EXPERMENTAL STUDY ON THE COMBINE EFFECT OF FLY ASH AND RICE HUSK ASH IN HIGH STRENGTH CONCRETE

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Abstract: **In this paper, the detailed experimental investigation was done to study the effect of partial replacement of cement by Fly Ash (FA) and Rice Husk Ash (RHA) in combine proportion started from 30% FA and 5% RHA and constant weight of admixture 0.7% by weight of cement throughout different mixes together in concrete by replacement of cement with the gradual increase of RHA by 5% and simultaneously gradual decrease of FA by 5%. Last proportion was taken 15%FA and 20% RHA. The tests on hardened concrete were destructive in nature which includes compressive test on cube for size (150 x 150 x 150 mm) at 7,14,,28, days of curing as per IS: 516 1959, Flexural strength on beam (150 x 150 x700 mm) at 28 days of curing as per IS: 516 1959 and split tensile strength on cylinder (150 mm ø x 300mm) at 28 days of curing as per IS: 5816 1999. The work presented in this paper reports the effects on the behavior of concrete produced from cement with combination of FA and RHA at different proportions on the mechanical properties of concrete such as compressive strength, flexural strength, and split tensile strength. Investigation reported that compressive strength increases by 42% in compared with targeted strength and reduces by 2% compared with control concrete at 28 days, flexural strength increases by 2.86% compared with control concrete at 28 days, split tensile strength decreases by 11% compared with control concrete at 28 days, were obtained at combination of 15% FA and 20% RHA. Partial replacement of FA and RHA reduces the environmental effects, produces economical and eco-friendly concrete.**

Keywords: **Fly Ash, Rice husk Ash, Flexural Strength, Admixture (NaoH), Compressive Strength, Split Tensile Strength**

I. INTRODUCTION

Concrete is the most widely used construction material on this planet. Concrete is the mixture of cement, coarse aggregates, and fine aggregates with water.Concrete is a heterogeneous mix of cement, water and aggregates. The admixtures may be added in concrete in order to enhance some of the properties desired specially. In its simplest form, concrete is a mixture of paste and aggregates. Various materials are added such as fly ash, rice husk, and admixture to obtain concrete of desired property. The character of the concrete is determined by quality of the paste . The key to achieving a strong, durable concrete rests in the careful proportioning, mixing and compacting of the ingredients.In the ancient period, construction work was mostly carried out with help of mudstone from industry. Fly ash is a by-product of burned coal from power station and rice husk ash is the by product of burned rice husk at higher temperature from paper plant artificial fibers are commonly used nowadays in order to improve the mechanical properties of concrete. Considerable efforts are being taken worldwide to utilise natural waste and bye product as supplementary cementing materials to improve the properties of cement concrete. Rice husk ash (RHA) and Fly ash (FA) with using admixture is such materials. RHA is bye-product of paddy industry. Rice husk ash is a highly reactive pozzolanic material produced by controlled burning of rice husk. FA is finely divided produced by coal-fired power station(Fly ash possesses pozzolonic properties similar to naturally occurring pozzolonic material. Fly ash used in this project was collected from deenbandhu chhotu Ramthermal power station yamnagar Haryana India and Rice used was obtained from Chachu Majra Paper mill Raipura Mohali Punjab

Over the past years, there has been an increasing number of papers on the use and utilization of industrial, agricultural and thermoelectric plants residue in the production of concrete. Different materials with pozzolanic properties such as fly ash, condensed silica fume, blast-furnace slag and rice husk ash have played an important part in the production of high performance concrete. During the late 20th century, there has been an increase in the consumption of mineral admixture by the cement and concrete is met by partial cement replacement. Substantial energy and cost savings can result when industrial by-products are used as a partial replacement for the energy intensive Portland cement. Among the different existing residues and by products, the possibility of using rice husk ash in the production of structural concrete is very important for India.

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2.1 LITERATURE REVIEW

(Alvin Harison, 2014) Investigated out to study the utilization of non-conventional building material (fly ash) for development of new materials and technologies. It is aimed at materials which can fulfil the expectations of the construction industry in different areas. In this study, cement has been replaced by fly ash accordingly in the range of 0% (without fly ash), 10%, 20%, 30%, 40%, 50% and 60% by weight of cement for M-25 mix with 0.46 water cement ratio. Concrete mixtures were produced, tested and compared in terms of compressive strength. It was observed that 20% replacement Portland Pozzolana Cement (PPC) by fly ash strength increased marginally (1.9% to 3.2%) at 28 and 56 d respectively. It was also observed that up to 30% replacement of PPC by fly ash strength is almost equal to referral concrete after 56 d. PPC gained strength after the 56 d curing because of slow hydration process.

(Dr S L Patil, 2012) Investigated out to study the utilization of fly ash in cement concrete as a partial replacement of cement as well as an additive so as to provide an environmentally consistent way of its disposal and reuse. This work is a case study for Deep Nagar thermal power plant of Jalgaon District in MS. The cement in concrete matrix is replaced from 5% to 25% by step in steps of 5%. It is observed that replacement of cement in any proportion lowers the compressive strength of concrete as well as delays its hardening. This provides an environmental friendly method of Deep Nagar fly ash disposal.

Swamy etal (1983) reported that concrete mixes containing30 percent by weight of fly ash (ASTM Class F) could be proportioned tohave adequate workability and early one-day strength and elastic modulus forstructural applications. The dosages of admixtures or superplasticizers were adjusted to btain cohesiveness and workability with slumps in excess of 4inches(100mm) for easy placeability I structural members with steelreinforcement.

(ACamoes, 2003) Investigated the possibility of producing low cost enhanced performance concrete or even low ost High performance concrete(HPC), with 28 day strength in the range of upto 60 MPa, using low quality as received materials like fly ash and locally available crushed aggregates.
B) In this wa,significant reduction in the use of Portland cement, as well as that scarce natural resources would be obtained. The effect of amount of fly ash was evaluated using0, 20%, 40% and 60% cement replacement in the mixures with different quantities of toatal binder (400kg/m3, 500kg/m3 and 600kg/m3). Workability, mechanical and durability properties of the produced concretes were studied. Findings indicate that it is possible to produce HPC with upto 60 MPa by replacing upto 40% of cement by fly ash and using local available crushed granite aggregates.

(Shaswata Mukherjee, 2012) Investigated out to study the physical and mechanical property of high volume fly ash cement paste. Ordinary portland cement was replaced by 0, 20, 30, 40, 50, 60 and 70 % class F fly ash (by weight). Water- binder ratio in all mixture was kept constant at 0.3. Cube specimens were compacted in table vibrator. As expected bulk density decreases with fly ash increment in the mixture. Apparent porosity and water absorption value increases with replacement ofcement by fly ash. Results confirm the decrease in compressive strength at 3, 7 and 28 day with fly ash addition and it is more prominent in case of more than 30% fly ash content mixes. Ultrasonic pulse velocity test results indicate that the quality of the paste deteriorate with increase of fly ash content in the mixture

M.U Dabai, 2009) Investigated that compressive strength tests which were carried out on six mortar cubes with cement replaced by rice husk ash (RHA) at five levels (0, 10, 20, 30, 40 and 50%). After the curing age of 3, 7, 14 and 28 days. His findings that the compressive strengths of the cubes at 10% replacement were 12.60, 14.20,22.10, 28.50 and 36.30 N/mm2 respectively and increased with age of curing but decreased with increase in RHA content for all mixes. The chemical analysis of rice husk ash revealed high amount of silica (68.12%), alumina (1.01%) and oxides such as calcium oxide (1.01%) and iron oxide (0.78%) responsible for strength, soundness and setting of the concrete. It also contained high amount of magnesia (1.31%) which is responsible for the unsoundness. this indicated that RHA can be used as cement substitute at 10% and 20% replacement and 14 and 28 day curing age.

3.1 EXPERIMENTAL PROGRAMME
Experimental programme comprises of test on cement, RHA, FA, concrete with partial replacement of cement with RHA and FA.

3.1.1 Rice Husk Ash
Rice Husk Ash was tested for different tests and test results as follows:
Normal Consistency = 17%
Initial and Final Setting time = 195 min. and 265 min.
Compressive Strength = 11 N/mm^2
Specific Gravity = 2.86

3.1.2 Ordinary Portland Cement
Ordinary Portland cement of 43 grade were tested for different
Normal consistency = 22%
Initial Setting time = 23 min.
Final Setting Time = 365 min.
Specific Gravity = 3.15

3.1.3 Fine Aggregate
Specific Gravity 2.47
Water absorption 0.166
Free Moisture Content 2%

3.1.4 Coarse Aggregate
Specific garvity 2.54

Water absorption 01
Fee moisture Content 0.0%

3.1.5 Mix proportioning
The mix proportion was done as per the IS 10262- 1982 The target mean strength was 38.25 Mpa (M30) for the OPC control mixture, The concrete cubes were cured in the tank for 7,and 28 days for compression test, Flexural strength test and tensile strength test. Table below shows

MATERIAL	QUANTITY	PROPORTION
Cement	335 Kg/ m^3	1
Sand	715.32 Kg/ m^3	2.15
Coarse Aggregates	1104.62 Kg/ m^3	3.30
Water	167.5 Kg/ m^3	0.00
Slump	75-100 mm	-----

4.1 Experimental Methodology

Test on Fresh Concrete
Fresh concrete was tested using slump cone test to find the workability of control concrete and concrete of combination of FA and RHA with partial replacement of cement.

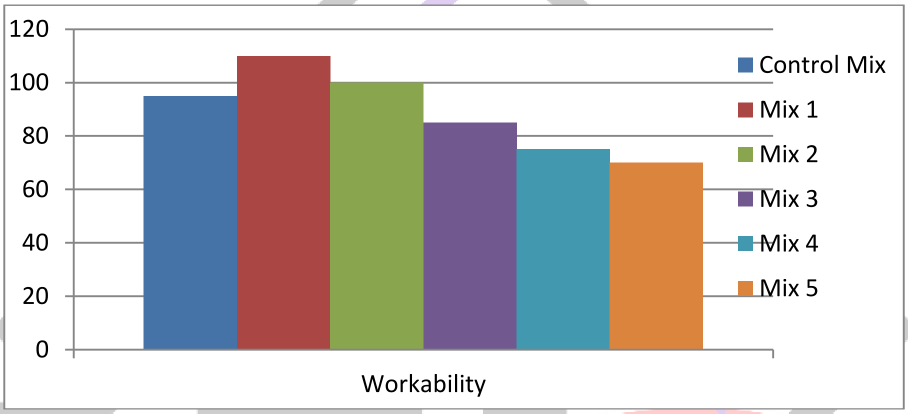

Fig.4.1 Variation of Workability with different mix proportions

Along Y axis of Histogram is different Slump Values and along Xaxis is control mix and mixes with different replacement of Fly ash and Rice Husk Ash

Figure 4.1 shows the comparative effects of addition of FA and RHA on workability of concrete. It was obser ved that FA increases the workability of concrete upto 15% as compared to control concrete. Gradual increase of RHA and gradual decrease FA shows gradual decrease in workability upto 20% as compared to compared concrete.

Addition of FA increases in workability because it has very low binding property and addition of RHA decreases workability due to water absorbent property because it has high specific surface area

4.2 TESTS ON HARDNED CONCRETE
Tests were done as per following codes of Bureau of Indian Standards. The test for compressive strength on cubes were measured at 7, 14, and 28 days of curing as per IS: 516 1959, test for flexural strength on beam was measured at 28 days of curing as per IS: 516 1959 [12] and test for split tensile strength on cylinder was measured at 28 days of curing as per IS: 5 816 1999

4.2.1 Compressive Strength Test
For compressive strength test, cube specimens of dimensions 150 x 150 x 150 mm were cast for M45 grade of concrete. The moulds were filled with different proportions of cement, Rice Husk Ash and Brick dust kilin. Vibration was given to the moulds using table vibrator. The top surface of the specimen was leveled and finished. After 24 hours the specimens were demoulded and were transferred to curing tank wherein they were allowed to cure for 7, and, 28 days. After 7 and 28 days curing, these cubes were tested on manual compression testing machine as per I.S. 516 1959. The failure load was noted. In each category, three cubes were tested and their average value is reported.
The compressive strength was calculated as follows:

Compressive strength (MPa) = Failure load / cross sectional area.

4.2.2 Flexural Strength Test.

The standard sizes of beam specimen were 15x15x70 cm. The beam moulds conform to IS:10086 1982 uring: The specimens were demoulded after 24 hours of casting and were transferred to curing tank where in they were allowed to cure for 28 days.. Test specimens shall be stored in water at a temperature of 24^0 34 ^{0}c for 48 hours before testing. These specimens were tested under flexural testing machine The specimens shall be tested immediately on removal from the water while they are still in the wet condition.: Flexural strength is calculated by $fb=pl/bd^2$

4.2.3 Tensile Strength Test.

For tensile strength test, cylinder specimens of dimension 150 mm diameter and 300 mm length were cast. The specimens were demoulded after 24 hours of casting and were transferred to curing tank where in they were allowed to cure for 28 days. These specimens were tested under compression testing machine. In each category, three cylinders were tested and their average value was reported

Tensile strength was calculated as follows as split tensile strength:

Tensile strength (MPa)=2P/π DL Where, P = failure load, D = diameter of cylinder, L = length of cylinder.

5.1 EXPERIMENTAL RESULTS

Results of M30 grade of OPC concrete filled with various proportions of Rice Husk Ash and Fly Ash for compressive strength, split tensile strength also for flexural strength test are shown in table below.

Table 5.1 Results of Compressive Strength

Mix Design	% of fly ash	% of RHA	Compressive strength after 7 days	Compressivestrength after 28 days
Mix C	0	0	30	50
Mix 1	30	5	25.22	48.22
Mix 2	25	10	23.37	49.10
Mix 3	20	15	20.33	47.00
Mix 4	15	20	18.17	35.68
Mix 5	10	25	16.17	28.00

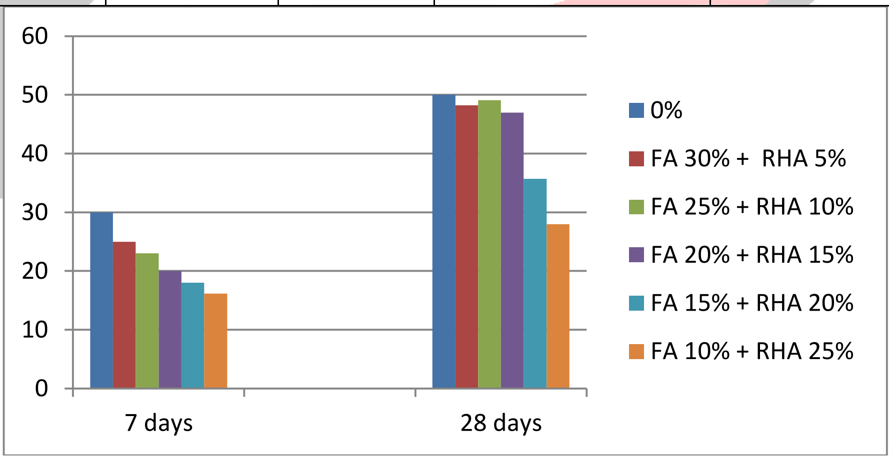

Fig 5.1 Comparison of compressive strength for different % of RHA and FA

In the histogram above along the Y-axis is Compressive strength of different mixes and along X-axis is control mix and mixes with different replacement of Fly ash and Rice Husk Ash after 7, 14, 28 days of curing

Figure 5.1 indicates the comparison of results of compressive strength using cube specimen of M30 grade of concrete for different percentage of cement, RHA and FA. Target strength of M30 concrete was 38.25 Mpa, but convention concrete gives 49.10 Mpa compressive strength at 28 days of curing. Comparative work shows maximum compressive strength obtained at combination of 25% FA and 10% RHA which was less than strength of control con rete but greater than target strength. It was observed that 42% strength was increase as compared to target strength and 2% strength decreases as compared to control concrete at 28 days of curing

TABLE 5.2 FLEXURAL STRENGTH AFTER 28 DAYS OF CURING

DESIGN MIX	% OF FLY ASH	% OF RICE HUSK ASH	FLEXURALSTRENGTH AFTER 28 DAYS
MIX C	0	0	8.76
MIX 1	30	5	7.87
MIX 2	25	10	8.96
MIX 3	20	15	7.23
MIX4	15	20	6.87
Mix 5	20	15	5.17

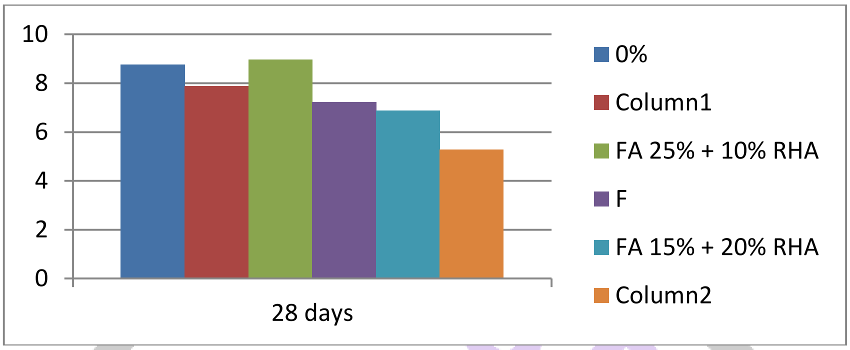

Fig 5.2 Flexural Strength after 28 days of curing

In the histogram above along the Y-axis is Flexural strength of different mixes and along X-axis is control and mixes with different replacement of Fly ash and Rice Husk Ash after 28 days of curing

Fig 5.2 Comparison of flexural strength for different % of RHA and FA at 28 days of curing and deflection of beam

Figure indicates the comparison of result of flexural tensile strength using beam specimens of M30 grade of concrete Beams wer tested after 28 days of curing for Flexural Strength. It was observed that maximum flexural strength was obtained at combination of 25% FA and 10% RHA and strength was increase by 2.86% as compared to control concrete at 28 days of curing

TABLE 5.3 SPLIT TENSILE STRENGTH AFTER 28 DAYS OF CURING

DESIGN MIX	% OF FLY ASH	% OF RICE HUSK ASH	SPLIT TENSILE STRENGTH AFTER 28 DAYS
MIX C	0	0	5.42
MIX 1	30	5	5.37
MIX 2	25	10	4.90
MIX 3	20	15	4.11
MIX4	15	20	3.96
Mix 5	10	25	2.96

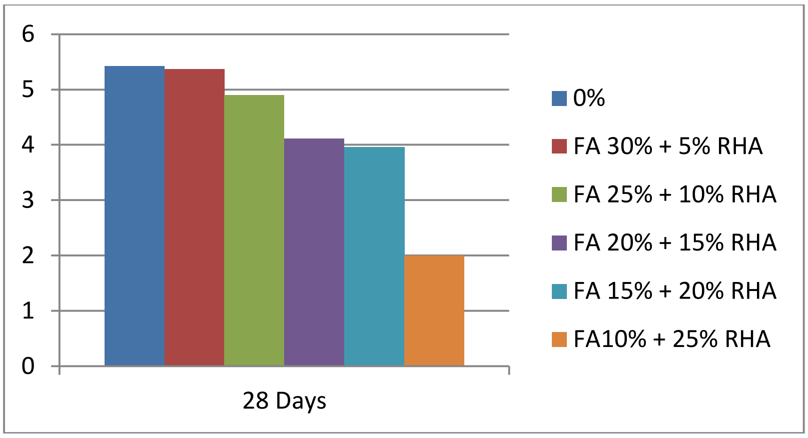

Fig 5.3 Shows tensile strength after 28 days of curing

In the histogram above along the Y-axis is Split Tensile Strength of different mixes and along X-axis is control and mixes with different replacement of Fly ash and Rice Husk Ash after 28 days of curing

Figure5.3 indicates the comparison of result of splitting tensile strength using cylindrical specimens of M30 grade of concrete It was observed that split tensile strength at the combination of 25% FA and 10% RHA decreases by 11% as compared to control concrete at 28 days of curing.

5.2 CONCLUSION

1) In this research it was investigated that fly ash is a pozzolanic material but having very low binding property so it increases the workability of concrete when it is replaced 25% with gradual increase of Rice husk ash and decrease of fly ash reduces the workability of concrete as Rice husk ash is highly poros material so it has more water absorbent property on the other side it has low specific gravity which reduces mass per unit volume so it makes the structure light in weight.Excess of tthese two materials in our environment create more environment pollution so these can be used with cement replacement in concrete to reduce its ill effects on environment. As we know cement is costly material.when cement is replaced with these waste minerals can make our strucrture economical.

2) Compressive strength increases with the increase in the percentage of Fly ash and Rice Husk Ash up to replacement (25%FA and 10% RHA) of Cement in Concrete for different mix proportions.

3) The maximum 28 days split tensile strength was obtained with combination of 25% Fly ash and 10% rice husk ash mix in all combinations which was less than control concrete.

4) The maximum 28 days flexural strength was obtained with combination of 25% fly ash and 10% rice husk ash mix.

5) The percentage of water cement ratio is reliant on quantity of RHA used in concrete. Because RHA is a highly porous material

6) The workability of concrete had been found to be decrease with increase RHA in concrete .

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