Performance Evaluation of Pozzolanos on A Fiber Reinforced Concrete

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ABSTRACT: *Concrete is a major building material which is been used in construction industry throughout the world. It is an extremely versatile material and can be used for all types of structures. As our aim is to develop concrete which does not only concern on the strength of concrete, it also having many other aspects to be satisfied like less porous, capillary absorption, durability. So for this we need to go for the addition of pozzolanic materials along with superplasticizer in a fiber reinforced concrete. The materials like fly ash , ground granulated blast furnace slag and silica fume is used for the partial replacement of cement. Thus concrete becomes inexpensive and eco-friendly. A through literature review was conducted to study and investigate the properties of these materials. Recron fiber is used in concrete for the production of fiber reinforced Concrete. So we are going to use Recron fiber in different percentage to the weight of concrete and study the 7 days and 28 days compressive strength to find the optimum percentage of fiber for getting maximum strength with maintaining the water cement ratio . Then partially replace cement with various pozzolanos with different percentages for fixing constant optimum fiber percentage cubes, cylinders and beams were casted and tested to analyze the change in compressive, split tensile and flexural strength.*

Keywords *– Recron Fiber, Silica Fume, Fly Ash, GGBFS, Strength*

1. Introduction

Concrete is the most widely used man-made construction material in the world. It is obtained by mixing cementitious materials, water, aggregate and sometimes admixtures in required proportions. OPC is one of the main ingredients used for the production of concrete and has no alternative in the civil construction industry. Unfortunately, production of cement involves emission of large amounts of carbon-dioxide gas into the atmosphere, a major contributor for green house effect and the global warming, hence it is inevitable either to search for another material or partly replace it by some other material. The search for any such material, which can be used as an alternative or as a supplementary for cement should lead to global sustainable development and lowest possible environmental impact. So for this we need to go for the addition of pozzolanic materials along with superplasticizer with having low water cement ratio. Also now a day's one of the great application in various structural field is fiber reinforced concrete, which is getting popularity because of its positive effect on various properties of concrete. The major advantages of fiber reinforced concrete are resistance to microcraking, impact resistance, resistance to fatigue, reduced permeability, improved strength in shear, tension, flexure and compression.

1.1 Objectives of the Study

The objective of the present work is to develop concrete with good strength, less porous, less capillarity so that durability will be reached. For this purpose it requires the use of different pozzolanic materials like fly ash, ground granulated blast furnace slag, silica fume along with fiber. So the experimental programme to be undertaken;

1. To evaluate effective use of pozzolanic materials with fiber to achieve the desire needs.
2. To find optimum dosage of Recron 3s fibers to get maximum strength for the M30 grade concrete
3. Obtaining the optimum replacement % of pozzolanos with a constant dosage of fiber.
4. Comparison of results.

2. Material characteristics

2.1 Materials

Table 1. Properties Of Cement

Property	Ramco 53 grade OPC
Specific gravity	3.14
Standard consistency	38 %
Initial setting time	130 min
Final setting time	315 min

Table 2. Properties of Aggregate

Property	Fine aggregate	Coarse aggregate (20 mm)	Coarse aggregate (12 mm)
Specific gravity	2.53	2.75	2.74
Water absorption	1.35%	0.45%	0.57 %
Aggregate crushing value	–	–	30.82%
Flakiness index	–	5.49%	17.77%
Elongation index	–	22.7%	15.28%

2.2 Mix Design

Table 3. Mix Design

Grade Of Concrete	M30
Material	Calculated Quantity/M^3
Cement	360 kg
Coarse aggregate : 20 mm	734 kg
Coarse aggregate : 12 mm	489 kg
Fine aggregate	862 kg
Water	144 kg
Superplasticizer (1%) (RHEOBUILT 1125)	3.6 kg

3. Experimental Investigation

Synthetic fiber i.e Recron fiber is used in concrete for the production of fiber reinforced Concrete. According to studies 0.2% to 0.4% is good for concrete. So we are going to use Recron fiber in different percentage i.e. 0%, 0.2%, 0.225%,0.25%, 0.275%, 0.3%, 0.325%, 0.35%0.375%, 0.4%, to the weight of concrete and study the 7 days and 28 days compressive strength to find the optimum percentage of fiber for getting maximum strength for M_{30} grade concrete with maintaining the water Cement ratio in the range of 0.4. Then partially replace cement with various pozzolanos , with different percentages like 5%,10%,15% for silica fume & fly ash, percentages like 40%,50%,60% for GGBFS fixing constant optimum fiber percentage cubes, cylinders and beams were casted and tested to analyze the change in compressive, splitting tensile and flexural strength.

4. Test Results

4.1 Compressive Strength Test for Finding The Optimum Percentage of Recron Fiber For Getting Maximum Strength.

Table 4. Effect of recron fiber on compressive strength using OPC for M 30 mix

Fibre content (%)	7 days compressive strength in (N/mm^2)	28 days compressive strength in (N/mm^2)
0%	25.70	39.11
0.2%	24.44	37.54
0.225%	25.53	38.63
0.25%	26.88	39.98
0.275%	28.00	41.20
0.3%	28.40	41.95
0.325%	29.95	42.40
0.35%	29.20	41.50
0.375%	25.06	38.43
0.4%	24.56	37.32

In case of Ordinary Portland cement it was observed that using Recron fiber from 0.2% to 0.225% the compressive strength is not increased, but as the fiber percentage was increased from 0.25% to 0.35% the compressive strength was increased and on further increment of fiber content

the strength reduces. From 0.25% to 0.35% of fiber content,7 day and 28 days compressive strength of concrete is higher at with 0.325% fiber compared to other fiber composition. so the optimum dosage of fiber for getting maximum strength for OPC was 0.325%.

4.2 Compressive strength test for finding the effective cement replacement (%) of silica fume with constant fiber content

Table 5. Effect of Silica Fume On Compressive Strength With 0.325% Fiber Using OPC

Silica fume (%)	7days compressive strength in (N/mm^2)	28days compressive strength in (N/mm^2)
0%	29.95	42.4
5%	34.48	45.17
10%	38.26	48.56
15%	34.59	46.31

There is a significant improvement in the strength of concrete because of the high pozzolanic nature of the silica fume and its void filling ability. The compressive strength of the M30 mix at 7 and 28 days age, with replacement of cement by silica fume with 0.325% fiber content was increased gradually up to an optimum replacement level of 10% and then decreased.

The maximum compressive strength of concrete with silica fume depends on three parameters, namely the replacement level, water cement ratio and chemical admixture. The superplasticizer admixture dosage plays a vital role in concrete to achieve the given workability at lower w/c ratio. Cement replacement up to10% with silica fume with a constant fiber content leads to increase in compressive strength.

4.3 Split tensile strength test for finding the effective cement replacement (%) of silica fume with constant fiber content

Table 6. Effect of silica fume on split tensile strength with 0.325%fiber using OPC

As replacement level increases there is an increase in split tensile strength for M30 grade of concrete up to 10% replacement level, and beyond that level there is a decrease in split tensile strength.

4.4 Flexural strength tests for finding the effective cement replacement (%) of silica fume with constant fiber content.

Table 7. Effect of silica fume on flexural strength with 0.325%fiber using OPC

Silica fume (%)	28 days flexural strength in (N/mm^2)
0%	5.94
5%	6.02
10%	6.38
15%	6.15

The flexural strength at the age of 28 days of silica fume concrete continuously increased with respect to controlled concrete and reached a maximum value of 10%replacement level for M30 grade concrete respectively.

4.5 Compressive strength test for finding the effective cement replacement (%) of fly ash with constant fiber content.

Table 8. Effect of fly ash on compressive strength with 0.325%fiber using OPC

Fly ash (%)	7days compressive strength in (N/mm^2)	28days compressive strength in (N/mm^2)
0%	29.95	42.4
5%	30.2	44.3
10%	32.7	46.2
15%	31.2	45.4

When mineral admixtures are added to the concrete containing super plasticizer the properties of fresh and hardened concrete was varied. It was observed that the workability of concrete was increased providing higher slump value. During the test , when fly ash was added the final setting time was increased. Out of the three combinations of fly ash replacement, 10% cement replacement with fly ash gives better results. The initial strength development is very slow.

4.6 Split tensile strength test for finding the effective cement replacement (%) of fly ash with constant fiber content.

Silica fume (%)	28 days Split tensile strength in (N/mm^2)
0%	3.76
5%	3.8
10%	4.01
15%	3.87

Table 9. Effect of fly ash on split tensile strength with 0.325%fiber using OPC

Fly ash (%)	28 days splitting tensile strength in (N/mm^2)
0%	3.65
5%	4.5
10%	5.2
15%	4.6

As replacement level increases there is an increase in split tensile strength for M30 grade of concrete up to 10% replacement level, and beyond that level there is a decrease in split tensile strength.

4.7 Flexural strength test for finding the effective cement replacement (%) of fly ash with constant fiber content.

Table 10. Effect of fly ash on flexural strength with 0.325%fiber using OPC

Fly ash (%)	28days flexural strength in (N/mm^2)
0%	5.94
5%	7.33
10%	8.5
15%	7.8

The flexural strength at the age of 28 days of fly ash concrete continuously increased with respect to controlled concrete and reached a maximum value of 10%replacement level for M30 grade concrete respectively.

4.8 Compressive strength test for finding the effective cement replacement (%) of GGBFS with constant fiber content.

Table 11. Effect of GGBFS on compressive strength with 0.325%fiber using OPC

GGBFS (%)	7days compressive strength in (N/mm^2)	28 days compressive strength in (N/mm^2)
0%	29.9	42.4
40%	30.2	43.6
50%	32.6	45.4
60%	31.4	44.2

Ground granulated blast furnace slag when it is powdered to very fine particle will have high cementitious properties. Large percentage of cement can be replaced with GGBS. In the study it was observed that cement when replaced with GGBFS there is a considerable increase in compressive strength. Since the particle size is very small it will react well and more dense concrete was produced and the strength is increased. Out of the three combinations considered cement replaced with 50% GGBFS shows higher strength and produced more workable concrete. The initial strength development is low since the pozzalanic reaction is slow. But in the 7 day test itself the strength of GGBFS replaced concrete was increased. In the 28 day strength also there is an increase in strength for all the three combinations considered. Replacing cement with 50% GGBFS was considered as the optimum cement replacement for M30 concrete.

4.9 Split tensile strength test for finding the effective cement replacement (%) of GGBFS with constant fiber content.

Table 12. Effect of fly ash on splitting tensile strength with 0.325%fiber using opc

GGBFS (%)	28 days splitting tensile strength in (N/mm^2)
0%	3.65
40%	3.71
50%	3.82
60%	3.76

As replacement level increases there is an increase in split tensile strength for M30 grade of concrete up to 50% replacement level, and beyond that level there is a decrease in split tensile strength.

4.10 Flexural strength test for finding the effective cement replacement (%) of GGBFS with constant fiber content

Table 13. Effect of fly ash on flexural strength with 0.325%fiber using OPC

GGBFS (%)	28 days flexural strength in (N/mm^2)
0%	5.94
40%	6.5
50%	7.7
60%	7.2

The flexural strength at the age of 28 days of GGBFS concrete continuously increased with respect to controlled concrete and reached a maximum value of 10%replacement level for M30 grade concrete respectively.

5. Conclusions

In the studies conducted to evaluate the performance of pozzolanos in a fiber reinforced

concrete,it was concluded that

1. In case of Ordinary Portland cement, it was observed that using Recron fiber from 0.2% to 0.225% the compressive strength is not incresed, but as the fiber percentage was increased from 0.25% to 0.35% the compressive strength was increased and on further increment of fiber content the strength reduces. From 0.25% to 0.35% of fiber content, 7 day and 28 days compressive strength of concrete is higher at with 0.325% fiber compared to other fiber composition.
2. The optimum dosage of fiber for getting maximum strength for M30 grade of concrete was 0.325%.
3. The compressive strength of the M30 mix at 7 and 28 days age, with replacement of cement by silica fume with an 0.325% fiber content was increased gradually up to an optimum replacement level of 10% and then decreased.
4. The replacement level of cement by silica fume increases there is an increase in split tensile strength & flexural strength for M30 grade of concrete up to 10% replacement level, and beyond that level there is a decrease in split tensile and flexural strength.
5. Out of the three combinations , the compressive strength of the M30 mix at 7 and 28 days age, replacement of cement by fly ash with an 0.325% fiber content was increased gradually up to an optimum replacement level of 10% gives better results. The initial strength development is very slow.
6. The replacement level of cement by fly ash increases there is an increase in split tensile strength & flexural strength for M30 grade of concrete up to 10% replacement level, and beyond that level there is a decrease in split tensile and flexural strength.
7. Cement replaced with 50% GGBFS with 0.325 % fiber shows higher compressive, split tensile and flexural strength strength than other three combinations. beyond that level there is a decrease in strength.

Based on the conclusions arrived at, one recommendation are made for future work that is detailed cost analysis should be carried out to determine the level of savings from the use of pozzolanos in a fiber reinforced concrete.

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