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EXPERIMENTAL INVESTIGATION ON SELF HEALING GEOPOLYMER CONCRETE

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Abstract - *"Self-healing concrete can be defined as the ability of concrete to autonomously heal cracks that may become embedded throughout its structure. This project involves in the investigation of effect of healing agent in Geopolymer concrete. For this purpose sodium silicate microcapsules are incorporated in the concrete matrix which helps in self- healing. The principle of self-healing is when crack occurs the healing agent (sodium silicate) is released and it reacts with calcium hydroxide in cement and produce a C-S-H gel (Calcium Silica Hydrate) that partially heal the crack. The concept of microcapsule healing is based on a healing agent being encapsulated and embedded in the concrete. The objective of this study was to evaluate the effects of preparation parameters, namely, temperature, agitation rate, and pH on the shell thickness and size (diameter) of the microcapsules in strength parameters of concrete.*

Keywords: *Self-healing concrete, Geopolymerization, Healing Agent, Alkaline Activators, Microcapsule preparation.*

1. Introduction

Geopolymer was the name given by Daidovits in 1978 to materials which are characterized by chains or networks or inorganic molecules. Geopolymer cement concrete is made from utilization of waste materials such as fly ash and ground granulated blast furnace slag (GGBS). Fly ash is the waste product generated from thermal power plant and ground granulate blast furnace slag is generated as waste material in steel plant. Both fly ash and GGBS are processed by appropriate technology and used for concrete works in the form of geopolymer concrete. The use of this concrete helps to reduce the stock of wastes and also reduces carbon emission by reducing Portland cement demand. Concrete is very good material to resist the compressive load to a limit but if the load applied on the concrete is more than their limit of resisting load, it causes the strength reduction of concrete by producing the cracks in the concrete and the treatment of the cracks in very expensive. Some of the property like durability, permeability ad strength of the concrete structure is also decreases. Due to increase in the permeability of the concrete the water easily pass through the concrete and come in the contact with the reinforcement of the concrete structure and after some time corrosion start due to this strength of the concrete structure will decreases so it will be necessary to repair the cracks. By introduce the bacteria in concrete it produce calcium carbonate crystals which block the micro cracks and pores in the concrete. In concrete micro cracks are always avoided but to some extent they are responsible to their failure in strength. The bacteria survive in the high alkaline environment that formed spores comparable to the plant seeds. The spores are of very thick wall and they activated when concrete start cracking and water transude into the structure the self – healing of cracks starts and is completed within 21 days of atmospheric exposure.

2. Curing process

Geopolymer concrete is cured by stream curing method. The concrete is cured by placing it in 120^0C for 24 hrs and after curing place the concrete in room temperature at 7, 14, and 28 days. To check the compressive strength at 7, 14, and 28 days

3. Alkaline Activators preparation

The combination of sodium hydroxide and sodium silicate solution is called alkali activators, In order to prepare the activator solution take 4g of sodium hydroxide pellets and mix it in 1lit of DI water and 22.5g of sodium silicate in 1lit of DI water. After that take 80% of sodium hydroxide and 20% of sodium silicate and mix it to get the alkaline activators and then it is added to the concrete.

4. Microcapsule preparation

Pour 200 ml of DI water in a 1000 ml beaker. Under agitation, add 5.00 g urea, 0.50 g resorcinol and 0.50g ammonium chloride. Set the pH (6-7) by using sodium hydroxide (NaOH) and hydrochloric acid (HCl) drop-wise with a disposable pipet. Add two to three drops of 1-octanol. Allow the solution to stabilize for approximately 6 – 8 minutes at the appropriate pH and rpm agitation rate.

Aqueous sodium silicate is prepare by take 60ml of water and than add 40g sodium silicate pellets than heat(80^oc) and agitate at 5-6 min. Mix 170 ml of DI water with 60 ml of an aqueous sodium silicate and add to the solution. Agitate the solution for approximately 5 min. While under agitation, To take 250ml of HCL was slowly added to the solution to form a gel/aqueous

solution. Add 100 ml of the gel/aqueous solution to the emulsion while maintaining a pH of 3.0 – 3.5. Allow the solution to stabilize for 13 – 15 minutes before 12.7 g of 37 wt % aqueous solution of formaldehyde was added to the emulsion. Wrap and cover the solution with aluminium foil, and slowly heat to the set temperature. Turn off the hot plate after 4 hours of continuous agitation. Once cooled to ambient temperature, the suspension of microcapsules was separated under vacuum filtration. Rinse microcapsules with DI water three times with 500 ml of DI water, and then allow to air dry for 48,72hrs.

Table-1: Compressive strength test on cube samples (N/mm^2)

% of alkali activators	7 Days	14 Days	28 Days	Mean value
0	27.11	31.11	35.67	32.39
	19.11	25.78	28	
	23.11	20.89	33.50	
20%	29.21	30.21	34.62	31.63
	20.12	25.78	27	
	22.26	24.89	33.27	
25%	29.35	31.11	34.70	31.43
	21.12	27.72	27.20	
	23.46	25.89	32.40	
30%	30.21	32.12	35.10	31.60
	22.30	28	27	
	23.60	26.20	32.70	

Table-2: Compressive test for healed concrete (N/mm^2)

% of alkali activators	56 Days	Mean value
0	34.80	32.03
	27.20	
	34.10	
20%	34.10	31.33
	26.80	
	33.10	
25%	34	31.03
	27	
	32.10	
30%	34.80	31.43
	27	
	32.50	

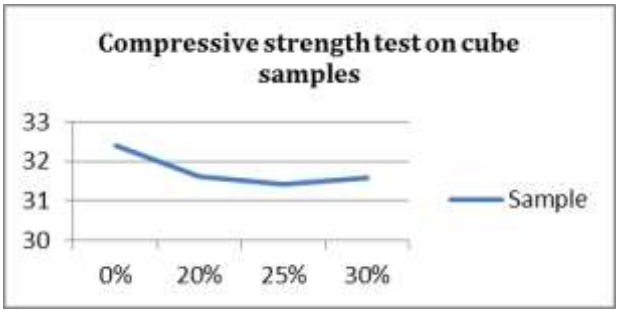

Chart 1 : Compressive strength test on cube samples

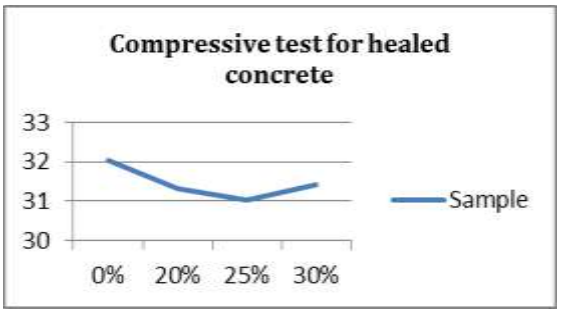

Chart 2: Compressive test for healed concrete

5. Conclusion

From the table the compression strength of the cubes shows that geopolymer concrete as good strength when compared to conventional concrete. Based on the results presented above the following conclusions are made, the objective of this project is evaluated that using of micro capsule has a better healing property on the concrete, after 56 days of healing period micro cracks in the concrete are completely sealed. Bonding strength of the concrete is also increased by micro capsules (by mainly adding sodium silicate).the test result show that the compressive strength of the self- healing concrete is relatively good when compared to normal concrete. From this it is notice that the load carrying capacity of the self- healing concrete is higher than the normal concrete.

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