ANALYSIS OF BAHAVIOUR OF STEEL FIBRE REINFORCED FLY ASH CONCRET

Mr. shailendra Gilhare , Dr. Ajay Swarup

[1] *M Tech scholar, Civil Department, SSSUTMS-Sehor, Madhya Pradesh, India*
[2] *Professor, Civill Department, SSSUTMS-Sehor, Madhya Pradesh, India*

ABSTRACT

Concrete is one of the most common materials used in the construction industry. In the past few years, many research and modification has been done to produce concrete which has the desired characteristics. Cementitious materials known as pozzolans are used as concrete constituents, in addition to Portland cement. There is always a search for concrete with higher strength and durability. In this matter, blended cement concrete with the incorporation of fibers has been introduced to suit the current requirements. Plain concrete has good compressive strength but has low tensile strength, low ductility and low fire resistance. To circumvent these shortcomings, extensive research by concrete technologist has led them to find a very promising concrete material called as fiber reinforced concrete.

A lot of research work has been done and is going on the use of steel fibers and also fly ash as cement replacement in enhancing different properties of concrete. Research work done by different researchers is discussed here in brief.

Keyword: - Concrete, Cementitious

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1. INTRODUCTION

As we know, brittle failure is the inherent property of the plain concrete, i.e. it has very low tensile strength and low strain capacity at fractures. These shortcomings of plain concrete are overcome by adding reinforcing bars or prestressing steel. The main drawback of the reinforcing steel is corrosion due to the ingress of chloride ions in the concrete. This problem becomes severe in coastal areas. Corrosion of steel bars forms rust with time. This rust is bigger in volume than iron which results in expansion. This expansion exerts large tensile stresses on concrete leading to the formation of cracks and thus propagation of these cracks leads to the spalling of concrete. To overcome this shortcoming, fibers are incorporated in cement concrete. There are different types of fibers available but here steel fibers are used because of their high tensile strength, ductility, ability to arrest propagation of cracks, improved bond strength, etc.

Extensive research has been done on SFRC using fly ash and silica fume as cement replacement but very little research has been conducted on SFRC using Fly ash. The present experimental work is mainly done to investigate the different strengths of SFRC using Fly ash as cement replacement. Silica fume and fly ash are the by-products and so has the uncontrolled engineering properties which sometimes don't give the required results. Instead, Fly ash is the manufactured product, produced by calsining fly ash at a temperature of 700 – 800^0c. Thus its controlled engineering properties yield good results regarding workability and durability of concrete. Silica fume or fly ash when blended with cement darkens the colour of concrete but Fly ash being white in colour doesn't alter the colour of concrete, thus enhancing aesthetic look.

1.1 Objectives:

The objective of this study is to investigate the behavior of Steel Fiber Reinforced Fly ash Concrete (SFRFAC) composite with various volume fractions and to investigate the following properties:

1. Compressive strength, flexural strength and indirect tensile strength for different volume of fly ash and silica fume.
2. To investigate the properties of fresh concrete such as workability and density.
3. To investigate optimum dose of fly ash and silica fume.
4. To study the different properties of concrete casted with optimum dose of fly ash determined in the last tests and different volume of steel fibers.
5. To investigate the optimum dose of steel fibers for the optimum dose of fly ash.
6. Finally, for the optimum dose of steel fibers and the optimum dose of fly ash use to studay the effect for shear, moment and torsion in beam.

2. LITRATURE SURVEY

1 Mohammadi, Singh and Kaushik, studied properties of plain concrete and steel fiber reinforced concrete (SFRC) containing fibers of mixed aspect ratio. An experimental programme was planned in which various tests such as inverted cone time; Vee bee time and compaction Factor were conducted to investigate the properties of plain concrete and fiber reinforced concrete in the fresh state. Compressive strength, split tensile and static flexural strength tests were conducted to investigate the properties of concrete in the hardened state. The specimen incorporated three different volume fractions, i.e., 1.0%, 1.5% and 2.0% of corrugated steel fibers and each volume fraction incorporated mixed steel fibers of size 0.6 · 2.0 · 25 mm and 0.6 · 2.0 · 50 mm in different proportions by weight. Complete load deflection curves under static flexural loads were obtained and the flexural toughness indices were obtained by ASTM C-1018 as well as JCI method. A fiber combination of 65% 50 mm + 35% 25 mm long fibers can be adjudged as the most appropriate combination to be employed in SFRC for compressive strength, split tensile strength and flexural strength. They found better workability as the percentage of shorter fibers increased in the concrete mix.

2 Pant Avinash S, Parekar Suresh R.The results of six bending, shear and torsion tests on steel fiber reinforced rectangular concrete beams without web reinforcement are presented and discussed. The variable parameter is longitudinal steel at bottom only. The top reinforcement, aspect ratio and volume fraction of steel fibers kept constant for all the beams. From the tests conducted, it was found that the torsional strength is independent of longitudinal reinforcement. The experimental results were compared with the modes of failure proposed by Mansur and Mansur and Paramasivam under combined bending, shear and torsion for SFRC beams and Dr. V. Ramakrishna and Vijayarangan for beams without web reinforcement under combined torsion and bending. It is shown that experimental results compare favorably with the theoretical predictions.

3. **Mansur and Mansur and Paramasivam,** Based on the test results some of the researchers proposed empirical equations and also developed analytical models for the torsional strength of fiber reinforced concrete beams in pure torsion. Very little research work was reported on plain concrete rectangular beams and rectangular beams without web reinforcement under bending, shear and torsion. Many researchers carried out tests on reinforced concrete beams with longitudinal reinforcement and web reinforcement under bending, shear and torsion and proposed modes of failure and some empirical formulae. Comparatively fewer attempts were carried out on fiber reinforced concrete beams in bending, shear and torsion. Mansur [11] and Mansur and Paramasivam [12] carried out the tests on steel fiber reinforced concrete beams (without

longitudinal and web reinforcement) in combined bending and torsion and in combined bending, shear and torsion respectively. They proposed two modes of failure as Mode 1 and Mode 2. They proposed two equations to predict the torsional strength of steel fiber reinforced concrete beams.

4 Singh and Kaushik

studied the fatigue strength of steel fiber reinforced concrete (SFRC). An experimental programme was conducted to obtain the fatigue-lives of SFRC at various stress levels and stress ratios. Sixty seven SFRC beam specimens of size 500× 100 × 100 mm were tested under four-point flexural fatigue loading. Fifty four static flexural tests were also conducted to determine the static flexural strength of SFRC prior to fatigue testing. The specimens were incorporated with 1.5% volume fraction of corrugated steel fibers. The results indicated that the statistical distribution of equivalent fatigue-life of SFRC was in agreement with the two-parameter Weibull distribution. They determined coefficients of the fatigue equation corresponding to different survival probabilities to predict the flexural fatigue strength of SFRC for the desired level of survival probability.

5 Banthia and Sappakittipakorn, in the opinion of these two researchers, crimped steel fibers with large diameters are often used in concrete as reinforcement. Such large diameter fibers are inexpensive, disperse easily and do not unduly reduce the workability of concrete. However, due to their large diameters, such fibers also tend to be inefficient and the toughness of the resulting fiber reinforced concrete (FRC) tends to be low. Hence, an experimental program was carried out to investigate if the toughness of FRC with large diameter crimped fibers can be enhanced by hybridization with smaller diameter crimped fibers while maintaining workability, fiber dispersability and low cost. The results showed that such hybridization, replacing a portion of the large diameter crimped fibers with smaller diameter crimped fibers can significantly enhance toughness. The results also suggested that such hybrid FRC, fail to reach the toughness levels demonstrated by the smaller diameter fibers alone.

3. SELECTION OF INGREDIENTS AND MIX DESIGN

3.2.1 Cement:

Among the chemical constituents of cement, the most important ones are C_3A, C_3S and C_2S. The C_3A portion of cement hydrates more rapidly, thereby reducing the workability of fresh concrete. It also adsorbs the chemical admixtures quickly which leads to reduction in availability of those admixtures for comparatively slower setting components of cement viz., C_2S and C_3S. This further affects the workability of fresh concrete and also its rate of retention of workability.

Regarding particle size distribution, it may be noted that finer particles hydrate faster than coarser particles and hence contribute more to early age strength concrete; however, at the same time, the faster the rate of hydration may lead to quicker loss of workability due to rapid and large release of heat of hydration. However, with reference to, the standard FAC test methods for properties of cement such as standard consistency, setting times, heat of hydration, etc., have to be modified as FAC mix contains mineral and chemical admixtures, which affect these properties significantly.

3.2.2 Fine Aggregate (Sand):

River sand is used as a fine aggregate. Among various characteristics the most important one for FAC is its grading. Coarser sand may be preferred as finer sand increases the water demand of concrete and very fine sand may not be essential in FAC as it usually has larger content of fine particles in the form of cement and mineral admixtures such as fly ash, silica fume etc. Also the water demand because of addition of fiber. The sand particles should also pack to give minimum void ratio, as the test result show that higher void content leads to requirement of more mixing water.

Properties such as void ratio, gradation, specific gravity and bulk density have to be assessed to design a dense FAC mix with optimum cement content and reduced mixing water.

4. EXPERIMENTAL PROGRAM

4.1 Aim of Experimental Work: The primary aim of this experimental program is to study the effect of silica fumes and fly ash content on the mechanical properties and non-mechanical properties of Steel fiber reinforced Concrete. Fly ash is used as mineral admixture and effect of different amount of Fly ash on the strength and durability related properties are studied. Also the effect of Fly ash on the workability characteristic of Steel fiber reinforced Concrete and its suitability for the construction industry is studied.

In this experimental program the strength parameters of concrete with varied doses of silica fumes, fly ash and steel fibers are studied. The concrete mix selected for this is M30.

4.2 Investigation of Concrete Properties:

Comparative study of effect of silica fumes and fly ash on Steel fiber reinforced concrete is done as far as following stated tests are concerned.

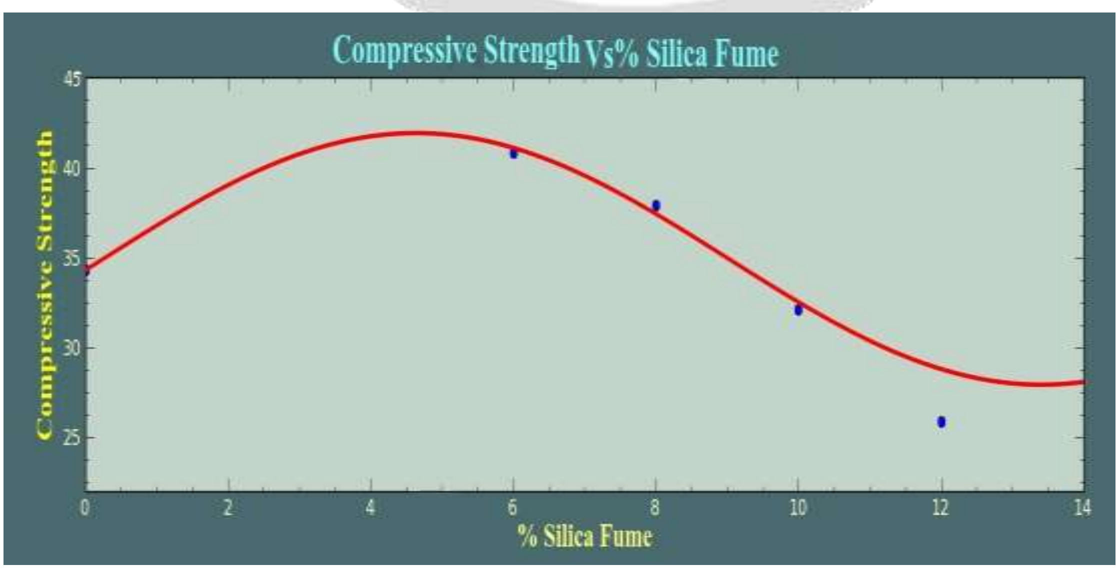
1) Workability (slump test).
2) Compressive strength test.
3) Flexural strength test.
4) Split tensile strength test.
5) Effective porosity test
6) Saturated water absorption test
7) Combine Effect of Shear and Torsion test on beam.

After performing all above test on FAC, following points are discussed.

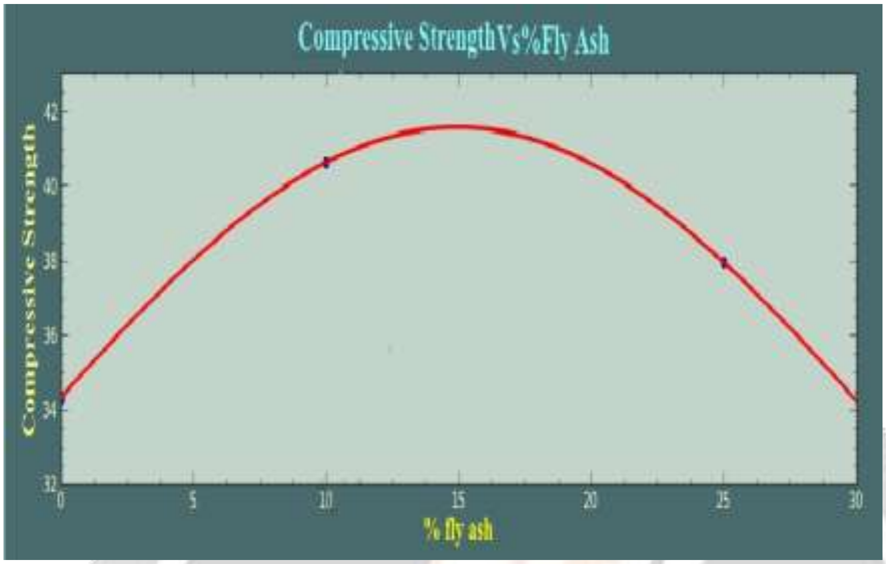
- Effect of fly ash on the above mentioned properties
- Effect of silica fumes on the behavior of concrete.
- Optimum dose of fly ash and silica fumes in concrete.
- For the optimum dose of fly ash and silica fumes finding out the optimum dose of steel fiber
- For the optimum dose of fly ash, silica fumes and steel fiber study the behavior of FAC beam under shear and torsion.

5 RESULT AND DISCUSSION.

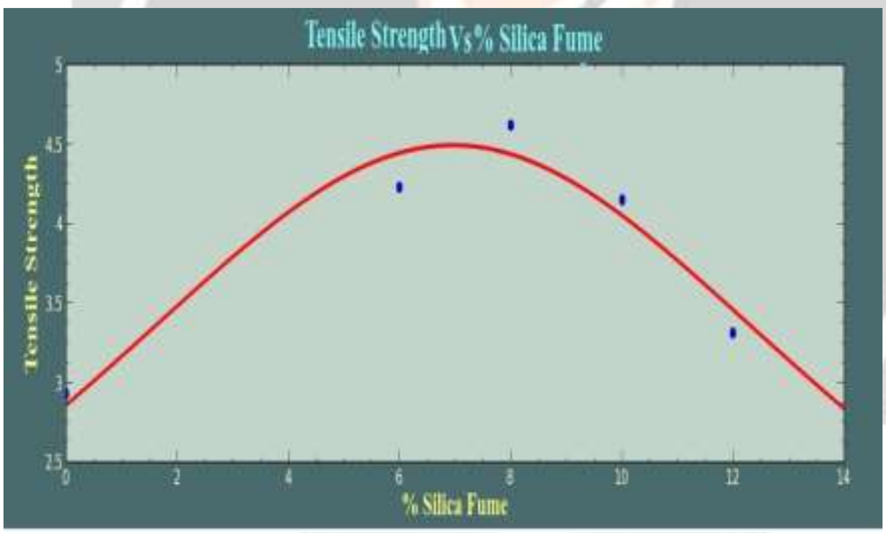
Compressive Strength Vs. %Silica Fume



Compressive Strength Vs % Fly Ash



Tensile Strength vs. % Silica Fume



6 Discussion:

1 Compressive Strength:

As expected the compressive strength increases with increase in content of fly ash. As the total water/binder ratio is kept constant, the variation of strength with respect to water/cement ratio remains open to discussion. The curve plotted denotes that the optimum dose of fly ash is 15 % for 41.58 MPa compressive strength.

Also the increase in silica fume content results in increase in the compressive strength up to meager extent. The optimized dose of silica fume found is 6 % of cement replacement for the compressive strength.

2 Split Tensile Strength:

The split tensile strength for w/c ratio of 0.3 to 0.4 varies from 12.8 to 18.3 % of its compressive strength. The higher tensile strength is due to reason that the full capacity of aggregate strength is utilized and also due the denser binding matrix forms by addition of fly ash. Addition of fly ash and silica fumes increases the split tensile strength of concrete. The experiments denote the sudden failure of material i.e. it didn't showed any hair crack propagation before failure.

6 CONCLUSION

1. The wet and dry density at 7 and 28 days has increased marginally for fly ash concrete over normal PCC. This may be due to partial cement replacement by fly ash, which dandifies the concrete because of its micro filler effect due to the relatively finer particle size.
2. The mechanical properties of concrete are enhanced with the addition of fly ash. All the properties of concrete like compressive strength, split tensile strength and flexural strength is increased. Also there is reduction in porosity as well as reduction in absorption capacity of the concrete as compared with normal concrete.
3. From the results and discussion it shows that for 15 % replacement of fly ash with 6 % addition of silica fume, concrete showing overall improvement.
4. In general, the significant improvement in various strengths is observed with the inclusion of Hooked end steel fibres in the plain concrete. However, maximum gain in strength of concrete is found to depend upon the amount of fibre content. The optimum fibre content to impart maximum gain in various strengths varies with type of the strengths.
5. Satisfactory workability is maintained with addition of fly ash and silica fume by using superplasticizers.
6. The optimum percentage fiber volume fraction for compressive strength, flexural strength and split tensile strength is upto 2.825%.
7. With increasing fiber content, mode of failure is changed from brittle to ductile failure when subjected to compression and bending.
8. The strength models developed for SFRC predicts the results of various strengths which are in good compliance with experimental results.
9. The properties like shear, torsion and bending is also improved due to addition of fibers in the concrete. This is obvious because the addition of fibers resists the development of internal micro crack in the concrete, which are responsible for the failure of the structure.
10. The optimum dose fiber for shear is 2.18 % and 4.07 % for with and without reinforcement respectively.
11. For torsional moment 2.21 % and 2.07 % volume fibers gives optimum strength. It concludes that the longitudinal reinforcement in the beams having less resistance in shear, torsion and moment.

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