Study On Strength Parameters Of Flyash Based Geopolymer Concrete With Coir Fibre Reinforcement For 10m, 12m Molar Activator

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Abstract:

Considering the environmental concerns increasing demand for developing alternative construction materials has been increased, Fly ash is used as alternative material for Ordinary Portland cement in the preparation of conventional concrete which forms the Geopolymer concrete and also reduces the CO_2 emission caused by Ordinary Portland cement. This paper deals with the experimental investigation done on performance of coir fiber reinforced fly ash based geopolymer concrete which is subjected to ambient curing. The mixes were designed for molarities of 10M, 12M. The coir fibre of length 25mm is used for different percentage as 0, 0.75, 1.5, 2.25, and 3. Before using in geopolymer concrete, the considered coir fibre is treated with latex adhesive liquid so that the coir fibre will not be affected by the moisture content in the geopolymer concrete. The alkaline solution of sodium silicate (Na_2SiO_3) is used as the binding material for coarse aggregate and fine aggregate. Sodium hydroxide (NaOH) solution is used to react with fly ash. The sodium hydroxide to sodium silicate ratio of 1:2.5 is considered for this work. The test specimens were 150mmx150mmx150mm cubes, 150mmx300mm cylinders; 1000mmx150mmx150mm beams are casted and cured under ambient curing conditions. The geopolymer concrete specimens are tested for their compressive strength, flexural and split tensile tests at the age of 7,14 and 28days. The test results indicate that the combination of fly ash and coir fibre can be used for development of geopolymer concrete.

Keywords: Fly ash, alkaline solution, Geopolymer concrete, Coir fibre, ambient curing

1. INTRODUCTION:

The inorganic alumino-silicate polymer, called geo-polymer which efforts to create ecological concrete which is synthesized from by-product of materials like fly ash which is high in silicon & aluminum. Geo-polymer was introduced in1978 by Davidovits to explain about the mineral binders with alkaline. Geo-polymer has two constituents they are basic materials & alkaline liquids. The basic materials are high in Si & Al. Fly ash constitutes of high amount of Si-Al materials, it has high cementitious property, and fly ash is by-product of coal that is available in thermal power plant.

To increase the life of structure is by using bond fiber polymer composites onto the structure. By this the tensile strength and the toughness of the structure increase and it improves deformation characteristics and minimizes the cracking effect of the structure. When these fibre composites are exposed to marine environment they are suffering from degradation because of surface blistering. Due to this degradation the adhesive bond strength is reduced and de-lamination about composites occurs. A further way is to restore steel bars by means of fibers to create a fiber reinforced concrete (FRC).

This type of reinforcing concrete improves the non-reinforced concrete properties which is highly brittle. Enough natural resources are available and researching on these natural resources is going on. Growth of natural fiber composite recently started. These fibres have high in impact strength but have moderate flexural and tensile properties and these are eco-friendly materials. Utilizing of coir fiber as low cost building materials is increased. The presence of fiber improves the ductility of mix, tensile and flexural strengths of mix, fracture roughness. Natural rubber latex is used for the treatment of coir fiber.

2. OBJECTIVE:

The investigation of the behavior geopolymer concrete with coir fiber as reinforcement is studied.

3. METHODOLOGY:

Flyash acts as the binder material in geo-polymer concrete. The coarse aggregate, fine aggregate are bind by flyash to form geo-polymerization. Coir fiber is aparted from coir dust and pith and a length of 25mm is considered. Sodium hydroxide solution is prepared by mixing NaOH with water. The prepared solution is used for soaking of the chopped coir fiber. For the soaking solution, 1liter of H_2O is taken and added to 5% of NaOH. The mercerization of coir fiber is done by allowing the soaking foe 48hrs. After the completion of soaking time i.e.,48hrs, the coir fiber is taken out from the solution and

thoroughly washed with distilled water and to be dried for 24hrs.The dried coir fiber is soaked in latex compound which is a combination of 70 percent of rubber latex, 10 percent of NaOH solution and 20 percent of distilled water for 15min and again allowed for drying for 24hrs. Metakaolin of 20percent is added to the amount of powder content for the purpose of setting only and not for the improvement of any strength parameters.

3.1 SOURCE MATERIALS:

3.1.1 Fly ash: Fly ash is the finely divided particle which is the residue obtained when the combustion of powdered coal is done. The chemical compositions of flyash is the combination of oxides of Calcium (CaO), Aluminum (Al_2O_3), Silicon (SiO_2), and Iron (Fe_2O_3), where the percentage of Titanium(Ti), Sodium (Na), Magnesium (Mg), Potassium (K), Sulphur (S) are present in slighter amount. Fly ash is preferred as Low-calcium (ASTM Class F).

3.1.2 Alkaline Liquids: For geo-polymerization the mixture of NaOH and Na_2SiO_3 is used. In polymerization process alkaline liquid plays a key role. To prepare NaOH concentration either flakes or pellets are allowed to dissolve in water. For 12M, to prepare NaOH concentration, 12x40 = 480 grams of flakes per one liter of the solution, where the molecular weight of NaOH is calculated as 40.

3.1.3 Coarse aggregate: The coarse aggregate 10 mm was used for this experimental work which is locally available.

3.1.4 Fine aggregate: The local river sand, passing through 4.75 mm was used in this experimental work.

3.1.5 Coconut Fiber: Coir fiber has the potential to be used as reinforcement in internal wall paneling system with binder component of cement and gypsum. Coir fiber is extracted from coconut outer shell. Coir fiber of 25mm length is chopped and various percentages of 0, 0.75, 1.5, 2.25, and 3 are used for this research.

3.1.6 Metakaolin: The Metakaolin is used for the investigation. The particle size of the metakaolin was referred with the help of scanning electron microscope. In powder content 20% is used as metakaolin for the setting purpose only.

3.1.7 Latex Rubber: Latex is natural or synthetic form of a polymer of micro particles in an aqueous medium. Latex is milky fluid in nature. Tannins, gums, sugars, oils, alkaloids, proteins, resins, and starches that coagulate on exposure to air are present in Latex rubber. Generally available latex is white in colour, but latex is scarlet latex, orange, or yellow in some plants.

3.2 COMPOSITE PREPARATION:

The 25 mm chopped coir fibers are allowed to soak in sodium hydroxide for 48hours for chemical treatment. After 48hours the treated coir fiber is thoroughly washed and dried for 24 hours. The dried fibers are then resin with latex compound which is prepared by the mixing of 70 percent of latex, 20 percent of water, and 10 percent of sodium hydroxide solution to achieve thee homogenization and is allowed to dip for 15 minutes and dried for 24 hours.

Polymerization is formed by the mixing of Na_2SiO_3 and NaOH. Sodium hydroxide is in the form of pellets or flakes. To form 12M, the sodium hydroxide flakes of 480 gms are dissolved in water to require the concentration. During the formation of concentration it liberates large amount of heat. To form polymerization the mixed sodium silicate and sodium hydroxide are allowed to keep at room temperature for minimum of 24hrs. This mixed solution acts as a binding agent.

3.3 MIXING, CASTING AND CURING:

To get the perfectly suitable binding agent the Na_2SiO_3 and NaOH are mixed 24hrs before to get polymerization. Manual mixing of all the materials is done. Fly ash and aggregate are mixed for about a minute, then the binding agent is added with small portions and the mixing is done for about 2minutes. Now to the mixture the treated fibers are added with slow increments and mixing is done properly. Cube specimens of 150*150*150mm for compressive test, cylindrical specimens of 150mm dia and 300mm height specimen for split tensile test and $100*100*500mm^3$ for flexural strength beam specimens were cast. Ambient conditions are used for curing of the specimens.

4. OBSERVATIONS AND RESULTS

RESULTS FOR MOLARITY 10

Compressive Strengths in N/mm^2

MOLARITY	Percentage of Coir Fiber	Number of Days for testing		
		7	14	28
10	0	5.08	5.37	12.20
10	0.75	6.83	7.16	13.8
10	1.5	7.412	7.58	15.26
10	2.25	8.28	9.3	15.84

10	3	6.54	6.68	13.8

Split tensile strengths in N/mm²

MOLARITY	Percentage of Coir Fiber	Number of Days for testing		
		7	14	28
10	0	0.09	0.13	0.68
10	0.75	0.1	0.16	0.85
10	1.5	0.22	0.22	1.02
10	2.25	0.54	0.36	1.76
10	3	0.27	0.27	1.46

Flexural strengths in N/mm²

MOLARITY	Percentage of Coir Fiber	Number of Days for testing		
		7	14	28
10	0	0.19	0.29	0.29
10	0.75	0.58	0.68	0.75
10	1.5	0.88	0.97	1
10	2.25	1.76	1.46	1.8
10	3	1.46	1.37	1.4

RESULTS FOR MOLARITY 12

Compressive Strengths in N/mm²

MOLARITY	Percentage of Coir Fiber	Number of Days for testing		
		7	14	28
12	0	7.701	8.57	9.47
12	0.75	7.9	8.7	9.78

12	1.5	7.85	8.77	9.84
12	2.25	9.3	9.45	10.58
12	3	7.12	8.14	10.13

Split tensile strengths in N/mm²

MOLARITY	Percentage of Coir Fiber	Number of Days for testing		
		7	14	28
12	0	0.15	0.2	0.27
12	0.75	0.18	0.23	0.31
12	1.5	0.32	0.27	0.34
12	2.25	0.378	0.41	0.48
12	3	0.232	0.37	0.41

Flexural strengths in N/mm²

MOLARITY	Percentage of Coir Fiber	Number of Days for testing		
		7	14	28
12	0	0.98	1.1	1.83
12	0.75	0.99	1.28	1.93
12	1.5	1.17	1.57	1.98
12	2.25	1.76	2.26	2.93
12	3	1.5	2.16	2.42

CONCLUSIONS:

1. The propagation of micro cracks are resisted.
2. 2.25 percentage of coir fiber is allowable as per research.
3. The strength parameters increase with increase of coir fiber percentage to optimum and then decreases
4. For 2.25 percentage of coir fiber the compressive strength is 11.65 percentage

more when compared to 0 percentage of coir fiber for 28 days.

5. For 2.25 percentage of coir fiber the split tensile strength is 41.65 percentage more when compared to 0 percentage of coir fiber for 28 days.
6. For 2.25percentage of coir fiber the flexural strength is 37.9 percentage more when compared to 0 percentage of coir fiber for 28 days.

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