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THE EFFECT OF NITRIC ACID ON CONCRETE MADE USING RICE HUSK ASH, STONE DUST AND STEEL FIBRE

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Abstract: This experimental study report, analyze the effect of nitric acid on concrete made using rice husk, stone dust and steel fiber was investigated. M25 grade of concrete samples containing some rice husk in partial replacement of cement (OPC) is proposed. In second portion of this research sand is replaced in some part by stone dust after finding the compressive strength. In the above process of finding compressive strength we take steel fiber as 1% of the volume of cement.

All the sample taken by varying quantity discuss above were tested for the strength and durability under the acidic environment of 5% Nitric acid exposure for 56 days.

RC- referral M25 concrete with OPC, RHAC- this concrete contain the optimum Rice Husk Ash level of 15% as a part replacement of OPC and Optimum Stone dust 45% use id replaced of natural sand. SFRHASDC- this sample of concrete contain 1% of steel fiber and optimum rice husk ash with stone dust. The compressive strength test for above mentioned sample is determine after 7, 28, and56 days.

It was observed that the nitric acid resistance of RHAC, RHASDC, and SFRHASDC was higher than the RC.Visual assessments were also carried out and photographs were taken to get some idea about how nitric acid affects the appearance of concrete.

1. INTRODUCTION

Concrete is made up of lime, it is most consumed material on earth after water. The most consumed material on earth for construction material is cement. The cement is manufactured artificially, final products of cement is used for many construction work sites. Mixture of coarse and fine aggregate with water and cement as a binding material in definite proportion is known as concrete. Admixture and additive in powdered form are some time used with concrete to improve to improve its quality and characteristics of final herded concrete. The concrete become hardened because of chemical reaction in between water and cement, concrete get gardened with time by loss of heat of hydration. But at present the durability of concrete and concrete structures has become a major concern. Including the durability problem of concrete, there are some other problems associated with the materials used in concrete production which are discussed in this chapter.

1.1 Objectives

1. To study the effect of inclusion of Rice Husk Ash (RHA) on the compressive strength of concrete and to find its optimum dose.

2. To study the effect of inclusion of Stone Dust on compressive strength of Rice Husk Ash Concrete and to find its optimum dose.

3. To study the effect of inclusion of steel fiber on Rice Husk Ash and Stone dust (RHASD) concrete.

4. To find the effect of acidic environment (Nitric Acid) on the selected concretes in respect of compressive strength and visual change.

2. MATERIAL USED FOR EXPERIMENT

2.1 Cement

Ordinary Portland Cement of Grade 43 (brand Shree cements) obtained from only single batch and same plant used throughout this investigation. The various physical properties such as standard consistency, initial and final setting time, fineness and compressive strength of OPC are determined and the values conform to the requirements of IS 8112-1989, 2013.

Specific gravity of cement was 3.15 obtained.

2.2 Aggregates

i. Fine aggregates: Those aggregates which pass through the IS sieve of gauge 4.75mm are fine aggregates. The fine aggregate is important in concrete as it shows the workability and uniformity in the mixture. According to IS 383:1970, the fine aggregate have divided into four different zones, that is Zone-I, Zone-II, Zone-III and Zone-IV. The selected river sand belongs to granding zone-II. as per IS 383:1970 IS sieve of 10mm, 4.75mm, 2.36mm, 1.18mm, 600µ, 300µ, 150 µ, were used for gradation test. physical properties of fine aggregates such as specific gravity, gradation, water absorption, bulk density, fineness modulus, were tested according to IS 2386-1963. Calculated specific gravity is 2.48 and water absorption is 0.54%. fineness modulus is 2.492.

ii. Coarse aggregates: mainly size of coarse aggregates is 10mm, 20mm, 40mm etc. as per IS 383-1970 IS sieve of 40mm, 20mm, 12.5mm, 10mm, 4.75mm, 2.36mm were used for gradation test. physical properties of coarse aggregates such as specific gravity, gradation impact test, water absorption, bulk density, were tested according to IS 2386-1963.calculated specific gravity is 2.68. Water absorption is 0.65%. Fineness modulus for 10mm & 20mm is 6.25, 7.27.

2.3 Rise Husk Ash

The rice husk was obtained from ASTRRA CHEMICALS, JAIPUR. Based on the data presented in Table 1 and with ASTM C618:2003 definition, i.e. for a material to be classified as pozzolanic, it should have SiO_2 minimum of 70%, while for loss of ignition (LOI) a maximum of 6%. Therefore from this study, the RHA used can be classified as Class N pozzolanic. The LOI for RHA is about 5.81%.

Table: 1 properties of Rise Husk Ash

Physical properties	RHA
Specific gravity	2.15
Mean grain size (µm)	2.54
Specific area cm^2 / gm	150000-180000
Color	BROWN
Chemical compositions (%)	
Silicon dioxide (SiO_2)	88.32
Aluminum oxide (Al_2O_3)	0.46
Iron oxide (Fe_2O_3)	0.67
Calcium oxide (CaO)	0.67
Magnesium oxide (MgO)	0.44
Sodium oxide (Na_2O)	0.12
Potassium oxide (K_2O)	2.91
Loss on ignition	5.81

2.4 Stone Dust

Grey colour stone dust was collected from local stone crushing units of jaipur. It was initially dry in condition and thoroughly retained on IS 150 µ sieve before preparation of mix. According to IS 383 IS sieve of 4.75mm, 2.36mm, 1.18mm, 600µ, 300µ, 150µ used for gradation test. Physical properties of stone dust such as specific gravity, fineness modulus, water absorption, etc. calculated specific gravity is 2.35. Water absorption is 0.50%. Fineness modulus is 2.32.

2.5 Hooked Steel Bar

The properties of the fibre are as follows:

Length (l)=59mm

Least dimension (d)=0.80

Aspect Ratio (l/d) =73.75

2.6 Nitric Acid

The nitric acid used for creating the acidic environment was of brand of EMPLURA. The specific gravity of nitric acid was 1.41 and normality was 69 %.Fig. shows the photograph of nitric acid container.

3. EXPERIMENTAL WORK

3.1 Mix Design

The concrete mix design was carried out as per the procedure given in IS: 10262(2009).

The Following stipulations were made.

1. Max size of coarse aggregate – 20 mm.

2. Degree of quality control – Good

3. Type of exposure – Extreme

Table presents the mix proportion of referral concrete M25 grade concrete.

Table: 2 Final Mix Proportions Obtained per m^3 of Concrete

Ingredients	Water	Cement	F.A	C.A
Quantity	186 lit.	465kg	610 kg	1145 kg
Ratio	0.40	1	1.31	2.46

3.2 Details of Experimental Set Up

After obtaining mix proportion of the referral concrete, the optimum quantity Rice Husk Ash replacement level in concrete was determined thereafter the optimum replacement level of Stone Dust in Rice Husk Ash concrete was determined. The optimum replacement levels were determined based on the 7 day and 28 day compressive strength. The optimum quantity of Rice Husk Ash was determined by varying the replacement levels of cement with Rice Husk Ash with cement. Similarly, the optimum quantity of Stone dust in the Rice Husk Ash concrete was determined by varying the replacement levels of natural sand by Stone Dust. After obtaining the optimum quantities of Rice Husk Ash replacement level and Stone Dust replacement level, cubes of Rice Husk Ash Concrete (RHAC), Rice Husk Ash Concrete-Stone dust (RHASDC) and Rice Husk Ash Concrete Stone dust concrete with Steel Fibre (SFRHASDC) were cast. After demoulding, the specimens were immersed separately both in Tap Water and 5% HNO_3 Solution. The pH of Nitric Acid solution was maintained lower than 4.

3.3 Compressive Strength Test of Specimens

The compressive strength was measured after 7and 28 day immersions in water to find out the optimum dose of Rice Husk Ash in concrete. Thereafter, the cubes were cast with different percentages (15%, 30%, 45%, 60%, and 75%) of Stone Dust in concrete containing optimum dose of Rice Husk Ash and cured in water for 7and 28day period before compressive strength test. After knowing optimum dose of Rice Husk Ash and Stone dust, samples of Referral concrete (RC), RHAC, RHASDC and SFRHASDC were prepared and compressive strength of the cube specimens were measured after 7, 28 and 56 days immersion separately in tap water and 5 % HNO_3 solution.

4. RESULTS

4.1 Effect of Nitric Acid on Compressive Strength of Diffrent Concretes.

The effect of Nitric acid on different concrete types-Referral Concrete (RC), Rice Husk Ash concrete (RHAC), Rice Husk Ash concrete-stone dust (RHASDC), Rice Husk Ash concrete-stone dust with steel fibre (SFRHASDC) is presented in this section. The specimens were cured separately in tap water and 5% HNO_3solution. The readings were taken at 7, 28 and 56 days.

4.2 Compressive Strength at 7 Day Exposure

The loss in compressive strength after 7 days of Nitric acid exposure is 15.61%, 11.44%, 18.42%, 12.23% for RC, RHAC, RHASDC, and SFRHASDC respectively. Table shows the comparison between the strength of specimens at 7 day cured in water and 5% HNO_3.

Table: 3 compressive strength of different concrete at 7 days

Type of Concrete	Comp. Strength (in MPa) (Cured in Water)	Comp. Strength (in MPa) (Cured in 5% HNO_3 Solution)	% Loss of Comp. Strength
RC	19.34	18	6.92%
RHAC	21.44	19.57	8.72%
RHASDC	23.32	21.26	8.83%
SFRHASDC	26.54	24.86	6.33%

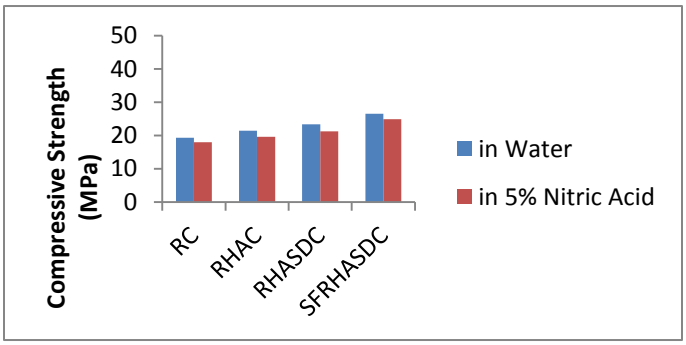

Fig.1.7 day Compressive Strength of different types of concrete in water & 5% nitric acid

4.3 Compressive Strength at 28 Day Exposure

The loss in compressive strength after 28 days of Nitric acid exposure is 11%, 12.92%, 12.29%, and 12.98% for RC, RHAC, RHASDC, and SFRHASDC respectively.Fig. shows the comparison between the strength of specimens at 28 day cured in water and 5% HNO_3.

Table: 4 compressive strength of different concrete at 28days

Type of Concrete	Comp. Strength (in MPa) (Cured in Water)	Comp. Strength (in MPa) (Cured in 5% HNO_3 Solution)	% Loss of Comp. Strength
RC	26.59	24.32	8.53%
RHAC	28.78	25.14	12.64%
RHASDC	30.38	27.36	9.94%
SFRHASDC	33.62	31.18	7.25%

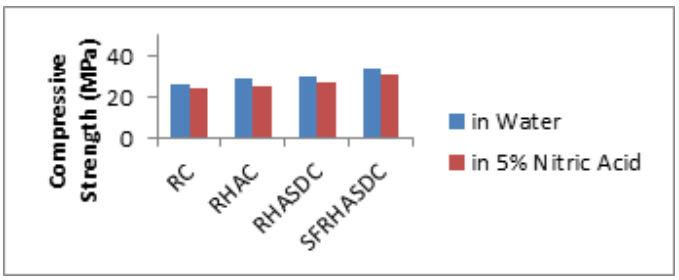

Fig. 2. 28 day Compressive Strength of different types of concrete in water & 5% nitric acid

4.4 Compressive Strength at 56 Day Exposure

The loss in compressive strength after 56 days of Nitric acid exposure is 9.23%, 11.20%, 11.71%, and 10.71% for RC, RHAC, RHASDC, and SFRHASDC respectively. Fig. shows the comparison between the strength of specimens at 56 day cured in water and 5% HNO_3

Table: 5 compressive strength of different concrete at 28 days

Type of Concrete	Comp. Strength (in MPa) (Cured in Water)	Comp. Strength (in MPa) (Cured in 5% HNO_3 Solution)	% Loss of Comp. Strength
RC	39.67	36.00	9.23%
RHAC	41.67	37.00	11.20%
RHASDC	42.67	37.67	11.71%
SFRHASDC	46.67	41.67	10.71%

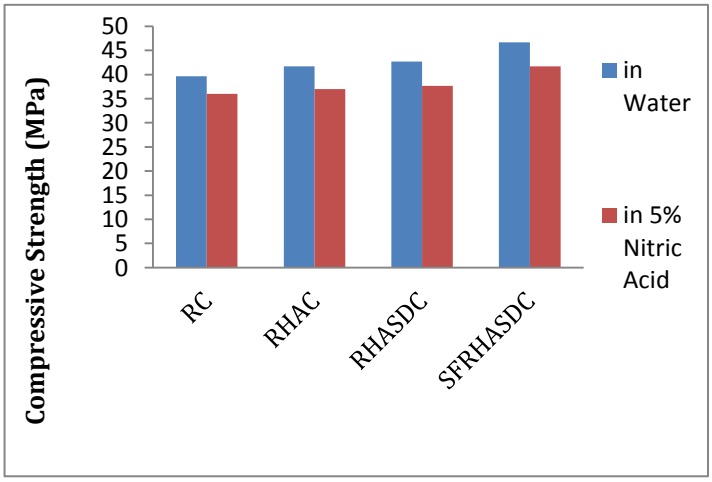

Fig. 3.56 day Compressive Strength of different types of concrete in water & 5% nitric acid

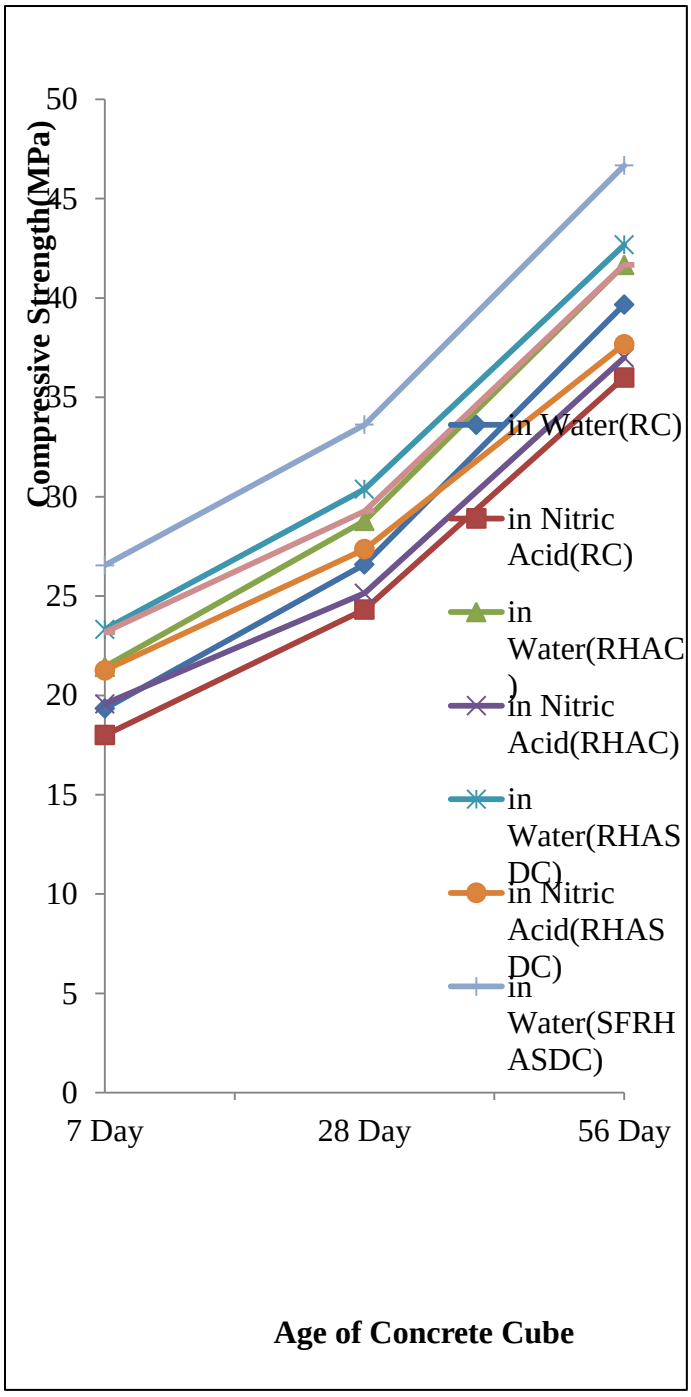

Fig 4: Variation in Compressive Strength of RC, RHAC, RHASDC, SFRHASDC with Age

5. CONCLUSIONS

Comparison of Compressive Strength of Different Concrete Mixtures

1. The compressive strength of Rice Husk Ash-Stone Dust Concrete with Steel Fibre (SFMKSDC) was higher in all cases considered.

2. The 7day Compressive Strength of RC samples immersed in 5% $HNO_3$was 15.61% less than those immersed in Water.

3. The 7 day Compressive Strength of RHAC samples immerged in 5% HNO_3was11.44% less than those immersed in Water.

4. The 7 day Compressive Strength of RHASDC samples immerged in 5% HNO_3was18.42% less than those immersed in Water.

5. The 7 day Compressive Strength of SFRHASDC samples immerged in 5% HNO_3was12.23% less than those immerged in Water.

6. The 28 day Compressive Strength of RC samples immerged in 5% HNO_3was11% less than those immersed in Water.

7. The 28 day Compressive Strength of RHAC samples immerged in 5% HNO_3was12.92% less than those immersed in Water.

8. The 28 day Compressive Strength of RHASDC samples immerged in 5% HNO_3was12.29% less than those immersed in Water.

9. The 28 day Compressive Strength of SFRHASDC samples immerged in 5% $HNO_3$was 12.98% less than those immersed in Water.

10. The 56 day Compressive Strength of RC samples immerged in 5% HNO_3was9.23% less than those immersed in Water

11. The 56 day Compressive Strength of RHAC samples immerged in 5% HNO_3was11.20% less than those immersed in Water.

12. The 56 day Compressive Strength of RHASDC samples immerged in 5% HNO_3was11.71% less than those immersed in Water.

13. The 56day Compressive Strength of SFRHASDC samples immerged in 5% HNO_3was10.71% less than those immersed in Water.

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