Flexural Strength of Geopolymer Concrete Beam

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Abstract -The Cement is an essential assume in processing the concrete, reducing the amount of cement reduces the green house gases such as co2 emission; which is emitted at the manufacturing process of cement. The best alternative of normal cement concrete is the geopolymer concrete. The geopolymer concrete was made using Flyash and Ground Granulated Blast Furnace Slag (GGBS) which are found as the by product or waste disposal in thermal power plant and steel manufacturing industries respectively. The reaction between GGBS and Flyash is said to be Polymerization.The geopolymer was used as a alternative to cement and the beams are casted using 0% Geopolymer and 100% Geopolymer. The Flexural test were made in this proposed work and the service load and flexural strength is increased their results were interpreted.

Keywords: flexural behaviour, reinforced concrete beams, geopolymer concrete beams.

I. INTRODUCTION

The current simple cement concrete it is an excellent alternative building material. Geopolymer concrete shall be manufactured without the use of any quantity of traditional Portland cement. When demand for concrete contributes to an increase in construction materials, so too is demand for Portland cement. The cement production is projected to grow from about 1.5 billion tons in 1995 to 2.2 billion tons in 2010. On the other hand, the climate change has become a big concern due to global warming. Davidovits suggested an alkaline liquid capable of reacting to binders with silicon (Si) and aluminum (Al). Geopolymers belong to the Inorganic Polymers family. The geopolymer material's chemical composition is similar to natural zeolitic materials but the microstructure is amorphous. The production of polymerization involves a significantly rapid chemical reaction on Si-Al minerals under alkaline conditions resulting in a three-dimensional polymeric chain and a ring structure consisting of geopolymer technology shows considerable promise for application in concrete industry as an alternative binder to the Portland cement. The alternative to cement replacement is fly ash, silica smoke, raise husk powder, metakaolin or a mixture of the above materials. Silicate and alumina are rich in fly ash and thus lead to the formation of alumina silicate gel as a geopolymer concrete with an alkaline solution. Geopolymer cement concrete is made from utilization of waste materials such as fly ash and ground granulated blast furnace slag(GGBS). Fly ash is the waste product generated from thermal power plant and ground granulated blast furnace slag is generated as waste material in steel plant. All fly ash and GGBS are treated using suitable methods and used in the form of geopolymer concrete for different works. Using this concrete can help to minimize waste supplies and also reduce carbon emissions by reducing demand for Portland cement. The key component of silicon and aluminum source geopolymers supplied by thermally activated natural materials or industrial by-products, and an alkaline activating solution that polymerizes these materials into molecular chains and networks to create a harden binder.

II. GEOPOLYMER CONCRETE

Geopolymer main components are the source materials, and the alkaline liquid. The source materials should be rich in silicon and aluminum for aluminum silicate dependent on geopolymer. Kaolinite, clays, micas, and alousite, spinel, etc. are also the natural minerals. Instead, commodity materials such fly ash, slica fume, slag, rice husk ash, red mud, etc. The alkaline liquids are formed by soluble alkaline metals such as sodium or potassium, because the mixture of sodium hydroxide and sodium silicate is used as alkaline liquids since it is inexpensive compared to potassium.

2.1 ALKALINE LIQUID

It is recommended that the alkaline be prepared by combining solutions of sodium silicate and sodium hydroxide allowing the mix to react to polymerization for a minimum time of 24 hours. Various grades of the sodium silicate solution are available commercially. Sodium silicate solution (Na_2SiO_3) with a mass ratio of 2.5 in sodium hydroxide (NaOH) is used. The pellet-shaped sodium hydroxide with purity of 97-98 per cent is available commercially. The solids are concentration in water. The solutions used are 8 Molar (8 M).Because sodium hydroxide's molecular weight is 40, and 8 molar solutions 8 X 40= 320 gms of sodium hydroxide was dissolved in 1000 ml of water in order to prepare. Within a solution the density of NaOH solids varies depending on

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the solvent concentration.

2.2 GPC CONCRETE

The materials required to render geopolymer concrete. The minimum concrete strength to be used for building is M 20 degree as per I.S: 456- 2000.In this analysis, therefore, the nominal mix needed for M 20 degree 1:1.5:3 is tried. The same blend ratio is also attempted in the concrete geopolymer. The constituents of 8 Molarity sodium hydroxide geopolymer concrete for M 20 grade concrete (1:1.5:3.0) is shown in Table 1.

Table 1 Constituents Of Geopolymer Concrete

Description	Quantity
Flyash	440kg/m3
(Na2SiO3+NaOH)/ Flyash	2.5
NaOH Solid	0.45
Water (dilute of NaOH)	18.02kg/m3
Na2SiO3 Solution	40.86kg/m3
Coarse aggregate <20mm	1350kg/m3
Fine aggregate	710kg/m3
Curing	28 days

III. EXPERIMENTAL INVESTIGATION

The test program consists of casting two beams, and testing them. Beam scale 150 X150 X100 mm, two of which are cement concrete control beams and geopolymer concrete beams. The beam were planned as reinforced under part. Using 8 mm diameter stirrups @ 150 mm c / c, it is reinforced with 2-12 # at bottom, 2-10 # at top. Control cement concrete beams cast with water cement ratio of 0.5 using M 20 grade (1:1.5:3) and Fe415 grade steel. Ordinary Portland cement, natural river sand, and maximum size 20 mm crushed granite are used for concrete power. Using high yield deformed bars (HYSD) with a diameter between 12 and 10 mm and the Poisson ratio is found as 0.12. The respectively known as reinforced cement concrete and geopolymer cement concrete. They are kept at room temperature for 1 day after casting the specimen in rest time. The word rest time is coined to denote the period taken at an elevated temperature from the completion of casting of the test specimen to the start of curing.

IV. TEST SETUP

The test specimen is mounded onto a 500kN capacity beam test frame. The beams are simply supported over a span of 3000 mm and subjected to symmetrically mounted two combined loads on the base. The load distance is 1000 mm. The load is applied to the support at two points each 500 mm away from the middle of the beam. Mindset 0.001 mm dial gages are used to measure deflections below the load points and to measure deflection at the mid- span. The reading on the dialgauge are reported at different loads. A demac scale is used to measure the strain in concrete. An automatic data acquisition unit is used during the test to collect the data.The first loads of crack are obtained through visual exam. The control beam crack patterns (RCC) figure 5.

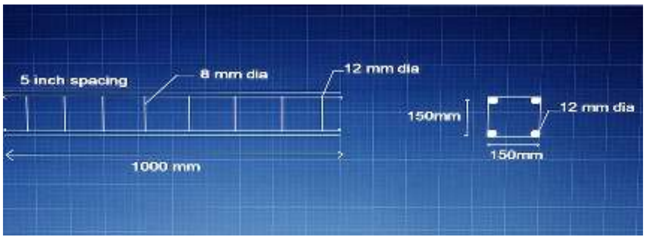

Figure 1. Reinforcement Details

Figure 2. opc concrete

Figure 3. opc concrete mix

Figure 4. fly ash and ggbs concrete mix

Figure 5. test setup

Sl No	Beam	Initial Crack Load (kN)	Service Load (kN)	Yield Load (kN)	Ultimate Load (kN)	Max. Deflection(mm)
1	RCC Beam	14	28	43	45	60
2	GPC Beam	17	31	46.50	48	64

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Figure 5. crack pattern of GPC beam

Figure 6. crack pattern of rcc beam

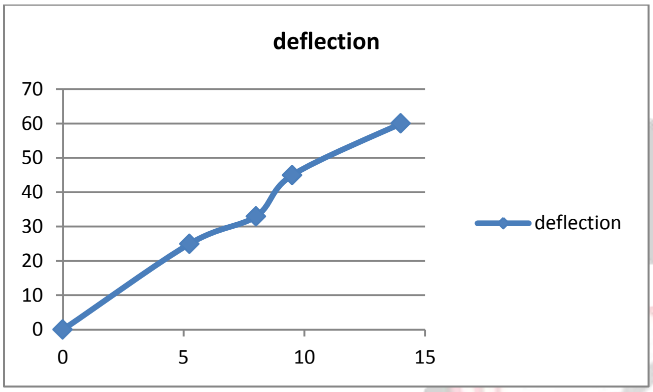

Figure 7. RCC beam deflection

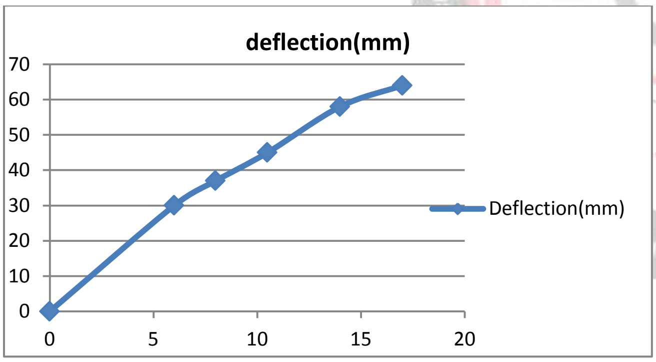

Figure 8. GPC beam deflection

V. CONCLUION

The reinforcement cement concrete and geopolymer concrete have a compressive strength of 26N/mm2 and 28.5N/mm2. The geopolymer concrete slump is obtained as 120mm even without water adding. The characteristics of load deflection obtained for the RCC beams and GPC beams are curvature that is almost identical. Compared to RCC beams(14kN), the first cracking and duty loads (17kN) of GPC beams show slightly greater. Geopolymer concrete beam flexural activity is more powerful than ordinary beams. The total efficiency of GPC beams is greater than RCC beams. GPC beams ‘total load efficiency is 12.57% higher than RCC beams. The patterns of cracking and the modes of failure found for GPC beams are identical to the beams of the RCC Initially, the beams collapsed by yielding the tensile steel followed by grinding concrete into the compression face. geopolymer concrete beam is flexural conduct is more powerful than ordinary beams.GPC beams essentially have higher power relative to RCC beams. since the strength of both ordinary Portland cement concrete and geopolymer concrete is comparatively equal, traditional concrete can be replaced by geopolymer concrete, taking into account environmental factors such as global warming, co2 emission.

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