

A Case Study on Compressive Strength of Geocrete

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Abstract: Geocement is obtained by the chemical reaction between silicon (Si) and aluminum (Al) ions and the chemical reaction takes place in the process of polymerization. Geocement doesn't require water at all for mixing and curing processes. It reacts with a special types of binder, known as geobinder in which both are combined to form a hardened mass, known as Geocrete. It can attain high initial strength gain within 3 hours of casting. Geocement is an alkali based cement, prevents the bacterial growth and is ideal for sewerage pipes, water pipes for storage and in food processing industries. This cement has a better acid resistance. Geocement make an eco-friendly environmental product. Geocement plays a vital role to reduce the global warming by reducing carbon dioxide emission by using a liquid binder. The aim of present experimental investigation is to study the properties of geocement i.e. the workability, compressive strength of geocrete. The project deals with M25 grade of Concrete. The test results are prepared by the combination of normal concrete and geocrete. At the age of 28 days, the compressive strength of M25 grade concrete is 32.26 MPa whereas the compressive strength of geocrete at the age of 28 days is 86 MPa. The major finding of this study is that the compressive strength of geocrete is more than that of normal concrete.

Keywords: Geocrete, Geocement, Geobinder, Concrete and Compressive strength

1. Introduction

Geocrete is a construction material composed of geocement and geobinder combined with sand, gravel, crushed stone, or other inert material such as expanded slag or vermiculite etc. The geocement and geobinder form a paste that hardens by chemical reaction into a strong stonelike mass. The inert materials are called as aggregates, and for economy no more cement paste is used than is necessary to coat all the aggregate surfaces and to fill all the voids. The geocrete paste is plastic and easily moulded into any form or trowelled to produce a smooth surface. Hardening begins immediately, but precautions are taken, usually by covering, to avoid rapid loss of moisture since the presence of geobinder is necessary to continue the chemical reaction and increase the strength. Too much of water produces a porous and weaker concrete. The quality of the paste formed by the geocement and geobinder largely determines the character of the geocrete. The mix design is referred as proportioning of the ingredients of concrete.

Geocrete may be produced as a dense mass which is practically artificial rock, and chemicals may be added to make it waterproof, or it can be made porous and highly permeable for such use as filter beds. Light weight concrete can be achieved by adding an air-entraining chemical. Normally, the full hardening period of concrete is at least 3 hours. The Bogue's compounds i.e. tricalcium aluminates and silicates formed during the hydration of cement results in the gradual increase in strength. Fine aggregate used in concrete was originally specified as roughly angular, but rounded grains are now preferred. Coarse aggregate is usually sharply broken. The weight of Geocrete varies with the type and amount of rock and sand. Concrete produced with trap rock may have a density of 2,483 kg/m³. Geocrete is stronger in compression than in tension, and steel bar, called rebar or mesh is embedded in structural members to increase the tensile and Flexural Strengths. In much geobinder, however, produces a geocrete that is addition to the structural uses, Geocrete is widely used

in precast units such as block, tile, sewer, and water pipe, and ornamental products.

2. Comparison between Geocement and Portland Cement

The comparison between geocement and portland cement with different types of properties like compressive strength, setting time, specific gravity, normal consistency, pollution cement to nature, etc., are tabulated in the Table 2.10.

Table 2.10: Comparison between Geocement and Ordinary Portland Cement

Geocement	Ordinary Portland Cement
The Specific gravity of Geocement is 2.15.	The Specific gravity of Ordinary Portland Cement is 3.15.
It doesn't require water for mixing or curing.	It requires water for mixing and curing.
Full Setting time is 3 hours.	Full Setting time is 24 hours.
Normal consistency of this cement is 41%.	Normal consistency of this cement is 26%.
It will attain compressive strength upto 88 MPa for M25 grade.	It will attain compressive strength upto 35 MPa for M25 grade.
It will reduce CO ₂ emission upto 65% when compared with other types of cement.	CO ₂ emission is more when compared with geocement.
No special admixture is required for geocement.	It requires special admixtures for Ordinary Portland cement.
Waste steel and power industry are used.	Waste steel and power industry are not used.
Road can be used within an hour of casting.	Road can't be used within hour of casting.
Skilled labour is not mandatory.	Skilled labour is mandatory.
It has got a significantly better acid resistance.	It doesn't have better acid resistance.

3. Experimental Investigation

3.1 Material Properties

3.1.1 Geocement:

Table 3.1: Physical Properties of Geocement

S. No	Property	Values
1.	Specific Gravity	2.15
2.	Normal Consistency	41%
3.	Setting times: Initial setting time	34 mins
	Final setting time	48 mins

Table 3.2: Chemical Characteristics of Geocement

S.No	Property	Actual Analysis
1.	Appearance	Fine gray dust
2.	Odour	No apparent odour
3.	Melting Point	>1500°C
4.	Solubility in water	Insoluble
5.	Specific gravity	2-3

3.1.2 Geobinder

Table 3.3: Chemical Composition of Geobinder

S. No	Chemical Name	Percentage (%)
1.	Water (H ₂ O)	53
2.	Salt of Silicic acid (Na ₂ O ₃ Si)	40
3.	Additives	7

Table 3.4: Chemical Characteristics of Geobinder

S. No	Property	Actual Analysis
1.	Appearance	Thick Liquid
2.	Colour	Hazy White
3.	Odour	Odourless to clay
4.	p ^H	11.5
5.	Specific gravity	1.5 at 25°C
6.	Solubility	Soluble
7.	Boiling point	105°C

3.1.3 Fine Aggregates

Table 3.5: Properties of Fine aggregates

S. No	Property	Values
1.	Specific gravity	2.59
2.	Fineness modulus	2.8
3.	Bulk density	
	i) Loose state	15.75 kN/m ³
	ii) Compacted state	17.05 kN/m ³
4.	Grading of sand	Zone – II

3.1.4 Coarse Aggregates:

Table 3.6: Properties of Coarse aggregates

S.No	Property	Values
1.	Specific gravity	2.61
2.	Bulk density	
	i) Loose state	14.13 kN/m ³
	ii) Compacted state	16.88 kN/m ³
3.	Water absorption, %	0.4
4.	Fineness Modulus	7.2

4. Casting of Cubes

Mix proportion of 0.50:1:2.26:3.81 is chosen according to its ingredients i.e. the Geobinder, Geocement, fine aggregates

and coarse aggregates. In the present study, 9 cubes were prepared for obtaining characteristic compressive strength of cubes. The casted cubes were tested at the age of 3, 7 and 28 days. Mix the Geocement and sand with trowel on a non-porous plate until uniform colour is achieved. Place the coarse aggregate in the flat surface and place the cement sand mix upon the aggregates and mix the entire materials thoroughly. Then add geobinder to the mixture. The geobinder - geocement ratio used in this mix is 0.50. Mixing time is the time elapsed between the water is added to the mix and casting of cubes.

5. Results

Tests were conducted to determine the properties of the Geocement and the compressive strength on hardened specimens. Normal procedures were adopted for testing. The experimental program was designed to compare the properties of compressive strength of cubes for M25 grade of concrete.

5.1 Properties of Geocement

The properties of any type of cement play a vital role in casting of concrete. The important properties of geocement are:

- Fineness of geocement
- Standard consistency of geocement
- Setting time of geocement

5.1.1 Fineness of Geocement

The fineness percentage of the geocement is 94%.

5.1.2 Standard Consistency of Geocement

The percentage of geobinder to obtain a geocement paste is 41%.

5.1.3 Setting Time of Geocement

The setting time plays a vital role on any type of cement.

The setting times are categorized into two types:

- a) Initial setting time
- b) Final setting time

a) Initial Setting Time

The initial setting time of geocement is 34 mins.

b) Final Setting Time

The final setting time of geocement is 48 mins.

5.1.4 Specific Gravity of Geocement

The specific gravity of geocement is 2.15

5.1.5 Compressive Strength

The variation of the cube compressive strength of M25 grade concrete and geocement with age for a given geocement is as shown in Fig 5.1 and the test results are formulated in table 5.1. The cube compressive strength is the average of three test specimens. It can be observed that the compressive strength of geocement is more than that of normal concrete.

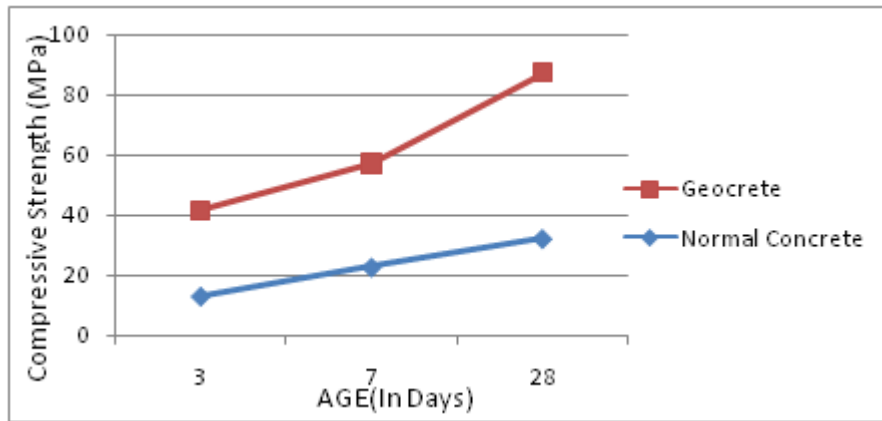


Figure 5.1: Variation of Compressive Strength between Geocrete and Normal Concrete

Table 5.1: Characteristic Compressive Strength of Cubes in MPa

S.No	Concrete Mix	Compressive Strength (MPa)		
		3 Days	7 Days	28 Days
1.	Normal Concrete	12.94	22.65	32.26
2.	Geocrete	28.64	34.44	86

6. Conclusions

The results of the experimental study show that the compressive strength of geocrete is more than that of the normal concrete.

- 1) This technology is advantageous in terms of simplicity and cost. The advantages come from low cost of geocement constituents, since a wide range of industrial waste and by-products as well as widely available natural raw materials are used, and the facilities that are commonly used now can be also involved. The results of feasibility study showed that the manufacturing cost of the compound is about 15-30% lower (comparison based on raw materials cost).
- 2) Based on the test results, it can be concluded that the compressive strength of geocrete for various days are i.e. the 3-day compressive strength is 28 MPa, the 7-day compressive strength is 34.4 MPa and the 28-day compressive strength is 86 MPa.
- 3) It is very interesting to note that the compressive strength achieved by geocrete is very high when compared with the controlled concrete.
- 4) The increase in strength of geocrete is due to increase of percentage of silica-oxide in the geocement.
- 5) The road constructed by using the geocrete, can be allowed for passage of vehicles within 3 hours.
- 6) Geocrete is an eco-friendly concrete because it will reduce the carbon dioxide emission upto 65% when compared with normal concrete.
- 7) The geocement has low specific gravity.
- 8) The setting action of geocrete is quick when compared with conventional concrete.
- 9) The geocement used in geocrete has a significantly better acid resistance when compared with other cements.

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