Study and Evaluation of Fresh and Mechanical Properties of Self Compacting Geopolymer Concrete on Replacement of Fine Aggregate at Various Percentage Levels with Copper Slag

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Abstract: **This paper presents the study of fresh and mechanical properties of self-compacting by geopolymer concrete(SCGC) to the effect 8 molarity on strength properties of classF flyash(FA)ground granulated blast furnace slag(GGBFS)and copper slag blended geopolymer concrete(GPC) At 10%,20%,30%40%and50% at varies levels of replacement of copper slag and chemical admixture are sodium silicate(Na2SiO3), sodium hydroxide(NaOH), this solution has been used as alkaline activator. In the present investigation to study the fresh properties test conducted as shown in below slump, L-box, V-funnel, and T50and same as the investigation to study the mechanical properties are compressive strength, ultrasonic pulse velocity and split tensile test at different curing periods after 7, and 28 days of curing at ambient room temperature. From the results, it is conducted that the increased replacement level of copper slag(CS)from0%to 50% increased the mechanical properties of self-compacting by geopolymer concrete(SCGC) the rebound hammer and UPV values also increase from 0%to50% replacement levels of copper slag(CS).**

***Keywords*: Fly Ash, Ground Granulated Blast Furnace Slag (GGBS) copper slag, alkaline activators**.

I.INTRODUCTION

The economic strength and even degree of civilization of any country is mirrored by the expansion rate of the infrastructures and highlighted by the assembly rate of concrete. Concrete is one in every of the foremost so much used construction resources within the world. Portland cement (PC); a vital constituent of concrete isn't associate environmentally friendly material. The assembly of Portland cement not solely depletes important quantity of natural resources however conjointly liberates a substantial quantity of carbonic acid gas (CO2) and alternative greenhouse gases into the atmosphere as a result of decarbonation of sedimentary rock and therefore the combustion of fossil fuels. it's reported that the worldwide cement trade contributes around one.65 billion heaps of the greenhouse emission annually. Due to the assembly of Portland cement, it's calculable that by the year 2020, the carbonic acid gas emissions can rise by regarding five hundredth from the present levels. Therefore, to preserve the worldwide atmosphere from the impact of cement production, it's currently believed that new binders area unit indispensable to exchange Portland cement. during this regard, the geopolymer concrete (GC) is one in all the revolutionary developments associated with novel materials leading to inexpensive and environmentally friendly material as an alternate to the laptop. gigacycle is AN innovative binder material and is created by whole exchange the laptop. it's incontestable that the geopolymeric cement generates 5–6times less CO_2 than PC.

GEOPOLYMER CONCRETE is new technology because it utilizes industrial waste and by products. Geopolymer concrete is emerging as a new environmentally friendly construction material for sustainable development, using Slag and alkali instead of PC as the binding material. This results in two benefits. i.e. reducing CO_2. GROUND GRANULATED BLAST FURNACE SLAG (GGBS) is a by-product from the blast-furnaces used to make iron. During the process, slag formed and it is then dried and ground to a fine powder.

FLYASH is rich in silica and alumina, has full potential to use as one of the source material for Geopolymer binder. Many research studies have manifested the potential use of solfa syllable primarily based rate. For this reason, low-calcium solfa syllable has been chosen as a base material to synthesize geopolymer so as to higher employ this industrial waste.

In fact, all concretes nearly believe basically on being totally compacted. just in case of huge and sophisticated structures; it's generally become troublesome to confirm full compaction. Despite the great combine style, inadequate compaction considerably lowers final performance of concrete. Placement of the contemporary concrete needs good operatives to confirm adequate compaction to realize the total strength and sturdiness of the hardened concrete. As concrete is created and placed at construction sites, underneath things distant from ideal, standard vibratory concrete in such things could cause risk to lab our and there are continuously doubts regarding the strength and durability of concrete placed in such locations. one in every of the solutions to beat these difficulties is that the employment of Self- Compacting Concrete (SCC).

SELF COMPCTING CONCRETE may be a form of concrete which may be compressed into each corner of the shape work strictly by means that of its own weight. it's usually accepted that SCC was developed initial in Japan within the late Nineteen Eighties in response to the dearth of good labor and therefore the want for improved sturdiness. in line with Out, the requirement for SCC was initial known by Okamura in 1986 and therefore the initial model was developed in 1988. SCC offers several advantages and blessings over ancient concrete. These embody Associate in nursing improved quality of concrete, reduced construction time, easier placement in full reinforcements, uniform and complete consolidation, enhanced bond strength, and reduced noise levels because of absence of vibration, lower overall prices, and safe operating environment. SCGC is an innovative type of concrete that does not require vibration for placing it and can be produced by complete elimination of ordinary Portland cement.

COPPER SLAG is a by-product of copper slag extraction by smelting. during smelting, impurities become slag which floats on the molten metal. Slag that is quenched in water produces angular granules which are disposed of as waste or utilized. copper slag is mainly used for surface blast-cleaning. Abrasive blasting is used to clean and shape the surface of metal, stone, concrete and other materials. the blasting media manufactured from copper slag brings less harm to people and environmental than sand.

II. SELF COMPACTING GEOPOLYMER CONCRETE MIX DESIGN PROCEDURE:

8 MOLARITY:

Step 1: The wet density of geopolymer concrete=2400 kg/m^3

Step 2: Mass of combined aggregate = 72.8% of the mass of concrete
= (72.8*2400/100) = 1747.2 kg/m^3

Step 3: Mass of Binders and the alkaline liquid = 2400-1747.2 = 652.8 kg/m^3

Step 4: Alkaline liquid to Binders ratio by mass = 0.45

Step 5: Assuming fly ash content = 450 kg/m^3
GGBS content = 450 kg/m^3

Step 6: Mass of alkaline liquid = 0.45*450 = 202.6 kg/ m^3

Step 7: Ratio of sodium silicate to sodium hydroxide solution = 2.5

Step 8: Mass of sodium hydroxide solution = 202.6/ (1+2.5) = 57.9 kg/ m^3

For 1 molar sodium hydroxide solution, 40g of sodium hydroxide pellets are dissolved in 1 liter of water.

i.e., for 1 molar: 40g pellets →1000g or 1000ml of water.

For 8 molars: 8x40g of pellets→1000g or 1000ml of water.

% of sodium hydroxide solids(pellets) in NaOH Solution = 32 %

In sodium hydroxide solution, solids = 0.32x57.9 = 18.528 kg/m^3

Weight of water in NaOH solution = 68% of 57.9
= 0.68×57.9 = 39.372 kg/m^3.

Step 10: Water content in sodium silicate solution=55.9%
Mass of sodium silicate solution =2.5 ×57.9 = 144.75 kg/m^3

Step 11: Coarse aggregate=0.45 X 1747.2 = 786.24 kg/ m^3

Step 12: Fine aggregate= 0.55 X1747.2 = 960.96 kg/ m^3

III. RESULTS AND DISCUSSION

Fresh and mechanical properties are of slump flow test, v-funnel test, l-box test were tested and for mechanical properties of split tensile test, compressive strength test and ultra pulse velocity test were tested for different ages and are tableted below.

FRESH PROPERTIES:

Slump flow test:

Slump flow take a look at equipment is shown in Fig thirteen Slump cone has twenty cm bottom diameter, ten cm prime diameter and thirty cm tall. during this take a look at, the slump cone mould is placed precisely on the twenty cm diameter graduated circle marked on the glass plate, crammed with concrete (6 liter) and raised upwards. the next diameter of the concrete unfold is measured in 2 perpendicular directions and therefore the average of the diameters is rumored because the unfold of the concrete. T50cm is that the time measured from lifting the cone to the concrete reaching a diameter of fifty cm. The measured T50cm indicates the deformation rate or consistency of the concrete. Slump flow and slump flow after T50 sec are shown in Table 1.

Table 1: Concrete mix of slump flow test in mm

S .No	Test	Percentage Of Replacement Of Fine Aggregate	Morality	Slump Flow In Mm	T50 Cm Slump Flow In Sec
1	Slump Cone	10	8	710	2.2
2	Slump Cone	20	8	705	2.3
3	Slump Cone	30	8	680	2.5
4	Slump Cone	40	8	650	3.2
5	Slump Cone	50	8	645	3.6

V-funnel test

V-funnel test apparatus dimensions are shown in Fig. In this test, trap door is closed at the bottom of V-funnel and V-funnel is completely filled with fresh concrete (12 litter). V-funnel time is the time considered from opening the trap door and complete empty the funnel. once more, the V-funnel is filled with concrete, kept for 5 minutes and entrap door is release. V-funnel time is calculated again and this indicates V-funnel time at T 5min are tabulated an shown below Table 2.

Table2 : Concrete mix of V-funnel test in sec

S.No	Test	Percentage Of Replacement Of Fine Aggregate	Morality	V-Funnel In (Sec)
1	v-funnel	10	8	7
2	v-funnel	20	8	7.2
3	v-funnel	30	8	8
4	v-funnel	40	8	9
5	v-funnel	50	8	9

L-box test:

L-box test apparatus dimensions are shown in Fig. 3.8. In this test, fresh concrete (14 liter) is filled in the vertical section of L-box and the gate is lifted to let the concrete to flow into the horizontal section. The height of the concrete at the conclusion of horizontal section represents h_2 (mm) and at the straight up section represents h_1 (mm). The ratio h_2/h_1 represents jamming ratio. Concrete mix of L-box test tabulated below in Table 3.

Table 3: Concrete mix of L-box test (h2/h1) in sec

S.no	Test	Percentage Of Replacement Of Fine Aggregate	Molarity	L-Box Ratio (H2/H1)
1	L-box	10	8	0.98
2	L-box	20	8	0.96

3	L-box	30	8	0.85
4	L-box	40	8	0.83
5	L-box	50	8	0.81

MECHANICAL PROPERTIES OF SCGC:

Split Tensie Test Results: Mix Proportions For Different Replacements Testing For Split Tensile Are Shown Below Table 4.

Table 4**:** split tensile test results

Property	**Age(Days)**	**Mix Proportions**				
		10%	**20%**	**30%**	**40%**	**50%**
Split Tensile Test	28	2.13	2.34	2.56	2.68	2.94
	90	2.87	3.01	3.21	3.34	3.56

Compressive Strength Test Results: compressive strength for different ages are tested and tabulated below Table 5.

Table 5: compressive strength results

Percentage of replacement of fine aggregate with copper slag	**Compressive strength**		
	7days	28 days	90days
0	32.16	33.18	38.89
10	33.16	34.05	39.67
20	34.83	35.2	41.12
30	34.67	35.23	42.23
40	35.31	36.23	44.58
50	37.63	39.02	46.42

Ultrasonic Pulse Velocity: Ultra Pulse Velocity Test Results For Different Ages Are Shown In Below Table 6.

Table 6: UPV Test Results

Property	days	90:10	80:20	70:30	60:40	50:50
UPV	7	3238	3423	3568	3695	3781
(m/s)	28	3497	3668	3885	3974	4074
	90	3668	3882	3908	4112	4208

4. CONCLUSIONS:

- The percentage of GGBS and Fly ash in the mix will affects the workability characteristics of SCGC.
- The inclusion of super plasticizer improved the workability characteristics of fresh concrete.
- Longer curing duration improves the process of Geo-polymerization resulting in higher compressive strength.
- There was a significant increase in mechanical properties with the increase in percentage of copper slag from 0%to 50% in all curing periods.
- When the percentage of copper slag and increased from 0%to 50%, rebound hammer value and UPV value also have been enhanced.

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