USE OF STEEL FIBRES & NATURAL FIBRES IN CLASS F FLY-ASH BASED GEOPOLYMER CONCRETE

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ABSTRACT

In this work, low-calcium (Class F) fly ash-based geopolymer is used as the binder, instead of Portland or other hydraulic cement paste to produce concrcte. The fly ash based geopolyrner paste binds the loose coarse aggregates, fine aggregate sand other un-reacted materials together to form the geopolymer concrete. The main difference between class F FIy Ash (FFA) and class C Fly Ash (CFA) is the calcium content. ln concrete fibres are used to improve impact resistance and greater ductility of failure in compression, flexural and torsion. The main purpose of the fibre is to control cracking and to increase the fracture toughness of brittle material through bridging action during both micro and macro cracking. The environment friendly altemative of the ordinary Portland cement is fly ash based geopolyner concrete The specimen were designed for the grade G30 with different types of fibre added to the concrete mix as 0.4%,0.8%,1.2%,1.6%,2.0%,2,4%,2.8%..Cubes were cast with different fibres for compressive stength. The aim of this research paper is to compare the compressive strength and split tensile strength of steel fibres and natural fibres for same percentage of usage of fibre

1.INTRODUCTION

Production of cement is increases due to increasing demand of construction industries. As the production of cement is increases, the rate of production of carbon dioxide is also increases. Generally for each ton of Portland cement production, releases a ton of carbon dioxide to the atmosphere. The greenhouse gas emission from the production of Portland cement is about 7% of the total greenhouse gas emissions. In addition, the extent of energy required to produce OPC is only next to steel and aluminium. On the other hand, the abundant availability of fly ash worldwide creates opportunity to utilise this by-product of burning coal, as a substitute for OPC to manufacture concrete. When used as a partial replacement of OPC, in the presence of water and in ambient temperature, fly ash reacts with the calcium hydroxide during the hydration process of OPC to form the OPC up to 60% by mass

2.EXPERIMENTALWORK

The material details are as follows:

2.1. Fly Ash

The fly ash is defined as the finely divided residue that results from the combustion of ground or powdered coal and that is transported by flue gases from combustion zone to the particle removal system

2.2. Alkaline Liquid

A combination of sodium silicate solution and sodium hydroxide solution was chosen as the alkaline liquid. Sodium-based solutions were chosen because they were cheaper than Potassium-based solutions. The sodium hydroxide solids were either a technical grade in flakes form (3 mm), with a specific gravity of 2.130, 97% purity.

2.3 Fine Aggregate

Locally available fine aggregate used was 4.75 mm size confirming to zone II with specific gravity 2.66.Water absorption and fineness modulus of fine aggregate was 1.35% and 2.74 respectively. Various tests such as specific gravity, water absorption, impact strength, crushing strength etc. Natural sand is used confirming to IS 383-1970

2.4 Coarse Aggregate

Coarse aggregate used was 20mm and less size with specific gravity 2.70. Testing of coarse aggregate was conducted as per IS: 383-1970. Water absorption and fineness modulus of coarse aggregate was 0.7% and 7.17 respectively.

2.5 Water

The water used was free from organic impurities of any type & drinkable water we used.2.

2.6. Steel fibre

(a) Hooked end

(b) Zigzag shaped

Steel fiber is a metal reinforcement. Steel fiber for reinforcing concrete is defined as short, discrete lengths of steel fibers with an aspect ratio (ratio of length to diameter) from about 20 to 100, with different cross-sections, and that are sufficiently small

2.7 Natural fibre

(a) Rice husk

(b) Coconut Fibre

3.TESTING OF SPECIMENS

The specimen used was cube specimens, beam specimens and cylinder specimens.

Dimensions of each test specimen are as follows:

Cube : 150 mm x 150 mm x 150 mm
Beam : 100 mm x 100 mm x 500 mm
Cylinder: 150 mm Diameter x 300 mm Length

- Beam specimens were used to determine flexural strength.
- Cubes specimens were used to find the compressive strength.
- Cylinder specimens were used to determine the splitting tensile strength.

4. TEST RESULTS

4.1 Compressive strength of GPC

Table 4.1 Compressive Strength on 7th Day

Sr No	Types of Fibers	Curing Time (Hrs)	Rest Period (Days)	Compressive Strength (N/mm²)	Average (N/mm²)
1	Steel Fibers (Hooked End)	24	7	33.78	33.19
				33.33	
				32.44	
2	Steel Fibers (Zigzag)	24	7	33.33	33.04
				31.11	
				34.67	
3	Natural fibers(Rish Husk)	24	7	28.44	29.78
				30.22	
				30.67	
4	Natural fibers(Coconut)	24	7	30.67	30.96
				30.22	
				32.00	

Table 4.2 Compressive Strength on 28th Day

Sr No	Types of Fibers	Curing Time (Hrs)	Rest Period (Days)	Compressive Strength (N/mm²)	Average (N/mm²)
1	Steel Fibers (Hooked End)	24	28	43.11	42.52
				42.67	
				41.78	
2	Steel Fibers (Zigzag)	24	28	42.22	42.22
				41.78	
				42.67	
3	Natural fibers(	24	28	33.33	33.48
				33.78	

	Rish Husk)			33.33	
4	Natural fibers(Coconut)	24	28	34.22	34.22
				33.78	
				34.67	

4.2 TENSILE STRENGTH OF GPC

Table 4.3 Effect of Types of fibres on Split Tensile strength on 7th day

Sr No	Types of Fibers	Curing Time (Hrs)	Rest Period (Days)	Average Split Tensile Strength (Mpa)
1	Steel Fibers (Hooked End)	24	7	4.85
2	Steel Fibers (Zigzag)	24	7	5.65
3	Natural fibers(Rish Husk)	24	7	3.70
4	Natural fibers(Coconut)	24	7	3.95

4.3 FLEXURAL STRENGTH OF GPC

Table 4.4 Effect of fibres on Flexural strength on 28th day

Sr.No.	Types of Fibers	Curing Time (Hrs)	Rest Period (Days)	Average Flexural Strength (Mpa)
1	Hooked end Steel fibre 1	24	28	8.20
	Hooked end Steel fibre 2			
	Hooked end Steel fibre 3			
2	Zigzag Steel fibre 1	24	28	8.42
	Zigzag Steel fibre 2			

	Zigzag Steel fibre 3			
3	Coconut fibre 1	24	28	7.80
	Coconut fibre 2			
	Coconut fibre 3			

4..4 PULL-OUT TEST ON GPC

Table 4.5 Effect of fibers on Bond strength on 7th day

Sr.No.	Types of Fibers	Curing Time (Hrs)	Rest Period (Days)	Average Pull-out strength
1	Hooked end Steel fibre 1	24	7	11.34
	Hooked end Steel fibre 2			
	Hooked end Steel fibre 3			
2	Zigzag Steel fibre 1	24	28	11.89
	Zigzag Steel fibre 2			
	Zigzag Steel fibre 3			
3	Coconut fibre 1	s24	28	13.89
	Coconut fibre 2			
	Coconut fibre 3			

5. CONCLUSION

- Percentage of steel fibers plays an important role to increase compressive strength of fly ash based geopolymer concrete reinforced with steel fiber.
- Compressive strength of Natural fibres show considerable result but natural fibres are weak in tension.
- Geopolymer concrete is more brittle than conventional concrete, steel fibres are used to make it an elastic one.
- Compressive strength of the Geopolymer concrete with fibers has increased.
- Split tensile strength of Geopolymer concrete with fibers has increased.
- Low-calcium fly ash-based geopolymer concrete has excellent compressive strength and is suitable for Structural applications.
- The bond strength of fibres added GPC is more than regular GPC and zigzag shaped Steel fiber shows more bond strength than other fibres.

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