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A study of durability properties of concrete using Geo cement and Vermiculite

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ABSTRACT

Cement manufacturing industry is one of the carbon dioxide emitting sources besides deforestation and burning of fossil fuels. The global warming is caused by the emission of green-house gases, such as CO_2, to the atmosphere. Among the greenhouse gases,CO_2 contributes about 65% of global warming. The global cement industry contributes about 7% of greenhouse gas emission to the earth's atmosphere. In order to address environmental effects associated with cement manufacturing, there is a need to develop alternative binders to make concrete. Consequently extensive research is on-going into the use of cement replacements, using many waste materials and industrial by products.

This work examines the possibility of using Geo Cement as a complete replacement of cement for new concrete and tested for its water absorption 28 days of age and was compared with those of conventional concrete. To assess effectiveness of partial replacement of sand by its weight with 10%, 15%, 20% of vermiculite.

Concrete containing 10% Vermiculite exhibits higher water absorption compared to the rest. The least Percentage in gain weight is 3.46 % for Concrete with 10% Vermiculite Specimens for M30 Grade of Concrete. Similarly for M35 Grade of Concrete – The Concrete with 10% Vermiculite exhibits3.98 % least Percentage in gain the control concrete and other Vermiculite proportions.

Keywords: Geocement, Vermiculite, Geobinder, Water absorption, Strength of Concrete**.**

1. INTRODUCTION

Concrete is the most usually utilized material in different sorts of development, from the deck of a cabin to a multi storied skyscraper structure from pathway to an airplane terminal runway, from an underground passage and remote ocean stage to skyscraper stacks and TV Towers. In the most recent thousand years concrete has requesting prerequisites both as far as specialized execution and economy while significantly shifting from compositional perfect works of art to the least difficult of utilities. It is hard to bring up another material of development which is as flexible as concrete.

Portland bond concrete is a standout amongst the most generally utilized development materials. As the interest for concrete as a development material builds, so additionally the interest for Portland bond. These days, with the utilization of elite concrete (HPC), the sturdiness and strength of concrete have been enhanced to a great extent. Be that as it may, because of the limitation of the assembling procedure and the crude materials, some natural detriments of Portland bond are as yet hard to overcome. There are two noteworthy downsides regarding maintainability.

Cement fabricate causes natural effects at all phases of the procedure. These incorporate outflows of airborne contamination as clean, gasses, commotion and vibration while working hardware and amid impacting in quarries and harm to farmland from quarrying. Hardware to decrease clean outflows amid quarrying and produce of cement is generally utilized and gear to trap and separate fumes gasses are coming into expanded utilize.

Geocement is a guarantee to diminish a dangerous atmospheric deviation by lessening carbon dioxide discharge utilizing an exclusive fluid Geobinder with different modern bye items viz. Flyash, Blast heater slag and so on. Geopowder, in this manner making it a situation amicable Green Product. The earth must be secured by anticipating dumping of waste by-item materials in uncontrolled behaviour and by ceasing Carbon dioxide (CO_2) discharge.

Prof. J. Davidovits, a prominent researcher imagined this innovation in which Silicon (Si) and Aluminum (Al)ions in the by-item materials is made to respond and the concoction response that happens for this situation is a polymerization procedure and thus item is called Geocement.

Vermiculite is having high silica content thus it is a decent building material. The warmth exchange to internal surroundings of home due to the materials requirement for dividers, floors, roofs and so on. For decreasing of these impact better option source is use of vermiculite tiles or floor materials and filler materials in the dividers.

2. LITERATURE REVIEW

Gourley (2003). Davidovits (1999) expressed that Low calcium (ASTM Class F) fly ash is favored as a source material than high calcium (ASTM Class C) fly ash. The nearness of calcium in high sum may meddle with the polymerisation procedure and change the microstructure (Gourley2003). Davidovits (1999) calcined kaolin mud for 6 hours at 750oC. He named this metakaolin as KANDOXI (KAolinite, Nacrite, Dickite OXIde), and utilized it to make geopolymers. With the end goal of making geopolymer concrete, he proposed that themolar proportion of Si-to-Al of the material ought to be around 2.0.On the way of the source material, it was expressed that the calcined source materials, for example, fly ash, slag, calcined kaolin, showed a higher last compressive strength when contrasted with those made utilizing non-calcined materials, for example kaolin dirt, mine tailings, and actually happening minerals (Barbosa, MacKenzie et al. 2000). In any case, Xu and van Deventer (Xu and van Deventer 2002) found that utilizing a mix of calcined (e.g. fly ash) and non-calcined material (e.g. kaolinite or kaolin earth and albite) brought about huge change in compressive strength and lessening in response time.

Rajni Lakhani, S.P Agarwal and Sapa Ghai learned about improvement of Energy Efficient Material from Vermiculite. In this field, a warm protected tile has been set up with shed Vermiculite. The vermiculite cement tiles have low water retention, better strength properties and low warm conductivity contrasted and customary tiles. In this review water assimilation, Flexural strength, compressive strength, Thermal conductivity tests is restricted

F.koksalet.al, O.Gencel, W.Brostow and H.E.Hagg Lobland (2014) learned about joined impact of steel strands and extended vermiculite on properties of lightweight mortar at lifted temperatures as turned out with finding that light weight mortar is surrendering great execution to 600oC and reasonable till 900oC. However mechanical properties fall definitely around 70% when presented to temperatures about1100oC. The specimens with the littler proportions of vermiculite cement exhibited a superior conduct as far as both mechanical properties and ultrasonic speed. The tests will be done on these venture is compressive strength test, split rigidity, ultrasonic heartbeat speed test.

3. MATERIALSAND METHODS

3.1 Properties of materials

3.1.1 Cement

Cement plays vital role in concrete. One of the important criteria tricalcium aluminate (C_3A) content, tricalcium silicate (C_3S) content, dicalcium silicate (C_2S) content etc. It is also necessary to ensure the compatibility of chemical and mineral admixtures with cement.

In this study, Zuari Cement of 53 grade Ordinary Portland Cement conforming to IS: 12269–1987 was used for the entire work. The cement was purchased from single source and was used for casting of all specimens. The physical properties of cement are furnished in Table 1.

Table 1 Physical properties of cement

S.No	Characteristics	Test Results	Requirements as per IS 12269 - 1987
1	Fineness (retained on 90-µm sieve)	6%	<10%
2	Normal Consistency	33%	--
3	Initial setting time of cement	90 min's	30 minutes (minimum)
4	Final setting time of cement	340 min's	600 minutes (maximum)

5	Expansion in Le-chatelier's method	4 mm	10 mm (maximum)
6	Specific gravity	3.15	3.10 – 3.25

3.1.2 Fine aggregate

The natural sand taken for this investigation is the locally available natural river sand. It was collected and cleaned for impurities, so that it is free from clayey matter, salt and organic impurities. Particles passing through IS sieve of 4.75 mm conforming to grading zone-II of IS: 383-1970 was used in this work. Properties such as gradation, specific gravity, fineness modulus, bulking, and bulk density had been assessed. The physical properties of sand are furnished in Table 2.

Table 2 Physical properties of Fine Aggregate

S.No.	**Tests Conducted**	**Results Obtained**		**Permissible Limits as per IS 383-1970**
1	Specific gravity	2.67		2.5 to 3.0
2	Fineness modulus	3.05		--
3	Bulk density	**Loose State**	1450 kg/m^3	1400 to 1750 kg/m^3
		Compacted State	1520 kg/m^3	
4	Water absorption (%)	1.09		Max 3%
5	Sieve Analysis	Zone – II		--

3.1.3 Coarse aggregate

Locally available machine Crushed angular granite, retained on 4.75mmI.S. sieve of maximum size of 20mm confirming to I.S: 383-1970 was used in the present experimental investigation. It is free from impurities such as dust, clay particles and organic matter etc. The coarse aggregate is tested for its various properties such as specific gravity, fineness modulus, elongation test, flakiness test, sieve analysis, bulk density in accordance with in IS 2386 – 1963. The physical properties of Coarse Aggregate are furnished in Table 3.

Table 3 Physical properties of Coarse Aggregate

S.No.	**Tests Conducted**	**Results Obtained**		**Permissible Limits as per IS 383-1970**
1	Specific gravity	2.78		2.5 to 3.0
2	Fineness modulus	7.52		--
3	Bulk density	**Loose State**	1480 kg/m^3	1400 to 1750 kg/m^3
		Compacted State	1560 kg/m^3	
4	Water absorption (%)	1.09		Max 3%
5	Flakiness Index	7.52		--
6	Elongation Index	20%		Max 25%

3.1.4 Water

Water used for mixing and curing shall be clean and free from injurious quantities of alkalies, acids, oils, salts, sugar, organic materials, vegetable growth (or) other substance that may be deleterious to bricks, stone, concrete, or steel. Potable water is generally considered satisfactory for mixing.

Water acts as a lubricant for the fine and coarse aggregates and acts chemically with cement to form the binding paste for the aggregate and reinforcement. Less water in the cement paste will yield a stronger, more durable concrete;

adding too much water will reduce the strength of concrete and can cause bleeding. Impure water in concrete, effects the setting time and causing premature failure of the structure.

To avoid these problems quality (potable) water must be proffered in construction works and PH value of water should be not less than 6. And also Quantity of water to be taken is important

3.1.5 Geocement

Geocement is a guarantee to diminish a dangerous atmospheric deviation by lessening carbon dioxide emanation utilizing an exclusive fluid Geobinder with different mechanical bye items viz. Flyash, Blast heater slag and so forth. Geopowder, consequently making it a domain agreeable Green Product. The earth must be ensured by counteracting dumping of waste by-item materials in uncontrolled conduct and by halting Carbon dioxide (CO2) emanation. Prof. J. Davidovits, a famous researcher imagined this innovation in which Silicon (Si) and aluminum (Al)ions in the by-item materials is made to respond and the synthetic response that happens for this situation is a polymerization procedure and consequently item is called Geocement

3.1.6 Vermiculite

Table 4 Properties of Vermiculite

(i) Physical Properties

S.No.	Name of Property	Results Obtained
1	Melting Point	1330^{o}
2	Specific Heat	1.08
3	Specific Gravity (Crude)	2.5
4	Mohs Hardness (Crude)	1-2
5	P_H	7 – 8
6	% Loss at $105^{o}C$	< 0.5
7	% Loss at $1000^{o}C$	< 6
8	Colour	Colourless, White, Green, Yellow

(ii) Chemical Properties

S.No.	Name of the Chemical	Percentage
1	Silicon	39.4
2	Magnesium	25.2
3	Aluminium	8.8
4	Potassium	4.5
5	Iron	4
6	Calcium	1.8
7	Carbonate	1.4
8	Titanium	0.8
9	Fluorine	0.5

3.2 Mix Proportions

Table 5 Quantities of Ingredients per Cum of M30 Grade Concrete

S. No	Mix Identification	Cement (kg's)	Fine Aggregate		Coarse Aggregate (kg's)	Geo binder (lit)
			Sand (kg's)	Vermiculite (kg's)		
1	C.C	340	680	0	1020	170
2	95% N.A + 5%	340	646	34	1020	170

	Vermiculite					
3	90% N.A + 10% Vermiculite	340	612	68	1020	170
4	85% N.A + 15% Vermiculite	340	578	102	1020	170
5	80% N.A + 20% Vermiculite	340	544	136	1020	170

Table 6 Quantities of Ingredients per Cum of M35 Grade Concrete

S. No	Mix Identification	Cement (kg's)	Fine Aggregate		Coarse Aggregate (kg's)	Geo binder (lit)
			Sand (kg's)	Vermiculite (kg's)		
1	C.C	380	760	0	1140	190
2	95% N.A+5% Vermiculite	380	722	38	1140	190
3	90% N.A+10% Vermiculite	380	684	76	1140	190
4	85% N.A+15% Vermiculite	380	646	114	1140	190
5	80% N.A+20%Vermiculite	380	608	152	1140	190

4. RESULTS AND DISCUSSIONS

4.1 Water Absorption of M30 concrete

Water absorption characteristics of the concrete play an important role for the durability of the structure. Ingress of water deteriorates concrete and in reinforced concrete structure, corrosion of the bars took place which results it no cracking and spalling of the concrete and ultimately reduces the life span of the structure. Test results of water absorption test are shown in Table 7. The result indicates that the water absorption of Concrete with Vermiculite is less compared to control concrete.

It can be observed that Water Absorption for Control Concrete is 3.87%. The Water Absorption for the Concrete with Vermiculite is minimum when compared to Control Concrete. Least percentage in Gain of Weight is 3.46% for Concrete with 10% Vermiculite. Figure 1 shows the variation of Water Absorption for Control Concrete and Vermiculite (5%, 10%, 15% & 20%).

Table 7 Water Absorptions of M30 at 28 days

Concrete	Vermiculite	Dry Weight (W1)	Wet Weight (W2)	% Gain in Weight ((W2-W1)/W1) x 100
Control Concrete	0	8.02	8.33	3.87
Vermiculite 5%	5	8.78	9.11	3.75
Vermiculite 10%	10	8.77	9.08	3.46
Vermiculite 15%	15	8.34	8.64	3.59

Vermiculite 20%	20	8.19	8.49	3.67

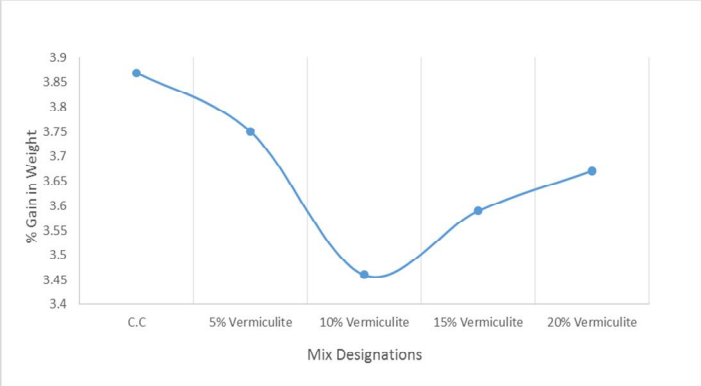

Figure 1 Variation of Water Absorption for M30 and Vermiculite (5%, 10%, 15% & 20%)

4.2 Water Absorption of M35 concrete

Water absorption characteristics of the concrete play an important role for the durability of the structure. Ingress of water deteriorates concrete and in reinforced concrete structure, corrosion of the bars took place which results it no cracking and spalling of the concrete and ultimately reduces the life span of the structure. Test results of water absorption test are shown in Table 8. The result indicates that the water absorption of Concrete with Vermiculite is less compared to control concrete. The difference in percentage of increase in weight is small.

It can be observed that Water Absorption for Control Concrete is 4.26%. The Water Absorption for the Concrete with Vermiculite is minimum when compared to Control Concrete. Least percentage in Gain of Weight is 3.98% for Concrete with 10% Vermiculite. Fig 4.2 shows the variation of Water Absorption for Control Concrete and Vermiculite (5%, 10%, 15% & 20%).

Table 8: Water Absorptions of M35 at 28 days

Concrete	Vermiculite	Dry Weight (W1)	Wet Weight (W2)	% Gain in Weight ((W2-W1)/W1) x 100
Control Concrete	0	8.52	8.88	4.26
Vermiculite 5%	5	8.59	8.95	4.18
Vermiculite 10%	10	8.37	8.70	3.98
Vermiculite 15%	15	8.35	8.69	4.08
Vermiculite 20%	20	8.55	8.96	4.85

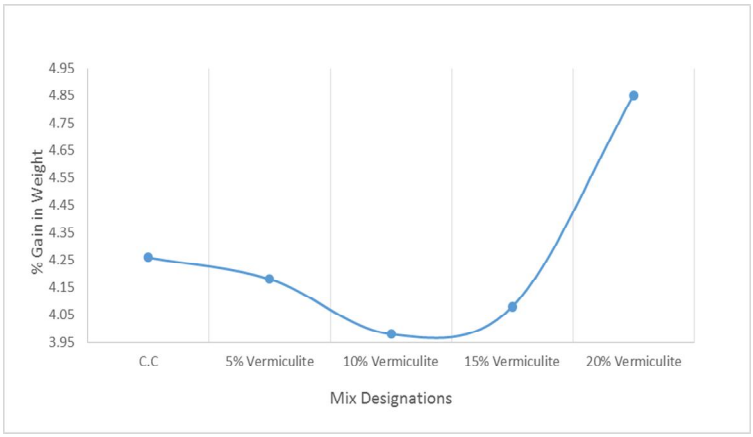

Fig. 4.2 Variation of Water Absorption for M35 and Vermiculite (5%, 10%, 15% & 20%)

5. CONCLUSIONS

- Test results of water absorption test shows that the porosity of concrete with Vermiculite has less water absorption than the control concrete.
- It can be observed that Water Absorption for Control Concrete is 3.87% for M30 Grade of Concrete. The Water Absorption for the Concrete with Vermiculite is minimum when compared to Control Concrete. Least percentage in Gain of Weight is 3.46% for Concrete with 10% Vermiculite.
- It can be observed that Water Absorption for Control Concrete is 4.26% for M35 Grade of Concrete. The Water Absorption for the Concrete with Vermiculite is minimum when compared to Control Concrete. Least percentage in Gain of Weight is 3.98% for Concrete with 10% Vermiculite

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