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MANUFACTURING OF ARTIFICIAL RICE HUSH ASH COARSE AGGREGATE

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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.

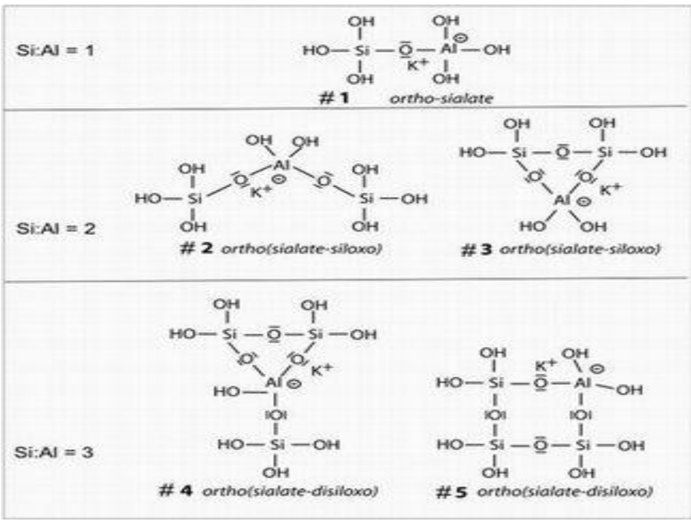

Fig. 1: Chemical Reaction of Polymerization

II. METHODOLOGY

The aim of the experiment is to replace coarse aggregate by artificially manufactured rice husk ash aggregate. To begin with different combinations of rice husk ash ,fly ash and cement along with different ratios of alkaline solutions where tried to find which combination gave us the best 'pellets' that can be used as replacement to coarse aggregate. The idea was to get aggregate of 20mm downsize. During the time of experiment different molarities of NaoH was used and the results are tabulated. In the below table SAMPLE A, SAMPLE B and SAMPLE C are used. SAMPLE A is completely composed of rice husk ash. SAMPLE B has 50% of rice husk ash and 50% of fly ash. SAMPLE C has 40% of rice husk ash, 40% of fly ash and 20% of cement. With reference the initial ratio of alkaline solution, i.e. Na2SiO3/NaoH was taken as 2.5 but was reduced as the experiment proceeded.

TABLE I: FOR 8M NaOH SOLUTION

SL.NO	Sample	Combination	Ratio Of Alkaline Solution				Remarks
			2.5	**2**	**1.5**	**1**	
1	Sample A	RHA	×	×	×	-	Pellets Not Formed
2	Sample B	RHA+FA	×	×	✓	-	Pellets Are Formed
3	Sample C	RHA+FA+CEMENT	×	×	✓	-	Pellets Are Formed

- **SAMPLE A** did not result in the formation of pellets on adding alkaline solution irrespective of ratios. The material remained in the form of powder even after adding large quantity of solution.
- **SAMPLE B** resulted in the formation of pellets when the ratio of alkaline solution was maintained at 1.5.The size of pellets formed was small. When the ratio of alkaline solutions was maintained at 2.5 and 2.0 the materials turned into paste on addition.
- **SAMPLE C** resulted in the formation of pellets when the ratio of alkaline solution was maintained at 1.5.The size of pellets formed was small. When the ratio of alkaline solutions was maintained at 2.5 and 2.0 the materials turned into paste on addition.

TABLE III: FOR 10M NaOH SOLUTION

Sl.No	Sample	Combination	Ratio Of Alkaline Solution				Remarks
			2.5	**2**	**1.5**	**1**	
1	Sample A	RHA	×	×	×	-	Pellets Not Formed
2	Sample B	RHA+FA	×	×	✓	-	Pellets Are Formed
3	Sample C	RHA+FA+CEMENT	×	×	✓	-	Pellets Are Formed

- **SAMPLE A** did not result in the formation of pellets on adding alkaline solution irrespective of ratios. The material remained in the form of powder even after adding large quantity of solution.
- **SAMPLE B** resulted in the formation of pellets when the ratio of alkaline solution as maintained at 1.5. the pellets obtained where of 20mm downsize as desired. When the ratio of alkaline solutions was maintained at 2.5 and 2.0 the materials turned into paste on addition.
- **SAMPLE C** resulted in the formation of pellets when the ratio of alkaline solution as maintained at 1.5. the pellets obtained where of 20mm downsize as desired. When the ratio of alkaline solutions was maintained at 2.5 and 2.0 the materials turned into paste on addition.

TABLE IIIII: FOR 12M NaOH SOLUTION

Sl.No	Sample	Combination	Ratio Of Alkaline Solution				Remarks
			2.5	2	1.5	1	
1	Sample A	RHA	×	×	×	-	Pellets Not Formed
2	Sample B	RHA+FA	×	×	×	-	Pellets Not Formed
3	Sample C	RHA+FA+CEMENT	×	×	×	-	Pellets Not Formed

- **SAMPLE A** did not result in the formation of pellets on adding alkaline solution irrespective of ratios. The material remained in the form of powder even after adding large quantity of solution.
- **SAMPLE B** did not result in the formation of pellets on adding alkaline solution. The materials turned into paste on adding alkaline solution immediately.
- **SAMPLE C** did not result in the formation of pellets on adding alkaline solution. The materials turned into paste on adding alkaline solution immediately.

By referring to above tables we can conclude that SAMPLE B and SAMPLE C results in PELLETS on adding alkaline solution of ratio 1.5 and the molaritie of NaOH solution should be maintained at 10. The combination, ratio of alkaline solution and molaritie of Na solution as mentioned above is maintained to manufacture artificial rice husk ash aggregates.

The aggregates or pellets obtained from the mixer where initially wet and needed to be dried so that minimum working strength will be gained by the pellets. Since the concept of geo polymerisation is being used, the only idea we had is that heat is required for chemical reaction to take place that helps in binding of materials and to gain strength. Ambient drying and oven drying of aggregates where employed. The aggregates that gained more strength when subjected to above two, i.e. oven drying or ambient drying are further used in the experiment. The observations are made as shown in below table IV and table V.

TABLE IV: DRYING OF AGGREGATES IN AMBIENT TEMPERATURE

SL.NO	Samples	Type Of Drying	Duration	Remarks
1	Sample B	Ambient	4 Days	Satisfactory Result Not Obtained
2	Sample C	Ambient	4 Days	Satisfactory Result Obtained

- **SAMPLE B** After drying for 4 days SAMPLE B could be easily broken by bare hands which meant that the aggregates had not gained the required strength.
- **SAMPLE C** the aggregates had gained enough strength. It was difficult to crush the aggregates by hand.

TABLE V: OVEN DRYING OF AGGREGATES

Sl. No	Samples	Type Of Drying	Duration	Remarks
1	Sample B	Oven	6 Hours @100^0c	Satisfactory Result Not Obtained
2	Sample C	Oven	6 Hours @100^0c	Satisfactory Result Not Obtained

On oven drying both SAMPLE B and SAMPLE C showed rapid expansion in size, colour changed from black to grey, dried completely and started forming powder when kept outside after sometime. Minimum force was enough to crush the aggregates completely by hand.

SAMPLE C on ambient drying gained required strength and showed that it can be used as coarse aggregate in further project work. Hence SAMPLE C is adopted in further experimental procedures. SAMPLE C had 20% of cement content. Since cement is the only costlier material used in making aggregate we had to reduce the cement content to make the aggregate as economical as possible. The 4 different aggregate sample namely SAMPLE C1, SAMPLE C2, SAMPLE C3 and SAMPLE C4 were prepared by adding 5%, 10%, 15% and 20% of cement content respectively in the mix. The above sample aggregates were subjected to series of tests as per IS2386:1963(part 3 and part 4) and compared with the values of normal coarse aggregate to select the best sample and use it in preparation of concrete.

Fig 2: Sample C after Ambient Drying

III. AGGREGATE TEST RESULTS

TABLE VI: PHYSICAL CHARACTERISTIC OF SAMPLE C1

SL.NO	Characteristics	RHA Coarse Aggregate	Normal Aggregate	IS Codes
1	Bulk Density	728 Kg/m^3	1400 Kg/m^3	IS 2386(Part 3):1963
2	Moisture Content	2.0%	0.3%	IS 2386(Part 3):1963
3	Water Absorption	1.6%	0.6%	IS 2386(Part 3):1963
4	Impact Value	37.8%	18% TO 35%	IS 2386(Part 4):1963
5	Crushing Value	38.6%	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	1.2	2.6 TO 2.9	IS 2386(Part 3):1963

TABLE VII: PHYSICAL CHARACTERISTIC OF SAMPLE C2

SL.NO	Characteristics	RHA Coarse Aggregate	Normal Aggregate	IS Codes
1	Bulk Density	834 kg/m^3	1400 kg/m^3	IS 2386(PART 3):1963
2	Moisture Content	1.3%	0.3%	IS 2386(PART 3):1963
3	Water Absorption	1.4%	0.6%	IS 2386(PART 3):1963
4	Impact Value	31.6%	18% TO 35%	IS 2386(PART 4):1963
5	Crushing Value	33.4%	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	1.9	2.6 TO 2.9	IS 2386(PART 3):1963

TABLE VIII: PHYSICAL CHARACTERISTIC OF SAMPLE C3

SL.NO	Characteristics	RHA Coarse Aggregate	Normal Aggregate	IS Codes
1	Bulk Density	905 kg/m^3	1400 kg/m^3	IS 2386(PART 3):1963
2	Moisture Content	0.8%	0.3%	IS 2386(PART 3):1963
3	Water Absorption	0.96%	0.6%	IS 2386(PART 3):1963
4	Impact Value	28.6%	18% TO 35%	IS 2386(PART 4):1963
5	Crushing Value	29.2%	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	2.3	2.6 TO 2.9	IS 2386(PART 3):1963

TABLE IX: PHYSICAL CHARACTERISTIC OF SAMPLE C4

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

IV. CONCLUSIONS AND SCOPE FOR FUTURE STUDIES

A. Conclusions

The physical characteristic values of SAMPLE C4 obtained are almost matching with the values of normal coarse aggregate values as specified in IS code 2386:1963(part 3 and part 4).since the bulk density of artificial aggregate is less when compared to bulk density of normal coarse aggregate, we can call the artificial aggregate as light weight aggregate and also we reduce the weight of concrete mix. The percentage of cement content used in the manufacture of SAMPLE C4 is retained to manufacture artificial aggregate in large quantity and these aggregates are used to replace normal coarse aggregate in concrete mix.

B. Scope for future studies

1. 1. The artificial aggregate thus manufactured can be used in different concrete mixes.
2. 2. The compressive and split tensile strength of such concrete mixes can be tested.
3. 3. Different grade of concrete mixes can be prepared using the artificial aggregate.

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