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Experimental Study to Enhence the Compressive Strenth of Concrete Using Cow Dung Ash, Rice Husk Ash and Alccofine

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Abstract— Cement, which makes up the majority of concrete, emits a significant amount of carbon dioxide, concrete has a remarkable environmental impact. If the amount of cement used in manufacturing of concrete is minimized by the use of mineral admixtures without compromising durability criteria, it is possible to lessen the environmental impact of concrete. In order to boost the strength and durability of concrete, which is formed of aggregates, portland cement, and water, at least one additional element, such as admixtures, supplemental cementitious material, or fiber, must be added. Pozzolanic elements like cow dung ash and rice husk ash can be incorporated into portland cement to create effective environmentally friendly concrete. The majority of the requirements for durable concrete can be met with the help of supplementary cementitious materials. Agriculture-based pozzolanic additives like Rice Husk Ash (RHA) and Cow Dung Ash (CDA) are widely available. Other supplemental materials like silica fume and fly ash are shown to be inferior to rice husk ash and cow dung ash. The goal of the current study is to examine the strength parameters of concrete of M20 grade adopting rice husk ash (RHA) and cow dung ash (CDA) as partial replacements for cement, respectively. In addition, concrete uses 5% of alccofine by volume. The specimens are prepared with partial replacements of cement by 0%, 5%, 10% and 15% of RHA and CDA. The sample specimens consist of concrete cubes, cylinders and beams. Compressive strength, split tensile strength and flexural strength tests are carried out and the test results are compared with that of conventional concrete.

Keywords: *Cement Replacement, Rice Husk Ash, Cow Dung Ash, Alccofine, Strength, Workability.*

I Introduction

One of the most important and quickly growing industries in the world, the construction sector is essential to the development of nations' economies. Since concrete is the only material that corresponds to it in terms of strength and accessibility, demand for it will steadily increase as construction projects expand across several emerging countries. The majority of the construction materials utilized in the modern world where we live are man-made composites, and concrete is one of the most important of them. This convenient building material is made by combining the appropriate proportion of aggregates (coarse and fine), cement, water, supplementary cementing materials. The mixture is then added with the right amount of additives to allow it to set and harden over time. The demand of cement in construction concrete technology is highly needed day by day to fill the gaps in infrastructural development such as buildings, highways, bridges, tunnels, parking, stadium, railway, airport, hydraulic structures due to industrialization. However, the concrete industry is one of the biggest consumers of natural resources and makes major contributions to the world anthropogenic carbon dioxide (CO2) emissions that cause air pollution, which has a greater impact on climate change and global warming. 0.9 tons of carbon dioxide are produced by making 20 bags of cement, which accounts for approximately 6% of total CO2 emissions into the environment [1]. 14 billion cubic meters of concrete are produced year to be used in the construction of roads, bridges, tunnels, homes, dams, and flood defenses, according to the Global Cement and Concrete Association (GCCA) [2]. The main cause of the concrete industry's high CO2 levels is the manufacturing of Portland cement, which is the primary binder and contributes to about 8% of the world's CO2 emissions with an annual production of more than four billion tons [3,4]. Additional binding components, such as pollutants from cow dung ash, sawdust, fly ash, silica fume, and rice husk ash, allow concrete technology to utilize millions of tons of wastes that would normally cause waste disposal issues [5]. Therefore, as civil engineers are in charge of bridging gaps and filling in voids, they are constantly looking for the construction sector that is environmentally beneficial. It is necessary to look for additional cementitious materials that can be used to partially replace cement. India is one of several emerging nations where the population is rapidly growing. To successfully accommodate them, we require infrastructural amenities like buildings, roadways, hydraulic systems, airports, and parking.

Construction materials, mostly concrete and others, are needed for those infrastructures. The price of construction products is extremely expensive today, particularly cementitious materials. In light of this, cement and concrete producers are attempting to hasten the switch to greener concrete by pledging to cut CO2 emissions by 25% by 2030 and achieving a goal in line with the Paris Agreement's goal of keeping global warming to 1.5°C [2]. Problems with waste disposal have been brought on by the large amounts of agricultural wastes produced in manufacturing businesses, such as rice husk. People are now more likely to employ inexpensive local resources like clay made from fly ash and cow dung because of this. This study focuses on using rice husk and cow dung ash as a partial substitute for cement in concrete.

RESEARCH OBJECTIVES

- To identify the methods for enhancing cost-effective concrete with a partial replacement cement made of cow dung ash and rice husk ash in the proper proportions.
- To investigate the strength parameters, the effectiveness of employing CDA and RHA as a partial replacement for cement enriched with Alccofine.
- To examine the differences between the compressive, split tensile, and flexure strengths of controlled concrete and concrete treated using CDA and RHA with Alccofine.
- To employ additional cementitious elements to make inexpensive, lightweight concrete that is structurally sound.
- To use locally accessible cementitious materials as a partial replacement in order to reduce the environmental effects caused by the manufacturing of cement.
- To encourage the use of locally available wastes with the intention of protecting the environment.
- To minimize the usage of the raw material, large replacement is done using the various by product materials that are available in the present day.

Literature Review

Amin et al. (2022), performed sugarcane bagasse ash (SCBA) and nano eggshell powder (NEP) are considered cementitious materials and were added to the cement at different percentages to reduce the cement contents in the concrete industry. The SCBA and NEP were added to cement content by 5 %, 10 %, 15 %, and 20 % for SCBA, and 2.5 %, 5 %, and 7.5 % for NEP. This study evaluates the fresh and hardened properties of HSC. . The best mixture result includes 5 % NEP with 15 % SCBA, which exhibited a dense form, no pores, and no cracks, as analyzed in the microstructure [6].

Muruthi et al. (2022), presents the suitability of eggshell powder (ESP) in high strength concrete with respect to the structural and durability performance observed from research findings. Based on the evidence collected from numerous research publications, it may be concluded that 8–10% replacement of cement is possible without compromising the mechanical strength and structural performance and it increases the hydration process during the early periods. However, the ESP had shown a negative impact on durability properties, particularly in the chemical environment [7].

Chong et al. (2021), This paper aimed to develop mathematical models for the prediction of eggshell concrete compressive strength using the mixed regression (MR) and response surface methodology (RSM). The analysis of contour plot concluded that eggshell powder increased the concrete compressive strength at an optimal replacement percentage between 5% and 10%. However, the cement partial replacement with eggshell powder is more optimal for mix design with higher water content [8].

Ramachandran et al. (2018), This paper is focused on M30 grade concrete mix namely normal concrete and concrete modified with Cow Dung Ash . Concrete modified with Cow Dung Ash was prepared by 15% partial replacement of OPC with CDA. After 28 days of curing, specimens were exposed in fresh water for 56, 90, 180 and 365 days. Result showed that pH, compressive and split tensile strength and better durability was significant. Lesser bacterial density was observed on concrete modified with CDA compared to Natural Concrete [9].

Dinakar et al. (2013), By using Metakaolin and cement with low water-binder ratio of 0.3 , high performance concretes can be developed. From results it can be realized that Cube Compressive strength, Splitting tensile strengths and elastic modulus results shown higher values at 10% replacement of cement by Metakaolin [1

Iv. Materials Used

(1) Cement - Ordinary Portland cement (OPC) is the most preferred binder in the manufacturing of concrete due to its good adhesive and cohesive properties that facilitate it's bonding with other materials. Locally acquired Ordinary Portland Cement of 53 grade of the ACC cement Branch conforming to ISI standards is used for casting the specimens in this work and standard test were conducted according to IS:8112-1989. The specific gravity and fineness of cement is 3.15 and 8.50%. Its initial and final setting time will be 40 minutes and 225 minutes respectively.

(2) Coarse Aggregate - The natural crushed stone aggregate of nominal size 20 mm are used in this work. The specific gravity in oven dry condition and water absorption of the natural coarse aggregate of 20 mm nominal size as per IS code 383-2016 were 2.85 and 0.268% respectively. The gradation of the coarse aggregate was determined by sieve analysis as per IS code.

(3) Fine Aggregate - Sand used throughout the experimental work was obtained from the Locally available nearby river in Bilaspur which is free from organic impurities. Fine aggregate passing through 4.75 mm IS sieve and retaining on 150 µ IS sieve is used in this study. The specific gravity in oven dry condition and water absorption of the sand as per IS code were 2.55 and 0.503% respectively, also confirming to Zone I of table 4 of IS 383-2016.

(4) Rice Husk Ash - The RHA was collected from Rice mill in Bahatarai Bilaspur. After milling the rice grains, rice husks as waste are collected for any intended purpose and others are burnt. It was brought in Materials and Concrete Laboratory and then sieved on 90 micron American Society for Testing and Materials (ASTM) sieve for replacement with cement.

(5) Cow Dung Ash - The cattle farming area close to Bilaspur is where the cow dung was collected. After being exposed to the sun for a week, the samples were calcined at 800°C for two hours in a muffle furnace. This specific temperature was chosen since it was discovered to produce CDA that was of superior quality **[11]**. The samples were burnt, then allowed to cool, and then they were pulverized by hand manually. For cement replacement, samples which passed it through a sieve with a 150 µm size were employed. The resulting cow dung ash had a dark grey appearance.

(6) Alccofine - Alccofine is a finely divided particle size that is higher than Micro Silica and lower than cement. Alccofine is a specifically processed product made from highly reactive glass-containing slag that was obtained through granulation. It reduces the amount of water required for a certain level of concrete workability. Also it can also be used as a super workability aid to increase flow or as a high range water reduction to improve compressive strength. Due to the greater particle size distribution of alccofine, concrete performs better in terms of durability. A ground-breaking substance called Alccofine 1203 is utilized to replace micro-silica and silica fumes. Better strength can be delivered by Alccofine 1203, but it is also environmentally friendly.

(7) Water - The most crucial yet least expensive component of concrete is this. For the concrete's preparation, regular tap water was used. The workability of the concrete mix increases with greater water content. When water is introduced to concrete, hydration reaction takes place, and the paste begins to harden as a result. A pH value of 6 to 8 is ideal for water. Water shouldn't include any salt because doing so will damage the concrete. The water utilized in this project is in accordance with the requirements of IS 456:2000 for mixing and curing.

MIX PROPORTION

Use of M20 grade concrete is made in accordance with IS 10262:2009 and IS 456:2000, with a water-cement ratio of 0.5 and a percentage replacement of cement by rice husk ash and cow dung ash of 0%, 5%, 10%, and 15%, respectively. Additionally, 5% of Alccofine was added as an additional cementing element to improve the concrete's properties.

After the concrete has been mixed, the specimen mix is poured into the designated molds. In this investigation, 171 cube specimens measuring 150 x 150 x 150 mm, 171 cylinder specimens measuring 150 x 300 mm and 57 beam specimens measuring 100 x 100 x 500 mm are all casted. The molded specimens must be demolded and then put in the water curing tank at room temperature after having been cast for 24 hours. After curing for different ages of 3 days, 7 days, and 28 days of curing, the cubes, cylinders, and beam specimens were examined for additional tests (compressive strength, split tensile strength, and flexural strength), and the results are obtained.

Table 1 - Mix Proportion

S.N.	Mix	Rice Husk Ash	Cow Dung Ash	Alccofine
1	Mix 1	0%	0%	0%
2	Mix 2	5%	0%	0%
3	Mix 3	10%	0%	0%
4	Mix 4	15%	0%	0%
5	Mix 5	0%	5%	0%
6	Mix 6	0%	10%	0%
7	Mix 7	0%	15%	0%
8	Mix 8	2.5%	2.5%	0%
9	Mix 9	5%	5%	0%
10	Mix 10	7.5%	7.5%	0%

11	Mix 11	5%	0%	5%
12	Mix 12	10%	0%	5%
13	Mix 13	15%	0%	5%
14	Mix 14	0%	5%	5%
15	Mix 15	0%	10%	5%
16	Mix 16	0%	15%	5%
17	Mix 17	2.5%	2.5%	5%
18	Mix 18	5%	5%	5%
19	Mix 19	7.5%	7.5%	5%

Average Compressive Strength Values

LITERATURE REVIEW, SLR

The various international and national research paper consist on this study area and determine the review work on it. the various international papers, scoops appears, sci papers and international conference, etc

Rao (2003) He obtained the fineness of ash ranging from 10000 to 20000Sq.cm/gm, where he found that at 16000 Sq. cm/gm fineness and even at 40%replacement of RHA not much difference in the strengths were observed.

Shetty (2005) discussed that RHA is obtained by burning rice husk in controlledtemperature with aim of protecting environmental pollution. RHAhas high SiO2content so that can be used as concrete admixture. RHA displays high pozzolaniccharacteristics and ads to high impermeability and thigh strength of concrete. RHA basically comprise of amorphous silica.

Gambhir (2006) highlighted that the average composition of RHAis 90%amorphous silica, 5% of carbon, and 2% of K2O.

Dabai & Muhammad (2009) studied the effect of RHA as cement admixture bytesting the compressive strength of cement cubes produced by replacing cement percentages with the RHA. The results clearly showed that suitable strengthof concrete at 28 days obtained with RHA could be replace for OPC at 10%and20% of replacement.

Habeeb & Mahmood (2010) presented their research on Study on properties of rice husk ash and its use as cement replacement material in Mat. Res. vol.13 no.2São

Carlos April June 2010. This paper investigates the properties of rice huskash (RHA) produced by using a Ferro-cement furnace. The effect of grindingon the particle size and the surface area was first investigated. The effect of

RHAaverage particle size and percentage on concrete workability, fresh density, super plasticizer (SP) content and the compressive strength were also investigated.10%RHA gave the optimum value. 5% replacement level achieved slightly lower values of compressive strength at early ages for up to 7 days. When 20%of OPCwas replaced for RHA, the strength of concrete achieved equivalent values totheOPC control mixture.

Mix	3 Days	7 Days	28 Days
Mix 1	12.09	20.52	22.06
Mix 2	12.64	20.33	25.22
Mix 3	14.54	21.06	26.88
Mix 4	11.28	12.25	17.6
Mix 5	14.2	16.68	24.08
Mix 6	15.9	17.6	21.9
Mix 7	13.2	15.8	19.5
Mix 8	14.2	25.7	28.34
Mix 9	19.77	28.88	32
Mix 10	18.53	20.4	22.11
Mix 11	19.77	22.44	30.66
Mix 12	21.2	24.53	23.92
Mix 13	18.33	19.55	21.65
Mix 14	15.3	17.9	26.6
Mix 15	16.2	19.1	22.9
Mix16	18.3	19.5	21.7
Mix 17	18.33	19.5	21.7
Mix18	21	28.9	27.7
Mix19	19	22.5	29.1

Wang et . al. (2011) have presented the research on Replacement of Cement withRice Husk Ash in Concrete in Advanced Materials Research (Volumes 295- 297).A feasibility study is made to use Rice Husk Ash as an admixture toanalready replaced Cement with fly ash (Portland Pozzolana Cement) in Concrete, and an attempt has been made to investigate the strength parameters of concrete(Compressive and Flexural).Five different replacement levels namely 5%, 7.5%, 10%, 12.5% and 15% were chosen for the replacement study. A range of curingperiods starting from 3 days, 7 days, 28 days and 56 days were considered inthestudy Series ranging from 5% to 10% RHA concrete but better compressivestrengths at later ages though showing lower compressive strengths initially Split tensile strengths are lower for RHA concrete when compared to normal concreteand kept on decreasing with increase of RHA

Akeke et.al. (2012) from the experiments and analysis of results of findings inthis research work, the following facts are established about RHA Concrete. RHAis a super pozzolan and its use in Civil Construction, besides reducingenvironmental pollute factors, will bring several improvements to concreteCharacteristics. The compressive strength and workability tests suggests that RHAcould be substituted for OPC at up to 25% in the production of concrete withnoloss in workability or strength. Based on the results of split Tensile Strength test, it is convenient to state that there is no Substantial increase in Tensile Strengthdueto the addition of RHA. The Flexural strength studies indicate that there is amarginal improvement with 10 to 25% RHA replacement levels. Rice HuskAshconcrete possess a number of good qualities that make a durable and good

Obilade (2012) has presented the research on Use of rice husk ash as partial replacement for cement in concrete in International Journal of Engineering and Applied Sciences, Sept. 2014. Vol. 5. No. 04.OPC was replaced with RHA by weight at 0%, 5%, 10%, 15%, 20% and 25%. Compacting factor test was carriedout on fresh concrete. Compressive Strength test was carried out on hardened150mm concrete cubes after 7, 14 and 28 days curing in water. The optimum addition of RHA as partial replacement for cement is in the range 0-20%.The compacting factor values of the concrete reduced as the percentage of RHA increased. The Compressive Strengths of concrete reduced as the percentage RHA replacement increased.

Gornale et.al. (2012) The increase in Compression strength for M-20,M-30andM-40 at 3,7 and 28days was increased by 20% to 30%. The increase in flexural strength for M-20, M-30 and M-40 at 3,7 and28 days was increased by 25%to30%.The increase in Flexural strength for M-20,M-30 and M-40 at 3,7and28days was increased by 25% to 30% when compared with the normal concrete at 28 days.

Kashyap et.al. (2013) have presented their research on Effect of Partial Replacement of Cement by Rice Husk Ash in Concrete in International Journal of Science and Research (IJSR) ISSN: 2319-7064.Use of RHA by 5%, 10%&15%& 20% by weight of cement in four different experiments to find out themaximum strength. It is compared with the strength of normal concrete by usingthe grade of M30 at the days of 7days, 14days & 28 days .At the initial ages, as replacement level of RHA increases the compressive strength also increases.

Mahendran (2014) presents strength and permeability attributes of concrete byoptimal substitution of cement with joint ratio of Fly ash (FA) and Rice huskash(RHA) with Synthesis Egg shell powder (ESP). Two categories of ash such as flyash, rice husk ash with four distinct contents of 5%, 10%, 20%, 30%, and 40%interms of weight were performed for the substitution of cement and addition of apersistent 5% egg shell powder in every substitution,assessment results accomplished underscore the point that strength and permeability properties of concrete significantly jumping up to 30% of cement substitution by combinedFA(15%), RHA (15%) with additive ESP (5%), and subsequently tends to drop downwith every supplementary accumulation of substitution outside this level.

Ramachandran et al. (2018) This paper is focused on M30 grade concrete mixnamely normal concrete and concrete modified with Cow Dung Ash. Concretemodified with Cow Dung Ash was prepared by 15% partial replacement of OPCwith CDA. After 28 days of curing, specimens were exposed in fresh water for 56, 90, 180 and 365 days. Result showed that pH, compressive and split tensilestrength and better durability was significant. Lesser bacterial density was observed on concrete modified with CDA compared to Natural

Concrete. Kumar (2018) represent that the partial replacement of cement by 10%flyashand 5% CDA, there is an increase in compressive strength of concrete after that the compressive strength gets lowered. The compressive strength for M25 grade concrete was 40.2N/mm2 which was maximum after 28 days of curing, for replacement of cement by 10% fly ash and 5% cow dung ash and this value is better than the compressive strength of 36.8N/mm2 at 0% mixing. It is found that the workability of concrete gets decreased as the percentage of fly ash and cow dung ash increases. The calculated slump value for concrete having (10%flyash+ 5% cow dung ash) defines it in the low workability category. So this concrete can use in concrete road construction and mass concreting. The standard consistency increases with the increase in amount of fly ash and cow dung ash. Hence, it requires more quantity of water. The byproducts uses reduces the cost of a concrete.

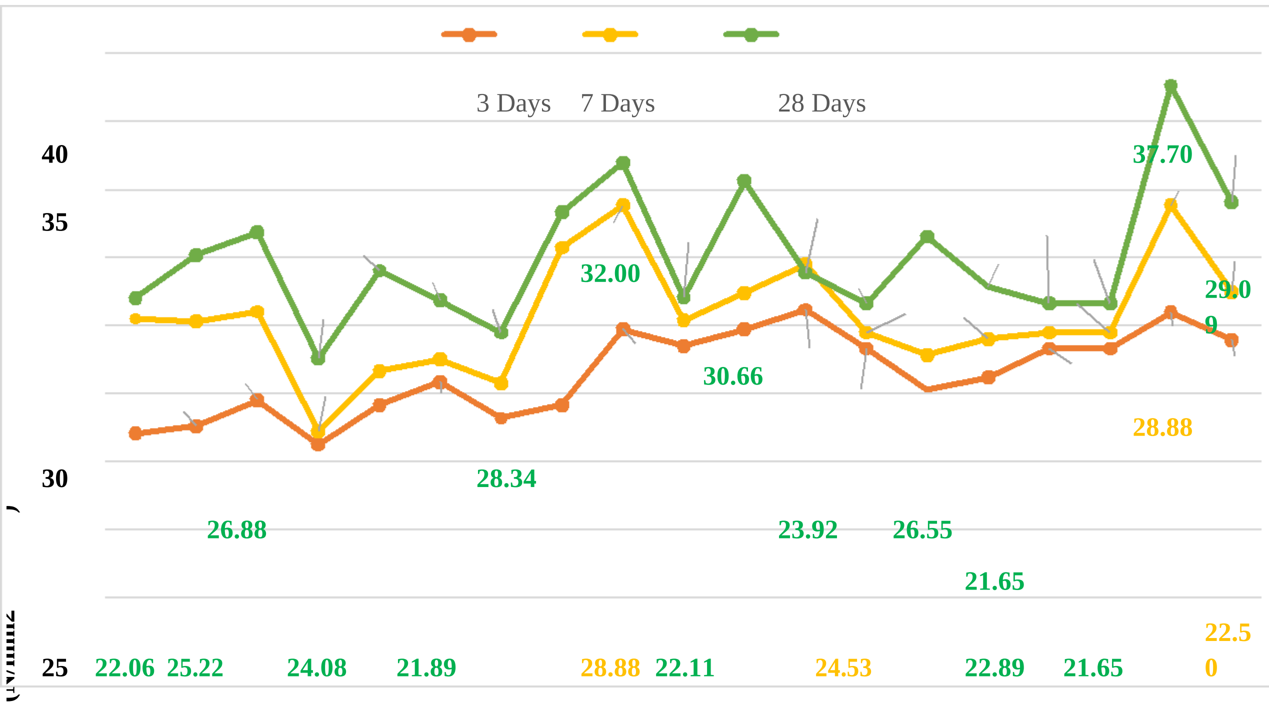
John (2020) the results shows by the partial replacement of cement withMetakaolin helps in achieving high strengths in concrete. At 15%replacement of cement with Metakaolin content improves the strength characteristics such as of Cube Compressive Strength, Split Tensile Strength and Flexural Strength.

Sivakrishna et. al. (2020) the production of green concrete is not only beneficial to creating a sustainable and resilient infrastructure, but it will help to meet thefuture demand for concrete, which will aid more development and urbanization

Zhang et al. (2022) this study proposes a high-water content clay improvement case using calcined waste oyster shells (COS) and carbonized cowdung compost (CC) as substitutes for cement to stabilize clay with high-water content, , thesolidifying agent/water ratio, C/(w/100), was introduced as an important parameter to evaluate the improvement effect of COS stabilized clay. **VI. RESULTS**

(1) Workability Test - According to IS: 1199- 1959, the workability of freshly mixed concrete was evaluated immediately. It is evident that the controlled concrete (Mix 1) received slump of 45 mm, however the mix with the highest slump (Mix 3) received slump of 50 mm and the least amount of slump value obtained 20 mm for (Mix 10 and Mix 11) 7.5% of CDA & RHA and 5% of RHA with 5% Alccofine which are less than controlled one respectively. The specimens with more RHA and CDA the concrete become less workable.

(2) Compressive Strength Test - Results of testing the compressive strength of cubes measuring 150 x 150 x 150 mm at 3 7 and 28 days after curing are displayed in the figure below. On a compression testing machine (CTM), the cubes are tasted. When compared to controlled mix, it can be noted that the average strength at days 3, 7, and 28 for varied mixes exhibits high strength. As the curing days gradually increased over the controlled mix, the compressive strength clearly indicated an improvement.



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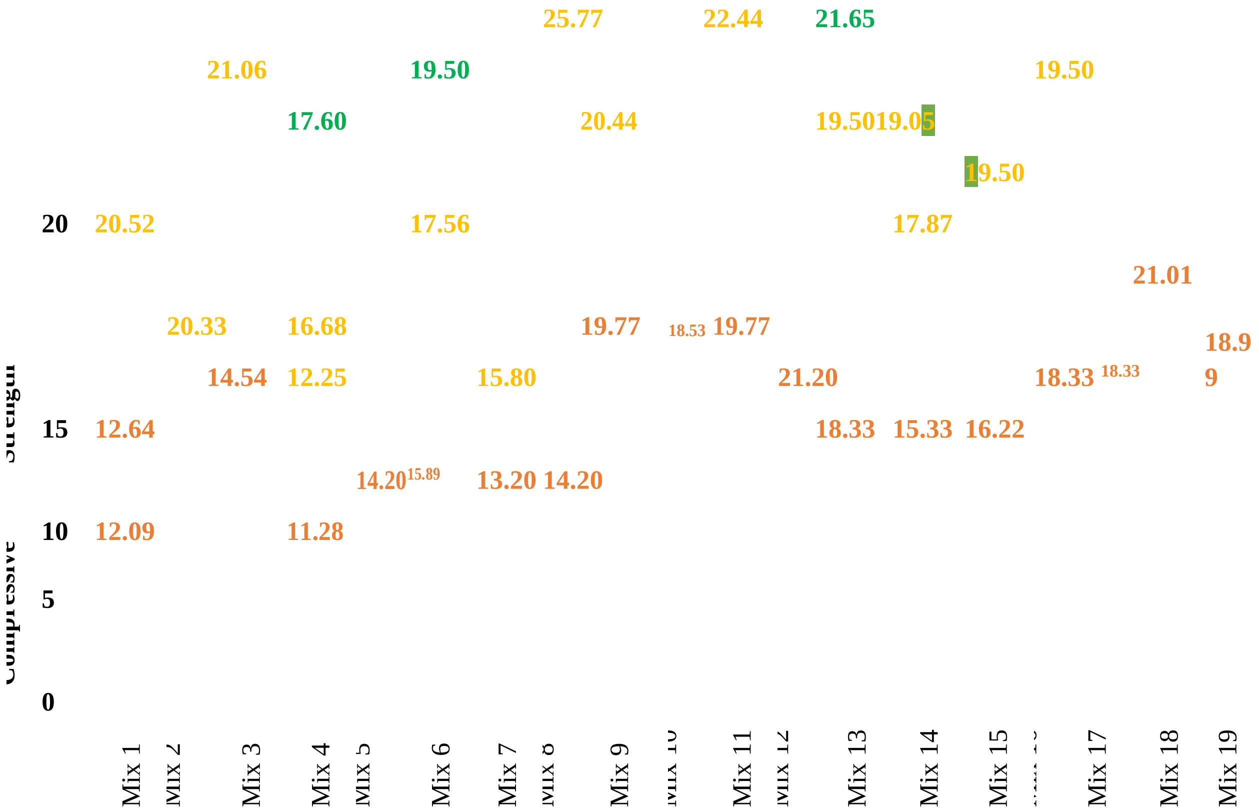
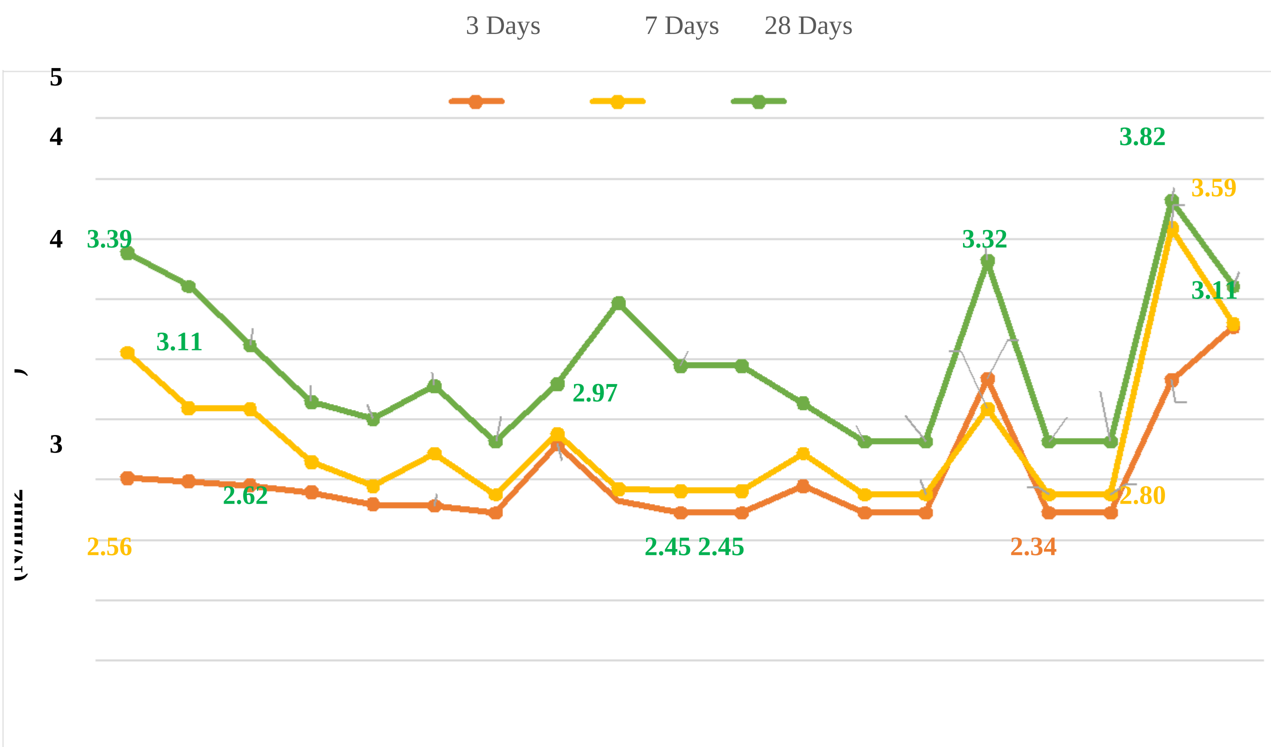


Figure 1 - Compressive Strength of Different Mix

(3) Split Tensile Strength Test - Results of testing the tensile strength of cylinders measuring 150 x 300 mm at 3, 7 and 28 days after curing are displayed in the figure below. On a compression testing machine (CTM), the cylinder specimens are tasted. When compared to controlled mix, it can be noted that the average strength at days 3, 7, and 28 for varied mixes exhibits high strength. As the curing days gradually increased over the controlled mix, the tensile strength clearly indicated an improvement.



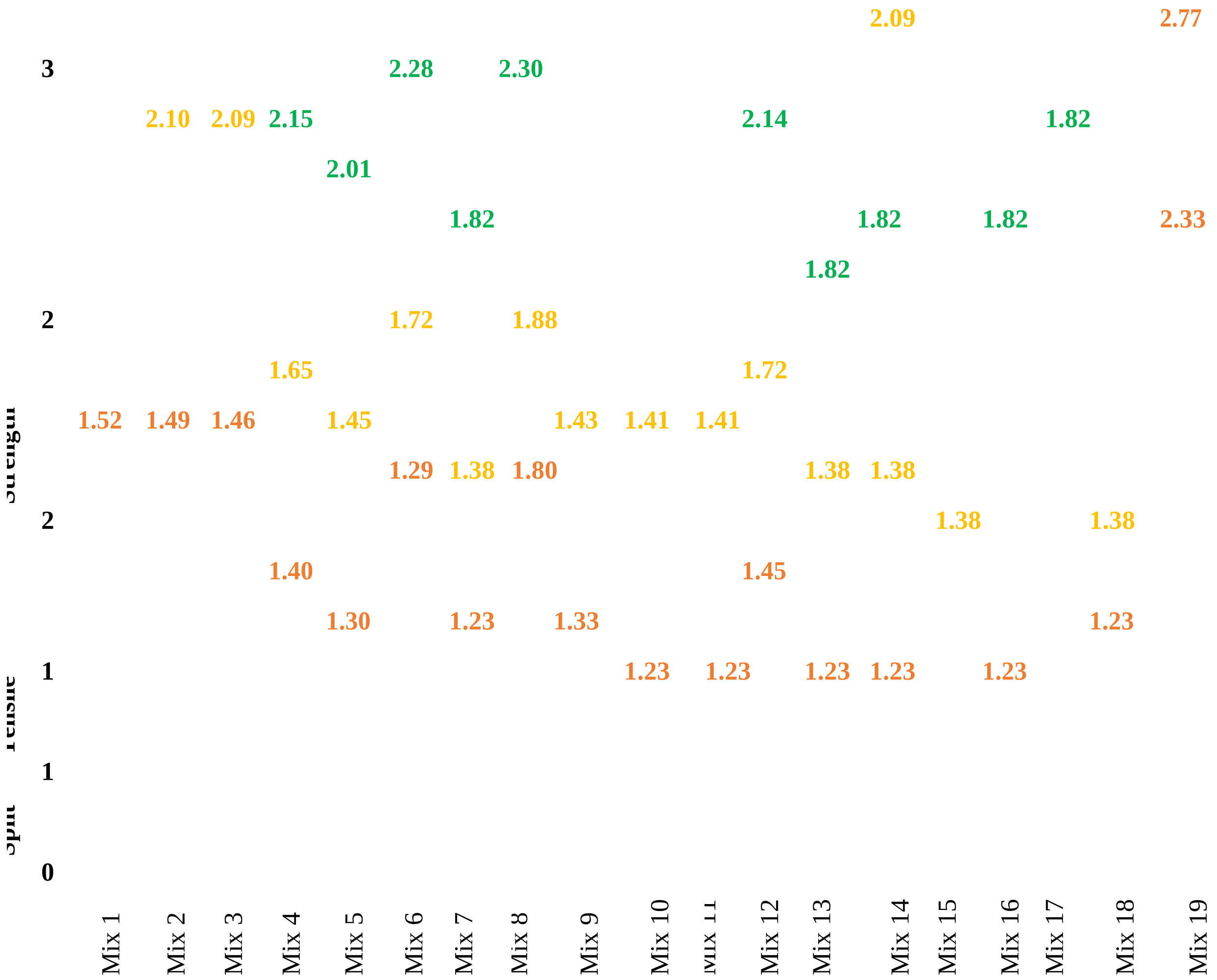


Figure 2 - Split Tensile Strength of Different Mix

(4) Flexure Strength Test - Results of testing the flexure strength of beams measuring 500 x 100 x 100 mm at 28 days after curing are displayed in the figure below. On a flexure testing machine, the beams are tasted. When compared to controlled mix, it can be noted that the average strength at 28 days for varied mixes exhibits high strength. As the curing days gradually increased over the controlled mix, the flexure strength clearly indicated an improvement.

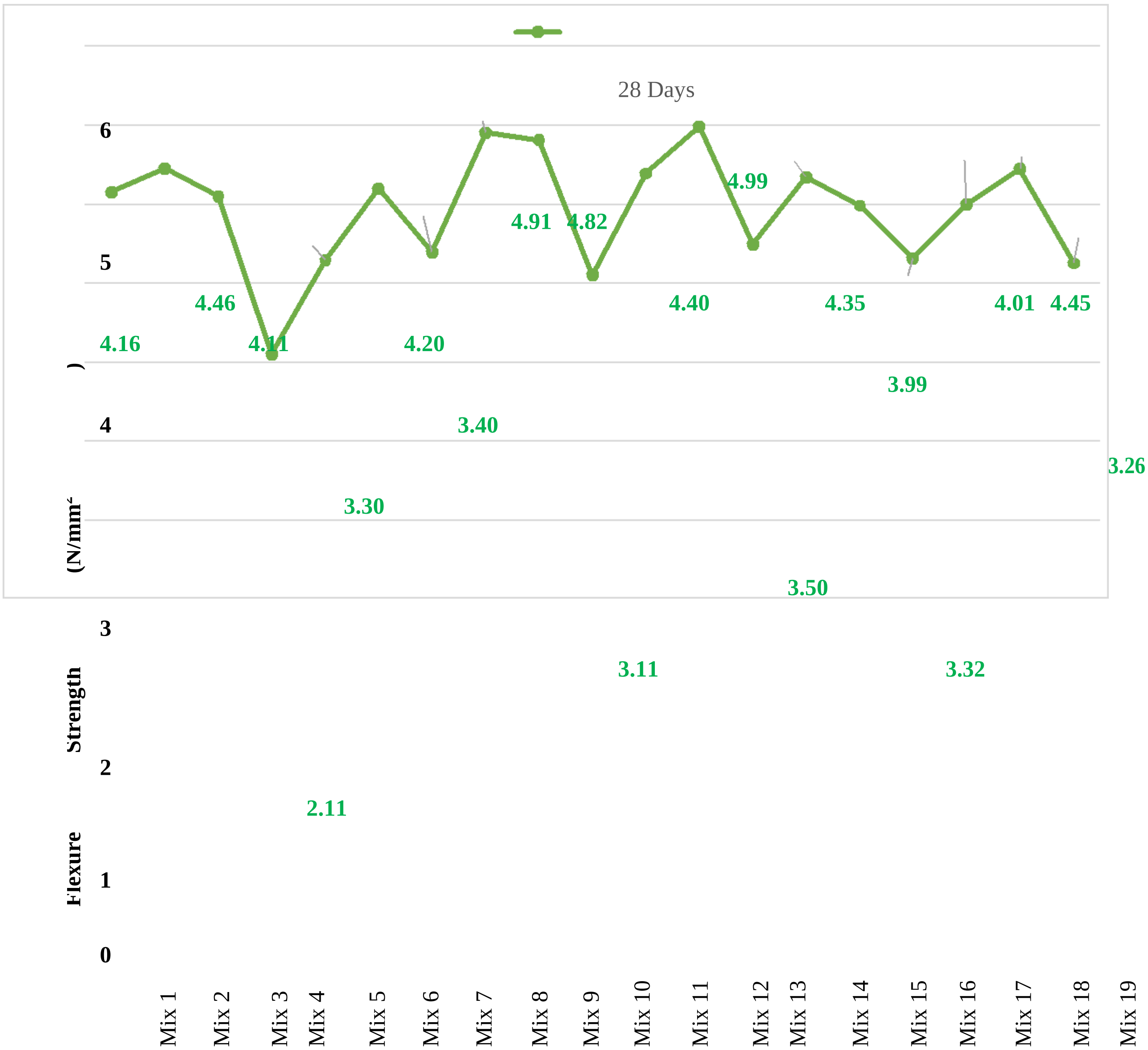


Figure 3 - Flexure Strength of Different Replacement

VII. CONCLUSIONS

The specimens of M20 grade of concrete by partially replacing rice husk ash and cow dung ash, incorporated with alccofine, to cement were cast and are tested for compressive, split tensile and strength at 3, 7 and 28 days. Flexural strength values were also obtained at 28 days. The obtained results were compared with conventional concrete after that following conclusion can be drawn

When the 10% replacement limit is not exceeded, cow dung ash and rice husk ash concrete can be made to function effectively in several floor and wall applications.

As the concentration of cow dung and rice husk ash in concrete grows, more water is needed, therefore Alccofine is appropriate in a specific range since it has a major limitation that must be identified before it is used.

The advantages of the cow dung and rice husk ashes include their light weight, which makes them suitable as building materials.

As CDA+RHA concentrations increase more water is needed to maintain the desired consistency. Compressive strength minimizes when CDA+RHA content rises and continues to grow as the curing time is extended.

With strength as a criterion, CDA+RHA of no more than 15% can be used to produce good and quality mortar and concrete.

The workability of concrete mixes containing cow dung and rice husk ash decreases because the particles of CDA and RHA are porous in comparison to river sand.

CDA and RHA possesses a complicated irregular texture of particles, therefore inter particle friction is increased, hence workability is decreased.

Increase in workability of concrete was observed for MIX 9 i.e RHA(5%)+CDA(5%) (Grade M20) for concrete cubes when cement was partially replaced with Alccofine up to 5%, after which it decreased. Rounded shape of the Alccofine particles along with the water repelling nature of Alccofine due to the presence of glass content results in the increase in workability. Compressive strength dipped with raise in level of fine aggregate substitution by CDA & RHA because the substitution of stronger matter with the weak material and increased porosity of concrete.

Compressive strength of concrete mixtures comprising 2.5% CDA and RHA as a part substitution of fine aggregate along with the 5% Alccofine as the partial replacement of cement (Mix 9,Mix 7 and Mix15) surpassed that of controlled concrete .

Strength and workability of concrete enhanced at all the ages with the incorporation of Alccofine as a part replacement to cement. This is due to this fact that a dense pore structure of concrete is achieved for Alccofine concrete mixtures due to its distinctive chemical chemistry and grain size distribution. Cow Dung Ash and Rice Husk Ash can be effectively used in manufacturing of high strength concrete when used along with Alccofine as a mineral admixture.

Alccofine is much finer than cement which fills the voids in the concrete and provides greater Strength.

Alccofine can replace cement up to 5% because after that the quantity of cement in concrete becomes very less and binder scarcity occurs due to less water-cement ratio in high strength concrete.

The combination of Rice husk ash and Alccofine can increase the strength of compression by 13% and decrease the cost of concrete by 1.3% .

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