International Journal of Civil Engineering and Construction

E-ISSN: 2707-8337
P-ISSN: 2707-8329
IJCEC 2023; 2(1): 17-20
Received: 24-12-2022
Accepted: 02-01-2023

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Experimental investigation of geopolymer concrete with full replacement of cement with fly ash, metakaolin and GGBS

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Abstract
Cement is used for construction purposes nowadays but it also leaves a large amount of carbon footprint behind which is not good for our environment so we need something else which is good for both construction and environment. Here comes geopolymer concrete this concrete is produced with the help of industrial waste such as fly ash, metakaolin, GGBS (ground granulated blast furnace slag). So by using geopolymer concrete we can protect our environment from the carbon impact of cement production. In this study, 7 days and 28 days compressive strength, split tensile strength, flexural tensile strength of samples were found out. As we know that geopolymer concrete is a new type of concrete that does not require the presence of OPC (ordinary Portland cement) as a binding material instead it use fly ash and GGBS that are rich in silica and alumina.

Keywords: Psychiatric disorders, suicide, suicide attempt

1. Introduction
It is firstly introduced by Davidovits in 1978 to describe a group of mineral binders with chemical composition similar to zeolites but the exception is that it has amorphous microstructure. It is called geopolymer concrete because raw materials used in the synthesis of Silicon based polymers are mainly rock forming minerals of geological origins. Its main purpose is that it resists corrosion and fire and it has higher compressive and tensile stress and it cures fully faster than ordinary Portland cement. It shrinks less than OPC. It relies on industrial by products such as fly ash, GGBS etc. to reduce the carbon footprints of cement production. Its only disadvantage is that it is difficult to create and requires special handling. It requires special alkalis that can be harmful to humans. GPC is one of the sustainable ways to reduce CO_2 emissions and energy utilization. It is environment friendly and extremely durable. It is produced by directly mixing aluminosilicate with alkali silicate solution. After mixing the paste is compacted into moulds and cured at 20 to 80 Degree Celsius. In India it is only used in Delhi metro project so it can be considered that in future GPC can be widely used for construction purpose in our country.
With the help of geopolymer concrete we can construct geopolymer bricks. These are the new innovation in the field of brick industry. Geopolymer are generally inorganic typically aluminosilicate non crystalline and covalently bonded networks.

2. Material used
Fly Ash
It is a by-product derived from combustion of coal in thermal power plants with silica and alumina content when used in concrete will help reduce the harmful effect on environment FA is defined as the finely divided residue that results from the combination of ground or powdered coal and that is transported by the flue gases from the combustion zone to the practical removal system. It is removed from the combustion gases by dust collection system, either mechanically or by using electrostatic precipitators, before they are discharged to the atmosphere. Its particles are typically spherical, finer than Portland cement and lime

GGBFS

Acronym for ground granulated blast furnace slag is a derivative from iron and steel industry and is available in form of fine powder. Physically GGBFS can be described as glassy, granular with silicates and al

Ground granulated blast-furnace slag (GGBS)

Ground granulated blast furnace slag, is a by-product of iron in blast-furnace. It especially includes silicate and aluminosilicate of melted calcium that periodically needed to be eliminated from the blast furnace. Ground granulated blast furnace slag have pozzolanic properties and are being used in the construction industry along with cement or lime as activators.

These days construction enterprise use of concrete goes on increasing hastily. Cement is essential constituent material of the concrete which produced by way of natural law cloth lime and silica. The GGBS has carried out which is by-product of iron industry and also can be used as replacement with binding material.

The use of GGBS has following effects

- Increase durability.
- Reduced permeability.
- Reduced shrinkage.
- Increased resistance to chemical attack.
- Prevents the occurrence of efflorescence.

Table 1: Properties of GGBS

Sr. No.	Physical characteristics	Value	Chemical characteristics	Value
1	Colour	Off white	Silica SiO_2	30.61%
2	Specific gravity	2.9	Alumina Al_2O_3	16.24%
3	Particle size	13.8um	Calcium Oxide Ca-O	34.48%
4	Bulk density	1000 to 1100 kg/m3	Sulphur Trioxide SO3	1.85%
5	Fineness	>350m2/kg	Ferric oxide Fe_2O_3	0.584%

Aggregates

Fine and coarse aggregates of standard sizes are used in geopolymer concrete.

Alkaline solutions

Hydroxides and silicates of sodium and potassium are used. These alkaline solutions on reacting with silica and alumina from source materials such as fly ash and GGBS will form binder material which provide strength to concrete.

Metakaolin

Dehydroxylated form of the clay mineral kaolinite is called metakaolin. The anhydrous calcined form of kaolinite is known as metakaolin. Minerals which is rich in kaolinite are called Chine clay or kaolinite. The metakaolin particle size is smaller than that of cement particle. The metakaolin quality and reactivity is strongly dependent upon raw material used. It can be produced from variety pf primary and secondary sources such as oil sand tailings, high purity kaolin deposits, paper sludge waste. It is used for various purposes because of its high performance, high strength and light weight. Metakaolin is a dehydroxylated form of the clay mineral kaolinite. Metakaolin is commonly used in the production of ceramics which is also used as cement. Metakaolin is a high quality pozzolan material. These particles are termed fly ash and are collected from the flue gases using mechanical and electrical precipitators or bag houses.

3. Experimentation and Observation

Various experiments done are:

Flexural strength test, compressive strength test, split tensile strength test and there observations are shown below:

Table 2: Composition content

Trial	Fly ash %	Metakaolin %	GGBS%	FA%	CA %
Mo	100	-	-	100	100
M1	80	10	10	100	100
M2	70	10	20	100	100
M3	60	10	30	100	100
M4	50	10	40	100	100
M5	40	10	50	100	100
M6	30	10	60	100	100

Table 3: Compressive strength

Duration	7 Days (N/m²)	28 Days (N/m²)
M0	11.75	13.5
M1	12.50	18.86
M2	14.80	21.33
M3	16.70	26.40
M4	18.55	29.80
M5	22.75	35.70
M6	21.50	33.60

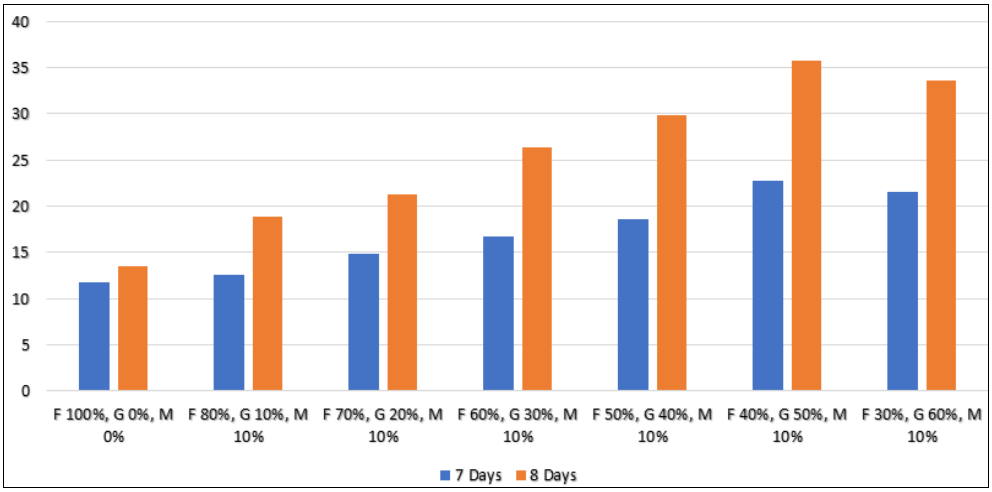

Fig 1: Compressive strength

Table 4: Split tensile strength

Duration	7 Days (N/m²)	28 Days (N/m²)
M0	1.14	1.72
M1	1.18	1.98
M2	1.29	2.35
M3	1.23	2.75
M4	1.75	3.16
M5	1.80	3.65
M6	1.64	2.80

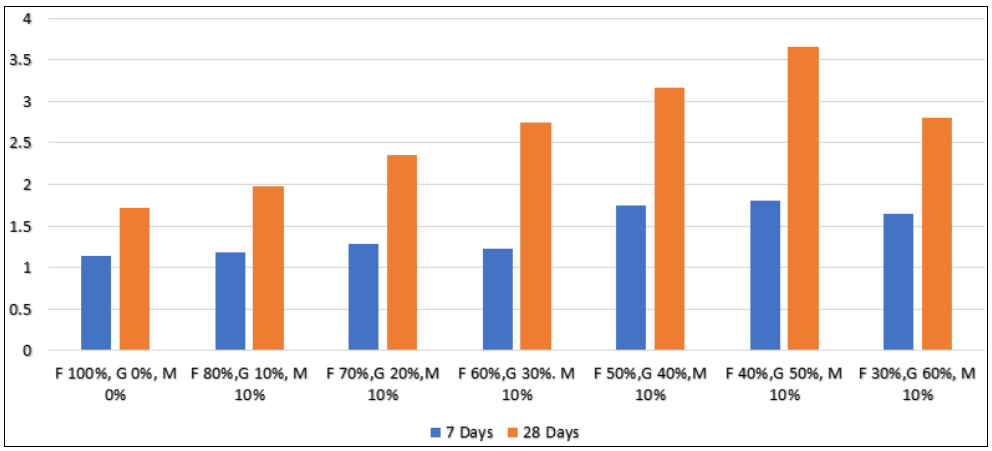

Fig 2: Split tensile strenght

Table 5: flexural strength

Duration	7 Days (N/m²)	28 Days (N/m²)
M0	1.31	1.80
M1	1.67	1.98
M2	1.89	2.35
M3	1.24	2.78
M4	2.75	3.19
M5	2.90	3.25
M6	2.55	2.65

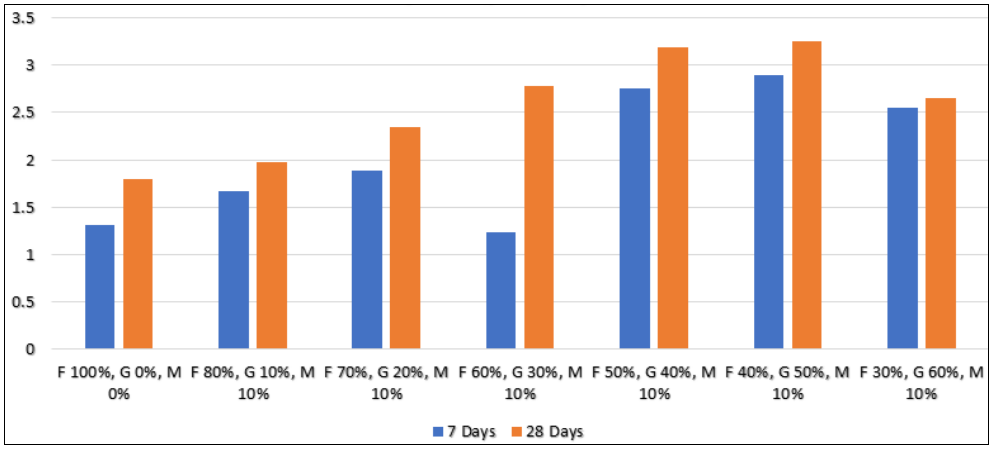

Fig 3: Flexural strenght

4. Conclusion

Geopolymer concrete is found out to be ecofriendly and economical at the same point. Due to the waste material used in different concentrations to give different results. Geopolymer concrete has less carbon footprint than the OPC (Ordinary Portland cement). The only drawback that is found in this experiment that with these concentration of waste material in geopolymer concrete it cannot be used in heavy construction work. The results of our experiment shows that it cannot hold large loads such as it cannot be used in bridge, multistory construction etc.

5. Future scope

1. Use of geopolymer concrete can reduce carbon footprint of cement hence it can save our environment.
2. Use of geopolymer concrete will utilize our industrial waste products which will also save our environment.

6. References

1. Konstantin Kovler, Nicolas Roussel. Properties of fresh and hardened concrete; c2011 Jan 7.
2. Pateel Alekhya, Aravindan S experimental investigation on geopolymer concrete; c2014 Apr 4.
3. Arya Elizabeth Matehw, Gopika Rajeev, Jerin Thomas John, Jinchu Sabu. Geopolymer concrete using GGBS with partial replacement of coarse aggregate with manglore tile; c2016 May 11.
4. Namita Patiyal, Jitender Kumar, Abhilesh Kant Sharma. Experimental study on geopolymer concrete with partial replacement of fine aggregate with foundry sand; c2016 Jun 2.
5. Sarath Chandra B Kumar, Ramesh K. durability studies of ggbs and metakaolin based geopolymer concrete; c2017 Jan 1.
6. Malleswara P Rao, Hamantha K Raja. Study of the properties of metakaolin and GGBS based geopolymer concrete; c2017 Jan1.
7. Durga Prasad N, Himath Kumar Y. study of behaviour of geopolymer concrete with respect to its mechanical properties of ggbs and fly ash; c2017. Feb 2.
8. Rakesh Kumar PK Mehta TP, Muhammed. Relation among mechanical properties of GGBSC; c2017 3 Mar.
9. Girish MG, Kiran K Shetty, Raja Rao. Geopolymer concrete an eco-friendly alternative to port land cement paving grade concrete; c2017 Jul 7.
10. Chiguru Nikhitha, Sunil Pratap S, Syed Riyaz. Use of geopolymer concrete as construction material; 2017 Sep 9.
11. Habeeb Lateef, Mohd Azreen Mohd Ariffin. Self-compacting geopolymer concrete with spend garnet as sand replacement; c2017 Oct 17.
12. Padmanaban MS, Sreerambabu J. geo polymer concrete with GGBS; c2018 Feb 2.
13. Mayank Mishra, KG Kirar, Chetan Sharma experimental investigation on the properties of concrete using steel fibre and GGBS; c2018 Mar 2.
14. Jay Shankar, Nagaraja PS. strength properties of fly ash, GGBS, fibre reinforced geopolymer concrete; c2018. Nov 11.
15. Shabarish Patil, Vineethraj Math, Rajatkumar Vaidya. Experiment study on suitability of geopolymer concrete paver on medium traffic condition highway; c2019 Feb 18.
16. Balaji K, Shanthini D. Investigation of early geo polymerization; c2019 Jun 5.
17. Rafey Merchant, Mohammad Hamza, Aatif Akhtar. A review on geopolymer concrete using partial replacement of demolished aggregate; c2019 Aug 20.
18. Zrar Safari Mahmood. Strength and durability characteristics of pumice based geopolymer paste; c2019 Sep 6.
19. Lateef N Assi, Rafal Anay, Davis Leaphart. Investigation of early geo polymerization process of fly ash based geopolymer paste using acoustic emission technique; c2019 Oct 30.
20. Velani Roshan, Kumar Bhogilal, Manvi Tejar Jayantilal, Jay Dalal. A review on geopolymer concrete by partial substitution of cement with marble dust and fine aggregate with copper slag; c2020 Jan 7.