An Experimental Investigation On Mechanical Properties Of Geopolymer concrete by using GGBS,Granite powder, Marble powder

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ABSTRACT:

Concrete, being material of choice in construction industry could be composed of naturally available materials. Cement in concrete is a binding material which produced by making use of natural materials leading natural materials to deplete. Thus, using the alternative materials which are waste products such as Ground Granulated Blast Furnace slag, Granite powder and Marble Powder without using cement along with some chemicals such as Sodium Silicate and Sodium Hydroxide to bind the concrete ingredients together to produce geopolymer concrete. An attempt has been made to find out an optimum mix for the geopolymer concrete by replacing Ground Granulated Blast Furnace slag with Granite powder and Marble powder. Compressive strength and tensile strength were carried out on concrete at 14 days and 28 days, Flexural strength were carried out at 28 days and 56 days. Rapid Chloride Permeability Test were carried out at 28 days.

Keywords: Ground Granulated Blast Furnace Slag, Granite powder, Marble powder, sodium silicate (Na_2SiO_3), Sodium hydroxide (NaOH)

1.INTRODUCTION

Environmental pollution is a major issue now-a-days. As far as construction industry has concerned, the production of cement leads mostly in polluting the environment. Geopolymer concrete could be an alternative material for normal concrete since it uses the waste products in place of cement which reduces the pollution also. In general, polymer concrete uses polymers to bind the concrete ingredients unlike the normal concrete, thus usage of water will also be very less. The polymers in this study were obtained from the manufacturers and the marble powder was taken from the marble powder stock yard at puttur and Granite powder was taken from the granite cutter at Tadipatri. The Ground Granulated Blast Furnace Slag gets reacted in presence of alkaline solution and makes all other materials in concrete to stick together to form a strong material which can resist against forces on it. Because of this sticky nature it can be moulded into any shape like normal concrete.

The influence of geopolymer concrete with these materials is investigated through compression test, split tensile test for 14and 28 days, flexure strength test for 28,56 days and RCPT for 28 and days of grade M30 concrete.
During the research these specimens are cured at room temperature.
GGBS+G.P100+0, 90+10, 80+20, 70+30, 60+40 and 50+50.
GGBS+M.P 100+0, 90+10, 80+20, 70+30, 60+40 and 50+50
GGBS+G.P+M.P 70+20+10, 60+20+20 & 50+20+30 (G.P is constant 20)
GGBS+M.P+G.P 70+20+10, 60+20+20 & 50+20+30 (here M.P is constant 20)

2.LITERATURE REVIEW

Paras et al (2015) Has examined the experimental study on geo polymer concrete by using GGBS as a replacement of fly ash upto100% the fresh and hardened properties of concrete were examined. The results showed to the replacement of fly ash increases the strength gradually. It has been observed that the air curing of geo polymer concrete also gives good strength.

Ajay et al (2017) Has done experimental study on mechanical properties of fly ash and GGBS based on geo polymer concrete. In this study fly ash replaced by 0%,25%,50%,100% by GGBS. The tests will be conducted on compressive strength, split tensile strength, Flexural strength at 3, 7, 28 days. This geo polymer concrete shows better results than conventional concrete. Geo polymer concrete is more advantageous, economical and eco-friendly. The geo polymer concrete gives early setting and early high strength.

DR.G.Prince et al(2013) Has studied an experimental investigation of Granite powder. Granite belongs to igneous rocks of family. This granite powder cheaply and freely available at granite cutter machines. The density of granite 2.65 to 2.75. The present study of granite powder replaced by fine aggregate 0%,5%,10%,20%,25% were added to the M30 mix of concrete After preparation of cubes, cylinder's, beams. The specimens were kept for air curing. Finally, the replacement of fine aggregate by granite powder gives good strength.

Abdul aleem et al (2012) studied geopolymer concrete. Geopolymer concrete is an innovative constructive material which shall be produced chemical action of inorganic material. The name of davidovits French professor1978 represents material by network inorganic molecules. This geopolymer concrete slightly lower impact on global warming compares to normal concrete.

B.Vijayarangan et al (2015) Studied on geo polymer concrete by using sodium silicate and sodium hydroxide polymers. The sodium hydroxide polymer when mixed with water it releases heat of 60^0.This concrete gives very high compressive strength compared to normal concrete. Joseph davidovits found that fly ash can react to an alkaline solution.

Dhavamani doss et al (2019) Studied on high strength geopolymer concrete with alumina and silica materials using manufacturing sand concrete. This paper studied on river sand completely replaced by M sand. The presently architectures are keen in constructing lean structures increases aesthetics looks of structures. This study mainly concentrated HSC sustainable materials without cement to find a solution to the above problem. The use of manufacturing sand in concrete contributes to strength due to better gradation. This geopolymer concrete gives better values compares to normal concrete.

Markandeya raju et al (2016) Studied compressive strength of concrete with partial replacement of aggregate with granite powder and cockshell. It is cheaply, freely available at granite cutter machines. Cock shell replacement by coarse aggregate. These two materials were added and prepared at different proportions like Granite powder and cockshell with 0%,5%,15%,25% and 25% gives increase in concrete strength increases. Finally, the replacement of fine aggregate by granite powder increasing in compressive strength.

Manpreet singh et al (2017) Has done a study on environmental and economic impacts of using waste marble powder concrete. Marble is one of the most common building material and usage of decorative purposes. Finally, the usage of marble powder in concrete as a replacement of cement gives positive effects in environment.

Bederina madani et al (2019) Has studied the effect of marble powder on the properties of self-compacting sand concrete. The main component of marble powder $CaCo_3$ is more 90%. This paper studies the effect of marble powder content properties on SCSC. The tests have been conducted at 28 days on compressive strength. The marble lime stone powder was grounded to 80 microns. The mini slump funnel, viscosity tests were also

3.MATERIALS

3.1 GROUND GRANULATED BLAST FURNACES (GGBS)

Ground granulated blast furnace slag is off white color and is a by-product, a mineral admixture which does not have cementations properties but when mixed in concrete produces compounds which Skins to cement. The GGBS material available in Astra chemicals Chennai.

Figure 1. GGBS

3.2 GRANITE POWDER

Granite belongs to igneous rock of family. This granite powder is totally dust and waste of material. This is used to main thing of replacement of sand. The Granite powder used to admixture of concrete. The main benefit of this powder usages to controlling of pollution. The granite powder available to granite cutting machines (tadipatri,ongole etc).

Figure 2. GRANITE POWDER

3.3 MARBLE POWDER

In that project the collection of marble powder from puttur. And we can reduce the environmental pollution by utilizing this marble powder for producing the other products. Marble powder can be used as filler in concrete and paving materials and helps to reduce total void content in concrete. Marble powder can be used as an admixture in concrete, so that strength of the concrete can be increased.

Figure 3. MARBLE POWDER

3.4 FINE AGGREGATE

Fine aggregate is usually sand are crushed stone that are <9.55mm in diameter. Fine aggregate are fundamentally sands won from the land or the marine condition. The aggregate those portions from 4.75mm to150 micron are named as fine aggregate.

Figure 4. FINE AGGREGATE

3.5 COARSE AGGREGATE

Coarse aggregate are particulates greater than 4.75mm.in this geo polymer concrete 20 mm of coarse aggregate used. However, for the most part extend between 9.5mm to 37.5 mm width. Coarse aggregates, the divisions from 20 mm to 47.5 mm are utilized as coarse aggregate. IS:383 are to be utilized. The flakiness and elongation tests will be conducted

Figure 5. COARSE AGGREGATE

3.6 SODIUM HYDROXIDE(NaOH)

This is white solid ionic compound consisting of sodium NA^+ cations and hydroxides OH^- anions. And this is usage of manufacturing of soaps and variety detergents.

Figure 6. SODIUM HYDROXIDE

3.7 SODIUM SILICATE (Na_2Si_{03})

Sodium silicate is a generic name for chemical compound Na_2SiO_3. And this is colorless to liquid form; they are readily soluble in water, producing to alkaline solutions

Figure 7. SODIUM SILICATE

3.8 WATER

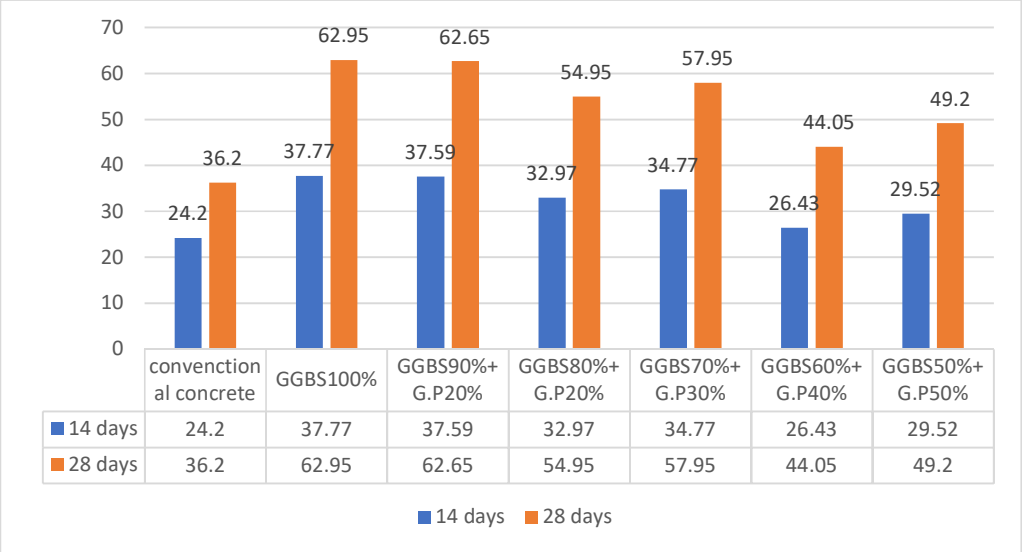
Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. Since it helps to from the strength giving cement gel. In this preparation, geopolymer concrete uses less water and then cubes and cylinders, Beams were casted.

Figure 7. WATER

4.EXPERIMENTAL TESTS AND RESULTS

4.1 COMPRESSION STRENGTH TEST:

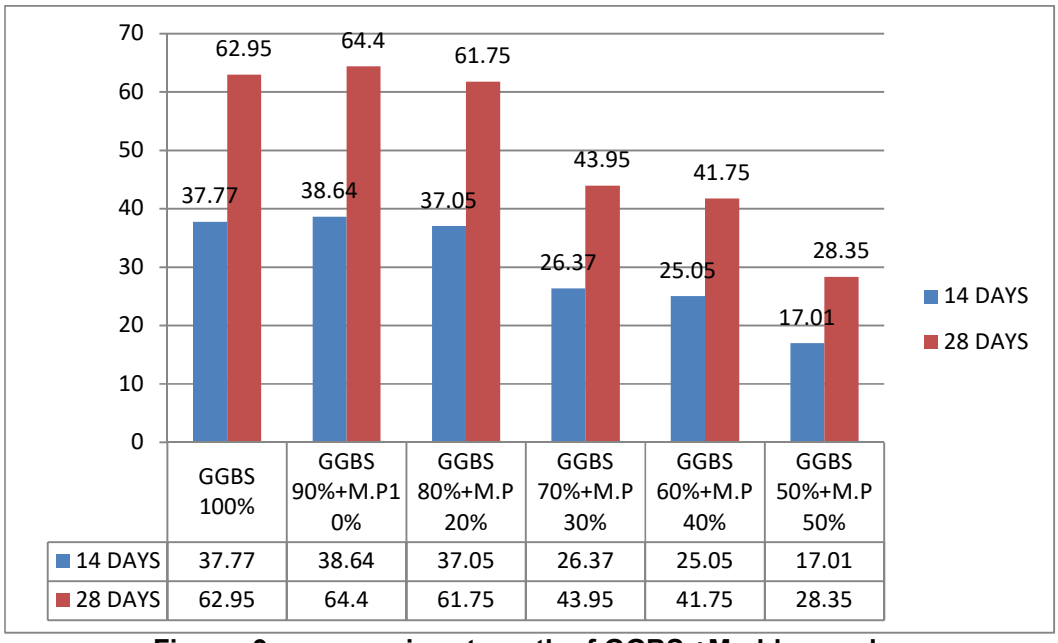
Concrete cubes of sizes 150mm x150mm x150mm were tested for crushing strength The main purpose of conducted by this test is finding of cube strength .These casting cubes are tested by compression testing machine after 14 and 28 days test will be conducted. And The actual load of compressive strength test machine is1.4 N/mm^2.



	convenctional concrete	GGBS100%	GGBS90%+G.P20%	GGBS80%+G.P20%	GGBS70%+G.P30%	GGBS60%+G.P40%	GGBS50%+G.P50%
14 days	24.2	37.77	37.59	32.97	34.77	26.43	29.52
28 days	36.2	62.95	62.65	54.95	57.95	44.05	49.2

Figure 8. Compressive strength of GGBS+Granite powder

Fig.8 Represents geopolymer concreteGGBS100% proportion strength 62.95N/mm^2 with in28 days highest value andGGBS60%+G.P40% proportion strength44.05 N/mm^2 lowest strength in 28 days



	GGBS 100%	GGBS 90%+M.P10%	GGBS 80%+M.P 20%	GGBS 70%+M.P 30%	GGBS 60%+M.P 40%	GGBS 50%+M.P 50%
14 DAYS	37.77	38.64	37.05	26.37	25.05	17.01
28 DAYS	62.95	64.4	61.75	43.95	41.75	28.35

Figure. 9 compressive strength of GGBS +Marble powder

Fig.9 Represents geopolymer concreteGGBS90%+M.P10%proportion strength64.4N/mm^2 within 28 days highest value and GGBS50%+M.P50%proportion strength 28.35 N/mm^2 lowest strength in 28 days

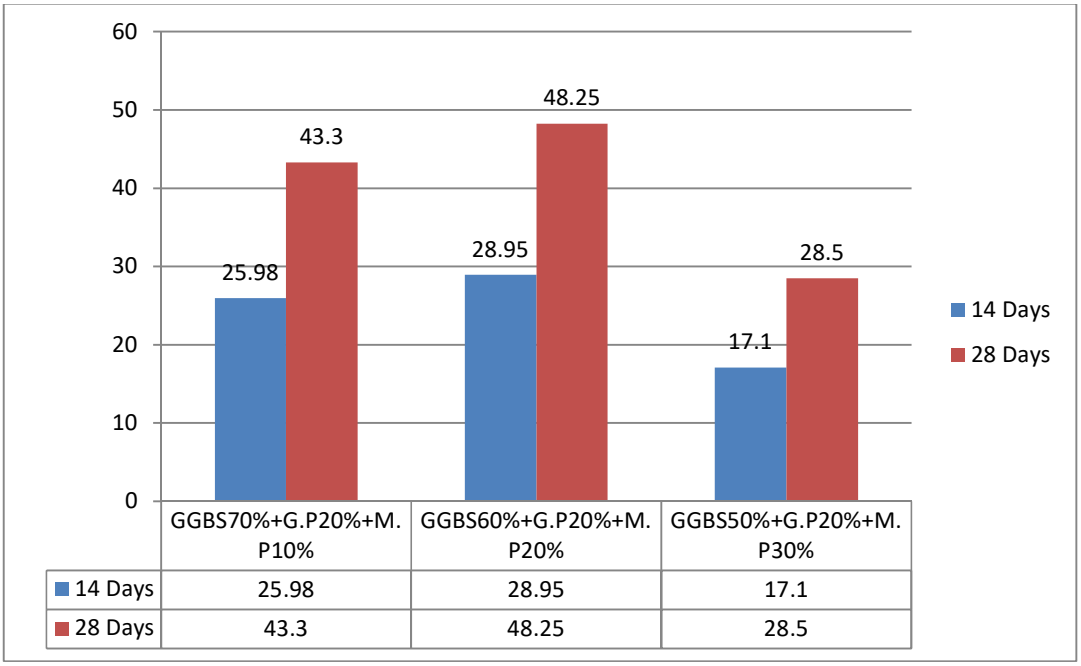


Figure.10 compressive strength of GGBS + Granite powder 20%(C) + Marble powder

Fig.10 Represents geo polymer concreteGGBS60%+G.P20%+M.P20% proportion strength 48.25N/mm^2 within 28 days highest value and GGBS50%+G.P20%+M.P30% proportion strength28.5 N/mm^2 lowest strength in 28 days

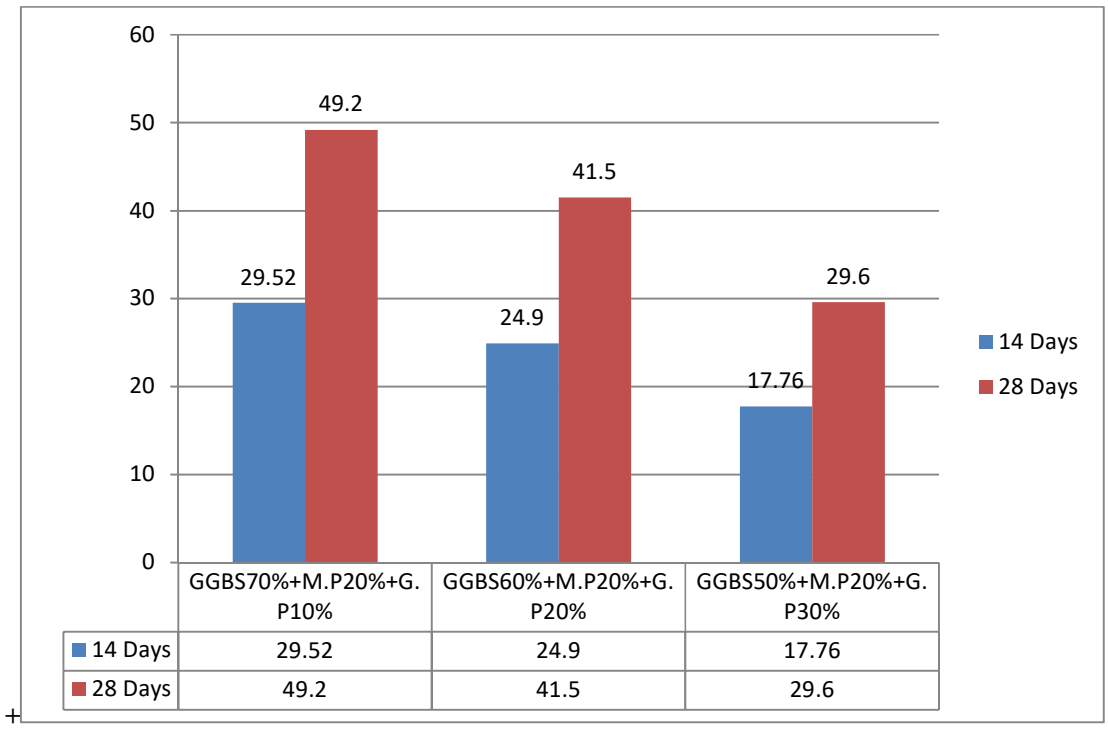


Figure.11 compressive strength of GGBS +Marble powder 20%(C)+Granite powder

Fig. 11 Represents geo polymer concreteGGBS70%+M.P20%+G.P10% proportion strength 49.2N/mm^2 within 28 days highest value and GGBS50%+M.P20%+G.P30% proportion strength29.6N/mm^2 lowest strength in 28 days

4.2 SPLIT TENSILE STRENGTH TEST:

Split tensile strength test was conducted by using the method prescribed by IS5816-1999.Cylynders size is 150mm x150mm x300mm were used for this test.The specimens were tested for 14 days,28 days. the cylinders specimens were placed in horizontal direction on the compressive testing machine

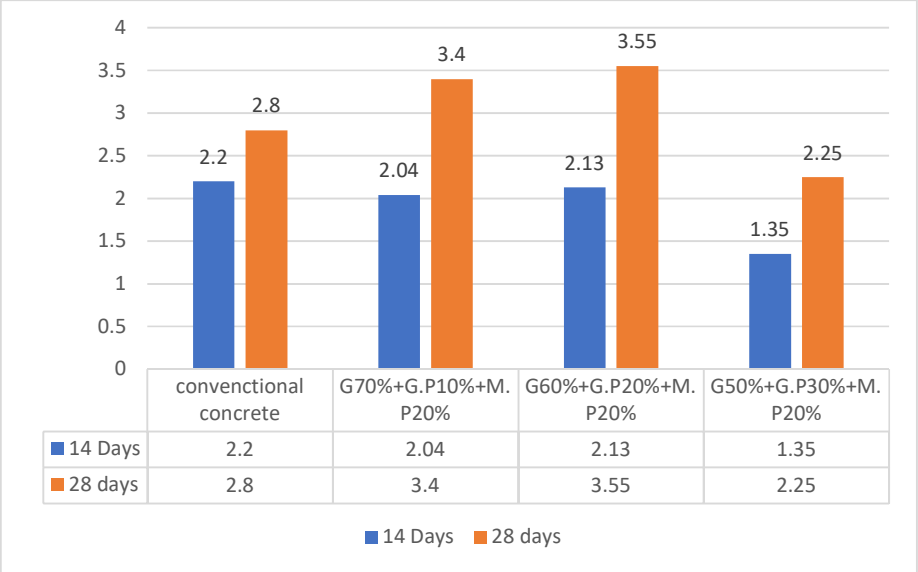


Figure.12 split tensile strength of GGBS +Marble powder 20%(C) + Granite powder

Fig. 12 Represents geopolymer concreteGGBS60%+G.P20%+M.P20% proportion strength 3.55N/mm^2 with in28 days highest value andGGBS50%+G.P30%+M.P20% proportion strength2.25N/mm^2 lowest strength in 28 days

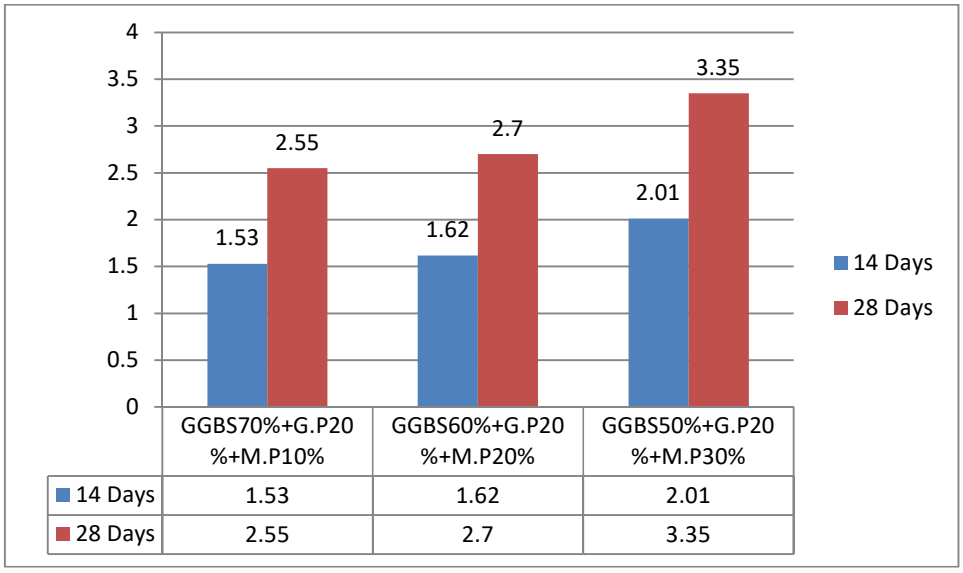


Figure.13 split tensile strength of GGBS + Granite powder 20%(C) +Marble powder

Fig.13 Represents geopolymer concreteGGBS50%+G.P20%+M.P30%proportion strength3.35N/mm^{2}within28dayshighestvalueand GGBS70%+G.P20%+M.P10%proportion strength 2.55 N/mm^2 lowest strength in 28 days

3 FLEXURE STRENGTH TEST:

Flexural strength test was conducted by using the method prescribed by IS516-1959.Beams of dimensions is 700mm x150mm x150mm were used for this test, the test specimen is placed in the machine at the bearing surfaces of the supporting and loading rollers.

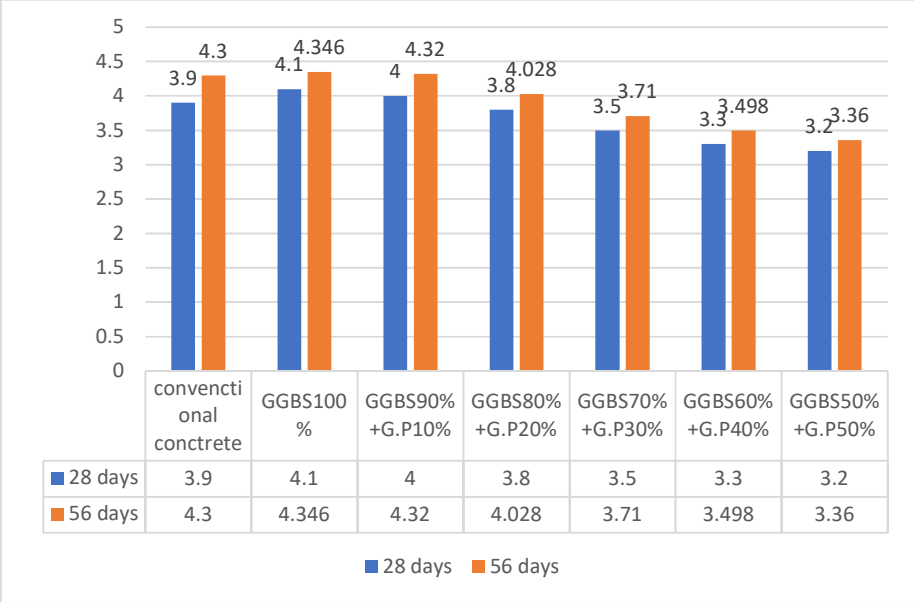


Figure 14. Compressive strength of GGBS+Granite powder

Fig.14 Represents geopolymer concreteGGBS100% proportion strength 4.34N/mm^2 with in56days highest value andGGBS60%+G.P40% proportion strength3.34N/mm^2 lowest strength in 56days

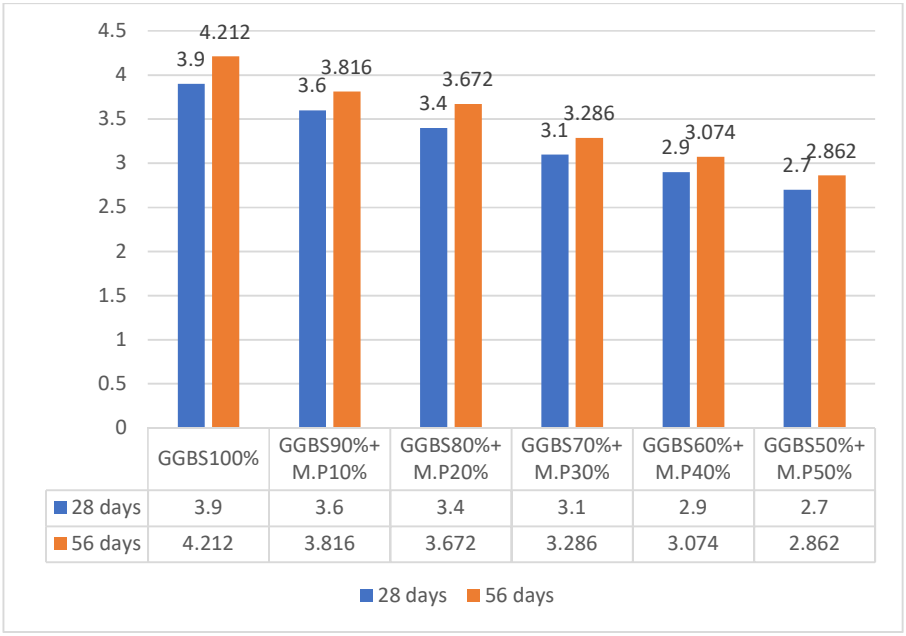


Figure. 15 Flexure strength of GGBS + Marble powder

Fig.15 Represents geopolymer concreteGGBS90%+M.P10%proportion strength3.816N/mm^2 within 56days highest value and GGBS50%+M.P50%proportion strength 2.862N/mm^2 lowest strength in 28 days

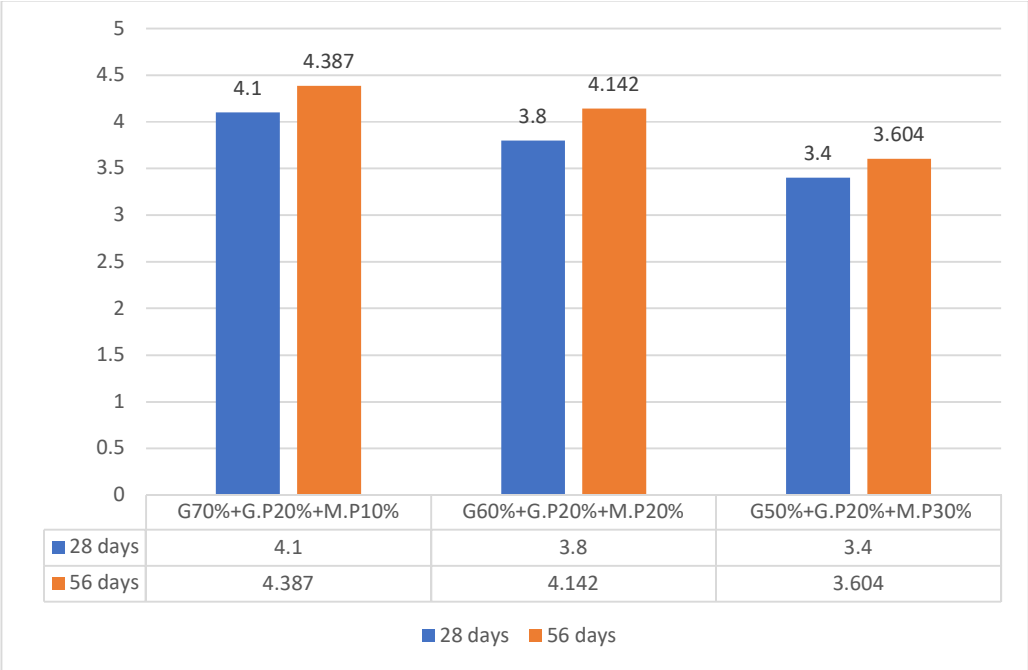


Figure. 16 Flexure strength of GGBS+Granite powder 20%(C)+Marble powder

Fig. 16 Represents geo polymer concreteGGBS60%+G.P20%+M.P20% proportion strength 4.14N/mm^2 within 56days highest value and GGBS50%+G.P20%+M.P30% proportion strength3.6N/mm^2 lowest strength in 56days

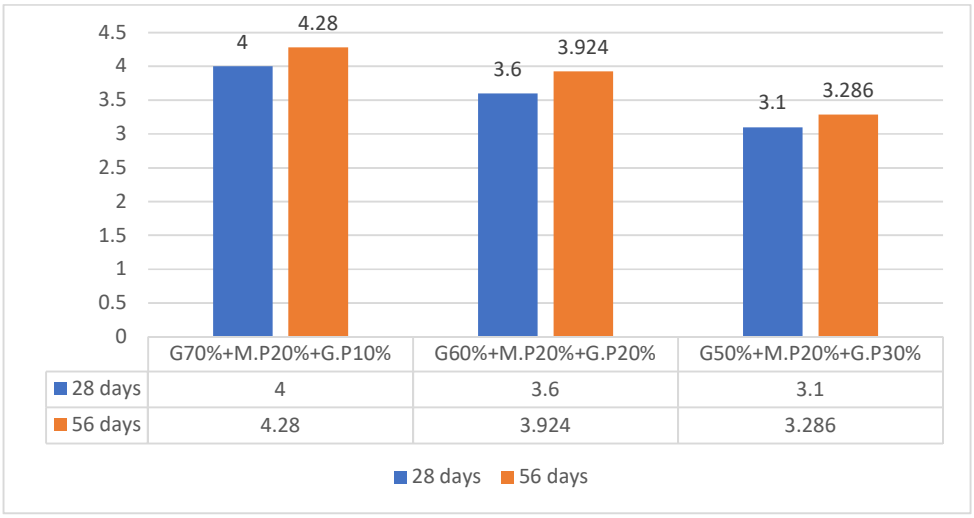


Figure.17 Flexure strength of GGBS+ Marble powder 20%(C)+Granite powder

Fig. 17 Represents geo polymer concreteGGBS70%+M.P20%+G.P10% proportion strength 4.28N/mm^2 within 56days highest value and GGBS50%+M.P20%+G.P30% proportion strength3.286N/mm^2 lowest strength in 56days.

5.CONCLUSION

- **In Compressive Strength Test**
- Represents geopolymer concreteGGBS100% proportion strength 62.95N/mm^2 with in28 days highest value andGGBS60%+G.P40% proportion strength44.05 N/mm^2 lowest strength in 28 days
- Represents geopolymer concreteGGBS90%+M.P10%proportion strength64.4N/mm^2 within 28 days highest value and GGBS50%+M.P50%proportion strength 28.35 N/mm^2 lowest strength in 28 days
- Represents geo polymer concreteGGBS60%+G.P20%+M.P20% proportion strength 48.25N/mm^2 within 28 days highest value and GGBS50%+G.P20%+M.P30% proportion strength28.5 N/mm^2 lowest strength in 28 days
- Represents geo polymer concreteGGBS70%+M.P20%+G.P10% proportion strength 49.2N/mm^2 within 28 days highest value and GGBS50%+M.P20%+G.P30% proportion strength29.6N/mm^2 lowest strength in 28 days
- **In Split Tensile Test**
- Represents geopolymer concreteGGBS60%+G.P20%+M.P20% proportion strength 3.55N/mm^2 with in28 days highest value andGGBS50%+G.P30%+M.P20% proportion strength2.25N/mm^2 lowest strength in 28 days
- Represents geopolymer concreteGGBS50%+G.P20%+M.P30%proportion strength3.35N/mm^{2}within28dayshighestvalueand GGBS70%+G.P20%+M.P10%proportion strength 2.55 N/mm^2 lowest strength in 28 days
- **In Flexure Strength Test**
- Represents geopolymer concreteGGBS100% proportion strength 4.34N/mm^2 with in56days highest value andGGBS60%+G.P40% proportion strength3.34N/mm^2 lowest strength in 56days
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REFERENCE

*1.Paras S. Pithadiya, Abhay V. Nakum "Experimental Study On Geo-Polymer Concrete By Using GGBS"International journal of researchin engineering technology.,vol 4,**(2015),** pg111-113*
*2.Ajay Takekar, GR Patil **"**has studied by Experimental study on mechanical properties of fly ash and GGBS based on geo polymer concrete".,International research journal of engineering and technology.vol 4,**(2017)**, pg 18-23*
*3.DR.G. PrinceArulraj,Mr.A.Adin and Mr.T.Sureshkannan **"**Has studied by experimental investigation of granite powder".,IRACST_Engineering Sciences and Technology. Vol 3**(2013)**, pg 193-198*
*4.M.I. AbdulAleem,P.D.Arumairaj"geo polymer concrete"Internatiinal journal of engineering sciences and engineering technology.,vol 1**,(2012),** pg 118-122*
*5.B. vijayarangan and hardijito "studied on fly ash based geopolymer concrete" **(2015)**, Vol.28*
*6.Dhavamani doss,sakthi doss study on high strength geo polymer concrete with alumina and silica materials using manufacturing sand. **(2019)** Vol.3:*
*7.Markandeya Raju Ponnada,S Siva Prasad "Studied by Compressive strength of concrete with partial replacement of aggregate with granite powder and cockle shell".,Malaysian journal of civil engineering**(2016),**pg 184-204*
8.Prakash (2013) Studied by parametric studied on compressive strength of geo polymer concrete ISSN:210-219, Vol.51
*9. Manpreet singh, Kailash Chaudhary,AnshumanSrivastava,DipenduBhunia **"**Has studied by a study on environmental and economic impacts of using waste marble powder concrete".,Journal of building engineering **(2017),** pg 1-25*
*10. BederinaMadani,Lamramohammed "Has studied by effect of marble powder on the properties of self-compacting sand concrete".,The journal of construction and building technology journal **(2011),5** pg 25-29*