INFLUENCE OF NAOH SOLUTION ON COMPRESSIVE STRENGTH OF RICE HUSK ASH BASED GEOPOLYMER

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ABSTRACT. Geopolymer is an inorganic alumina-silicate compound binder, synthesized by alkali activating the materials of geological origin or from by-product materials such as fly ash, rice husk ash, etc., that are rich in silicon and Aluminum. Geopolymer, a specific material has superior engineering properties and durability and is a greener alternative to Ordinary Portland cement (OPC). In this paper, the influence of alkaline activator to binder ratio on the compressive strength of rice husk ash based geopolymer has been investigated. The geopolymer mix was prepared by alkali-activating the rice husk ash in alkaline environment of 12M NaOH solution. The proportion of alkaline activator to rice husk ash was varied from 0.5 to 0.7. The results showed that the compressive strength was directly proportional to alkaline activator liquid to binder ratio.

Keywords: Geopolymer, Alumina-silicate, Rice husk ash, Compressive strength.

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INTRODUCTION

Cement is the basic ingredient of concrete which is used in construction worldwide. The production of cement required natural earth resources like limestone. It is also known that every tonne cement production requires a tremendous amount of energy for roasting 2.8 tonne raw materials that sends nearly a tonne of carbon-dioxide skywards. Utilization of waste materials or by-product as a alternative to cement not only save energy and natural resources but also protect our environment. Consequently, one of the challenging issue in solid waste management can be answered by this concern and also can contribute to economy in solid waste management as well as in cement production.

Recently, geopolymer, an inorganic polymer, has shown potential to compete with cement and has received considerable attention. It is commonly known as third generation cement followed by lime and Ordinary Portland Cement [1]. Geopolymer is formed by alkali-activating the alumino-silicate material [2]. The metallurgical slags, coal combustion ashes and various other industrial by-product which are rich in Al and Si, are mostly used as source material. The sodium silicate, sodium hydroxide, potassium hydroxide, potassium silicate and sodium carbonate may be used as alkaline activator. Based upon the chemical composition of source material, combination of two alkaline activators or one alkaline activator can be used for geopolymerisation. By geopolymerisation, wastes which are rich in alumino-silicate can be converted into cementitous material [3].

Rice husk is agriculture by-product, generally 20% of the weight of rice paddy, obtained by processing of rice paddy[4]. During burning of rice husk, 25% weight of this husk is converted into ash and termed as rice husk ash(RHA)[5]. The RHA consists of 90-95% silica content [6]. It has been used as alternative cementitious binder in place of conventional cementitious binder.

The present research work is thus to examine the strength development in rice husk ash based geoploymer with the different proportion of alkaline activator.

MATERIAL AND METHOD

Rice husk ash, collected from kissan rice mill in Faridkot district, Punjab, was used to synthesis the geopolymer composite. The chemical composition of rice husk ash is given in Table 1. The sodium hydroxide solution was used as alkaline activator for geopolymerization. The sodium hydroxide pellets with 98% purity were used to prepare the sodium-hydroxide solution of 12 molarity. The sodium hydroxide supplied by local supplier was used for investigation. The sodium hydroxide was in pellets form. One litre sodium hydroxide solution of molarity 12M was prepared by dissolving 480 gram pellets in water. River sand was used as fine aggregate which passes through the 2 mm sieve and retained on 90µm.

At first, alkaline activator and rice husk ash were mixed for 10 minutes. After that, appropriate amount of water and sand were added and mixed thoroughly. The mix proportions are given in the Table 2.The ratio of rice husk ash to sand and water to solid were fixed at 1:3 and 0.35 respectively. The mixtures were poured into 70.6mm×70.6mm×70.6mm cube moulds and subjected to thermal curing at 80°C for 24 hours. After de-moulding, the samples were cured at ambient temperature until testing. The

compressive strength was determined at age of 3, 7, 14 and 28 days using universal testing machine.

Table 1 Chemical composition of rice husk ash

SR. NO.	ELEMENT	WEIGHT %
1)	C	32.19
2)	O	30.67
3)	Na	0.22
4)	Mg	0.52
5)	Al	0.91
6)	Si	31.47
7)	K	2.17
8)	Ca	0.72
9)	Fe	1.13

The compressive strength was determined by using Universal Testing Machine (UTM) as shown in Figure 1. The specimen was kept between the compressive plates and gradually load was applied till the failure of the specimen occurred and thus the compressive strength of the specimen was found.

Figure 1 Compressive strength testing

Table 2 Mix proportion

MIX	ALKALINE ACTIVATOR TO BINDER RATIO	RICE HUSK ASH (gm)	ALKALINE SOLUTION (gm)	FINE AGGREGATES (gm)
M1	0.5	200	100	600
M2	0.6	200	120	600
M3	0.7	200	140	600

RESULT AND DISCUSSION

The compressive strength results are elucidated in Figure 2.When the alkaline activator to binder (AAB) ratio was 0.5, the 3 days compressive strength obtained was 8.06 N/mm^2. When the proportion of alkaline activator was raised then compressive strength enhanced rapidly as the 3 days compressive strength observed was 20.08N/mm^2 corresponding to alkaline activator to binder ratio 0.7. The compressive strength at the age of 7 days, 14 days and 28 days respectively with the rise in AAB ratio from 0.5 to 0.7 as shown in Figure 2.

The extensive research has been made on the behaviour of alumino-silicate material in alkaline solution. Accordingly, influence of AAB ratio was examined. The study demonstrated that the values of 0.7 AAB ratio provide maximum compressive strength of 35 N/mm^2 at the age of 28 days and increment in compressive strength was found with increase in AAB ratio. As geopolymerisation process formed $nM_2O.Al_2O_3.xSiO_2.yH_2O$ gel which depends on the dissolution of Si and Al in alkaline solution and content of NaOH solution promotes the dissolution of rice husk ash [7]. The alumino-silicate particles react with alkaline solution and formed gel. When the gel hardens, it bound the particle with each other which results in dense structure and stronger compressive strength.

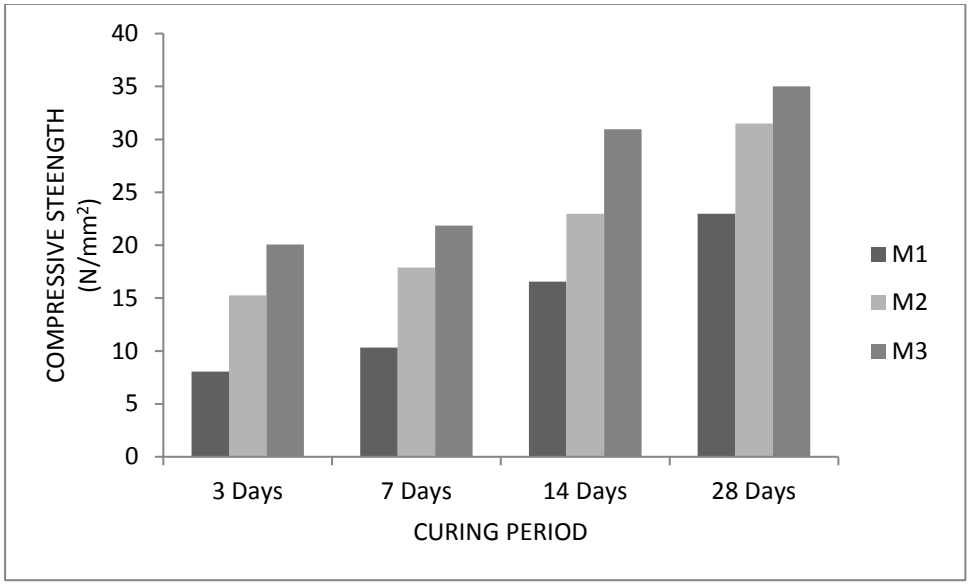

Figure 2 Compressive strength of geopolymer specimen

CONCLUSION

The compressive strength of rice husk ash based geopolymer was increased with the increment in proportion of alkaline activator. There was also increase in the compressive strength with age of mortar for a definite proportion of alkaline activator.

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