A Laboratory Assessment of Different Molarity of Alkaline Activator Geopolymer Concrete by Replacement of Fly Ash by Rice Husk Ash

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Abstract — Various molar concentrations of sodium hydroxide and sodium silicate solutions were prepared, ranging from 11M to 14M, and were utilized to activate the geopolymerization process. For each molarity, a series of mixes was designed with incremental RHA replacements of 5%, 10%, 15%, and 20%. On the 28th day, the compressive strength of the concrete mixes find the optimum value of 12M, 900Ccuring temperature and 10% replacement of rice husk provide the best result as per the design of M-30 grade of geopolymer concrete.Laboratory assessments revealed several key findings. Firstly, as RHA content increased, a noticeable improvement in the early strength of GC was observed, attributed to the high reactivity of the silica in RHA. However, beyond 10% RHA replacement, diminished returns in strength properties were noted. Secondly, the molarity of the alkaline activator played a significant role in the setting time and workability of the GC, with higher molarities causing rapid setting but reduced workability.

Keywords: Mix Design, Rice Husk Ash (RHA), Slump Value, Molarity, Curing Temperature and Compressive Strength

I. Introduction

Globally, concrete consumption is surpassed only by water, making it a major consumer of our planet's natural resources (referenced: Mehta, 2002). The surge in concrete usage is directly proportional to the demand for Portland cement. Each year, the global production of concrete exceeds 14 billion tons, which necessitates the production of an estimated 2.8 billion tons of cement (source: Cembureau, 2007). A concerning offshoot of this production is the industrial emission of harmful gases such as CO2, exacerbating global warming. Notably, the production of a single ton of Portland cement leads to the emission of almost an equivalent amount of CO2 (cited: McCaffrey, 2002; Davidovits, 1994a). The Intergovernmental Panel on Climate Change (IPCC) has highlighted the role of CO2 emissions in driving climate change (reference: IPCC, 2007). Given these implications, it's essential to seek alternate cement-making materials that satisfy construction demands while curtailing contributions to global warming. This aligns with the broader goal of promoting environmental sustainability.

II. Results

This chapter briefly describes the test results of the present study. It is cementing free concrete replacing the content of cement totally by fly ash. Here, alkalisation of fly ash with alkali solutions varying in different molar concentrations on the effect of strength of concrete is studied. Tabulated charts and graphical results are illustrated in this chapter.

A. *Slump Value:*

Slump value of geo-polymer concrete tends to decrease with increase in molarity.

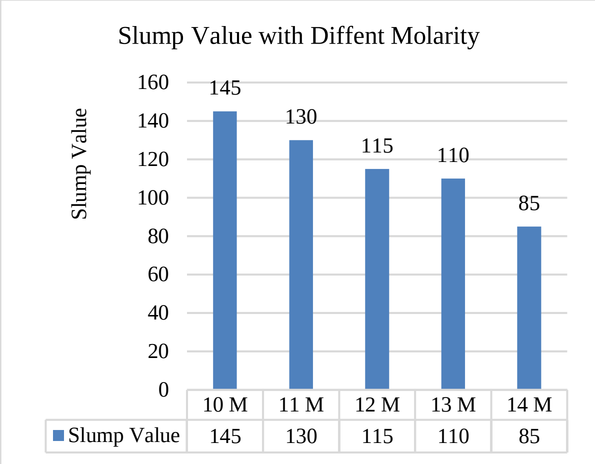

Fig. 1: Slump Values for Different molarity of GPC

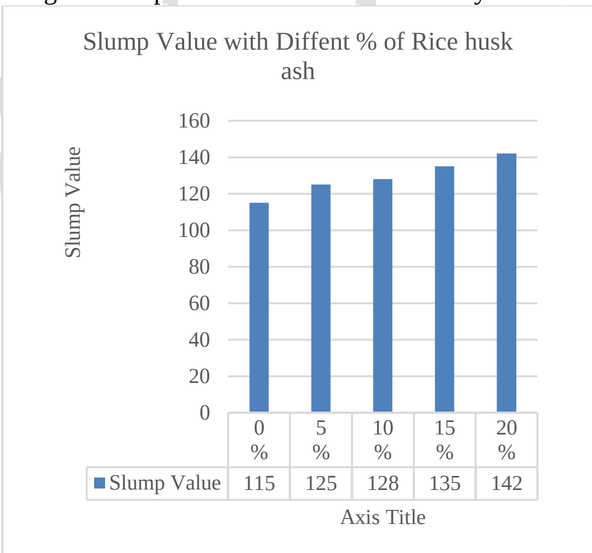

Fig. 2: Slump Values for Different % of Rice husk ash in GPC

B. *Compressive Strength*

Compressive strength of geopolymer concrete specimens was determined at 7 and 28 days, following all the IS specifications. Testing was carried out in accordance with IS 516, IS 1199, IS 9013, IS 10086 and IS 14858.

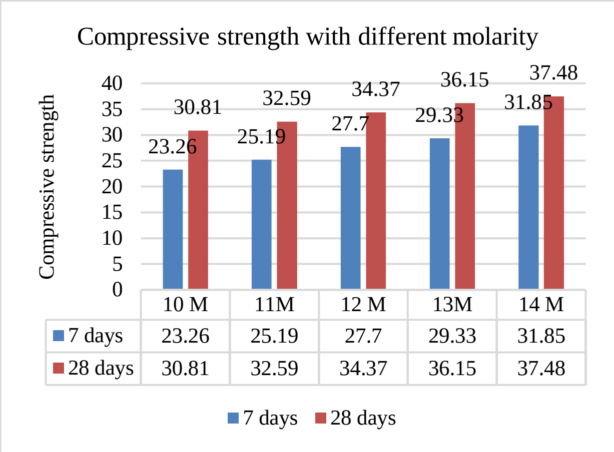

Fig. 3: Compressive strength with different molarity with up to 14 M concentration.

Strength of oven dried concrete is slightly more as compared to accelerated steam cured concrete at 30°C. Geopolymer concrete gains much higher strength at initial time of curing and gains slow strength at later ages.

Table 6.3 12 M Concentration with Different Curing Temperature

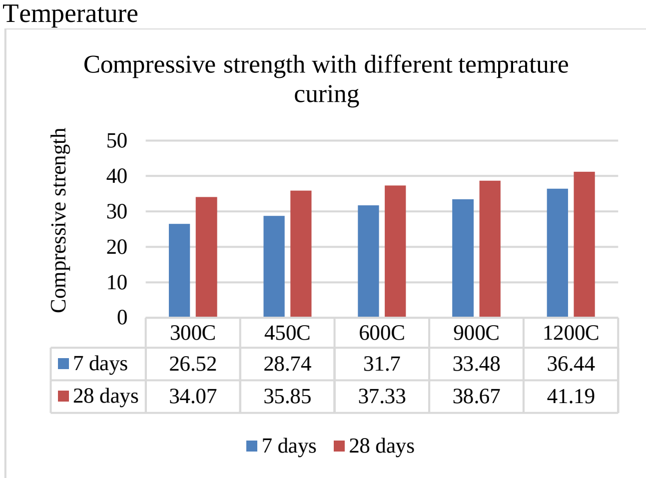

Fig. 4: 12 M Concentration with Different Curing Temperature

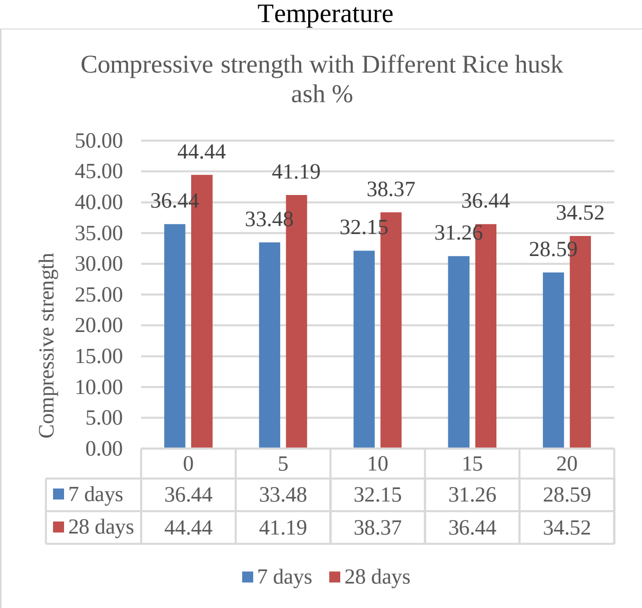

Fig. 5: 12 M Concentration and 90^{0}C With Different Rice husk ash %

III. CONCLUSION:

- The pan mixer efficiently blended all the dry constituent materials.
- When water was added to the dry mix, which contained only fly ash, along with both fine and coarse aggregates, the mixture appeared quite dry.
- With the introduction of the geopolymer binder, the mix became thicker. As the mixing time progressed, its cohesiveness improved, resulting in a more consistent mix. The addition of a superplasticizer significantly enhanced workability.
- The cohesive test yielded satisfactory results.
- On the 28th day, the compressive strength of the concrete mixes find the optimum value of 12M, 90^{0}Ccuring temperature and 10% replacement of rice husk provide the best result as per the design of M-30 grade of geopolymer concrete.
- Increasing the molarity decreases workability and resulted in an increase in compressive strength. But rise husk % increase than workability also increase but compressive strength decreased.

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