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An Experimental Study on Compressive Strength of Reinforced Concrete Cubes using Wheat Husk Ash & Rice Husk Ash as a Partial Replacement of Cement

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Abstract: ***In the current period of speedy transportation development, availability of costly construction materials is increasing in India. India is a crop growing based country because of its farming economy so many infrastructural changes are growing on day by day and scenario of India has been changed in the form of agricultural construction. Low cost construction materials like wheat straw ashes are to be used with concept of right amount of skills, technologies, design aids, performance of worker without degrading the quality control of materials. A series of experiments have been conducted in laboratory to compute mechanical properties of concrete like initial and final setting time of concrete, workability test, and compressive strength of reinforced cement concrete cubes for M-20 grade including wheat straw ash and rice husk ash as a partial replacement materials of cement by varying percentage of WSA and RHA. By conducting this experiment and keeping in view of an R.C. pavement with low cost materials like wheat straw ash and rice husk ash it is noticed that this low cost materials will give higher strength because wheat straw ash and rice husk ash are having high silica contents like 90% to 95% respectively and silica content is much more beneficial for any types of cement for gaining higher strength.***

Keywords: Rice Husk Ash, Wheat Husk Ash, R.C. Pavement, Compressive Strength

1. Introduction

In the present era of rapid infrastructure development, availability of costly construction materials is increasing in India. India is an agriculture based country because of its agricultural economy so many infrastructural changes are growing on day by day and scenario of India has been changed in the form of agricultural construction. Since also now-a-days there are many agricultural products are growing day-by-day using well stabilized techniques in the form of better irrigation infrastructure system for Indian farmers. In Madhya Pradesh (M.P.) zone, each year, thousand tons of agricultural residues like as Wheat Husks are produced. Amorphous silica is produced by maintaining the combustion temperatures between 500°C-600°C under oxidizing conditions for prolonged period. The ash produced after the husks have been burned is known as wheat straw ash. It contains 85-95% silica and can be an economically available raw material for the production of silicates and silica. From Rice Husk Ash 85% silica contents produced, in very small particle size of less than 30 microns – Silpozz for application in High Performance Concrete. Thompson etal [1] studied and prepared technical report of bi-product of wheat straw. Goyal etal [2] did experimental analysis on wheat husk ash and rice husk ash with different percentage for using as a binding material. Sani Aliyu etal [3] studied experimental analysis on concrete workability using WHA and RHA. Khatri [4] did experimental analysis on compressive strength of concrete cubes including admixture and rice husk ash. Jain etal [5] conducted an experimental comparison study on compressive strength using wheat husk ash, rice husk ash, saw dust ash etc. Usman etal [6] Observed behavior of wheat straw reinforced concrete for improving micro shrinkage cracks observed in concrete pavements by using steel and artificial fibers. In all these study the point of observation is that none of the study has been conducted on reinforced concrete cubes for road pavement construction work using wheat husk ash and rice husk ash as a partial replacement of cement. By keeping it from point of view an experimental analysis has been carried out in REC college Material Lab, Bhopal. Observations have been taken and results are plotted in excel sheet to show difference between compressive strength of reinforced and without reinforced cubes using WHA and RHA as a partial replacement of cement.

2. Methodology

For doing experimental work cement, sand and aggregates are taken as per I.S. code 456-2000 for M-20 grade of concrete. Reinforced diameter is kept constant as 8 mm for all the work. Table 1 shows the required quantity of materials used in the lab work such as WHA and RHA as for as reinforcing bar diameter as 8 mm has been used. These reinforcing bars are used in cubes because to check reinforcing strength of cubes in compressing testing machine.

Table 1: Materials required For Preparation of 3 concrete cubes

S. No	*Material*	*Quantity*	*Unit*
1	Cement	6	Kg
2	Sand	9	Kg
3	Aggregate	18	Kg
4	WHA-5% with and without reinforcement	300	Gram
5	WHA- 15% with and without reinforcement	900	Gram
6	WHA- 30% with and without reinforcement	1800	Gram
7	Water	3	Litre
8	RHA-5% with and without reinforcement	300	Gram
9	RHA- 15% with and without reinforcement	900	Gram
10	RHA- 30% with and without reinforcement	1800	Gram
11	Reinforcement diameter	8	mm

First of all initial and final setting time of cement was found out as per consistency of cement. Then workability of concrete by Slump Cone Apparatus was found out. After completion of these tests according to above given materials in Table No. 1 cubes were molded in mould size 150 mm by 150 mm for 7, 14 and 28 days including 5%, 15% and 20% Wheat Husk Ash & Rice Husk Ash respectively. These cubes were again molded including reinforcing bars of 8 mm diameter also at a space of 5 c.m. centre to centre above the one thick layer of concrete once for WHA and next for RHA percentage wise as mentioned above for 7, 14 and 28 days respectively. Reinforcement has been used in mesh form only. Water cement ratio was taken as 0.45 for all the experimental analysis. Ordinary Portland cement grade- 43 is kept constant throughout the work. These cubes are then tested in compressive testing machine after proper curing. Table 1 describes quantity of materials used in all the experimental work. Before using Wheat Husk Ash & Rice Husk Ash as a partial replacement of cement they were tested for sieve analysis to remove garbage unwanted materials and then for moisture content determination to find out actual moist in them before mixing with cement, sand and aggregates with water and then for ash content at different temperatures like at 400°C, 500°C and 600°C respectively and it was found that right temperature for WHA is 600°C because wheat husk is more heavy as compared to rice husk so in this regard right temperature for RHA is to be found out 450°C. at this temperature color of ash was actually grayish color just like as cement.

3. Experimental Analysis

In laboratory experimental work compressive strength of concrete cubes for different conditions as given in Table No. 1 are observed and calculated. In this table quantity of materials has been mentioned only for 3 cubes while this not sufficient for above no. of cubed molded so as per M-20 grade ratio is 1:1.5:3 and according to that quantity of materials have been increased. Here tables are tabulated below shows the experimental results of laboratory. In which Table 2 shows compressive strength of concrete cubes without using WHA and RHA with and without reinforcement.

Table 2: Compressive strength of concrete cubes without WHA & RHA comprises only normal concrete and reinforced concrete

No. of Days	*Compressive Strength of Normal Concrete N/mm^2*	*Compressive Strength of Reinforced Concrete* N/mm^2
7	16.1	18.65
14	17.8	20.76
28	18.0	22.3

Table 3: Compressive strength of concrete cubes with 5%, 15%, 20% WHA without reinforcement

No. of Days	*Compressive Strength of Concrete cubes with 5% WHA N/mm2*	*Compressive Strength of Concrete cubes with 15% WHA N/mm2*	*Compressive Strength of Concrete cubes with 20% WHA N/mm2*
7	19.5	21.01	22.01
14	21.9	24.10	25.10
28	23.01	25.59	27.83

Table 4: Compressive strength of concrete cubes with 5%, 15%, 20% WHA with reinforcement

No. of Days	*Compressive Strength of Concrete cubes with 5% WHA+ Reinf N/mm2*	*Compressive Strength of Concrete cubes with 15% WHA+ Reinf N/mm2*	*Compressive Strength of Concrete cubes with 20% WHA+ Reinf N/mm2*
7	21.11	25.01	27.40
14	23.71	28.9	31.0
28	25.50	30.3	33.8

Table 5: Compressive strength of concrete cubes with 5%, 15%, 20% RHA without reinforcement

No. of Days	*Compressive Strength of Concrete cubes with 5% RHA N/mm2*	*Compressive Strength of Concrete cubes with 15% RHA N/mm2*	*Compressive Strength of Concrete cubes with 20% RHA N/mm2*
7	20.15	21.01	22.01
14	22.55	24.10	25.10
28	24.37	25.59	27.83

Table 6: Compressive strength of concrete cubes with 5%, 15%, 20% RHA with reinforcement

No. of Days	*Compressive Strength of Concrete cubes with 5% RHA+ Reinf N/mm2*	*Compressive Strength of Concrete cubes with 15% RHA+ Reinf N/mm2*	*Compressive Strength of Concrete cubes with 20% RHA + Reinf N/mm2*
7	22.72	27.27	28.15
14	25.88	30.21	31.90
28	27.24	32.67	34.40

4. Results & Discussions

Above experimental results are graphically plotted in excel sheet.

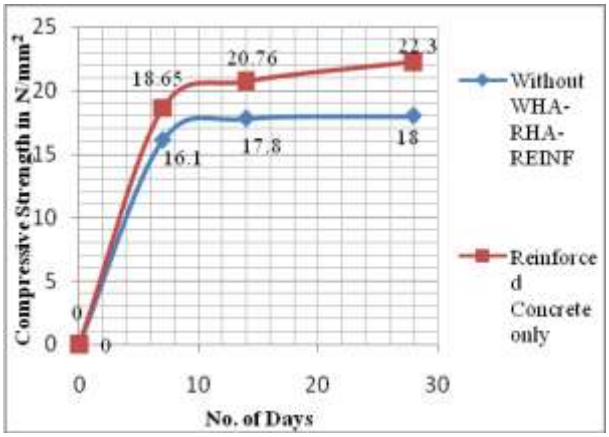

Figure 1: Compressive strength of Concrete cubes on 7, 14 and 28 days without using WHA, RHA with Plane and Reinforced Concrete

As shown in Figure 1 that compressive strength is increasing for reinforced concrete cubes on 7 to 28 days curing. Percentage of strength increment is 15.83% on 7 days, 16.62% on 14 days and 19.2% on 28 days by using reinforcement as compared to without reinforcement i.e. normal concrete.

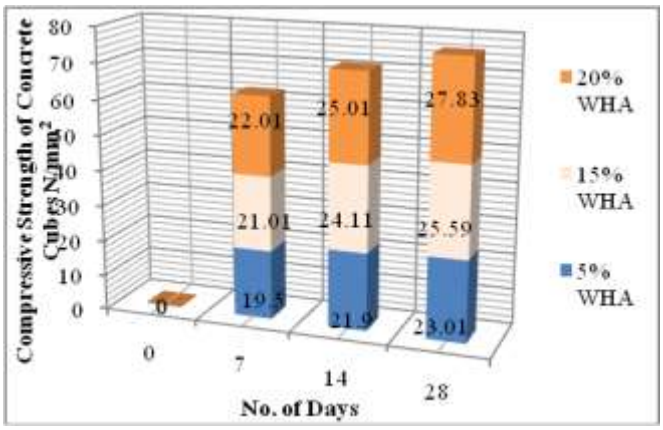

Figure 2: Compressive strength of Concrete cubes on 7, 14 and 28 days with 5%, 15%, and 20% WHA

In above tables it has been already discussed that by inclusion of WHA as a partial replacement of cement in normal concrete compressive strength of concrete cubes is increased continuously so in this regard in Figure 2 a comparison study has been carried out to show the difference between 5%, 15% and 20% WHA. As shown in figure that as compared to 5% WHA compressive strength is increased 10.08% on 28 days for 15% WHA and when WHA is used 20% so compressive strength is increased 8.05% on 28 days as compared to 15% WHA as a partial replacement of cement. Similarly, comparison study was conducted between 5% and 20% WHA on 28 days w.r.t compressive strength so it was found that strength is increased about 17.31%. It is also studied that compressive strength of concrete cubes is increased about 21.77%, 29.66% and 35.32% with inclusion of 5%, 15% and 20% WHA respectively on 28 days as compared to normal concrete as shown in Figure 1.

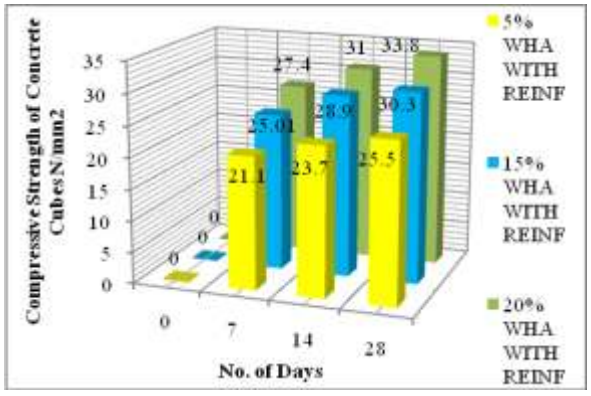

Figure 3: Compressive strength of Concrete cubes on 7, 14 and 28 days with WHA plus Reinforced Concrete

As it has already been discussed in previous graphs that by inclusion of WHA as a partial replacement of cement in normal concrete plus reinforcement in the form of 8mm diameter reinforcing bars at a distance of 5c.m. centre to centre, compressive strength is increased continuously so in this regard in Figure 3 a comparison study has been carried out to show the difference between 5%, 15% and 20% WHA with reinforcement. As shown in above Figure no. 3 that when comparison was done between 5% and 20% WHA plus reinforcement on 28 days w.r.t compressive strength so it was found that strength is increased about 24.55%. It is also studied that compressive strength of concrete cubes is increased about 12.54%, 26.40% and 34.02% with inclusion of 5%, 15% and 20% WHA plus reinforcement respectively on 28 days as compared to reinforced concrete only as shown in Figure no.1 in which it is clarified that when normal concrete is used in the construction so it gives less strength but when reinforcement bars are used in that so compressive strength of concrete is increased. When Wheat husk ash and Rice husk ash are used in concrete so workability is increased and simultaneously compressive strength of normal concrete cubes and reinforced concrete cubes is increased according to percentage of WHA and RHA.

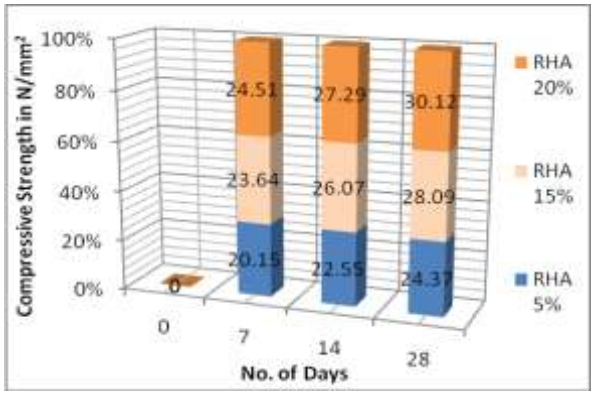

Figure 4: Compressive strength of Concrete cubes on 7, 14 and 28 days using 5%, 15% and 20% RHA without reinforcement

After a brief discussion from previous graphs it was found that by inclusion of RHA as a partial replacement of cement in normal concrete compressive strength is increased continuously as compared to WHA so in this regard in Figure 4 a comparison study has been carried out to show the difference between 5%, 15% and 20% RHA. As shown in

Figure 4 that as compared to 5% RHA compressive strength is increased 13.24% on 28 days for 15% RHA and when RHA is used 20% so compressive strength is increased 6.73% as compared to 15% RHA on 28 days.

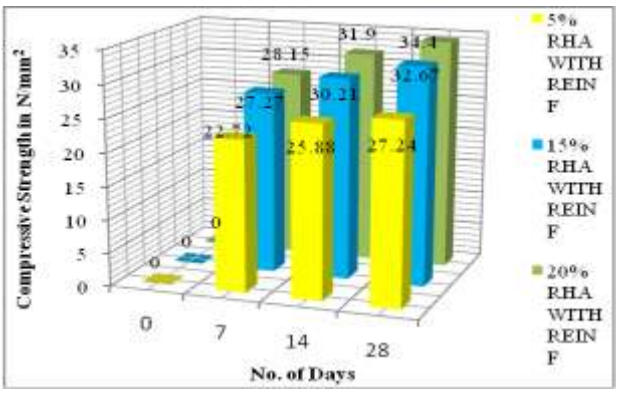

Figure 5: Compressive strength of Concrete cubes on 7, 14 and 28 days using 5%, 15% and 20% RHA with reinforcement

As it has already been discussed in previous graphs that by inclusion of RHA as a partial replacement of cement in normal concrete plus reinforcement in the form of 8mm diameter reinforcing bars at a distance of 5c.m. centre to centre, compressive strength is increased continuously so in this regard in Figure 5 a comparison study has been carried out to show the difference between 5%, 15% and 20% RHA with reinforcement. As shown in above figure no. 5.19 that when comparison was done between 5% and 20% RHA plus reinforcement on 28 days w.r.t compressive strength so it was found that strength is increased about 20.81%. It is also studied that compressive strength of concrete cubes is increased about 18.13%, 31.74% and 35.17% with inclusion of 5%, 15% and 20% RHA plus reinforcement respectively on 28 days as compared to reinforced concrete only as shown in Figure no. 1.

5. Conclusions

1) Compressive strength of 15% WHA without reinforcement but with normal concrete as compared to 5% wheat husk ash is increased about 23.36% on 7 days, 26.17% on 14 days and 29.66% on 28 days respectively.
2) Compressive strength of 15% WHA with reinforcement is increased about 25.42% on 7 days, 28.16% on 14 days and 26.40% on 28 days as compared to reinforced concrete respectively.
3) Compressive strength of 20% WHA without reinforcement but for normal concrete is increased about 26.85% on 7 days, 28.82% on 14 days and 35.32% on 28 days respectively.
4) Compressive strength of 20% WHA with reinforcement is increased about 31.93% on 7 days, 33.03% on 14 days and 34.02% on 28 days as compared to reinforced concrete respectively.
5) Compressive strength is found to be increased for RHA cubes as compared to normal concrete cubes i.e. 20.09% on 7 days, 21.06% on 14 days and 26.12% on 28 days respectively.
6) Compressive strength of 5% RHA with reinforcement is increased about 17.91% on 7 days, 19.78% on 14 days and 18.13% on 28 days as compared to reinforced concrete respectively.
7) Compressive strength of 15% RHA without reinforcement but with normal concrete is increased about 31.89% on 7 days, 31.17% on 14 days and 35.92% on 28 days respectively.
8) It is also concluded that compressive strength of concrete cubes is increased about 21.77%, 29.66% and 35.32% with inclusion of 5%, 15% and 20% WHA respectively on 28 days as compared to normal concrete.
9) It is also concluded that compressive strength of concrete cubes is increased about 12.54%, 26.40% and 34.02% with inclusion of 5%, 15% and 20% WHA plus reinforcement respectively on 28 days as compared to reinforced concrete only.

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Author Profile

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