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EXPERIMENTAL STUDY ON RICE HUSK ASH AS COARSE AGGREGATE IN CONCRETE

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Abstract- Rice milling industries produce a byproduct named husk. This surrounds the paddy grain. While milling 78% of weight is retained as rice, bran and broken rice. Remaining 22% of paddy weight is received as husk. The fuel for parboiling process in the rice mill is generated by using this husk. During firing process 25% of husk is converted into ash called rice husk ash. In India annually 20 million tons of rice husk ash is produced. When it's dumped the rice husk ash is causing treat to surrounding environment and causing damage to land. Many ways are being thought for disposing rice husk ash by making commercial use of it. In 1978 Davidovits showed that silicon (Si) and aluminium (Al) present in fly ash, rice husk ash, blast furnace slag reacts with alkaline solutions like NaoH and KOH to produce binders. Since the chemical reaction taking place is polymerization he termed it as 'Geopolymers'. The polymerization process is a slow process. To fasten the process, activator Na2Sio3 is added. Oligomers or many small molecules are combined into covalently bonded network in geopolymerization. The formation of three dimensional macro molecular structure is believed to be from the contribution of oligomers through geo chemical synthesis. The polymerization process can be applied for commercial production of human needs.

KEYWORDS— Geopolymerisation, Rice Husk Ash, Coarse Aggregate, Concrete, Alkaline Solution

I.INTRODUCTION

Concrete is artificial pourable mix of cement, sand, water and gravel that hardens into super strong building material. Fine aggregate being sand and coarse aggregate being gravel or crushed stones in most concrete mixes. Particles greater than 0.19inch, generally ranging between 3/8 or 1.5 inches in diameter are termed as coarse aggregate. Till this time coarse aggregates are manufactured by crushing large blocks of naturally occurring rocks in quarries using large machines. This has affected the environment in significant manner. The present situation demands for replacement of coarse aggregates since many quarries are closed due to lack in availability of rocks. Rice milling industries produce a byproduct named husk. This surrounds the paddy grain. While milling 78% of weight is retained as rice, bran and broken rice. Remaining 22% of paddy weight is received as husk. The fuel for parboiling process in the rice mill is generated by using this husk. During firing process 25% of husk is converted into ash called rice husk ash. In India annually 20 million tons of rice husk ash is produced. When its dumped the rice husk ash is causing treat to surrounding environment and causing damage to land. Many ways are being thought for disposing rice husk ash by making commercial use of it.

In 1978 Davidovits showed that silicon (Si) and aluminium (Al) present in fly ash, rice husk ash, blast furnace slag reacts with alkaline solutions like NaoH and KOH to produce binders. Since the chemical reaction taking place is polymerization he termed it as 'Geopolymers'. The polymerization process is a slow process. To fasten the process, activator Na2Sio3 is added. The chemical reactions that leads to polymerization process is shown in diagram 1. Oligomers or many small molecules are combined into covalently bonded network in geopolymerization. The formation of three dimensional macro molecular structure is believed to be from the contribution of oligomers through geo chemical synthesis. The polymerization process can be applied for commercial production of human needs.

The process in which the binders are shaped and sized to the requirement is called 'Palletization'. The rpm or speed of the mixer is controlled to the requirement. The centrifugal force acting on the materials inside the mixer along with the alkaline solutions added shape the binders as required.

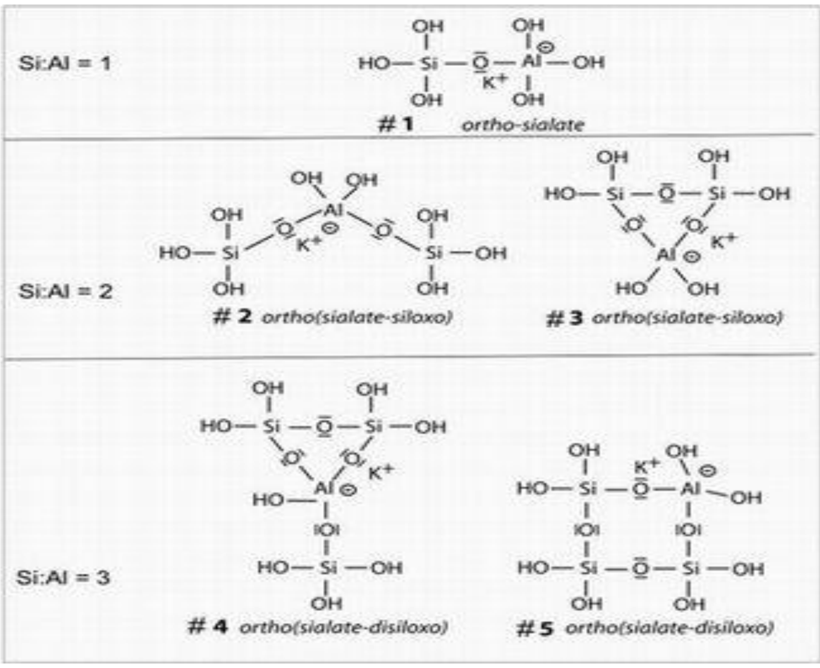


Fig. 1: Chemical Reaction of Polymerization

II. METHODOLOGY

For the objective, the properties of raw materials were examined first i. e. Sieve analysis, water absorption and specific gravity etc…

To achieve the objective, at first the rice husk ash coarse aggregate was manufactured by adding 40% cement, 20% fly ash and 40% rice husk ash. The ingredients were mixed in alkaline solution of ratio 1.5 and molarity of NaoH was maintained at 10 molar. The resulting pellets were subjected to ambient curing and had the following physical characteristics as shown in below table. The tests were conducted as per IS 2386(Part 3):1963.

Table 1: physical characteristics of RHA coarse aggregate

SL.NO	Characteristics	RHA Coarse Aggregate	Normal Aggregate	IS Codes
1	Bulk Density	987 kg/m^3	1400 kg/m^3	IS 2386(PART 3):1963
2	Moisture Content	0.5%	0.3%	IS 2386(PART 3):1963
3	Water Absorption	0.74%	0.6%	IS 2386(PART 3):1963
4	Impact Value	23.8%	18% TO 35%	IS 2386(PART 4):1963
5	Crushing Value	24.2%	18% TO 35%	IS 2386(PART 4):1963
6	Fineness Modulus	2.8	2.0 TO 4.0	IS 2386(PART 1):1963
7	Specific Gravity	2.76	2.6 TO 2.9	IS 2386(PART 3):1963

2.1: Concrete Mix Design

A concrete of grade 20N/MM^2 was designed and proportions of ingredients are as shown in table 2

Table 2: mix proportion

1	Cement	372 kg/m^3
2	Water	186 kg/m^3
3	Fine aggregate	737.76 kg/m^3
4	Coarse aggregate	1152.576 kg/m^3
5	Water cement ratio	0.5
6	Yield	2448.336 kg

2.2: Preparation of Test Cubes

The study of using **rice husk ash coarse aggregate** in place of **normal coarse aggregate** over M20 grade concrete by replacing it in various percentage such as **100%, 75% & 60%** is done with the help of various experimental tests. Three mixes namely **MIX A, MIX B** and **MIX C** are prepared by replacing normal coarse aggregate by **100%, 75%** and **60%** respectively. The results of compressive strength, split tensile strength and flexural strength for each mix are reported.

III. RESULTS AND DISCUSSION

3.1: Compressive Strength

9 concrete cubes of M20 grade for each mix namely **MIX A, MIX B**, and **MIX C** was prepared by collecting required quantity of materials.**MIX A** cubes were kept for ambient curing while **MIX B** and **MIX C** cubes were subjected to gunny bag curing. The cubes are tested for compressive strength at 7 days, 14 days and 28 days.

Table3: Compressive Strength Results

MIXES	7 DAYS		14 DAYS		28 DAYS	
	LOAD (KN)	STRENGTH (N/mm2)	LOAD (KN)	STRENGTH (N/mm2)	LOAD (KN)	STRENGTH (N/mm2)
NOMINAL	341.2	15.2	543	24.1	736.5	32.7
A	120.43	5.35	132.27	5.88	135.6	6.03
B	179.47	7.98	251.6	11.18	329.57	14.65
C	266.4	11.84	360.93	16.04	503.93	22.4

3.2: Split Tensile Strength Test

The materials required to prepare M20 grade concrete was collected.The materials are mixed thoroughly and cylindrical mould was filled in 4 equal layers by giving 35 blows to each layer. The mould was placed in moist condition for one day.9 cylinders were prepared for each mix namely **MIX A, MIX B, MIX C.MIX A** cylinders were kept for ambient curing while **MIX B** and **MIX C** cylinders were subjected to gunny bag curing. The cylinders were tested after 7 days, 14 days & 28 days.The load is applied gradually till the specimen fails and the failure load is noted.

Table4: Split Tensile Strength Test Results

MIXES	7 DAYS		14 DAYS		28 DAYS	
	LOAD (KN)	STRENGTH (N/mm2)	LOAD (KN)	STRENGTH (N/mm2)	LOAD (KN)	STRENGTH (N/mm2)
NOMINAL	105.3	1.49	171	2.42	229	3.24
A	11.9	0.17	25.9	0.24	33.37	0.47
B	57.23	0.81	79.53	1.13	105.1	1.48
C	118.67	1.67	134.6	1.9	154.87	2.19

3.3: Flexural Strength Test

The test specimens stored in water for 48 hours before testing shall be taken out and tested immediately in the wet condition only. The dimension of each specimen shall be noted before testing. Any loose sand and other materials are wiped clean from the surface. The specimen shall be kept on the machine such that the centre line of specimen and the axis is aligned properly. Load is applied at a rate of 7kg/sq cm/min. The load is applied till the specimen fails and maximum load is noted down.

Modulus of rupture, F_b= pl/bd^2.

If rupture is greater than 20 cm for 15 cm specimen and 13.3 cm for 10 cm specimen

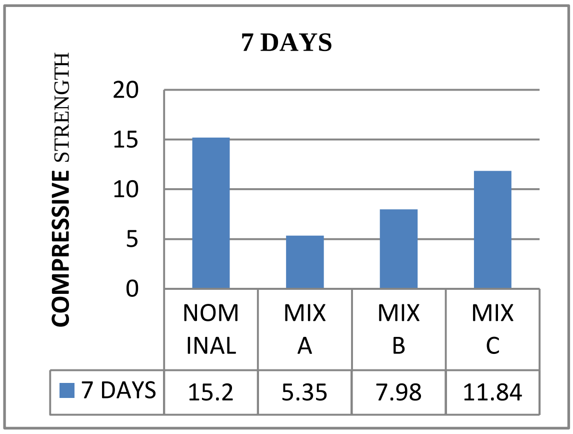
F_b=3pa/bd^2

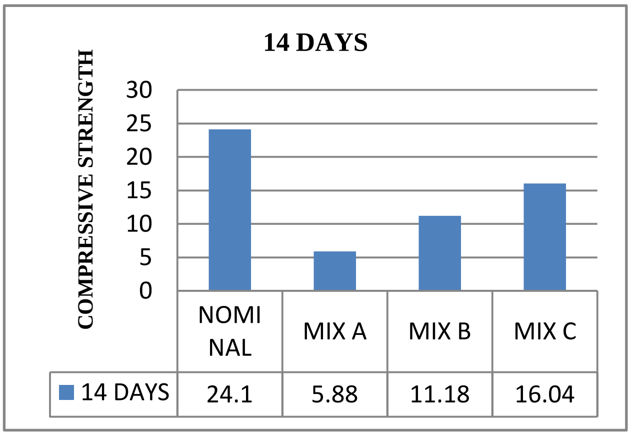
Table 5: Flexural Strength Test Results

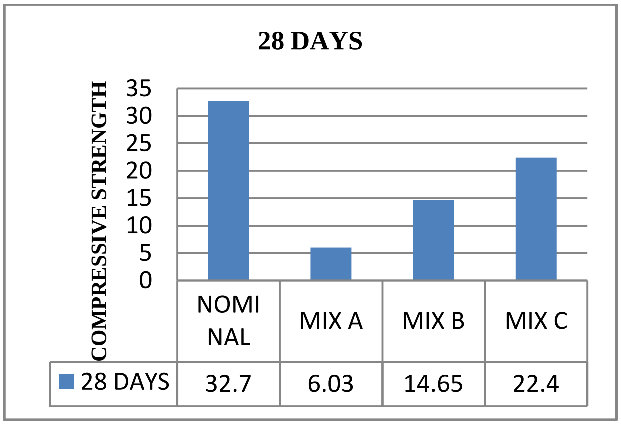
MIXES	7 DAYS		14 DAYS		28 DAYS	
	LOAD (KN)	STRENGTH (N/mm2)	LOAD (KN)	STRENGTH (N/mm2)	LOAD (KN)	STRENGTH (N/mm2)
NOMINAL	3.7	1.48	5.95	2.38	8.5	3.39
A	0.5	0.18	0.5	0.2	0.6	0.25
B	1.1	0.45	2.3	0.92	4.3	1.7
C	2	0.8	3.25	1.3	6	2.4

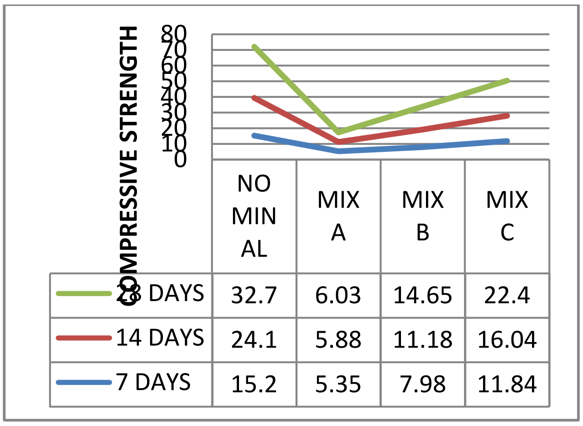
IV.CONCLUSION

4.1: Compressive Strength



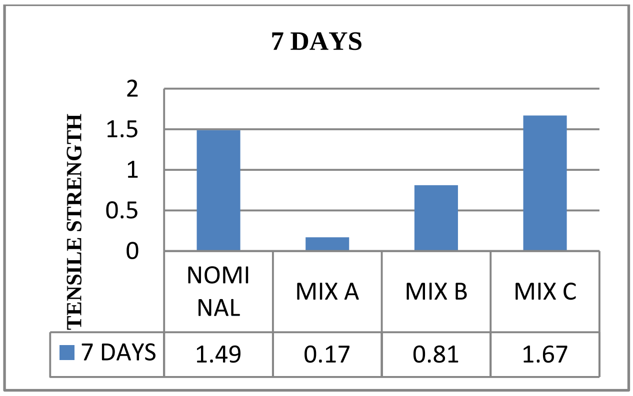


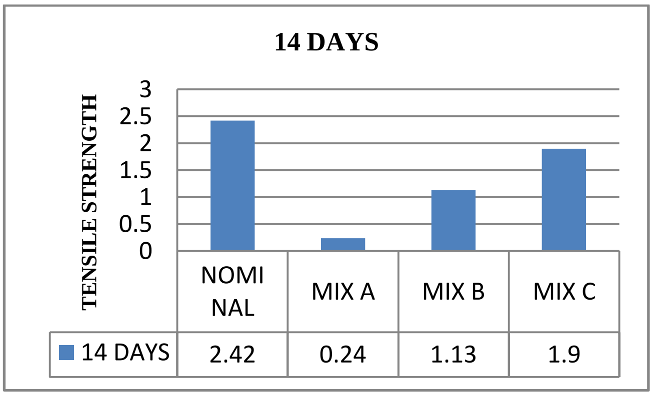


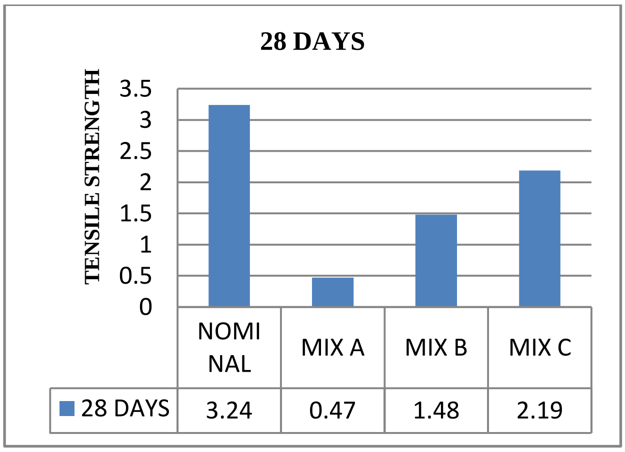


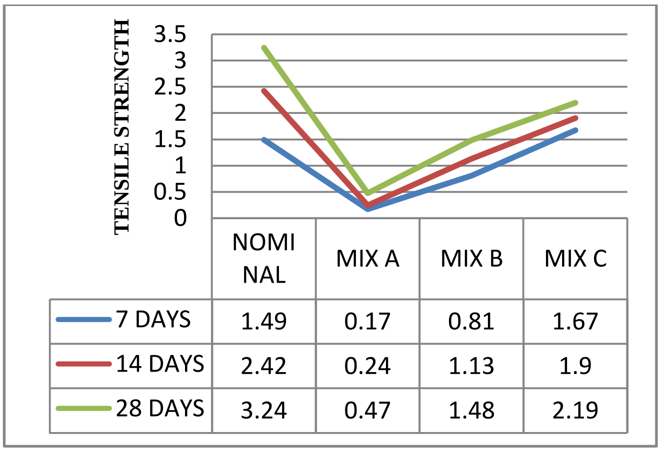
MIX Ashowed 10.31% increase in compressive strength between 7 to 14 days and 2.55% gain in compressive strength between 14 to 28 days.**MIX B** showed 40.1% increase in compressive strength between 7 to 14 days and 31.04% gain in compressive strength between 14 to 28 days.**MIX C** showed 35.47% increase in compressive strength between 7 to 14 days and 39.65% gain in compressive strength between 14 to 28 days.**NOMINAL M20** mix showed 58.55% increase in compressive strength between 7 to 14 days and 35.68% gain in compressive strength between 14 to 28 days.

4.2: Split Tensile Strength



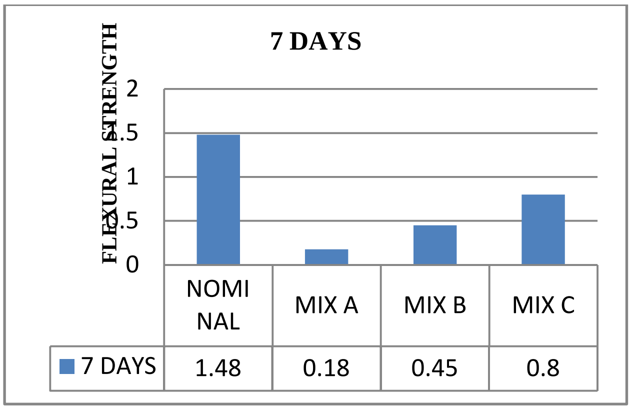


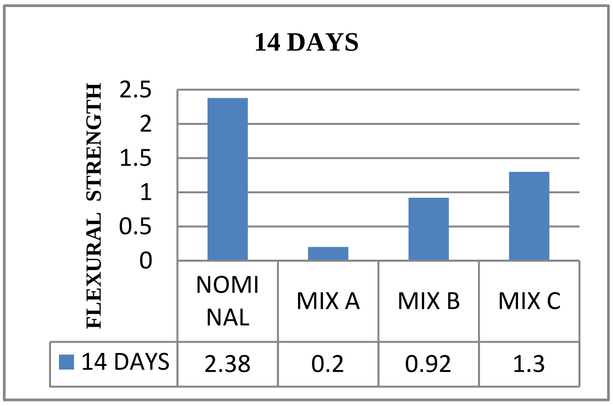


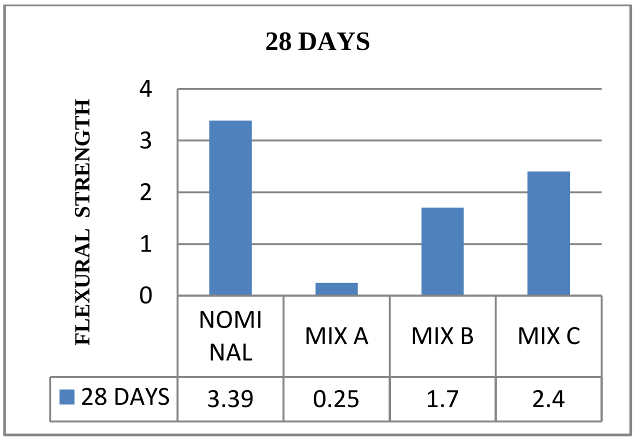


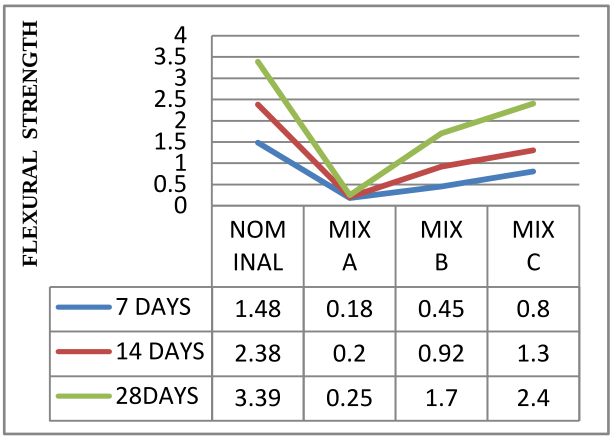
MIX Ashowed 58.82% increase in tensile strength between 7 to 14 days and 74.07% gain in tensile strength between 14 to 28 days.**MIX B** showed 39.51% increase in tensile strength between 7 to 14 days and 30.97% gain in tensile strength between 14 to 28 days.**MIX C** showed 13.77% increase in tensile strength between 7 to 14 days and 15.26% gain in tensile strength between 14 to 28 days.**NOMINAL M20** mix showed 62.41% increase in tensile strength between 7 to 14 days and 33.88% gain in tensile strength between 14 to 28 days.

4.3: Flexural Strength









MIX Ashowed 11.11% increase in flexural strength between 7 to 14 days and 25% gain in flexural strength between 14 to 28 days.**MIX B** showed 104.4% increase in flexural strength between 7 to 14 days and 84.78% gain in flexural strength between 14 to 28 days.**MIX C** showed 62.5% increase in flexural strength between 7 to 14 days and 84.61% gain in flexural strength between 14 to 28 days.**NOMINAL M20** mix showed 60.81% increase in flexural strength between 7 to 14 days and 42.44% gain in flexural strength between 14 to 28 days.

4.4:Scope for future studies

There are still many aspects of use of Rice husk-ash modified concrete and in RCC structural members, which are yet to be studied before its use is standardized. The following is a list of the some possible areas where future expedient research may be directed.

- Study on concrete using higher percentages of rice husk ash coarse aggregate can be made.
- Further investigations on the mechanical properties such as stress-strain properties & durability of such concretes can be carried out.
- Study on behaviour of concrete containing rice husk ash coarse aggregate to marine environment can also be made.
- Study on beams to be done in more detail and same work can be extended on slabs.
- A study on mechanical properties of modified concrete using rice husk ash coarse aggregate
- Reinforced sections can be casted and tested accordingly for this modified concrete.
- Characterization study on Rice husk-ash collecting the samples from different sources so that they can be standardized for better application as alternate material in concrete.
- Study on young's modulus of the modified concrete.

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