Experimental Analysis of The Strength Characteristics of Concrete by Using Rice Husk Ash And Shredded Steel Waste

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Abstract- *Rice Husk Ash is an example of pozzo-lanic building material that has played an essential role in the manufacturing of Cement Concrete. Mineral additive consumption by the cement and concrete industries has increased since the late 20th century. Partial replacement of the cement with supplementary cementitious material in concrete helps to meet the rising demand for cement and concrete. A number of pozzolanic materials have been shown to be effective in the production of high-performance concrete.*

This study focuses on the incorporation of Agricultural i.e. Rice Husk Ash and Industrial waste Shredded Steel materials into cement con-crete, which has the potential to improve concrete properties while also being environmental friend-ly. In this experimental study, Rice Husk Ash (RHA) was used to partially replace cement in proportions of 10%, 14% and 18% and Shredded Steel (SS) waste was used to partially replace sand in proportions of 5%, 10% and 15% with both elements being replaced separately in different mixes and simultaneously in the different combinations of these two waste materials. Com-pressive strength was measured after 07 days and 28 days, as well as workability by measuring slump cone of different prepared mixes. After the analysis of all the tests results it has been discov-ered that when OPC replaced with 10% RHA and Fine Aggregate replaced with 4% Shredded Steel it increases, compressive strength before decreasing. However, as the percentage of RHA increases in the concrete mix it keeps decrease in the wor-kability of the prepared concrete.

Keywords- Rice Hish Ash, Shredded Steel Waste, Compressive Strength, Workability, Slump

I. INTRODUCTION

1.1 INTRODUCTION

Concrete is the world's most frequently used man-made construction material, and it is also the most widely used substance on the earth, second only to water. It is made by proportionally mixing cementing materials, water, aggregates, and sometimes admixtures. Placed in moulds and left to dry, the mixture hardens into a rock-like mass known as concrete. The chemical reaction between water and cement causes hardening, which lasts a long time and makes the concrete stronger over time. The spaces of bigger particles are filled by smaller particles, and the voids of fine aggregate are filled with cement-like binding elements, making hardened concrete an artificial stone. Because cement is used in both mortar and concrete, it is the most important component of the infrastructure and has been recognised as a durable building material. However, experts are becoming increasingly concerned about the environmental qualities of cement, as cement manufacturing is responsible for around 2.5 percent of total universal waste discharges from commercial resources.
Now days there are a significant growth in the field of infrastructure which directly promotes a rapid growth of Steel and Cement factory due to increase in demand. In the present scenario the overall cement production was about 4.30 billion metric tons worldwide in the financial year 2020-21.

In India in the financial year 2020-21 overall cement Production was recorded 330.0 million M.T.

The Steel & Cement industry is one of the two biggest producers of carbon dioxide (CO_2), of which half is from chemical process and 40% from consuming fuel.

Cement is the source of about 8% of the World's Carbon Dioxide (CO_2) emissions according to think tank "Chatham House".

In Process of production of Cement by firing limestone, clay, and other materials in a kiln. CO_2 is emitted from the energy used to fire the material, and the chemical reaction produced from the mixture when it is exposed to heat.

Approximately 0.85-0.90 ton of CO_2 is emitted for manufacturing Per Ton of Cement.

The CO_2 produced from structural concrete is assessed at 410 kg/m3.

Reducing CO_2 emission while producing enough Cement and concrete to meet the demand will be quite challenging. This huge amount of production of cement prompts utilization of natural resources and it is quite unsafe for environment.

In Contrast, 3% annual decline are necessary by 2030 to get on track with the “Net Zero emission” by 2030 Scenario.

In this century, the use of recycled or waste materials in the construction of civil structures is a major issue. In the building business, the use of waste materials reduces the amount of Portland cement used per unit volume of concrete. The manufacturing of OPC emits a lot of energy, which can be reduced by partially substituting waste products for cement. Mineral admixtures improve compressive strength, pore structure, and permeability in concrete and mortar. The amount of Portland cement used in concrete is reduced when Pozzolana is substituted fractionally. The cost of building, energy loss, and waste emissions such as carbon dioxide (CO_2) are all reduced as a result of the reduction in cement quantity. This lowers energy use and, as a result, lowers the rate of global warming.

1.2 UTILIZATION OF WASTE MATERIALS

Cement production is an energy-intensive process that has negative environmental consequences. One tonne of OPC produces one tonne of carbon dioxide gas, which results in 1.6 billion tonnes of CO_2 being emitted into the atmosphere each year. The rising usage of additional ingredients in cement concrete is driven by a number of factors:

- To reduce the use of cement by partially replacing it with materials that have cementitious properties.
- To improve the qualities of both freshly laid and hardened concrete. Several researchers have recently developed high-performance concrete by using superplasticizers and fine mineral admixtures to reduce the water/cement ratio.

In underdeveloped countries, cost-effective construction materials are critical in ensuring that projects are affordable. Because of their specific features, waste materials in building can be used to create structures that are both cost-effective and long-lasting. Fly ash is a waste product from the manufacturing industry that can be used to replace cement and improve the characteristics of concrete.

According to prior studies, a variety of alternative waste materials improve the compressive strength and workability of concrete. It has been discovered that combining waste materials in specific proportions improves the compressive strength of concrete for a given ratio. When both components are mixed together to make concrete, the characteristics of the concrete may change significantly.

1.3 SHREDDED STEEL WASTE

Steel Plant in India annually produces around 30.0 million tons of waste product out of which 65% of materials being reused by industry where as 35% of waste material remain unused.

- Steel Shredded Steel Scrap is generated when steel is cut, drawn, extruded, or machined.
- It is also generated in Steel workshop from grinding metal during the process of drilling, turnings, clippings and stampings leftover when parts are made from iron and steel during the manufacturing processes.

The use of shredded steel waste in the production of concrete for various civil engineering projects is a topic of great importance. Waste utilisation is an appealing and innovative method of reducing costs and environmental problems, or possibly eliminating them altogether, while also achieving resource conservation. Steel workshops and industries can provide large amounts of shredded steel trash locally. When this product is discarded freely, it has a detrimental impact on the environment; consequently, it is vital to reuse this waste in other projects.

Partially substituting cement and sand in concrete reduces energy consumption, so current practise may allow a reduction in cement or sand content in the concrete mix up to a specific limit. In the construction of buildings, shredded steel waste is used as an alternative resource. Using shredded steel scrap as a partial replacement for sand in the production of high-strength concrete has received a lot of attention in the last decade. Cement concrete with shredded steel waste is added to increase its qualities, particularly its compressive strength and other resistance. Shredded steel waste is made up of fine particles that are smaller than the normal sand particle size. Because of its extreme fineness and, shredded steel waste is a very effective alternative material.

1.4 RICE HUSH ASH (RHA)

These are the remains of rice grains' hard protective coatings. Rice husk is obtained at krishi Farms, where rice is harvested from the farm and removed from the rice husk using a thrasher, before being burned. Rice husk burning takes about 48 hours to complete. Due to the chilling process, rice husk ash remained unchanged for another 12 hours after 48 hours. The rice husk ash is then ground mechanically to make rice husk finer, as finer husk produces better results in concrete when substituted by cement.

Rice Husk Ash Is a by-product of agriculture and is generated in Rice Mills. Rice Husk (Rice Hull) is a coating of seeds or grains of rice. Rice husk which is obtained from Rice mill is of no use i.e. it is not even be consumed by animals. It is exclusively used as a fuel in various big industries because its burning temperature is very high.

Rice production was registered about 510 million M.T. financial year 2020-21 worldwide and 119.0 million M.T. in India in financial year 2019-20.

In rice Mill when Paddy is milled 20% of Weight obtained is Husk.
When this Husk is burnt in boiler 20% of Total Husk weight obtained is Ash.
i.e. For every 1000 kg (01 Ton) of Paddy milled in Rice Mill around 20% of its weight ie. 200 Kg Husk is generated.

When this Husk is burnt in boiler approximate 20% of Total weight of Husk i. e. 40 Kg Ash is generated.

According to "Fapohunda et al" (Published in International Journal of Sustainable Built Environment) highest Amorphous Silica could be obtained by burning Rice Husk in boiler at a temperature of 500-700 Degree Centigrade.

1.5 OBJECTIVE

The following are the objectives of the work:

- To Utilize waste materials generated from our Agriculture field such as Rice Husk Ash (RHA) and waste materials generated from Steel plant and Steel workshop such as Shredded Steel (SS) ie. Steel Powder in preparation of Concrete.
- To conduct comparative study between the properties of Concrete by adding up waste materials in different ratios with the plain cement concrete. The properties examined (determined) are compressive strength and workability of concrete.
- To minimize pollution generated from Cement Industries and save environment.
- Minimize the extraction of natural raw resources and to ensure the sufficient resources for future generation.
- To minimize the overall cost of Concrete.

II. LITERATURE REVIEW

The contamination of the natural environment and the falling capability of the dumping facilities is a major problem worldwide. Now a day, the increasing industrialization is accountable for a considerable amount of deposited industrial wastes, which is a call for recycling of wastes to protect the surrounding environment. Several researchers investigated the suitability of these waste materials as construction materials by partially replacing cement, sand or aggregate in concrete and mortar with these materials.

Many works have been done to explore the benefits of using pozzolanic materials in making and enhancing the properties of concrete. **Thomas and Shehata, 1999** have studied the ternary cementitious blends of Portland cement, silica fume, and fly ash offer significant advantages over binary blends and even greater enhancements over plain Portland cement [17].

Sandor, 2016 have studied the Portland cement-fly-ash- silica fume systems in concrete and concluded several beneficial effects of addition of silica fume to the fly ash cement mortar in terms of strength, workability and ultra sonic velocity test results [14].

Oyejobi, D. O., Abdulkadir, T. S. and Ajibola, V., 2014 explained in their research evaluates rice husk ash (RHA) as a cementitous constituent in concrete productions. Raw rice husk obtained from rice mill situated in Ilorin metropolis, Kwara State, Nigeria was burnt in a furnace at a controlled temperature of 700oC for a period of four hours. The ash was analysed for its physical and chemical properties. The mechanical performance of the ash in the concrete was investigated when used as a partial replacement for cement in concrete at 10%, 20% and 30% respectively with a control test that contains 0% RHA. Experimental findings showed that the RHA can be categorized as N-class pozzolana according to ASTM C618-12. The workability of the concrete falls as the RHA content increases. It was also observed that the compressive strength of Rice Husk Ash Concrete (RHAC) increases with curing age but decreases as the percentage of cement replacement with ash increases. The density of the concrete produced also reduces even with age as the percentage replacement of cement with ash increases. The optimum compressive strengths of RHAC are 25.80 N/mm2 , 22.73 N/mm2 and 19.6N/mm2 while the corresponding densities are 2449.67Kg/m 3 , 2348.33Kg/m 3 and 2265.67Kg/m 3 respectively at 10%, 20% and 30% at 28 days curing age when compared with the control test which is 27.47

N/mm2 and 2517.67 Kg/m 3 . These values for RHAC produced can therefore be used for reinforced concrete with either normal or lightweight aggregates. This will not only improve the quality of the concrete but also reduce drastically burning of agricultural waste that causes environmental pollution [11].

The enhancement of concrete technology can minimize the consumption of normal assets and energy sources which diminish or destroy the burden of pollutants on the surroundings. At the moment, huge extent of marble powder have been generated in ordinary stone processing plants with critical collide on the ambiance and life **Aalok and Sakalkale, 2014** [1].

Lam, Wong, and Poon, 2012 in their studied entitled Effect of fly ash and silica fume on compressive and fracture behaviors of concrete had concluded enhancement in strength properties of concrete by adding different percentage of fly ash and silica fume [9].

Replacement of sand with waste powder as a fine aggregate in concrete draws severe awareness of researchers and investigators. The utmost compressive and flexural strength were experimented for specimens containing a 6% dissipate mud when compared with ordinary mix and it has been also instigate that mixing of waste powders up to 9% could efficiently be used as a preservative material in civil materials **Singh and Nanda, 2012** [16].

With the addition of obtained waste marble powder the characteristics of concrete steadily increases up to certain bound. With the addition of Marble powder early strength increase in concrete is elevated. It has been revealed that the best percentage for substitution of marble powder with cement and it is approximately 10% binder for both casted cubes and cylinders.

According to **Hendriks and Janseen, 2003** there are numerous alternatives for the reuse of recycled materials in structures. For each alternative a number of scientific and environmental aspects are applicable. Also, explains numerous models which can be utilized to take the optimal assessment. In common the world-wide used Life Cycle Assessment can be applied s a multi-parameter model for the ecological effects [6].

Khatri R.P. et al., 1995 explained that minimum essential mixing time has during mixing. It has been concluded that high w/c values resulted in short stabilization times. In addition, the contents of silica fume and quartz flour as well as the type of cement and super plasticizer affected the stabilization time considerably [7].

Concrete prepared using recycled aggregates have been used for many years in several countries which go ahead the way in this concept **Kwan et al., 2012,** many major projects have been completed in these countries with cheering results. Its utilization is so widely spread worldwide, so, that several countries have adopted it and are preparing regulatory documents about its use [8].

Application of fine recycled aggregates in concrete improves the properties of cement concrete. Several researchers determined effect over most vital properties of concrete compressive and tensile strength; modulus of elasticity; water absorption; shrinkage; carbonation and chloride penetration. For the long-term durability of reinforced or prestressed concrete carbonation and chloride penetration are significant properties. Experiments have been performed by preparing concrete mixes with different rates of substitution of fine aggregates with fine recycled aggregates obtained from crushed concrete. Testing results had been compared with concrete of same mix proportions without any recycled aggregates.

Reuse of waste materials from construction industry is a creative step towards sustainable and green construction **Uygunoglu, 2011** [18].

Usage of waste materials in construction has been considered as good thought; however, this thought has been not accepted widely between the researchers. But, through proper concrete mix design the concrete having recycled aggregate can achieve target strength and is appropriate for broad variety of applications in construction. Good knowledge regarding durability and properties influencing durability is required for applying recycled aggregate in construction.

Pacheco-Torgal and Jalali S, 2011 presented important information over the robustness and design methodology for recycled aggregates. Parameters investigated in this study are compressive strength, ultrasonic pulse velocity, shrinkage, water absorption and intrinsic permeability. It has been observed from results that the in recycled aggregates concrete ultrasonic pulse velocity is higher, and it contains low water absorption intrinsic permeability. By replacing 80% of the total coarse aggregate with recycled aggregates and by following mix design method proposed by the Department of Environment, target crushing strength can be achieved [12].

Radlinski, Olke and Nantung, 2010 in their experimental work entitled effect of mixture composition and Initial curing conditions on the scaling resistance of ternary concrete have find out effect of different proportions of ingredients of ternary blend of blinder mix on scaling resistance of concrete in low temperatures [13].

Barbhuiya, Gbagbo, Russeli and Basheer, 2009 studied the properties of fly ash concrete modified with hydrated lime and silica fume concluded that addition of lime and silica fume improve the early days compressive strength and long term strength development and durability of concrete [4].

Accumulation of waste marble dust in cement has been presented by **Aliadbo, 2014**, in this work cement mortar and concrete composed by applying marble dust have been found to be improved, with the addition of marble dust. Concrete composed adding of marble dust as replacement of sad reveals improved act compared to replacement of cement. The chief idea of this investigation has been found to be examine the opportunity of utilizing waste marble dust in cement and concrete making [2].

The usefulness of waste marble dust as preservative material combine together with cement is examined by **Aruntas et al., 2010** for this plan, waste marble dirt added cements were attained by inter blending with marble dust with Portland cement ashes at dissimilar combine ratios at different percentages by weight. Standard cube size of mortar prisms has been artificial with the obtained cements. On these mortar prisms, strength tests have been accepted sample on different days of curing [3].

Emre and Sukru, 2015 examined the blended cements produced by using the building stone powder was out of sulfate concentration for unusual properties. Prepared mortar specimens had been cured /under water for 28 days and then exposed to several different extents of sodium sulfate solution for large number of days. Performances of cements had been determined by testing properties like compressive and tests. In mixed binders exclusively cements produced by substituting waste provides like strength data when compared with ordinary Portland cement at the ages of different curing days [5].

Shayan and Xu, 2006 studied the presentation of glass powder in concrete in the real situations, a field examination has been performed by means of a 40 MPa concrete combination, including and considering a range of proportions of glass powder in and as cement replacement. Several blends were formed and most of the mixtures also involves sand-size meshed glass collective substances, were used to cast several concrete slabs. Concrete casted has been tested for the compressive and separating tensile strength, shrink and rise, ultrasonic pulse velocity, and permeability of chloride. Basic models had been cut from the slabs of various life spans for the same as well as for micros assessment. Mixtures with glass powder blend showed acceptably when compared in drying shrinkage and alkali reactivity. The outcomes revealed that GLP can be incorporated into high strength concrete at considerable proportions such as 20-30% to substitute of cement. Application of glass powder provides for substantial well utilization of waste glass in prepared mixes and noteworthy changes in the production of harmful gases to environment [16].

Mehmet et al. 2014 explained the result of chemical over few good strength gains of mixed cement mortars in order to expand a enhanced consideration for enhancement of hydration and strength of newly mixed cements. Pastes and mortars, containing the mixed blends and the ordinary cement had bee also formed and they had been cured within water to pending tests. Experimentations including test of chemical compositions of mixtures and strengths after different curing periods have been performed according to standard codes [10].

Xiamwei and Zhenyu, 2013 have been investigated the causes of ground waste concrete powder, impending from the close mix, on water requirement for normal characteristics of concrete. The results presented that the 20% of waste powder to the weight of mix cement has modest consequence of the normal tested properties [20].

From above literature review it has been observed that, high use and manufacturing of cement and sand as the main construction material in concrete construction affects the atmosphere by creating huge quantity of CO_2gas. Many studies have tried to find a way to reduce the use of Portland cement to diminish these problems without increasing construction cost. Partial replacement of cement and sand by other materials is one such method and with a proper amount of replacement, it has the benefit of improving the properties of concrete, reducing costs, conserving energy and minimizing waste emission.

III. MATERIALS USED

3.1 BACKGROUND

This chapter presents the description materials used in the present work. Following materials have been discussed here –

1. Cement
2. Coarse and Fine aggregates
3. Water
4. Shredded steel waste
5. Fly Ash
6. Rice husk ask
7. Concrete

IV. EXPERIMENTAL INVESTIGATION WITH CONVENTIONAL DESIGN MIX FOR M-35 GRADE CONCRETE

Step-01: To conduct some basic test of ingredients at site Laboratory.
Step-02: To Prepare Design Mix of Conventional Concrete for M-35 Grade.
Step-03: To Cast Cube sample to examine "Compressive Strength" and to conduct "Slump Test" at site Laboratory to determine the Workability of concrete.

4.1 MIX DESIGN

I) The First Step towards the Experimental Investigation was to conduct some basic test at Site Laboratory to find out data required for preparation of Experimental analysis of Design Mix:

(i) Specific Gravity of Coarse Aggregate and Fine Aggregate.
(ii) Specific Gravity of "Admixture".
(iii) Water Absorption of Coarse Aggregate and Fine Aggregate.
(iv) Aggregate Impact Value (AIV).
(v) Flakiness and Elongation Index of Aggregate.
(vi) Grading of Coarse and Fine Aggregate.
(vii) Fineness test of Cement.
(viii) Fineness test of RHA.

Table 1 Cube Strength for Design Mix for M-35 Grade Control Concrete

Age of Cube Specimen	Average Compressive Strength(N/Sqmm)
07 Days	33.348
28 Days	48.830

4.2 EXPERIMENTAL INVESTIGATION BY PARTIALLY REPLACING SAND WITH SHREDDED STEEL IN CONCRETE MIX OF M-35 GRADE

I) Step-01: To Prepare Design Mix of M-35 Grade by Partially replacing Sand with different percentage of dosage 5%,10%,15% of "Shredded Steel".
Step-02: To Cast Cube Specimen (09nos.)for each three different percentage of dosage 5%,10%,15% of "Shredded Steel" to examine Compressive Strength and also to perform "Slump Test"at site Laboratory to determine Workability of concrete.

Material Selected for Experiment research purpose by Introducing two Ingredients in normal concrete mix:

(I) Shredded Steel/Steel Dust
(II) Rice Husk Ash (RHA)
II) Shredded Steel /Steel Dust:

As we know that Fine aggregates generally consist of natural sand or crushed stone. Medium and Coarse sand are to be used in Concrete.

The properties of Shredded Steel /Steel dust particle (< 4.75mm) used as fine aggregate was also confirming to Zone-II in accordance with the requirements of IS: 383-1970 when it was tested in Site Laboratory.

For using Shredded Steel/Steel Dust Particle only one method was studied:

1. Fine Aggregates (FA) can be replaced by Shredded Steel (SS)/ Steel Dust Particle (SDP) with definite Percentage (%).

III) 2nd Trial Mix Design:

For M-35 grade concrete mix design was prepared by partially replacing Sand with Solid constituents consisting of Shredded Steel /Steel Dust Particle (< 4.75mm) with a percentage of 5%, 10% and 15% and keeping other constituents like OPC-43 Grade Cement, Coarse Aggregate unchanged.

Three different proportion was selected for preparation of Design Mix:

(i) 95% sand +5% SS
(ii) 90% Sand +10% SS
(iii) 85% Sand +15% SS

The Sieve Analysis Test was conducted at Site Laboratory to confirm that combined sample of fine aggregate with all three different ratio is lying under Zone-II as per the specification of IS:383.

IV) In order to achieve the best result number of trial mix for M-35 Grade Concrete was prepared keeping Cement, W/c Ratio almost same & replacing Fine Aggregate with Shredded Steel (Steel Dust) with different percentage of dosage of 5%,10% & 15%.

V) Mix Ratio for M-35 by replacing Fine Aggregate with different percentage of dosage of 5%,10%,15%:

Table 2 Mix Ratio for M-35 by replacing Fine Aggregate with different percentage of dosage of 5%, 10%, 15%

Trial Mix	Fine Aggregate		Weight of Fine Aggregate (in Kg)	
	Sand	Steel Dust Particle (>4.75mm)	Sand (Zone-II)	Steel Dust Particle (>4.75mm) (Zone-II)
M-1	95%	5%	711.282	46.131
M-2	90%	10%	673.846	92.262
M-3	85%	15%	636.410	138.392

V. CONCLUSIONS AND RECCOMMENDATION FOR FUTURE WORK

5.1 DISCUSSION

Utility of materials such as Rice Husk Ash (RHA) and shredded steel (SS) in Construction industry reduces the use of Portland Cement and thus reduces the construction cost.

In the present concrete mixes have been prepared by adding these materials in different percentage. Concrete mixes formed are tested for compressive strength and slump values and compared with ordinary Portland cement concrete values.

5.2 CONCLUSIONS

Workability: of Concrete decreases with increasing percentage of RHA by replacing Cement. From study it was clear that Slump decreased with increase in RHA content. This is due to high specific surface area of RHA dosage of Super Plasticizer was increase to 1.0% by weight of Cement to maintain the required slump and to increase workability of Concrete.

Fineness: of RHA is more compare to cement due to which the Cohesiveness and stiffness of concrete mixture increases.
Strength: Study shows that 10% cement replaced by RHA exhibits upper strength at than control concrete at all ages.
Water absorption capacity: Study from the observed Slump shows that RHA used Concrete possesses more water absorption compare to Control Concrete.

From observed results the Cement can be replaced by RHA with Optimum dosage 10%.

Study shows that Sand replaced by 4% Shredded Steel and OPC Cement replaced by 10% RHA exhibits upper strength than control concrete at all ages.

5.3 ADVANTAGE OF USING RICE HUSK ASH IN CONCRETE

- The incorporation of rice husk ash in concrete converts it into an eco-friendly supplementary cementitious material, it helps in cutting down the environmental pollution.
- Rice husk ash provides good compressive strength to the concrete.
- Compare to various other supplementary materials Rice Husk is much cheaper and easily available and transportation cost is also low.
- The heat of hydration is reduced. This itself help in drying shrinkage and facilitate durability of the concrete mix.
- RHA particles size should range from 4 µm to 75 µm, with a mean particle diameter between 8 µm to 6 µm, and a surface area of at least 20m2 /g. There is a reduction in the Permeability of Concrete structure.
- There is a higher increase in the chloride and Sulphate attack resistance.

5.4 RECOMMENDATION FOR FUTURE WORK

Few more properties such as compactness, consistency and other strengths are required to be tested by adding supplementary materials. Increased volume of experimental data with other materials and is to be collected and used to study the suitability of different waste materials. Resistance to chloride attack, carbonation and corrosion of reinforcement and other environmental attacks is required to investigate.

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