International Journal of Engineering Innovations in Advanced Technology

ISSN: 2582-1431 (Online), Volume-4 Issue-2, June 2022

The Development of A Low-Calcium Geopolymer Concrete Made From Fly Ash And Marble Powder

Chawan Vijay Kumar
M. Tech student (SE), Department of Civil Engineering, Swami Vivekananda Engineering College, AP, India
Email: chawanvijaykumar886@gmail.com

A Neelima
Assistant Professor, Department of Civil Engineering, Swami Vivekananda Engineering College, AP, India
Email: neelima.arangi@gmail.com

Abstract. **If you compare geopolymer concrete to cement concrete, it is a novel and rising trend in today's concrete business. It can be used as a good substitute for cement concrete and has a variety of benefits over cement concrete, including greater durability. Geopolymer concrete is a kind of green concrete that was created by repurposing waste materials from various power generation companies and thermal power plants. Because of the presence of alkaline activators in geopolymer concrete, it has strong heat resistance capabilities and provides firm bonding between particles, which may result in superior mechanical properties. Geopolymer concrete is also more durable than plain cement concrete. When exposed to acids in a maritime environment, it demonstrates exceptional resistance to corrosion. When low calcium fly ash is used in place of cement, the strength is increased to 40 N/mm2. The amount of marble powder used as a filler was varied as a percent of 0, 5, 10, 15, 20, and 25% to achieve the desired strength of 40 N/mm2. The highest strength was observed when fly-ash was used as a 20% replacement for cement. The molarity of NaOH was employed as 12 molarity at a 2.5 alkaline liquid ratio, which is a good value. They were kept consistent throughout all of the mixes.**

***Keywords*:** **Fly-ash, Marble Powder, Sodium Hydroxide (NaOH).**

I. INTRODUCTION

Geopolymers are inorganic, typically burned materials that are used to create long-lived, covalently bonded, non-crystalline (formless) systems. Geopolymers are used in a variety of applications. Obsidian is an example of a geopolymer that occurs naturally. Flame and heat-resistant coatings and glues, restorative applications, high-temperature earthenware production, new folios for heat-proof fibre composite materials, lethal and radioactive waste epitomes, and as establishing components in the production of concrete are all possible applications for industrially delivered geo polymers.[2] Many logical and mechanical controls, including modern inorganic science, physical science, colloid science, mineralogy, geography, and many types of construction process innovations are being researched in relation to geopolymer qualities and applications.[6] The raw elements that are employed as a part of the amalgamation of silicon-based polymers are, for the most part, shake-shaped minerals that have a geographical origin, thus the term "geopolymer." In 1978, Joseph Davidovits coined the word and founded the non-profit French logical organisation (Association Loi 1901) Institute Geopolymer, which continues to operate today (Geopolymer Institute).[7]

Manuscript received June 12, 2022; Revised June 25, 2022; Accepted June 30, 2022

A. Geo polymer concrete

The meanings of the phrases 'geopolymer bond' and 'geopolymer concrete' are frequently misunderstood, leading to misunderstandings. [1] As opposed to concrete, which is a composite material formed by mixing and solidifying bond with water (or a basic arrangement in the case of geopolymer concrete) and stone totals, bond is a sheet of paper called a bond. Materials of the two types (geopolymer bonds and geopolymer cements) are financially available in a variety of markets across the world.[9]

B. Objectives of the Study

- To survey the workability of geopolymer concrete with different rates of supplanting of bond with low calcium fly cinder and marble powder.

- To survey the compressive quality of solid block of geopolymer concrete with different rates of supplanting of bond with low calcium fly fiery remains and marble powder.
- To survey the spilt elasticity of solid chambers of geopolymer concrete with different rates of supplanting of bond with low calcium fly fiery debris and marble powder.

C. Aim of the project

The use of common Portland bond made contamination the earth because of the emanation of CO2. To dodge the contamination caused because of concrete an elective material had been presented. Flyash is the material which is fine in nature and had restricting properties like that of OPC. Flyash is the side-effect of coal enterprises which is delivered by consuming anthracite. Flyash is rich in alumina and silica which when responded with basic arrangement it frames alumina-silicates gel that ties the total and creates crisp cement.

The devastating quality of flyash based geopolymer solid increments as the expansion in flyash and diminishes the porosity. The flyash based geopolymer has better protection from warmth and fire when contrasted with ostensible cement. The properties of flyash based geopolymer has great properties when contrasted with ostensible solid which upgrades the workability and pressure quality of cement.

D. Scope of the project

Geopolymer cement is a creative substance that offers a genuine alternative to traditional Portland cement in applications such as transportation frameworks, development, and seaward transportation applications.

Geopolymer cements have the ability to cure more quickly than Portland-based cements. Within 24 hours, they had gained a significant amount of muscle strength. They do, however, set gradually enough that they may be mixed in a batch plant and transported in a concrete mixer without setting too quickly.

II. MATERIALS AND PROPERTIES

The ingredients used in the production of fly ash (or) slag based geopolymer specimens include low-calcium dry fly fiery remnants (class F) and marble powder as the source material, aggregates, alkaline liquids, water, and a super plasticizer for the final product.

A. Marble powder

These sort strong waste materials ought to be inactivated appropriately without contaminating the earth. The most appropriate inactivating strategy these days is reusing. Reusing gives a few preferences, for example, ensuring the characteristic assets, vitality sparing, adding to economy, diminishing the waste materials and contributing for what's to come.

Table 1. Following are the chemical property of Marble powder

Material	LOI	SiO2	Al2O3	Fe2O3	CaO	MgO	SO3	K2O	Na2O
Marble powder	40.630	4.990	1.090	1.090	32.230	18.940	0.020	0.910	0.630

B. Fly ash

Fly ash (also known as fly fiery debris or fly ash) is a coal-burning by-product that is composed of small particles that are pushed out of the boiler (or) kettle with the flue gases. The powder that collects at the bottom of the kettle is referred to as ash (or) fiery debris. The great majority of people in the city are completely unaware of what fly fiery trash is or how it is used. However, for concrete producers, fly-flaming endures, and the present regulatory dispute that is attempting to turn the situation around is a significant issue. Because of its beneficial use in concrete structures for more than a decade, the Natural Protection Agency (EPA) of the United States is currently reviewing the collection, storage, transfer and reuse of fly cinder to ensure that it is properly figured out to limit potential harm to human health and the environment.[4]

Table 2. Physical properties of the fly ash used

Color	Whitish grey
Bulk density (g/cm^3)	0.9940
Specific gravity	2.2880
Moisture (%)	3.1400
Average particle size (μ)	6.9200

C. Fine aggregate

Locally accessible clean stream or river sand which is dried is utilized for the examination as appeared in the physical properties of sand obtained on conducting sieve and specific gravity test are appeared in underneath table no 3.

Table 3 Physical properties of fine aggregate.

Sl. no	Physical properties	Test results
1	Specific gravity	2.62
2	Fineness modulus	2.85
3	Water absorption	1.5%
4	zone	II
5	Bulk density (kg/m^3) Dense rodded loose	1620 1400

D. Coarse aggregate

It was decided to conduct the experimental study using coarse aggregates that were readily available from nearby sources. The aggregates that passed through 12.5 sieves and were held on a 4.75 mm sieve were used in the manufacture of a reinforced concrete section example, which was demonstrated in the video. This is seen in Table 4, which shows the sieve investigation of coarse aggregates. The sieve examination of aggregates conforms to the requirements of IS 383:1970 for graded aggregates, as demonstrated in the test on coarse aggregates, which was carried out in accordance with IS 2386:1963 to determine specific gravity, bulk density, and fineness modulus of the aggregates in question. A summary of the findings is presented in Table 4 below.

Table 4. Physical properties of coarse aggregates

Sl.no	Physical properties	Test results
1	Fineness modulus	7.61
2	Specific gravity	2.68
3	Elongation index	11%
4	flakiness	13.8%
5	Crushing strength	24%
6	Water absorption	0.5%
7	Impact value	17%

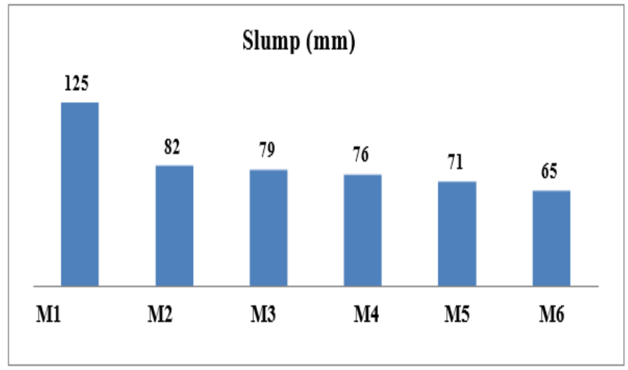
III. RESULTS AND DISCUSSIONS

A. Workability of Geopolymer concrete

The viscosity and cohesiveness of a freshly mixed geopolymer concrete mix were found to be very high, with a medium to high slump. The workability of the GPC mix reduces as the grade of the concrete rises in the mix proportions. A frustum of a cone with a height of 300 mm is used as a mould for the slump test. The base has a diameter of 200 mm and a little hole at the top that is 100 mm in diameter. The findings of the Slump cone test are shown in the table below.

Table 5. slump cone test

Mix id	Slump (mm)
M1 (0%)	125
M2 (5%)	82
M3 (10%)	79
M4 (15%)	76
M5 (20%)	71
M6 (25%)	65



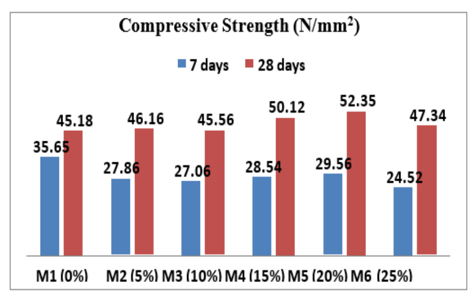
Graph 1. Slump cone test

B. Compressive strength of concrete

The compressive quality is the most pivotal properties of solidified cement and is considered as the trademark material incentive for the arrangement of concrete As Compressive quality is dealt with to be most vital property of cement. The examples were tried on 2000kN keeping to code according to IS 516; 1959.The aftereffects of Compressive Strength are refered to in table.

Table 6. Compressive Strength Results (N/mm^2)

Mix Id	7 Days	28 Days
M1 (0%)	35.65	45.18
M2 (5%)	27.86	46.16
M3 (10%)	27.06	45.56
M4 (15%)	28.54	50.12
M5 (20%)	**29.56**	**52.35**
M6 (25%)	24.52	47.34



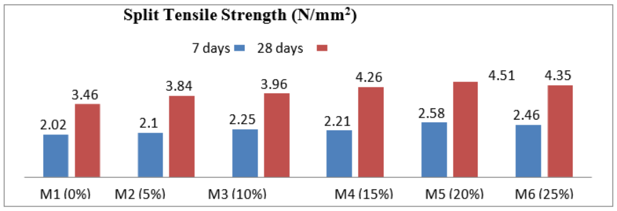
Graph 2. Compressive strength of concrete

C. Split Tensile Strength of Concrete

The split rigidity of geopolymer concrete is considered as portion of compressive quality, the round and hollow examples of 150mmx300mm were threw and tried under 2000kN load limit testing Machine binding to IS: 516:1959. The results of split Tensile Strength are cited in Table below

Table 7. Split Tensile Strength Results (N/mm^2)

Mix Id	7 Days	28 Days
M1 (0%)	2.02	3.46
M2 (5%)	2.1	3.84
M3 (10%)	2.25	3.96
M4 (15%)	2.21	4.26
M5 (20%)	**2.58**	**4.51**
6 (25%)	2.46	4.35



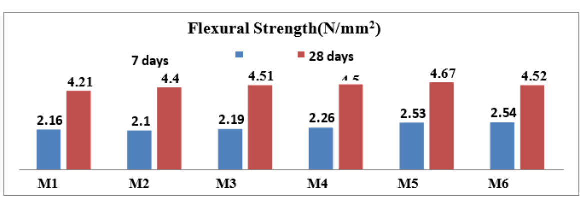
Graph 3. Split tensile strength

D. Flexural strength of concrete

Flexural quality is otherwise called rupture quality, it is an average property which is characterized as a material's capacity to oppose distortion under load or worry in a material just before it yields in a flexure test. The flexural quality of 100*100*500mm bars was tried according to May be: 516-1959.The outcomes for flexural quality are referred to in table.

Table 8. Flexural Strength Results (N/mm^2)

Mix Id	7 Days	28 Days
M1 (0%)	2.16	4.45
M2 (5%)	2.1	4.4
M3 (10%)	2.19	4.51
M4 (15%)	2.26	4.56
M5 (20%)	2.53	4.67
M6 (25%)	2.54	4.52



Graph 4. Flexural strength of concrete

IV. CONCLUSIONS

- Compressive strength increases with increase of marble powder standard increase in strength were observed at 28 days age in comparison with control geopolymer mix.
- Addition of Marble Powder helps in enhancing mechanical and durability Properties of Geopolymer concrete.
- Increase in sodium hydroxide concentration increase the compressive, flexural strength respectively.
- Addition of Marble powder results in reduction of weight for GPC specimens in comparison with control mix.
- Decrease in the Water content helps is easy and comfortable setting of geopolymer concrete and favors geopolymerization reaction.
- Addition of SP gelenium B233 helps is rapid ejection of extra water percolated and present in geopolymer concrete specimens.
- Addition of marble powder improves the toughness and texture of geopolymer specimens.

REFERENCES

[1] Bakharev, T. (2005b). Geopolymeric materials prepared using Class F fly ash and elevated temperature curing. Cement and Concrete Research, 35(6), 1224-1232.

[2] Bakharev, T. (2005c). Resistance of geopolymer materials to acid attack. Cement And Concrete Research, 35(4), 658-670.

[3] Balaguru, P., Kurtz, S., & Rudolph, J. (1997). Geopolymer for Repair and Rehabilitation of Reinforced Concrete Beams. The Geopolymer Institute. Retrieved 3 April, 2002, from the World Wide Web: www.geopolymer.org

[4] Cheng, T. W., & Chiu, J. P. (2003). Fire-resistant geopolymer produced by granulated blast furnace slag. Minerals Engineering, 16(3), 205-210.

[5] Comrie, D. C., Paterson, J. H., & Ritchey, D. J. (1988). Geopolymer Technologies inToxic Waste Management. Paper presented at the Geopolymer '88, First European Conference on Soft Mineralogy, Compiegne, France.

[6] Davidovits, J. (1984). Synthetic Mineral Polymer Compound of The Silicoaluminates Family and Preparation Process, United States Patent -4,472,199 (pp. 1-12). USA.

[7] Davidovits, J. (1988a). Soft Mineralurgy and Geopolymers. Paper presented at the Geopolymer '88, First European Conference on Soft Mineralurgy, Compiegne, France.

[8] Gilbert, R. I. (1988). Time Effects in Concrete Structures. Amsterdam: Elsevier. Gilbert, R. I. (2002). Creep and shrinkage models for high strength concrete -proposalfor inclusion in AS3600. Australian Journal of Structural Engineering, 4(2), 95-106.

[9] Gourley, J. T. (2003). Geopolymers; Opportunities for Environmentally Friendly Construction Materials. Paper presented at the Materials 2003 Conference: Adaptive Materials for a Modern Society, Sydney.