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COST COMPARISION OF GEOPOLYMER CONCRETE AND M25 GRADE CONVENTIONAL CONCRETE USING COMPRESSIVE STRENGTH

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ABSTRACT

Ordinary Portland cement is the most widely used binder in concrete production. Cement's popularity is growing as a result of its capacity to provide both immediate and long-term strength. It is, however, energy-intensive and requires a significant amount of natural resources in its manufacture. Furthermore, the manufacture of one tonne of cement releases around one tonne of CO2 into the sky, contributing to global warming and environmental degradation. When exposed to a harsh environment, the performance of concrete in terms of durability is also a crucial concern.

The creation of geopolymer concrete (GPC) is an important step towards the production of eco-friendly concrete. It's an inorganic alumina-silicate compound made from geological or industrial wastes such fly ash, slag, GGBFS, rice husk ash, and so on. Environmental contamination can be addressed through the effective use of industrial by-products. Due to the lack of Ca(OH)2, geopolymer concrete is projected to be more durable than traditional concrete.

The goal of this project is to investigate the effects of different replacement levels of class Fly Ash (FA) and Ground Granulated Blast Furnace Slag (GGBS) on the micro characteristics of geopolymer concrete (GPC) (FA0%-GGBS100%, FA25%-GGBS75%, FA50%-GGBS50%, FA75%-GGBS25%, FA100%-GGBS0%). Alkaline activators will be sodium silicate (Na2SiO3) and sodium hydroxide (NaOH) solutions. The results reveal that the mechanical properties of the mix deteriorate as the FA concentration increases, regardless of curing times such as 14 and 28 days at room temperature.

Keywords: Geopolymer Concrete, Compressive Strength, Fly Ash, Ground Granulated Blast Furnace Slag, Rice Husk.

I. INTRODUCTION

The geopolymerisation process occurs as a result of a fast chemical reaction between Si-Al minerals and alkaline liquids, resulting in a three-dimensional polymeric chain and ring structure made up of Si-O-Al-O links (Davidovits 1994).

$$Mn\ [-(SiO2)\ z–AlO2]\ n.\ wH2O$$

where M represents an alkaline cation such as potassium, sodium, or calcium; the symbol – indicates the presence of a link; n is the degree of polymerisation or polycondensation; and z is one, two, three, or even higher, up to 32.

In geopolymer concrete, the binder is the source material with alkaline activator, whereas in Portland cement concrete, the binder is hydraulic cement paste. The binding material is different, but the rest of the materials are the same. The geopolymer binder paste is mixed with loose coarse and fine aggregates to make geopolymer concrete, which can be made with or without admixtures. The same machinery that is used to make cement concrete can also be utilised to make geopolymer concrete.

II. LITERATURE REVIEW

A comprehensive literature related to the present work has been collected and reviewed critically. A brief review about constituents of geopolymer, strength and durability of geopolymer concrete are presented in this chapter.

Bakharev (2005) investigated on the performance of fly ash based geopolymer mortar in terms of its resistance to acids. The results shows geopolymer has lost strength of around 35% over a period of 5 months of

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exposure to acidic environment. It is due to migration of alkalis from geopolymer to acidic solution. Further, geopolymer has exhibited better resistance to sulphuric acid than acetic acid.

Adam et al. (2010) studied the strength, sorptivity and carbonation of alkali activated fly ash geopolymer concrete. It has been observed that alkali content of the activator improved the strength of GPC cured at elevated temperature. Also, high alkali content remarkably lowered sorptivity.

Suresh Thockchom et al. (2011) found that addition of silica fume in fly ash geopolymer mortar yield higher compressive strength. It has also been stated that silica fume inclusion imparted higher compressive strength and also better sulphate resistance than control.

Nath & Sanjay kumar (2013) attempted to study the properties of geopolymer concrete incorporated with slag and fly ash. Two kinds of slag such as corex and GBFS were used to make geopolymer concrete and cured at 270C. The 6M NaOH was used as alkali activator. It has been reported that a characteristics of corex slag are almost similar to GBFS. However, reaction products formed were marginally high in GBFS. But strength development was better in corex slag than GBFS because of dense microstructures developed in corex slag concrete.

III. MATERIAL

The material used in present experimental project.

Cement: In this present work cement of 25 grade ordinary Portland cement (OPC) is used for casting cubes for all concrete mixes.

Fly Ash & Ground Granulated Blast Furnace Slag: In this current project the fly ash and GGBS are collected from the Nature and Green private limited is located in Jamnagar (District), Gujarat.

Figure 1: Fly Ash

Figure 2: Ground Granulated Blast Slag

Fine Aggregate: Natural River sand was used as fine aggregate.

Figure 3: Fine Aggregate

Coarse Aggregate: Crushed granite stones of size 20mm and 10mm were used as coarse aggregate.

Figure 4: Coarse Aggregate

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Alkaline Liquid: SA mixture of sodium silicate solution and sodium hydroxide solution was utilised as the alkaline liquid. A local provider provided the sodium silicate solution (Na_2O= 13.7 percent, SiO_2= 29.4 percent, and water= 55.9% by mass). A local supplier provided sodium hydroxide (NaOH) in flakes or pellets with a purity of 97 percent to 98 percent. By dissolving the flakes or pellets in water, the sodium hydroxide (NaOH) solution was created. The mass of NaOH solids in a solution varies based on the solution's concentration, which is measured in molar, M. For example, a 10M NaOH solution included 10x40 = 400 grammes of NaOH solids (in flake or pellet form) per litre of solution, with 40 being the molecular weight of NaOH.

Figure 5: Sodium Hydroxide

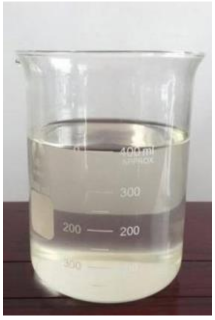

Figure 6: Sodium Silicate

IV. METHODOLOGY

The water-cement ratio, cement strength, concrete material quality, and quality control during the manufacturing process are all elements that affect the compressive strength of concrete.

According to IS 516, compressive strength tests will be performed on cubical specimens after 14 and 28 days of curing for all combinations (1956). Three 150 mm x 150 mm x 150 mm cubical specimens will be cast and examined. The specimen's compressive strength will be determined by dividing the greatest load applied to the specimen by its cross-sectional area.

Making of Geopolymer concrete.

Aluminosilicate material is dissolved in a strong alkaline solution to create geopolymer cements. The resulting paste can be mixed with aggregates and cured to produce concrete with properties similar to portland cement concrete in terms of strength and elasticity. Fly ash, a byproduct of coal combustion, is frequently used as an aluminosilicate material. Because it does not rely on hydration reactions to cure, geopolymer cement concrete is particularly appealing for prestressed concrete construction due to its rapid strength development and reduced tendency for shrinkage and creep when compared to portland cement concrete.

For comparative investigation, M25 grade conventional concrete (CC) has been developed (see Appendix (B) as per IS 10262 (2009) and IS 456 (2000).

V. RESULT AND DISCUSSION

After 14 and 28 days of curing, the compressive strength of GPC mixtures will be measured. These compressive strength values will be compared to those of M25 concrete grade (CC).

At different curing times, the compressive strength of CC (M25) and GPC mixes (FA100%-GGBS0%; FA25%-GGBS75%; FA50%-GGBS50%; FA75%-GGBS25%; FA0%-GGBS100%).

Table 1: Compressive strength of CC and GPC

Mechanical Property		**Compressive strength Pc (MPA)**	
Age (Days)		**14**	**28**
	M25	24.50	33.45
	FA0- GGBS100	43.10	45.20
	FA25- GGBS75	37.40	37.80
Mix-	FA50- GGBS50	27.45	30.15

Design	FA75- GGBS25	10.00	10.20
	FA100- GGBS0	7.85	7.90

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The cost analysis of Geopolymer concrete and M25 grade of Conventional Concrete was the main topic of this section. Due to their impact on the industry as a whole, time, cost, and quality are the three most significant aspects in construction. Civil engineering is always interested in any breakthrough that has a positive impact on these aspects.

The compressive strength test is quite simple to perform. As a result, the compressive strength test is the most commonly performed on concrete. The compressive strength of concrete after 28 days after casting is used to specify the quality of concrete, which is referred to as grade of concrete. With prolonged hydration, the concrete gains strength. The pace of strength gain is faster at first, but it slows down as you become older. The 28-day strength is commonly assumed to be the full strength of concrete.

M25 grade Conventional Concrete has a 28-day compressive strength of 33.45Mpa. In the instance of Geopolymer Concrete, the proportion of FA50%: GGBS50% is 30.15Mpa to attain the same strength. As a result, the cost of one cubic meter of Geopolymer Concrete for the aforementioned proportion is calculated and compared in this chapter to the cost of one cubic meter of M25 grade Conventional Concrete.

Table 2: Geopolymer Concrete vs. Conventional Concrete Cost Analysis

Material	Unit	Rate (Rs)	Control concrete (M25)		GPC (FA50%-GGBS50%)	
			Quantity	Amount(Rs)	Quantity (Kg/m^3)	Amount (Rs)
Cement	Bags	350/-	9.50	3614/-	0	0.00
GGBS	Kg	4/-	0	0	204.5	817/-
Fly ash	Kg	2.5/-	0	0	204.5	511/-
CA 20	Kg	90/-	0.44	40/-	0.52	46.8/-
CA 10	Kg	70/-	0.30	20/-	0.52	23.8/-
Sand	Kg	1.2/-	0.45	0.54/-	0.37	0.44/-
ium silicatesolution	Kg	15/-	0	0	60	900/-
NaOH pellets	Kg	120/-	0	0	20	2400/-
Total				3675.54		4699.04/-
Cost over CC(%)						27.845

According to Table 3, the initial material cost of Geopolymer Concrete (FA50-GGBS50) was approximately 27% more than that of Conventional Concrete (M25). The increased material cost of GPC compared to CC provides the impression that GPC is significantly more expensive than CC for the same strength.

VI. CONCLUSION

The following conclusions can be drawn from the findings of this investigation:

1. At 28 days' compressive strength, the starting material cost of Geopolymer Concrete (FA50%-GGBS50%) is roughly 27% more than that of Conventional Concrete (M25).

2. For a given proportion of mix, compressive strength increases with age.

3. When mixed in a proportion of FA: GGBS: 0:100, geopolymer concrete has the highest compressive strength, regardless of curing time.

4. The compressive strength of geopolymer concrete decreases as the FA content increases, regardless of the curing period.

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