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STUDY OF FLYASH BASED GEOPOLYMER CONCRETE WITH STEEL FIBER AND REVIEW

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ABSTRACT

Today concrete is used in a massive amount for construction work as the construction industry is growing day by day and so the demand of concrete. The worldwide production of Ordinary Portland cement is increasing at the rate of 9% annually and is contributing to the 5% to 8% of total production of greenhouse gases. The environment friendly alternative of the ordinary Portland cement is fly ash based geopolymer concrete. and it should be studied comprehensively. In this paper comparison of compressive strength between conventional concrete with different quantities of steel fiber and fly ash based geopolymer concrete with 8M and 16M and different quantities of steel fiber is done. The main aim of this paper is to compare the compressive strengths of conventional concrete reinforced with steel fiber and geopolymer concrete reinforced with steel fiber and normal geopolymer concrete. Test specimens are prepared with size of 150 X 150 X 150mm moulds.

Key Words - Geopolymer, Fly ash, Steel fiber, Compressive strength.

I. INTRODUCTION

The geopolymer concept proposed by Davidovits shows considerable solution for application in concrete industry as an alternative binder to the conventional cement. Considering it as environmental friendly alternative, geopolymer technology can reduce carbon-di-oxide emission by cement industries by about 80%. When the globalisation is considered the demand of concrete is increasing day by day resulting in the high demand of ordinary Portland cement. On the other hand there is change in climatic condition due to increase in greenhouse gases in our atmosphere. Cement industry contributes about 5% to 8% of total greenhouse gas production, so there is need to control this emission of carbon-dioxide by finding a green substitute to ordinary Portland cement which will help to reduce production of greenhouse gases from cement industries.

II. MATERIALS

2.1 FLY ASH

Fly ash is the waste material obtained as a residue from burning of a coal in furnace or locomotives. We get it in the powdered form. The colour of fly ash is either grey or blackish grey. It is one of the most abandoned material on earth. It is one of the main ingredients in creation of geopolymer concrete as it plays an important role in the geopolymerization process. There are two classes of fly ash class F and class C. Each class of fly ash has its own unique properties.

2.2 STEEL FIBER

The steel fiber used in geopolymer concrete has diameter 0.45mm, length of 25mm, it has aspect ratio of 55.55. Number of steel fibers per kg is 30946.

2.3 ALKALINE LIQUID

The solution of sodium hydroxide and sodium silicate is used as alkaline solution in the present study. Commercial grade sodium hydroxide in pellets form (97%-100% purity) and sodium silicate solution having 7.5%-8.5% of Na2O, 25%-28% of SiO2, and water of 63.5%-67.5% are used.

2.4 FINE AGGREGATE

Fine aggregate used in tis study is river sand with specific gravity 2.60, fineness modulus of 4035. Size of fine aggregates used is less than 4.75mm. and it was made sure that it is free from clay and mineral sand.

2.5 COURSE AGGREGATE

The aggregate retained on 4.75mm IS sieves are known as coarse aggregates. 20mm and 12.5 mm size aggregates are used in this study. Aggregate having specific gravity 2.90, fineness modulus 7.2, water absorption 8.5%, impact value 9.10% and crushing value of 17.8 are used.

III. LITERATURE REVIEW

S. E. Wallah and B. V. Rangan affirmed that, there is no noteworthy gain in the compressive strength of heat cured fly ash based geopolymer concrete with age. The fly ash based geopolymer concrete cured at ambient temperature gains strength with age. The 7^{th} day compressive strength of ambient temperature cured geopolymer concrete depends upon average temperature during the first week after casting. It is observed that higher the ambient temperature, better is the compressive strength. [1]

P. K. Jamdade and U. R. Kawade considered the compressive strength of geopolymer concrete by oven curing method. The geopolymer concrete is cured at different temperatures in the oven i.e.60℃, 90℃ and 120℃. The results were observed and it was seen that compressive strength increases with increase in curing temperature and the duration of curing plays an important role for compressive strength of geopolymer concrete. Longer the curing period, higher the compressive strength as the polymerization process improves with time. [2]

N A Lloyd and B V Rangan has conducted study on fly ash based geopolymer concrete to be aware of effects of basic factors influencing properties of geopolymer concrete. The results were used to propose simple method for design of geopolymer concrete. This study is conducted for various short term and long term properties of the geopolymer concrete. The results of the tests conducted on large scale reinforced geopolymer concrete can be used for manufacturing of precast concrete products that will be helping infrastructure expansion. [3]

Yasir Sofi and Iftekar Gull studied different properties of fly ash based geopolymer concrete. The M20 grade geopolymer was formed by nominal mix of 1:1.5:3 (fly ash: fine aggregates: coarse aggregates) by changing ratio of alkaline liquid to fly ash from 0.3 to 0.45. The compressive strength test, tensile strength test and flexural strength test were conducted on the fly ash based geopolymer concrete. The parameters that affect compressive strength, flexural strength and tensile strength were analyzed and proved experimentally. It was seen that increase in ratio of alkaline liquid to fly ash decreases strength of fly ash based geopolymer concrete.

Also it was concluded that flyash based geopolymer concrete possess good compressive strength and have good durability distinctiveness. [4]

IV. METHODOLOGY

4.1 Mixture Proportion

The mixture proportion to make M20 grade fly ash based geopolymer concrete reinforced with steel fibers is done by nominal mix of 1:1.5:3(same as conventional concrete) . Steel fiber is added in percentage of weight of fly ash. For the conventional concrete of M20 grade nominal mix design is used and percentage of steel fibers is varied considering weight of cement.

4.2 Preparation of Alkaline solution

in this research paper the strength of fly ash based geopolymer concrete is examined for mixex of 8 molarity and 16 molarity. The molecular weight of Sodium Hydroxide is 40. Hence to prepare 8 molar solution 320 g of sodium hydroxide pellets are weighed and dissolved in 1liter distilled water to make sodium hydroxide solution. Same procedure is followed to prepare 16 molar sodium hydroxide solutions.

4.3 VI.III Mixing

All materials were collected. While mixing, weigh batching is done. Fly ash is collected and weighed; coarse aggregates and fine aggregates are batched differently. Steel fiber is collected and weighed as per requirement. The dry mixing of all ingredients is done for 3 minutes. After dry mixing the alkaline solutions and steel fibers are added and wet mixing is done for 4 Minutes. This prepared concrete is poured in the moulds and proper tamping is done by tamping rod to avoid honeycombing.

V. RESULTS AND DISCUSSION

5.1 Test specimen

Test specimens for compressive strength were made wit h cubes of 150 X150X150mm cast iron steel moulds. For each mix proportion three cubes were cast. The curing period for 8M and 16M geopolymer concrete with varying amount of steel fibres was 6hrs at 90℃ by oven curing and the conventional concrete was cured for 28 days.

Table 1. Details of test specimen

Sr.No	TYPE OF CONCRETE	MOLARITY	% OF STEEL FIBER	NO. OF SPECIMEN
1	Geopolymer	8M	0.50%	3
2	Geopolymer	8M	1%	3
3	Geopolymer	8M	1.50%	3
4	Geopolymer	8M	2%	3
5	Geopolymer	16M	0.50%	3
6	Geopolymer	16M	1%	3

7	Geopolymer	16M	1.50%	3
8	Geopolymer	16M	2%	3
9	Geopolymer	8M	0%	9
10	Geopolymer	16M	0%	9
11	Conventional		0.50%	3
12	Conventional		1%	3
13	Conventional		1.50%	3
14	Conventional		2%	3
Total				54

5.2 Compressive strength test

Different values of compressive strengths for 8M geopolymer concrete reinforced with steel fibre, 16 M geopolymer concrete reinforced with steel fibre and conventional concrete reinforced with steel fibre are given bellow in following tables.

Table 2. Compressive strength of 8M GPC

SR.NO.	% OF STEEL FIBRE	COMPRESSIVE STRENGTH
1	0	15.9
2	0.5	18.1
3	1	26.17
4	1.5	23.4

Table3. Compressive strength of 16M GPC

SR.NO.	% OF STEEL FIBRE	COMPRESSIVE STRENGTH
1	0	18.54
2	0.5	19.13
3	1	33.57
4	1.5	28.7
5	2	34.8

Table5. Compressive strength of conventional concrete

SR.NO.	% OF STEEL FIBRE	COMPRESSIVE STRENGTH
1	0	20.37
2	0.5	19.13
3	1	23.2
4	1.5	26.18
5	2	30.32

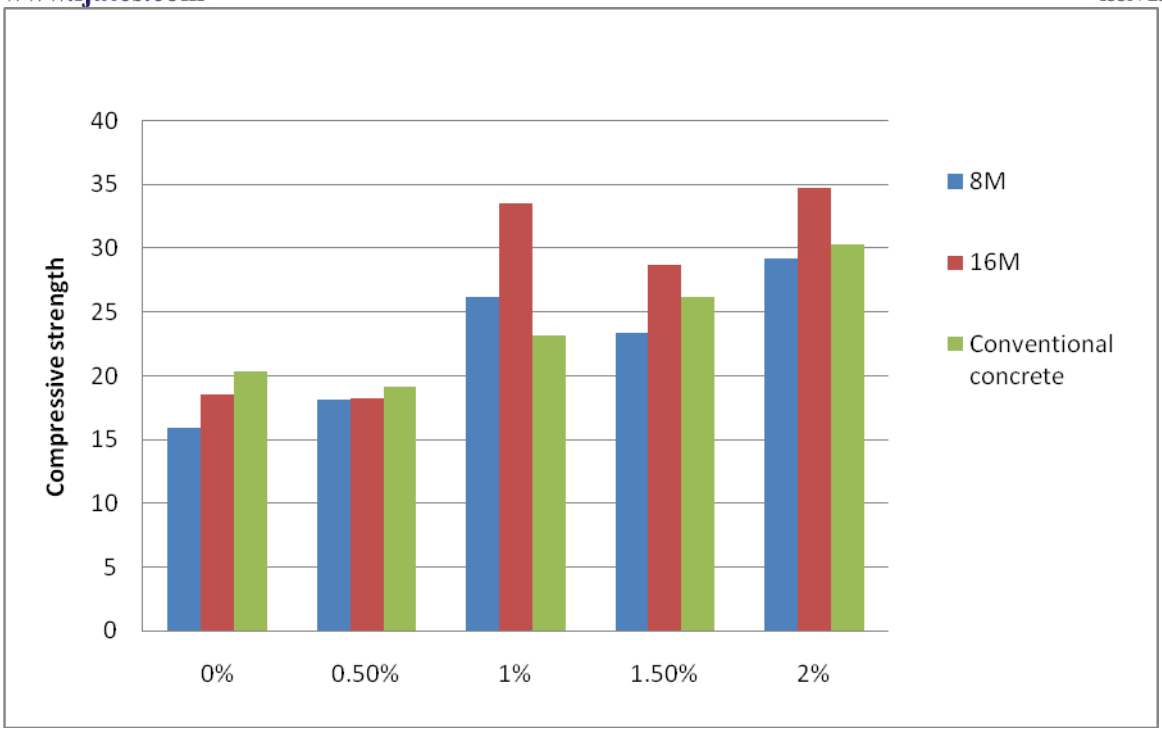

Fig 1. Comparison of compressive strength with varying conditions

VI. CONCLUSION

Based on experimental investigation following conclusions are made-

1. The compressive strength for fly ash based geopolymer concrete varies with the concentration of sodium hydroxide solution that is Molarity of the sodium hydroxide solution.
2. The compressive strength for fly ash based geopolymer concrete is gained in very less curing time compared to conventional concrete.
3. Percentage of steel fibers plays a vital role to increase compressive strength of fly ash based geopolymer concrete reinforced with steel fiber.
4. Fly ash based geopolymer concrete reinforced with fly ash can replace the conventional concrete for the precast products where curing conditions can be maintained.

VII. FUTURE SCOPE

The overall study from above shows that there is scope to use fly ash based geopolymer concrete replacing conventional concrete, as the time needed for curing is very less which will definitely help to maintain economy, also this will help to reduce environmental pollution. The total water consumed for curing of concrete will be reduced by using this technology.

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