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Comparative Study on Geopolymer and Conventional Concrete Beams Subjected to Flexural loading

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Abstract - *Geopolymer concrete has been researched and has exhibited predominant mechanical execution as a promising option in contrast to OPC concrete. The behavioural comparison between conventional concrete and GPC concrete beams is shown. The 12 numbers of beams were casted. 6 numbers of geopolymer concrete and 6 numbers of conventional concrete beams, the steel percentage variations are 0.579%, 0.837%, 1.214%, 1.502%, 1.772%,1.821%,.The Beam size is 125x250x2000 mm. The beams are tested in loading frame still failure under static load. The testing of beam is done. The load-displacement response of the geopolymer beam and conventional beams are obtained and compared. The failure behaviour of geopolymer beam is similar to the conventional concrete beam under flexural loading. But geopolymer concrete beams behave well in compare to the conventional concrete beams. The deflection is also noticed less in GPC beams than conventional concrete beams. Thus the geopolymer concrete beams gives good results than results compare to the conventional concrete beams.*

Key Words: **Geopolymer concrete, Flexural loading of beams.**

1. INTRODUCTION

Concrete is quite possibly the most generally utilized development materials on the planet. Portland cement is a basic constituent of concrete still it's dangerous to the atmosphere. The production of Portland cement not only drain significant amount of natural resources but also releases a tolerable amount of co_2 and other greenhouse gases to the environment as a result of de-carbonation of limestone and the burning of fossil fuels. Geopolymer concrete is moderately another concept which can be considered as the most innovative breakthrough in the area of concrete innovation. GPC is a revolutionary form of concrete that does not need compaction for placing it and can be generated by complete elimination of OPC. The use of GPC technology in producing concrete has environmental gain as it could minimize the carbon dioxide pollution to the atmosphere up to 85 % compared to OPC concrete, in order to minimize greenhouse gas emissions, efforts are required to improve ecological friendly construction materials. The dedication of popular Portland concrete creation worldwide to ozone depleting material discharges is assessed to be roughly 1.35 billion tons annually or roughly 7% of the total greenhouse gas emissions to the earth's atmosphere. In Geopolymer concrete the binder materials from Ordinary Portland Cement is replaced by the by-products from the industries. There are many materials that can be replaced for OPC are Fly ash, GGBS and clay. Currently thousands of industries produce million tons of by-products disposing into the rives or sea or landfills. Since these pozzolonic Materials and alkaline activator the Ordinary Portland Cement can partially or fully replaceable. The Geopolymer concrete mix has ingredients are Fine Agg., Coarse Agg., GGBS, sodium hydroxide(NAOH), fly ash, water and sodium silicate(NA_2SIO_3).This study includes mix design of GPC, and flexural loading on ordinary Portland cement concrete and Geopolymer concrete beams, and also the differentiation between the flexural characteristics of conventional and geopolymer concrete.

2 OBJECTIVES

The aims of this experimental study are as follows,

- To study the new solid properties of geopolymer concrete.
- To review the hardened properties of geopolymer concrete.
- To find the behaviour of GPC reinforced beams under flexural loading.
- Finally differentiate between GPC and OPC reinforced beams with different percentage of the steel.

3 Supplementary products for cement

3.1 FLY ASH

It is a by-product of coal fire power station is called Fly ash. It is used for partial or fully replacement of cement in standard concrete mixes. It is aim to Geopolymer concrete to reinstate Ordinary Portland Cement with binder material. It is observed that more than billions of tons of fly ash is presently exhibit in the world with the rate of use is 20%. From the Coal Fire Power Station fly ash is accumulated all over the universe for concrete concrete mix. The fine powder of fly ash is generated after it feeding in to the mills. Then the fine powder is blazed in boiler to generate steam required for production of power. During this action, they form in shape of sphere of calcium silicate in nature.

There are two types of fly ash are available worldwide. Those types are are depend on the content of calcium. They are,

- C- type
- F- type fly ash

If the percentage of calcium is less than 8% are called Class C- type fly ash. And if the percentage of it's more than 8% are called Class F- type fly ash.

3.2 GGBS

GGBS is also another by-product of the iron industries. It is generally utilised to minimum heat hydration combat abrasion draining from ground water or resist other other contrary environmental conditions. GGBS is produced during steel production, while iron ore, coke and flux are excited in the blast furnace to melt stage. Residues of molten materials are gathered and easily cooled after the melting point step has done. This molten material includes the flow of ore and coke ash aluminates and silicate that have been chemically fused to form blast funace slag, then cooled the slag, and field furnace can be used.

Table -1: Mix Design of Conventional concrete

Cement	425 kg/m^3
Water	192 lit/m^3
Fine agg	588.53 kg/m^3
Coarse agg.	1235 kg/m^3

Table -2: Mix Design of Geopolymer concrete

Fine Agg	720 kg/m^3
Coarse Agg	1080 kg/m^3
Fly Ash	69 kg/m^3
GGBS	276 kg/m^3
Sodium Hydroxide	54 kg/m^3
Sodium Silicate	135 kg/m^3
Water	28.03 kg/m^3

4 METHODOLOGY

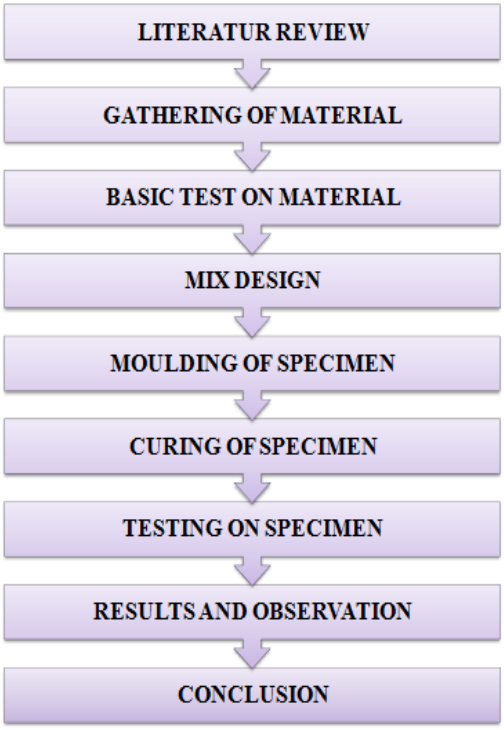

Chart -1: Methodology

5 TEST RESULTS OF FLEXURAL LOADING ON BEAMS

5.1 TESTING BEAM SPECIMENS

12 numbers of beams were tested for this experimental study. In those 12 numbers of beam 6 beams are made up of conventional concrete and remaining 6 beams are made of geopolymer concrete. The beam size is 125X 250 X 2000 mm. The beam numbers are for conventional concrete columns are CC1, CC2, CC3, CC4, CC5 and CC6 and the column numbers for geopolymer concrete columns are GC1, GC2, GC3, GC4, GC5 and GC6.

The percentage of the steel is varied. There are 6 numbers of percentages were used for casting of RC columns as follows,

Table -2: Percentage of Steel Used In Beams

COLUMN	PERCENTAGES OF STEEL PROVIDED	REINFORCEMENT DETAILS
CC1& GC1	0.579%	2 numbers of 8mm ø bars 2 numbers of 10mm ø bars
CC2& GC2	0.837%	2 numbers of 8mm ø bars 2 numbers of 12mm ø bars

CC3& GC3	1.214%	2 numbers of 8mm ø bars 4 numbers of 10mm ø bars
CC4& GC4	1.502%	2 numbers of 8mm ø bars 2 numbers of 10mm ø bars 2 numbers of 12mm ø bars
CC5& GC5	1.772%	2 numbers of 8mm ø bars 4 numbers of 12mm ø bars
CC6& GC6	1.821%	2 numbers of 8mm ø bars 6 numbers of 10mm ø bars

5.2 TEST RESULTS

COLUMN	% OF STEEL PROVEIDED	MAXIMUM LOAD IN KN	DEFLECTION AT MAXIMUM LOAD(mm)
NC1	0.579%	60	6.1
GC1	0.579%	70	4.67
NC2	0.837%	70	4.22
GC2	0.837%	80	4.02
NC3	1.214%	80	7.1
GC3	1.214%	90	6.1
NC4	1.502%	85	7.56
GC4	1.502%	95	7.06
NC5	1.772%	100	6.74
GC5	1.772%	105	6.515
NC6	1.821%	105	7.58
GC6	1.821%	115	6.08

5.3 COMPARISON OF RESULTS

The graphical comparison of test results for flexural loading of beams of geopolymer concrete and conventional concrete beams with the respective percentages of steel provided.

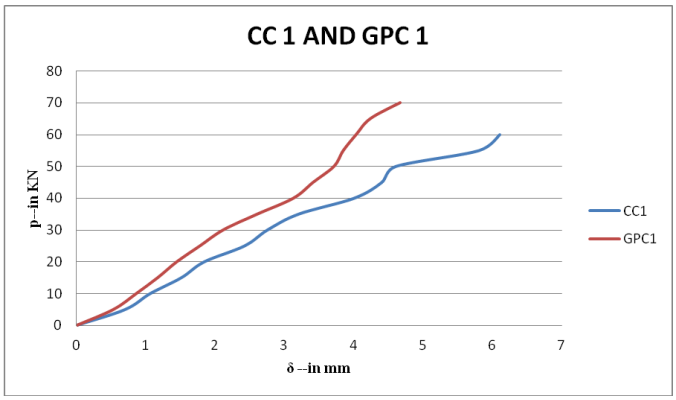

Chart -2: Comparison of CC1 and GPC1

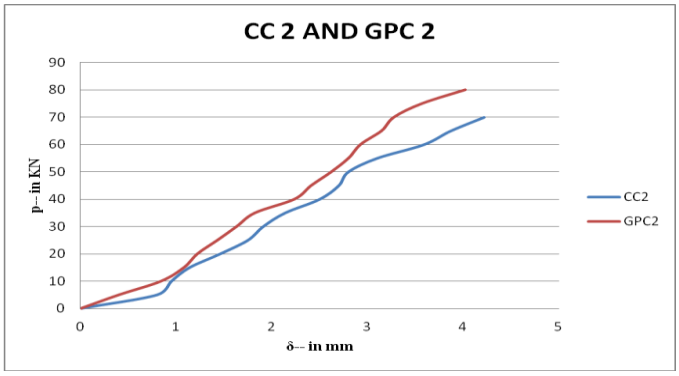

Chart -3: Comparison of CC2 and GPC2

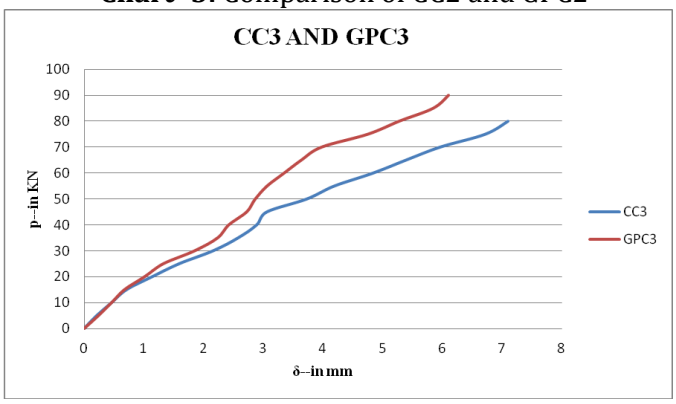

Chart -4: Comparison of CC3 and GPC3

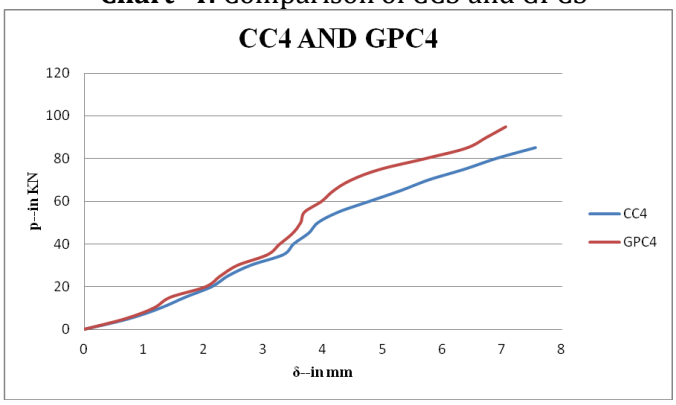

Chart -5: Comparison of CC4 and GPC4

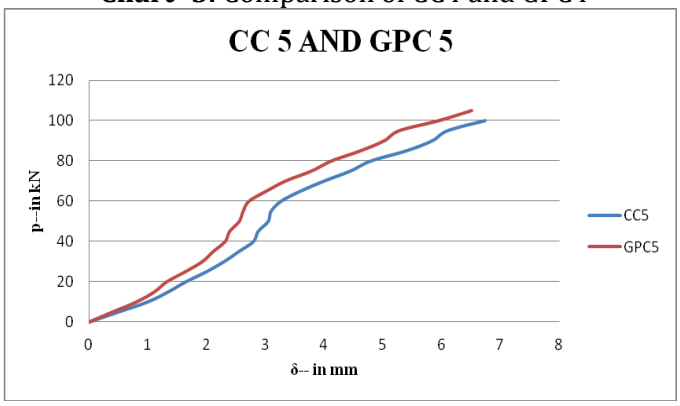

Chart -6: Comparison of CC5 and GPC5

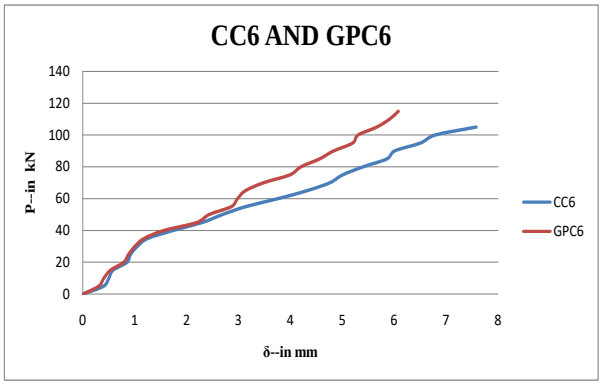

Chart -7: Comparison of CC6 and GPC6

CONCLUSION

Flexural tests were conducted on 12 number of rectangular beams, out of which six beams are conventional concrete(CC) and remaining six are geopolymer concrete(GPC) RC Beams with six different reinforcement conditions by varying the reinforcement percentage in each of the beam such as 0.579%,0.837%, 1.214%, 1.502%, 1.772%, 1.821%, and M_{20} grade of the concrete used in all the beam's. Curing time at the age of three, seven and twenty eight days compressive strength of conventional concrete found to be less than that of geopolymer concrete, All the beams were tested for the middle third portion under pure bending. While testing The cracks first appeared in flexure zone on the bottom face (Tension zone) and extended gradually towards top surface (Compression zone) with every increase in load for all beams. The first crack appeared in flexural zone at a distance of around 600 to 700 mm & 700 to 900 mm respectively in both CC & GPC beam specimens from supports.The complete nature of beam load-deflection and breakdown is studied. After completing the testing of beam it has shown that the load taken by geopolymer concrete(GPC) beam is more compared to conventional concrete(CC). The load carried by the beam is also raised as the percentage of steel is increased, geopolymer concrete(GPC) beam's shows less deflection compared to conventional concrete beam's for same percentage of steel. at the failure load conventional concrete shows a warning by more number of cracking at the tension zone but in geo polymer concrete shows less warning and sudden failure of the beams were observed.

REFERENCES

1. M. Ratna srinivas, Y. Himath Kumar, B. Sarath Chandra Kumar "Studies on Flexural Behavior of Geopolymer Concrete Beams with GGBS".
2. Mr.M.Gokulakrishnan, Ms.A.Dhanalakshmi, Assistant Professor, "Analytical study On Flexural Behaviour Of Reinforced Geopolymer Concrete Beams".
3. C. K. Madheswaran, P S Ambily, J. K. Dattatreya, Ramesh G, CSIR-Structural Engineering Research Centre, Taramani, Chennai, India "Experimental Studies on Behaviour of Reinforced Geopolymer Concrete Beams Subjected To Monotonic Static Loading".
4. Khoa Tan Nguyen, Taun Anh Le,Kihak Lee "Experimental Study On Flexural Strength Of Reinforced Geopolymer Concrete Beams".
5. D. Annapurna, Prof.Ravande Kishore, M. Usha Sree Civil Engineering Department, University College of Engineering, Osmania University, Hyderabad "Comparative Study Of Experimental And Analytical Results Of Geo Polymer Concrete".
6. K.S.Siddharthan, S.Narmadha P.G. Scholar, Assistant Professor Department of Civil Engineering, Dhirajlal Gandhi College of Technology, Salem Experimental "Investigation On Flexural Behavior Of Reinforced Geo-Polymer Concrete Under Day-Light Curing".
7. Nindyawati, Sri Umniati B, and Puput Risdanareni, Department of Civil Engineering, Universitas Negeri Malang, Malang, Indonesia "Flexural Test of Fly Ash based Geopolymer Concrete Beams".
8. Yamini J. Patel , Niraj Shah "Development Of Self-Compacting Geopolymer Concrete As A Sustainable Construction Material".
9. S.Deepa Raj, N. Ganesan, Ruby Abraham and Anumol Raju, "Behavior Of Geopolymer And Conventional Concrete Beam Column Joints Under Reverse Cyclic Loading".