtained by burning and crushing the stones containing clay, carbon ate of lime and some amount of carbonate of magnesia. The clay content in such stones is about 20 to 40 per cent. The natural cement is brown in colour and its best variety is known as the 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. It was in the eighteenth century that the most important advances in the development of cement were made finally led to the invention of normal setting Cement. This cement was invented by a mason Joseph Aspdin of Leeds in England in 1824. He took out a patent for this cement and called it Portland cement because it had resemblance in its color after setting, to a variety of sandstone which is found in abundance in Portland in England. Though his patent made no mention of the necessity of using high temperature, it is felt that he was the first to realize the same and if so, then the invention of modern Portland cement must be attributed to him.

Cement is the binding material, obtained by burning and cursing of clay stones containing Calcium Carbonate and Magnesium Carbonate ($CaCO_3$ and $MgCO_3$).Cement used is 53 grade Ordinary Portland cement.

3. TESTING OF CEMENT

3.1 CONSISTENCY OF CEMENT

Standard consistency of cement paste is define as that consistency with permits vicate plunger to penetrate a point to 5 -7 mm from the bottom of the vicate mould. In this test standard consistency is also called normal consistency. Certain or minimum quantity of water to be mix with the cement so as to complete chemical reaction between water and cement.

3.2.Initial and Final Setting time of Cement

Cement is widely used material in building construction for making cement mortar and concrete. As we know that cement start hydrates when it is mixed with water. In presence of water, cement has a property to achieve strength and get hardened within a short period. So its mandate to place the cement in position without losing its plasticity. Some precast concrete plants expose freshly made concrete elements to steam curing immediately after casting. Final Setting time of cement

The time at which cement completely loses its plasticity and became hard is a final setting time of cement.

3.3. FINE AGGREGATE:Fine aggregate are the material in concrete (or in mortar) of size of about 4.75 mm and lesser, used to fill the voids present in the coarse aggregate. Generally, sand and rock dust are used as the fine aggregate material. Natural sand, crushed stone are the examples of fine aggregate and its usage is limited by its availability and application. In the present paper the role of aggregates on the structure and behaviour of lime mortars is examined by studying the influence of the aggregate content and the grain size on strength, porosity and volume stability of the mortars. Capillary porosity by suction was also measured as an indicator of resistance to weathering. It is shown that coarse aggregates contribute to the volume stability of lime mortars independent of strength enhancement when adequate compaction reduces the capillary pores. The highest strength values, and consequently, the low porosity, were attained by lime mortars of low binder/aggregate ratio which contained aggregates of maximum size 0–4 mm.

Manufactured sand is popularly known by several names such as Crushed sand, Rock sand, Green sand, UltraMod Sand, Robo sand, Poabs sand, Barmac sand, Pozzolan sand etc. IS 383-1970 (Reaffirmed 2007) recognizes manufacture sand as ‘Crushed Stone Sand’.Crushed stone sand is produced by crushing boulders. Manufactured sand is produced by rock-on-rock or rock-on-metal Vertical Shaft Impactor (VSI) in which the process that produced alluvial deposits is closely simulated. Particle size reduction and achieving equidimensional shape is critical to get desired properties. If rock is crushed in compression lot of inherent properties exhibited by natural river sand are lost. If proper technique of manufacturing is not adopted aggregates are bound to become flaky and elongated. Improvements to sand by way of washing, grading and blending may have to be done before use at the consumer end.

In case of manufactured sand all the processes mentioned above can be done at manufacturing plant itself and controls are much better in producing quality fine aggregates.

. M-sand can also be used for making masonry mortar and shall conform to the requirements of IS 2116-1980 (Reaffirmed 1998) – “Specification of sand for Masonry mortars

RHA generally referred to an agricultural by-product of 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 RHA particles. In an investigation rice husk ash obtained from Indian paddy when reburnt at 650 °Cfor a period of 1 h transformed itself into an efficient pozzolanic material rich in amorphous silica content (87%) with a relatively low loss on ignition value (2.1%) There are two ways to burn rice hush: controlled and uncontrolled methods. Initially rice husk was converted into ash by open heap village burning method at a temperature, ranging from 300 °C to 450 °C . When the husk was converted to ash by uncontrolled burning below 500 °C, the ignition was not completed and considerable amount of unburnt carbon was found in the resulting ash . The ash produced under controlled burning conditions between 550 °C and 700 °C by incinerating temperature for 1 h possibly transforms the silica of the ash into amorphous phase. Burning duration varied between 15 m to 24 h, while according to various investigation the optimum time would be 6 h with 680 °C .

Most of the researchers have demonstrated the total effect of RHA in concrete and mortar. However, the unique filler effect or pozzolanic effect of RHA in cementitious system is not studied comprehensively. The aim of this research is to determine the physical and chemical effects of RHA on the properties of mortar including mechanical properties (compressive strength, flexural strength) durability properties (water absorption, porosity) and microstructure development. In this regard, RHA and natural sand (NS) were ground to have median particle sizes (d_{50}) of 6.72, 18.6 and 6.85, 18.9 μm, respectively. Portland cement Type I was replaced by ground RHA and sand separately at the rate of 2.5%, 5%, 7.5%, up to 20% by weight of cementitious materials to cast the mortar. Compressive strength, flexural strength, water absorption and porosity of RHA and NS mortars were determined at various curing ages. Maximum compressive strengths of mortar due to pozzolanic reaction of RHA are found to be 21.5 MPa (when d_{50} = 6.72 μm) and 10.1 MPa (when d_{50} = 18.6 μm) after 90 days of curing and 20% cement replacement level. Results also show that for specific cement replacement level, compressive strength due to filler effect of ground NS is almost constant and maximum 3.3 MPa at 20% replacement of cement. Similarly, finer RHA (d_{50} = 6.72 μm) blended mortar shows improved flexural strength (10.4 MPa), minimal water absorption (2%) and total porosity (1%) than coarser RHA (d_{50} = 18.6 μm) blended mortar at 90 days curing age and 20% replacement level. These results are also coherent with the microstructural studies of mortars. The results indicate that the influence of RHA on the properties of mortar is mainly attributed from the pozzolanic reaction of RHA which depends significantly on its particle size.

Coarse aggregates passing through 20mm sieve and retained on 12.5mm sieve having specific gravity of 2.71 and water absorption of 0.50% is used in the present investigation. The properties of the coarse aggregate used in a concrete mixture affects the modulus for a few reasons. One property is the modulus of elasticity of the coarse aggregate. A higher aggregate modulus will result in a concrete having a higher modulus. As expected, a lightweight aggregate will have a lower modulus than the mortar paste. Conversely, a strong aggregate produces a concrete that is stronger than the mortar paste

Aggregates constitute about 70-75% of the volume of concrete and are essentially inert in nature. They are added in the concrete to provide bulk of the concrete with a rigid skeleton structure. Recycled aggregates are substantially different in composition and properties compared with natural aggregates, leading it hard to predict the performance of recycled aggregate concrete and design their mix proportions. Coarse aggregate is mined from rock quarries or dredged from river beds, therefore the size, shape, hardness, texture and many other properties can vary greatly based on location. Even materials coming from the same quarry or pit and type of stone can vary greatly.

Most generally, coarse aggregate can be characterized as either smooth or rounded (such as river gravel) or angular (such as crushed stone). Because of this variability, test methods exist to characterize the most relevant characteristics, since exact identification would be impossible. Several key characteristics that are frequently used to describe the behavior of coarse aggregates include relative density (or specific gravity), bulk density, and absorption.

Generally common type of ***aggregate*** are selected for providing ***high performance concrete***. But when high strength is the primary concern of high performance concrete, the strength of coarse aggregates themselves are critical.

4. TESTING OF AGGREGATES

4.1 Sieve analysis

The sieve analysis, commonly known as the gradation test, is a basic essential test for all aggregate technicians. The sieve analysis determines the gradation (the distribution of aggregate particles, by size, within a given sample) in order to determine compliance with design, production control requirements, and verification specifications .The fraction passing one sieve size and not another is not a true measure of the particle diameter. It means that there is at least one diameter of the particle which enables it to pass the upper sieve. Particles with largely different dimensions for length, width and height in particular, like reed compost, tend to orientate horizontally and not pass sieves which they can easily pass if handled manually. Finally the sieves may have square or round holes which slightly influence the result (round holes retaining very slightly more material, depending on particle shape).

This test covers the procedure to find and check the gradation of the fine aggregate i.e. sand. There are different types of sand, so we will have to judge that which type of sand is the best to be used. The sand is differentiated on the basis of its gradation. The sand will be called graded if it consists of particles having a variety of dimensions, such type of sand is recommended for use because this type of sand will posses the capability to form a compact structure thus will have more strength as compared to fine sand. The fine sand will also form compact structure but will increase the amount of water needed in concrete, which will decrease the strength of the concrete.So the degree of gradation will decide about the sand to be used. Degree of gradation is also called fineness modulus of sand. We find fineness modulus and compare it the standard recommended values

The sample supplied satisfies the requirements of grading Zone I as per IS: 383-1970

4.2 .Specific gravity

The Pycnometer is used for determination of the specific gravity of soil particles of both fine grained and coarse grained soils. The specific gravity of soil is determined using the relation:Pycnometer filled with water only.

4.2.1.(a) Specific gravity of M Sand

Manufactured sand or M Sand, as it is popularly known, is an effective, Eco friendly and economical alternative to river sand. Due to its ready availability and reliable strength, M Sand has become popular for use in construction. Thereby to save the topsoil of the locality, use M Sand for construction.

4.2.2(b) ***Specific gravity of Coarse aggregates***

The coarse aggregate specific gravity test measures coarse aggregate weight under three different sample conditions:

- Oven-dry (no water in sample).
- Saturated surface-dry (SSD, water fills the aggregate pores).
- Submerged in water (underwater).

Using these three weights and their relationships, a sample's apparent specific gravity, bulk specific gravity and bulk SSD specific gravity as well as absorption can be calculated.

Aggregate specific gravity is needed to determine weight-to-volume relationships and to calculate various volume-related quantities such as voids in mineral aggregate (VMA), and voids filled by asphalt (VFA). Absorption can be used as an indicator of aggregate durability as well as the volume of asphalt binder it is likely to absorb.

4.3. ***Aggregate crushing strength***

The property of a material to resist impact is known as toughness. Due to movement of vehicles on the road the aggregates are subjected to impact resulting in their breaking down into smaller pieces.

The aggregates should therefore have sufficient toughness to resist their disintegration due to impact. This characteristic is measured by impact value test.

The aggregate impact value is a measure of resistance to sudden impact or shock, which may differ from its resistance to gradually applied compressive load

4.4.FINENESS MODULUS

Fineness modulus of sand (fine aggregate) is an index number which represents the mean size of the particles in sand. It is calculated by performing sieve analysis with standard sieves. The cumulative percentage retained on each sieve is added and subtracted by 100 gives the value of fine aggregate.

Fine aggregate means the aggregate which passes through 4.75mm sieve. To find the fineness modulus of fine aggregate we need sieve sizes of 4.75mm, 2.36mm, 1.18mm, 0.6mm, 0.3mm and 0.15mm. Fineness modulus of finer aggregate is lower than fineness modulus of coarse aggregate.

4.4.1.Fineness modulus of Fine Aggregate

Procedure

- Take the IS sieve analysis consist of 10mm,4.7mm,2.36mm,1.18mm,600µ, 300µ, 150µ sieve. Take suitable quality of fine aggregate of known quantity is taken.
- Sieve the above quality of sand through a selected set of sieve arranged according to these sizes .Place a pan at the bottom of sieves a lid at the top.

Fineness Modulus Of Coarse Aggregate

Procedure

- Take the set of IS sieve analysis consists of 80mm,40mm,20mm,16mm,

  12.5mm, 10mm, 2.36mm sieve.

- Take the suitable quantity of coarse aggregate of known quantity is taken.
- Sieve the above quantity of coarse aggregate through a selected set of sieve arranged according to these sizes.
- Place a pan at the bottom of sieves a lid at the top.

4.5.**Mix Design for M30 Grade Concrete**

Mix design can be defined as the process of selecting the suitable ingredients of concrete and determining their relative properties with the objective of producing concrete of certain minimum strength and durability as economically as possible. The concrete mix has been designed for M30 grade as per IS 10262-2009.The specified concrete grade involves the economical selection of relative proportion of cement ,fine aggregate ,rice husk ash (RHA) and water.The performance of these type of concrete was determined by workability test, compressive test and tensile test on hardened concrete.

4.5.1Data for Mix design

- The following basic data are required to be specified under IS sieve design data.
- Degree of workability desired.
- Standard deviations of compressive strength of concrete.

4.5.2.Requirements of concrete Mix Design

The requirement which form the basis of selection and proportions of mix ingredients are as follow,

The minimum compressive strength required from structural considerations.

- The adequate workability necessary for full compaction with the compacting equipment available.
- The maximum water cement ratio and/or maximum cement content to give adequate durability for the particular site condition.

4.5.3.Factors to be considered for Mix Design

- The grade designation giving the characteristic strength requirement of concrete.
- Maximum nominal size of aggregates to be used in concrete may be as large as possible within the limits prescribed by IS456:2000.
- The cement content is to be limited from shrinkage ,cracking and creep.
- The workability of concrete for satisfactory palcing and compaction is related to the size and shape of section,quantity and spacing of reinforcement and technique used for transportation ,placing and compaction.

5.RESULTS AND DISCUSSION

5.1 FRESH CONCRETE TEST

The most widely used test for assessing the workability of concrete of normal consistency The test is carried out using a metal mould in the shape of a conical frustum known as a slump cone or Abrams **cone**, that is open at both ends and has attached handles. The tool typically has an internal diameter of 100 millimetres (3.9 in) at the top and of 200 millimetres (7.9 in) at the bottom with a height of 305 millimetres (12.0 in).The cone is placed on a hard non-absorbent surface. This cone is filled with fresh concrete in three stages. Each time, each layer is tamped 25 times with a 2 ft (600 mm)-long bullet-nosed metal rod measuring 5/8 in (16 mm) in diameter.[2] At the end of the third stage, the concrete is struck off flush with the top of the mould. The mould is carefully lifted vertically upwards, so as not to disturb the concrete cone.

The concrete then slumps (subsides). The slump of the concrete is measured by measuring the distance from the top of the slumped concrete to the level of the top of the slump cone.[3]For 0%ash replacement in concrete

5.2 CURING OF MOULDS (7,14,28 DAYS)

Curing of concrete is done to maintain the Optimum moisture content (OMC) i.e. to prevent the loss of water which is required for the hydration of cement, to avoid shrinkage cracks and premature stressing or disturbance in concrete.

5.3COMPRESSIVE STRENGTH OF CUBE AT VARIOUS AGES

The strength of concrete increases with age. Table shows the strength of concrete at different ages in comparison with the strength at 28 days after casting.

Compressive strength of concrete cube test provides an idea about all the characteristics of concrete. By this single test one judge that whether Concreting has been done properly or not. Concrete compressive strength for general construction varies from 15 MPa (2200 psi) to 30 MPa (4400 psi) and higher in commercial and industrial structures.
Compressive strength of concrete depends on many factors such as water-cement ratio, cement strength, quality of concrete material, quality control during production of concrete etc.

5.3.1.Procedure

(a)Cube Casting

- Measure the dry proportion of ingredients (Cement, Sand & Coarse Aggregate) as per the design requirements. The Ingredients should be sufficient enough to cast test cubes
- Thoroughly mix the dry ingredients to obtain uniform mixture
- Add design quantity of water to the dry proportion (water-cement ratio) and mix well to obtain uniform texture
- Fill the concrete to the mould with the help of vibrator for thorough compaction
- Finish the top of the concrete by trowel & tapped well till the cement slurry comes to the top of the cubes.

(b)Curing

- After some time the mould should be covered with red gunny bag and put undisturbed for 24 hours at a temperature of 27 ° celsius ± 2
- After 24 hours remove the specimen from the mould.
- Keep the specimen submerged under fresh water at 27 ° celsius. The specimen should be kept for 7 or 28 days. Every 7 days the water should be renewed.
- The specimen should be removed from the water 30 minutes prior to the testing.
- The specimen should be in dry condition before conducting the testing.
- The Cube weight should not be less than 8.1 Kgs

(c)Testing

- Now place the concrete cubes into the testing machine. (centrally)
- The cubes should be placed correctly to the machine plate (check the circle marks on the machine). Carefully align the specimen to the spherically seated plate.
- The load will be applied to the specimen axially.
- Now slowly apply the load at the rate of 140kg/cm^2 per minute till the cube collapse.
- The maximum load at which the specimen breaks is taken as a compressive load.

5.3.2.SPLIT TENSILE STRENGTH

The tensile strength of concrete is one of the basic and important properties. Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. A standard test cylinder of concrete specimen (300 mm X 150mm diameter) is placed horizontally between the loading surfaces of Compression Testing Machine (Fig-4). The compression load is applied diametrically and uniformly along the length of cylinder until the failure of the cylinder along the vertical diameter. To allow the uniform distribution of this applied load and to reduce the magnitude of the high compressive stresses near the points of appplication of this load, strips of plywood are placed between the specimen and loading platens of the testing machine. Concrete cylinders split into two halves along this vertical plane due to indirect tensile stress generated by poisson's effect.

6. CONCLUSION

Based on the experimental investigation the following conclusions are,

The present work explores the suitability of using Rice husk ash as a replacement of cement partially. The suitability of rice husk ash as a cementitious material was assessed by conducting the physio-chemical analysis of the ingredients and the influence of RHA on concrete properties (fresh state and hardened state). From the chemical analysis conducted on RHA it was found that it contains nearly 80% silica.

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