Study on Properties of Geopolymer Self Compacting Concrete

V. L. S. Srinvas, U. Anees Ahamed, V. Y. S. V. Somaraju, Y. Himath kumar

Abstract:--- Ordinary Portland cement (opc) which will be used in the Concrete releases a high amount of the carbon dioxide (CO2) in the atmosphere during manufacturing process. This leads to increase of level of greenhouse gases and hence contributes in global warming. Material like Geopolymer concrete is best alternate solution for this problem. In Geopolymer solid results from various enterprises, for example, ground granulated blast furnace slag (GGBS), Fly Ash and Rice Husk Ash are utilized as source material, basic activator arrangement blend of NaOH and Na2SiO3 is utilized to activate these source materials as to shape geopolymer mortar and furthermore some super plasticizers are utilized which acts as a binding material for coarse and fine aggregate to hold them together in the lattice. Geopolymer concrete (GPC) can be utilized rather than ordinary Portland concrete. In this work the impact of grouping of NaOH arrangement on mechanical properties of GPC is broke down by fluctuating the molarity of NaOH by ground granulated impact heater slag based geopolymer concrete. The molarity of NaOH can changed from 6M to 16M. Be that as it may, NaOH and Na2SiO3 gives quality by polymerization. All GPC blends were set up for various molarities and relieved under encompassing restoring conditions since GGBS significantly affect the setting time and the quality advancement of GPC when restored at surrounding temperature or in the immediate daylight. Geopolymer solid examples are tried for compressive quality at various ages and some functionality tests like L-box, V-funnel, and slump flow. It is found that GGBS based GPC has very low workability, it is highly cohesive and stiffened and it can be handled for about 10-15 minutes only after this mix starts setting. It was seen that maximum quality is accomplished with 16M molarity arrangement. GGBS based geopolymer solid give huge quality at 10M, 12M molarity of NaOH arrangement.

Index Terms: Ground Granulated Blast furnace slag (GGBS), Geopolymer concrete (GPC), molarity (M), sodium hydroxide, Sodium silicate.

I. INTRODUCTION

By increasing anxiety, the natural significances of waste transfer has driven scientists to research the utilization of the losses for potential development materials. By utilizing these waste materials we can the emission of CO2 in the earth and can likewise take care of the issue of waste transfer. GGBS has utilized in OPC concrete from significant lot to supplant bond. An experimental study has been conducted to find out the optimum usage of ground granulated blast furnace slag in concrete for getting maximum strength; it was observed that the strength of concrete has been increased with increase in the GGBS content. The optimum usage level of Ground granulated blast furnace slag content was about 55- 59% of the total binder content. Geo-polymer is considered as the new generation of cement after lime and Ordinary Portland cement. In geo-polymer concrete pozzolans such as ground granulated blast furnace slag (GGBS) and fly ash have been activated by using alkaline solution to form a binder and hence we can completely replace the use of OPC in concrete. In this method, the alkalinity activator fluid can be low to gentle or high.

Overview of GGBS

According to data published for 2015 by World Steel Association (WSA), India's position in world steel production is third with an output of 89.4 million tones. Typically, for ore feed containing 60 to 65 % iron, blast furnace slag production ranges from about 300 to 540 kg per ton of pig or crude iron produced; Assuming a conservative value of about 0.3 ton of blast furnace slag per ton of steel in blast furnace process, for Indian steel production of about 89 million tones, the blast furnace slag availability of about 27 million 3 tones. The melted slag has content 30-40% silicon dioxide (SiO2) and approximately 40% calcium oxide (Ca_O), which is close to the chemical configuration of OPC furnace slag when ground to a size less than 45 micron meter, can have a specific area of about 400 to 600 m2 /kg.

Fig. 1 : Ground Granulated Blast furnace slag cement.

Geopolymer Concrete:

Geopolymer the name given by Daidovits in the year 1978 to materials which are described by chains or arranges or inorganic atoms. Present day inorganic science, physical science, colloid science, mineralogy, geography, and in different kinds of designing procedure advances. As indicated by T.F. Yen[1] The utilization of this solid serves to the lessen the load of squanders and furthermore it diminishes carbon emanation by decreasing Portland concrete demand(opc).The fundamental constituent of the geopolymer wellspring of silicon and aluminum which

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are given by the thermally enacted characteristic materials (e.g:kaolinite) or mechanical results (e .g: fly cinder or piece) and a soluble initiating arrangement which for instance silico-oxide (- Si-O-Si-O-), silico-aluminate (- Si-O-Al-O-), ferro-silico-aluminate (- Fe-O-Si-O-Al-O-) or alumino-phosphate (- Al-O-P-O-), made through a procedure of Geopolymerization Geopolymer is being contemplated broadly and indicates guarantee as a greener option in contrast to Portland bond concrete. Research is moving from the science area to building applications and business creation of geopolymer. It has been discovered that geopolymer concrete has great designing properties.

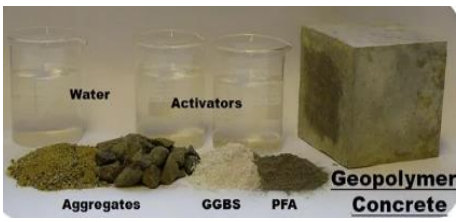

Fig. 2: Geopolymer concrete

Self-compacting Concrete:

Self-Compacting Concrete, which streams under its very own weight and does not require any outer vibration for the compaction, has reformed solid position, was first presented in the late 1980's by Japanese specialists [4], and is exceptionally useful solid that can stream under alone weight through confined segments without the isolation and dying. The most extreme coarse total molecule size and complete volume utilizing different thickness upgrading admixtures. Okamura and Ozawa have proposed a blend proportioning framework for SCC [5]. For Self-Compacting Concrete, it is important to utilize super plasticizers so as to get the high portability. Including a vast volume of powdered material or consistency changing admixture can take out the isolation [6,13]. The powdered materials that can be included is fly fiery debris, silica seethe, lime stone powder, glass filler and quartzite filler. This paper portrays a strategy explicitly created to accomplish oneself compacting concrete. What's more, to the test results for acknowledgment qualities for self-compacting cement, for example, droop stream, J-ring, V-channel and L-Box are introduced. Further, the quality attributes as far as compressive quality for 7-days, 28-days and 90-days are additionally be exhibited.

II. OBJECTIVE

From the current scenario that OPC is causing considerably environmental hazards such as increasing global warming by releasing harmful gases like greenhouse and enormous consumption of power and raw materials for production of OPC. The main objective to study is to find the alternative of OPC to solve these problems.

- To find alternative for an OPC in concrete.
- To reduce CO2 release and produce environmental friendly to the concrete mix.
- To produce a efficient price product.
- To produce high strength concrete than -ordinary Portland cement concrete.

III. MATERIAL DESCRIPTION

Materials Used

- Ground granulated blast furnace slag (GGBS)
- Sodium hydroxide (NaoH)
- Sodium silicate (Na2SiO3)
- Aggregates (F.A + C.A)
- Sodium Chloride (Nacl)

Materials

The materials used for to study are shown in the Below.

The multi-fold advantages of GGBS:

Guarantees high strength of structure. Diminishes the temperature rises and maintains a strategic distance from early-age warm breaks andfurthermore improve the functionality. It is grayish in shading and generously lighter than Portland bond. Resultantly it relaxes the visual effect of extensive Structures, for example, connects and holding dividers [6].

Employments of GGBS:

- High-rise structures.
- Marine applications such like as dams, shore security
- 1Construction.
- Effluent and sewage treatment plants.
- Cement items, for example, tiles, funnels, squares, and so on.

Sodium Hydroxide **(NAOH)**

Sodium hydroxide is a caustic base and alkali that decomposes the proteins at an ordinary ambient temperatures may cause a severe chemical burns in it. It is high soluble in the water, and readily absorbs moisture and the carbon dioxide content from the air It is a commercially available as "sodium hydroxide". It is a pungent-ethereal, colorless to slight yellow viscous liquid that is in soluble in water at all concent1rations [7]. Sometimes, it is dyed dark brown during production to alert people to its hazards [8]. The historical name of this acid is oil of vitriol [9].Sulfuric acid has a wide ranges of application includes in domestic acidic drain cleaners [10], it is an electrolyte in lead-acid batteries and in various cleaning agents. It is also a central substances in the chemical industries.

Sodium Silicate(NA_2SIO_3)

Sodium silicate is also known a technical and common name for a admixtures of such compounds like met silicate, also called as water glass, or liquid glass.Sodium chloride [13] also known as salt or halite, The products have a wide variety of uses, including the formulations in GGBS, passive fire protections, textile and lumber process, manufacture of refractory of ceramics, it as adhesives, and in the production of the silica gel.

IV. LITERATURE REVIEW

Chilingar, G.V.; examine geopolymer is a material that can be utilized in numerous types of utilizations, for

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example, for structure, car, aviation, and a lot more applications. It displays numerous phenomenal physical, warm and synthetic properties. Geopolymer material gives a financially savvy and reasonable answer for the reuse of unsafe buildup material and it experienced green science procedure treatment. Geopolymerization process includes in the mix blend of aluminosilicate from regular mineral or mechanical waste, for example, fly fiery remains or slag or rice husk cinder with actuated basic arrangement.

Self-compacting concrete (SCC) will upgrade the characteristics and improves efficiency and working conditions because of disposal of compaction. SCC is appropriate for putting in structures with blocked support without having any vibration and it helps in accomplishing higher nature of surface completions. Anyway use of high receptive NAOH and NA2SIO3 as an admixtures as a compelling pozzolan which causes extraordinary improvement in the pore structure and furthermore similarity is influenced by the qualities of materials and the blend extents, it winds up important to advance a system for the blend plan of SCC .In this paper displays an exploratory method for the plan of self-compacting concrete blends.

V. METHODOLOGY

The quality of a Geo polymer concrete is inspects for blends of 6 & 8 Molarity of NaOH. The atomic weight of NaOH is 40. To get ready 8 Molarity of arrangements, we have taken 8x40=320gm of sodium hydroxide chips. These chips are weighed and it is dissolves completely in an distilled water to frame 1 liter arrangement. In the same manner, for 10 molarity, we take 10x40=400gm of NaOH flakes are weighed and dissolve in distilled water to make 1 liter of solution. These solutions should be prepared 24 hours prior to their usage in material for experiments. In this study the ratio have taken for Sodium hydroxide (NaOH) and Sodium Silicate (Na2SiO3) is 1:2.

VI. FRESH AND HARDENEND PROPERTES OF CONCRETE AND TEST METHODS

Slump Stream Test (1) AndT 50cm Test

The droop stream is utilized to evaluate the even free stream of oneself compacting concrete (SCC) without impediments. The tests technique depend on to deciding the droop. The distance across of the solid circle is a measures for a filling capacity to concrete.

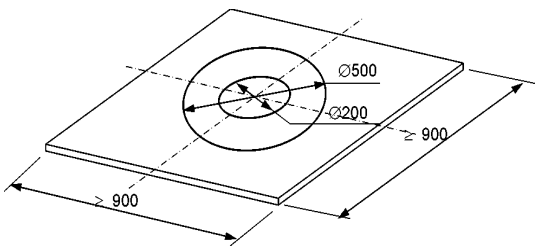

Fig. 7 slump flow test

V-Funnel Test (4) AndV-Pipe Test At T5 Minutes:

It comprises of V-formed pipe Uses to decide the V-pipe stream of time. The test is definitely not an appropriate when the most extreme size of the total surpasses in excess of 20 mm. The channel is filled around a 12 litters of concrete and after that time taken for it to course through the mechanical assembly is estimated. After this channel can be refilled by concrete and left for 5 minutes to settle. On the off chance that solid demonstrates an isolation than the stream time will be increments fundamentally.

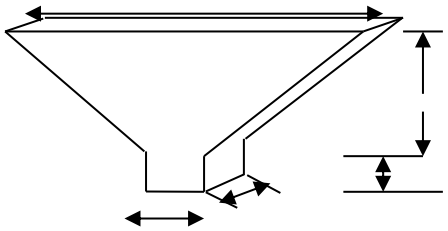

FIG. 8 V- FUNNEL TEST

Box Test Method

The device comprises of a rectangular segment confine the state of a 'L', with a vertical and even segment, isolated by a moveable entryway the entryway is lifted to give the strong stream access to the dimension imparted as a degree of that remaining in the vertical region (*H2/H1in the blueprint). It shows the inclination of the strong when it is extremely still.

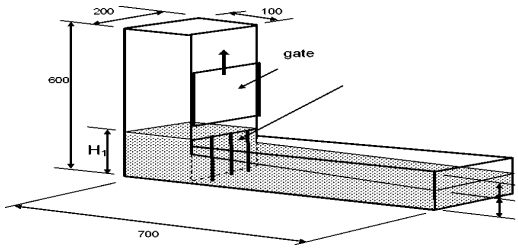

Fig- 9- L – BOX TEST

VII. TEST RESULTS

Slump Flow Test(1) And T_{50} Cm Test

The higher the droop stream esteem the more noteworthy its capacity to fill its formwork under its own weight. An estimation of at any rate 650mm is required for the Self compacting concrete. There is no commonly acknowledged counsel on what are sensible for resistances about a predetermined esteem, however ± 50mm.

The T50 time is a helper indication of the stream. A lower time of pointer increasingly conspicuous have more stream limit. The time required is 3-7 seconds is sufficient for basic planning applications, and 2-5 seconds for cabin application.

V-Funnel Test (4) AndV-Channel Test At T5 Minutes

This test demonstrates the simple stream of the solid; shorter the stream the time show more noteworthy stream of capacity. For Self compacting concrete (SCC) a stream time of 10 seconds is to be viewed as proper. The reversed cone shape confines the stream, and the stream times may give some sign of the weakness for the blend to blocking. As indicated by a channel test stream time under 6s is prescribed for a solid to fit the bill for a Self-compacting concrete SCC [15]. Following 5 minutes of setting, isolation of solid will demonstrates a less persistent stream with an expansion in stream time.

Box Test Method

In the event that the solid streams as openly as like as water, sat rest of them will be in level, so H2/H1 = 1. In this way the closer test esteem, is known as the 'blocking proportion', is to solidarity, to the better the stream of the solid. T20 and T40 times can give same sign of simplicity of stream concrete, however no reasonable qualities have been commonly concurred. Clearly hindering of coarse total behind the strengthening bars are been identified outwardly. The passing capacity is controlled by utilizing the L-box test [16**].**

S.NO	TEST METHOD	PROPERTY	UNITS	M1
1	Slump Flow	Filling Ability / Flow ability	Mm	NA
2	Slump Flow of $T_{50\ cm}$	Flow ability	Sec	NA
3	V-Funnel at 0min	Filling Ability / Flow ability	Sec	NA
4	V-Funnel at $T_{5\ min}$	Segregation	Sec	NA
5	L-Box	Passing ability	-	NA

VIII. RESULTS AND DISCUSSION

Strength:

The examples were taken according to IS516:1959 and the qualities were ascertained for 3, 7 and 28days.

Compressive Strength:

The specimens used for this compressive test were cubes of standard size 150mm x150mm x150mm.For each period of time of each molarity 3 specimens were taken and a total of 3specimens for 6M and 3 specimens for 8M were taken for all this time periods shown i.e. 3 days, 7 days, 28 days and from the testing it is observed that 8M specimens have good compressive strength compared to that of 6M specimens. And in the percentage of strength increase with respect to the time period of 8M specimens show good results compared to that of 6M specimens.

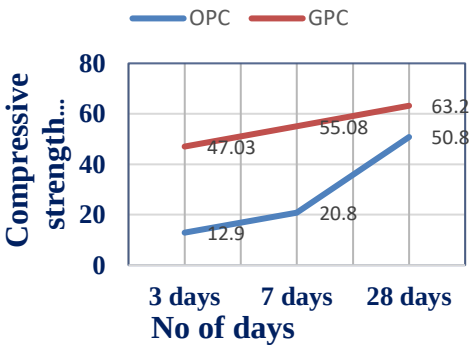

Fig. 10: The above represents the compressive strength after 28 days.

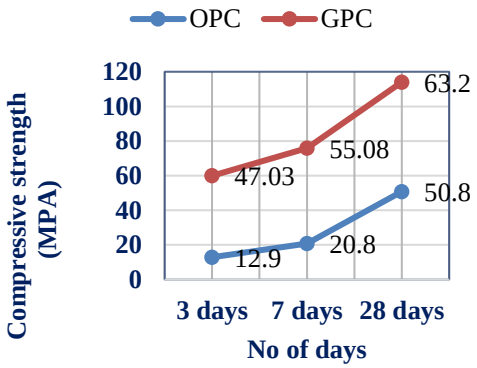

Fig. 11: The above graph representing the test Result values of compressive strength.

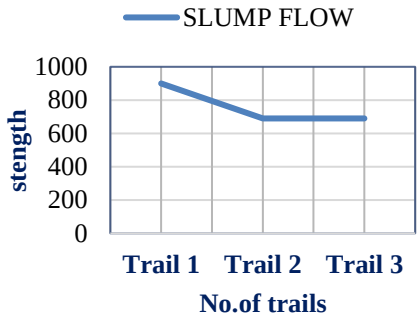

Fig. 12: The above graph representing the test Result values of slump flow

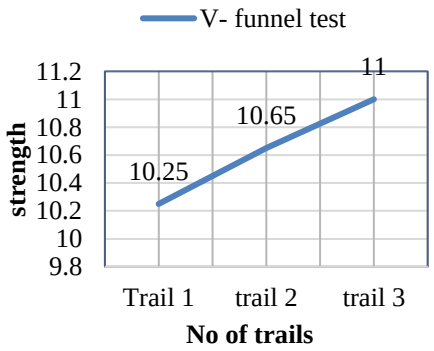

Fig.13 : The above graph representing the test Result values of V-funnel

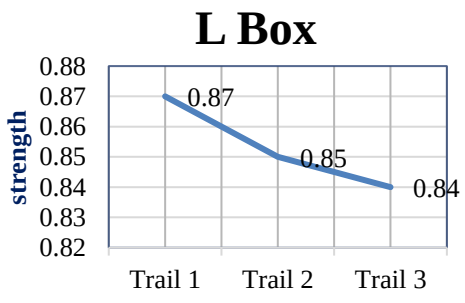

Fig. 14: The above graph representing the test Result values of L-box.

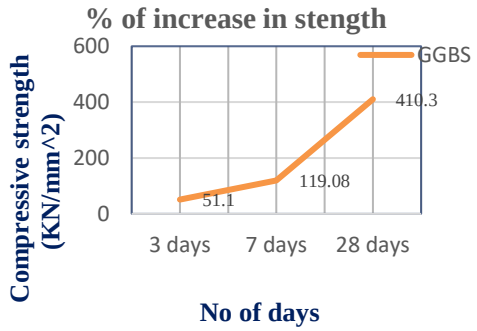

Fig. 15: Graph representing the test result values of compressive strength for 7 days and 28 days of 6 m

IX. CONCLUSION:

- The compressive strength will be varies for different ages like 3days, 7days, 28days.
- In case of workability factor the value will be changed.
- Therefore, it was observed that as the molarity increases strength increases, thus 8 M specimens have good strength compared to that of 6M specimens
- But in durability 8M specimens show good
- Resistance compared to that of 6M specimens
- While comes to the slump flow factor at 5min the slump is passed at a range of 2.6sec.
- In case of v-funnel the flow ability is not found due to the mix has been settled quickly
- In case of l-box the flow ability is not passed due to the mix has been settled quickly.

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