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EFFECT OF THE COMBINED APPLICATION OF RICE HUSK ASH, CRUMB RUBBER AND STEEL SHOT DUST ON VARIOUS PROPERTIES OF CONCRETE

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Abstract- The environment can be subject to different environmental problems if waste material is left. The reuse of waste materials is therefore conscientious. Waste can be used to produce new products or can be used as admixtures to increase the utilization of natural resources and to protect the environment from waste deposits. In this project, I am using three different types of waste products, with the aim of either enhancing or maintaining the strength of the concrete without any negative impact due to the three substances. All three waste products are present in fine solid form and are used at different percentages in combination with traditional materials. Rice Husk Ash and Steel Shot Dust can be obtained from industry as a raw waste product and can be used without any recycling. However, Rubber Crumb is obtained by reducing scrap tires down to sizes ranging from 3/8" to 40 mesh particles with the help of grinding machines. Cubes, cylinders & beams of grade M30 concrete were prepared at different percentages of all three waste products to understand the behavior of the concrete through appropriate testing.

Keywords: Concrete , Rice Husk , Rubber Crumb

I. INTRODUCTION

1.1 General

Concrete is man-made substance most found on earth. This is an important building material which is widely used in houses, bridges, highways, and dams. Its uses range from pavements, kerbs, pipes, and drains to structural applications. It is a composite material which consists mainly of cement, water and aggregate (gravel, sand, or rock) from Portland. They form a workable paste when these materials are mixed, and then slowly harden over time.

1.2 Use Of Waste In Concrete

The cement industry is one of the two major sources of carbon dioxide (CO_2), producing up to 8 percent of this gas's man-made emissions worldwide, 50 percent of which come from the chemical process and 40 percent from burning coal. The CO_2 emitted for the manufacture of structural concrete (using ~14% cement) is estimated at 410 kg/m^3 (~180 kg/tonne @ 2.3 g/cm^3 density) (reduced to 290 kg/ m^3 with a 30% cement substitution for fly ash). The CO_2 emissions from concrete manufacturing are directly proportional to the cement content used in the concrete mix; for the manufacture of each ton of cement, 900 kg of CO_2 was produced, representing 88 percent of the emissions associated with the typical concrete mix.

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Ii. Literature survey **Kushagra Jhamad et. al. (2017)** The authors used steel shot dust while preparing M25 grade concrete blocks with 5%, 10% and 15% percent replacement. The compression test was applied in 7 days and 28 days respectively on the blocks. As observed, the 5 percent replacement of cement shows maximum increase in compressive strength after 28 days of healing and at 15 percent the strength starts to decrease again comparatively.

Nikhil Brari1 and Dr. Hemant Sood (2017) The paper explains how crumb rubber and rice husk ash are used to make concrete environmentally friendly. The authors have separately analyzed the effect of the aforementioned constituents on concrete properties. The addition of rubber has been found to increase ductility, toughness, impact resistance while having a negative effect on compressive strength and workability. In the case of RHA, pozzolanic material has been found to be reliable.

The compressive strength of the concrete mix with 10% RHA was significantly increased and cement could be replaced by up to 20% RHA without adversely affecting the strength.

Shivam Sharma and Sonia Chutani (2017) The paper discusses the strength determination of cement concrete mix using rubber fibre and rice husk powder. Rubber fibers were partially replaced by coarse aggregates and cemented rice husk ash. The size of the rubber fibers taken was 50-60 mm in length and 1.5-2 mm in width. M40 grade concrete was first constructed in this investigation. On cubes and cylinders, the compressive strength test and split tensile strength test were performed with partial replacement of coarse aggregates at 0 percent, 0.5 percent, 1 percent and 1.5 percent with rubber fibers and 0 percent, 7 percent, 11 percent and 15 percent rice husk ash with cement. Results showed an increase in compressive strength when replacing 11 per cent rice husk ash and 0.5 per cent rubber fibers and split tensile strength respectively when replacing 7 per cent rice husk ash and 1 per cent rubber fibres. Those compressive strength and split tensile strength values are equivalent to the regulated concrete strength of 40 N/mm^2 at a mix ratio of 1:1.67:2.39.

N Kaarthik Krishna, S Sandeep, and K M Mini (2016) In the present investigation, Rice Husk Ash was used as a cement mixer in concrete and its properties were studied. The effort was also made to analyze the strength and usability parameters of the concrete. For normal concrete, the mix design is based on the Indian Standard (IS) system and, using this as a guide, the mix design has been designed to replace Rice Husk Ash. Four different rates of substitution, namely 5 per cent, 10 per cent, 15 per cent and 20 per cent, were selected and studied for the replacement process.

Amit Kumar I. and Dr. Abhay S. Wayal (2015) The paper presents an overview of the work done on using RHA as a partial replacement of concrete cement and its effect on concrete workability, compressive strength and chloride permeability. It was concluded that the workability of the fresh concrete mix is decreasing as the percentage of RHA replacement in concrete increases. Good superplasticizer and proper mix design can achieve the required operability. Partial replacement of cement with RHA improves the compressive strength of hardened concrete whereas in the studies the optimum percentage of replacement varies. Concrete penetration of chloride ions decreases as the percentage of RHA increases mainly due to RHA's pore refining capacity. The optimal percentage of replacement was found to range from 10 to 20 per cent from the above.

Ishtiaq Alam et. al. (2015) For this analysis, rubber was applied to concrete and different properties were investigated and compared with ordinary concrete such as compressive strength , tensile strength, ductility, etc .. As a result, rubberized concrete has been found to be robust, less ductile, to have greater crack resistance but to have a low compressive strength relative to ordinary concrete. By adding some amount of silica to it, the compressive strength of rubberized concrete can be increased.

Shanmugapriya M (2015) In this study, the author studied optimum quantity of the rubber aggregate to be replaced in place of aggregate by compromising the strength and improving any one of the property of the concrete which imparts low by using mineral aggregate.

S.Selvakumar and R.Venkatakrishnaiah (2015) The goal of this project was to research the efficacy of rubber as a replacement for fine aggregates and to use crumb rubber to reduce global warming. Aggregate properties, basic gravity, water absorption, acidity resistance was to be conducted to determine the properties of the concrete specimens to be cast and tested for construction. Mixing with a different percentage of replacement (5 per cent, 10 per cent, 15 per cent and 20 per cent) and its feasibility for replacement were discussed.

Neela Deshpande et al. (2014) The object of this investigation is to research the different properties of rubber. An attempt is made to build 25 MPa concrete using artificial sand, Shredded rubber, and crumb rubber as an aggregate source, using IS 10262:2009. A comparison with the control mix mainly their compressive strength, split tensile strength & flexural strength, using traditional material, would allow the assessment of the suitability for structural applications of using shredded aggregate and crumb rubber in concrete as percentage replacement. There is also an attempt to cover the shredded Rubber particles with NaOH solution, using the same in concrete.

Ephraim et al. (2012) Investigated Concrete compressive strength with rice husk ash as a partial substitution of standard Portland cement. RHA 's specific gravity was found to be 1.55, RHA concrete density was found to be 2.043, 1.912 and 1.932 kg/m^3 at 10 percent, 20 percent, and 25 percent respective replacement percentages. RHA concrete with a slump value of more than 100 mm has been found to be very workable. The introduction of RHA into concrete has resulted in increased water demand and improved resistance. The 28-day compressive strength values were found to be 38.4, 36.5 and 33 N/mm^2 at 10 percent, 20 percent, and 30 percent respective replacement percentages. Compared favorably with the regulated, the compressive strength values obtained were 37 N/mm^2 at a mix ratio of 1:1.5:3

A. Seco, et al. (2012) The goal of this review was to improve awareness on the application of different industrial waste in the field of construction. Most industrial waste can be removed by structural engineering and construction, while at the same time reducing both the use of Portland Cement and the environmental issues generated by the disposal of waste. There are industrial wastes with pozzolanic characteristics that can at least partially replace Portland Cement without loss of resistance and even increase other properties such as toughness. They all have the ability to be used as reusable, lightweight and low-cost binders

Ilker Bekir Topcu and Abdullah Demir (2012) An attempt has been made in this analysis to classify the different properties required for the construction of a concrete mix with rough tyre rubber chips as aggregate in a systematic manner. As part of the present experimental investigation, the M20 grade concrete was chosen as the reference concrete specimen. Scrap tire rubber chips were used as a coarse aggregate to replace the traditional coarse aggregate.

I. AIM OF THE OBJECTIVES

Based upon the research gaps identified the following objectives were formulated:-

1. Obtain an eco-friendly concrete by the combined application of **Rice Husk Ash (RHA), Crumb Rubber (CR),** and **Steel Shot Dust (SSD)**.

2. Evaluate the compressive strength, split tensile strength and flexural strength of the newly made concrete at 7 days, 15 days and 28 days.

II. MATERIALS AND MIX DESIGN

3.1 CEMENT

Cement, one of the most important construction materials, is a binding agent that adheres to building units such as blocks, bricks, tiles, etc. Cement usually refers to a very fine powdery product composed primarily of calcareous (calcium), sand or clay (silicon), bauxite (aluminum) and iron ore, and can include shells, chalk, marl, shale, coal, blast furnace slag, slate. In cement manufacturing plants the raw ingredients are processed and heated to form a rock-hard substance which is then ground into a fine powder for sale. Cement mixed with water causes a chemical reaction and forms a paste that sets and hardens to bind individual structures of building materials. In a cement manufacturing plant, calcareous and other raw materials such as silicate, bauxite, iron ore, etc. are heated so that carbon dioxide molecules are released from the calcareous to form quicklime, which combines with the other ingredients, resulting in the production of calcium silicates and other products. Thus, it is made of clinker, a rock-hard substance. Gypsum is applied to the clinker and then ground into a fine powder known as Portland cement, which is the final product. The properties of cement utilized for the work are as under:

MAKE & GRADE	SPECIFIC GRAVITY	FINENESS BY SIEVE ANALYSIS	INITIAL SETTING TIME	FINAL SETTING TIME	NORMAL CONSISTENCY
ULTRA TECH-43	3.13	2.02%	30 min	280 min	32

3.2 CONCRETE

Concrete is a building substance composed of a hard, chemically inert particulate matter, known as aggregate (usually sand and gravel), which is bound together by cement and water. Concrete is characterized by the type of aggregate or cement used, by the particular qualities it expresses, or by the methods used to produce it. In ordinary structural concrete, a water-to - cement ratio defines the quality of the concrete in large measure. The lower the amount of water, everything else being equal, the more solid it is. The mixture needs to provide just enough water to ensure that each aggregate particle is completely covered by the cement paste, that the gaps between the aggregate are filled, and that the concrete is sufficiently liquid to be effectively poured and distributed. The amount of cement in relation to the aggregate (expressed as a three- part ratio of cement to fine aggregate to coarse aggregate) is another durability element. There will be relatively less aggregate in case strong concrete is needed. Concrete strength is measured in pounds per square inch or kilograms per square centimeter of force required to crush a specimen of a given age or hardness. The strength of concrete is influenced by environmental conditions, in particular temperature and humidity. If it is allowed to dry prematurely, it can encounter unequal stresses of tensile which cannot be resisted in an imperfectly hardened state. The concrete is kept damp for some time after pouring in the process known as curing, to slow down the shrinkage that happens as it hardens. Low temperatures have an adverse impact on its strength too. To make up for that, an additive like calcium chloride is mixed in with the cement. This speeds up the setting process, which in turn generates enough heat to counter moderately low temperatures. In freezing temperatures, large concrete forms that cannot be adequately covered are not poured out. Following the guidelines and procedure recommended by the Indian Standard Method of Concrete Mix Design (**IS 10262 – 1982**) a design mix for concrete grade M-30 was prepared.

FINE AGGREGATE

Aggregate is the granular material used to make concrete or mortar and is considered a fine aggregate because the particles of the granular material are so fine that they pass through a 4.75 mm sieve. It is commonly used to increase the amount of concrete in the building industry, so it is a cost-saving material and you should know more about the fine aggregate size, its density and grading zone to find the right content. The properties of cement utilized for the work are as under:

PROPERTY	DESCRIPTION
Maximum Size	4.75 mm
Fineness Modulus	2.83
Specific Gravity	2.64
Zoning	Zone-III

3.4 COARSE AGGREGATE

The Coarse aggregate serves as an inert concrete filler material. Coarse aggregates used in building materials with larger scale fillers. Coarse aggregates are the particles which retain on a sieve of 4.75 mm. The main sources of the coarse aggregate are dolomite aggregates, crushed gravel or stone, natural disintegration of rock. The coarse aggregate surface area is smaller than the fine aggregates. The properties of coarse aggregate utilized for the work are as under:

PROPERTY	DESCRIPTION
Maximum Size	20 mm
Bulk Density	1824
Specific Gravity	2.76

WATER

The tap water was used for concrete production. The water used was tasteless, odorless, impurity-free and had a specific gravity of 1

Step 2: RICE HUSK ASH AND IT'S PROPERTIES

Rice husks or hulls are seed coatings, or grains, of rice. The hull is made from hard materials, including Opaline, Silica and Lignin, to protect the seed during growing season. For the most part the hull is indigestible to humans. When the rice husk is properly brunted it has a high SiO_2 content and can be used in conjunction with cement as secondary cementing material (SCM) to make concrete goods. Mehta secured a patent in 1978 for manufacturing RHA, which could be used as pozzolana. RHA contains a high SiO_2 material, the majority of which is in amorphous form. It is a popular pozzolana, which has many uses in the concrete and cement industries. RHA can be used as an economical replacement for silica fume that has almost the same properties as micro silica as SCM. Therefore, the use of less costly RHA is more beneficial in reducing the overall cost of concrete production, reducing the demand for cement leading to less environmental pollution by cement factories, thereby providing economic and environmental benefits, as well as providing a way of disposing of this agricultural waste product which otherwise has little alternative usage. RHA was procured from a ghee manufacturing company from Rajpura, Punjab. The size of RHA procured was found out to be less than 75 μ after performing sieve analysis.

2.1: CRUMB RUBBER AND IT'S PROPERTIES

Rubber can also be used as also fine and coarse aggregates. When the scrap tyre rubber or other rubber is shredded into uniform granules, the substance obtained is known as Crumb Rubber and has been tested in the light of its important use in the construction industry.
The waste tyre was obtained from a local factory for the recycling of tyres, and the size of crumb passing through a sieve of 2.36 mm and retained at 600μ was used for the experiment.

2.2: STEEL SHOT DUST AND ITS PROPERTIES

Steel shots are used in blasting process, which then converts into dust, known as Steel Shot Dust. The size of Steel Shot Dust was between 15μ to 30μ and obtained from Steele Industries.

Step 3:

IV FUTURE SCOPE

The results have shown us that the incorporation of RHA and SSD along with RC can improve strength. However, with increased percentage of RC, strength decreases. Future study should determine the limiting percentage of RC at which it nullifies the positive effect of RHA and SSD. Also, the effect due to addition of plasticizers should also be determined in case the concrete is to be used for the production of highly workable concrete.

V CONCLUSION

This research was conducted to understand the effect of addition of Rice Husk Ash, Rubber Crumb and Steel Shot Dust on the harden properties of concrete i.e., Compressive Strength, Split Tensile Strength & Flexural Strength of concrete. Also, inference regarding the workability of concrete can also be made.

The different observations considering the test results are as following:

1. The workability of concrete after the addition of RHA, SSD & RC showed a decrease in the slump value. The decrease in slump can be understood by the fact that RHA is highly dry material that is hydrophilic in nature and thus absorbs a lot of water on mixing. However, the spherical grains of SSD helped in increase of workability as it does not absorb any water and provided an ease in mixing with the increased percentages. This shortcoming can be solved with the help of using plasticizers if a greater workability is needed.
2. The compressive strength of concrete was found to be higher that the plain concrete and a highest strength of 11.41% was recorded for M3 mix. A lower strength was found for M6 mix at 28 days with the only difference of RC content from the M3 mix.
3. The compressive strength increase can be attributed to the addition of RHA and SSD as the strength increases from 7.41% at 14 days to 11.41% at 28 days.
4. The split tensile strength of concrete was found to be higher that the plain concrete and a highest strength of 15.95% was recorded for M3 mix. An approximately equal strength was found for M6 mix with the only difference of RC content from the M3 mix.
5. A higher rate of strength increase was seen during the first seven days and afterwards the strength increased however at a slower rate.
6. After 28 days, the highest split tensile strength was observed for M3 mix and M6 mix with a higher RC content recorded a lower strength.
7. The flexural strength did not show a prominent increase at initial days; however, at 28 days a 5.86% increase was observed in case of M3.
8. The flexural strength of mixes was found to be more than the normal concrete.
9. The RC is showing a negative effect on the all the three strength parameters as the results for 3% replacement by RC shows lower values than 1.5% replacement by RC (keeping the rest proportions same).

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