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Steel and Glass Fibre Reinforced Concrete: A Review

Er. Lakshit Gupta[1], Er. Harpreet Singh[2]

[1]M. Tech, Dept of Civil Engineering, Chandigarh Univesity, Gharaun, Mohali, Punjab, India
[2]Assistant Professor, Dep. of Civil Engineering, Gharaun, Mohali, Punjab, India

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Abstract – *The paper identifies the problems faced in the applications of conventional concrete design and the possibilities to deal with it using steel and glass fiber reinforcement in the mix design. The replacement of cement by these fibers, in different ratios, has produced a more durable concrete which in application in most countries. The addition of these fibers into concrete can dramatically increase the compressive strength, tensile strength and split tensile strength of the concrete. Glass fibers have high tensile strength and fire-resistant properties thus reducing the loss of damage during fire accidents whereas steel fibers are used to prevent/control plastic and drying shrinkage in concrete and significantly increases its flexural toughness, the energy absorption capacity, ductile behavior prior to the ultimate failure, reduced cracking, and improved durability. Hence a review of these studies is done and conclusions are drawn.*

Key Words: **Steel, Glass, Fiber, Cement, Strength, Compressive, Durability.**

1. INTRODUCTION

Concrete is the most widely used man made material. Its applications in infrastructure development has provided the desirable properties like high compressive strength, durability and stiffness under usual as well as harsh environment conditions. It is obtained by mixing cementing materials, water and aggregates, and sometimes admixtures, in required proportions. The mixture when placed in forms and allowed to cure hardens into a rock-like mass known as concrete. One of the undesirable characteristics of the concrete as a brittle material is its low tensile strength, and strain capacity. Conventionally, this reinforcement is in the form of continuous steel bars placed in the concrete structure in the appropriate positions to withstand the imposed tensile and shear stresses. Fibers, on the other hand, are generally short, discontinuous, and randomly distributed throughout the concrete member to produce a composite construction material known as fiber reinforced concrete (FRC). Fiber-reinforced normal concrete is mostly used for on-ground floors and pavements, but can be considered for a wide range of construction parts (beams, pliers, foundations etc.) either alone or with handtied rebars. Concrete reinforced with fibers (which are usually steel or glass fibers) is less expensive than handtied rebar, while still increasing the tensile strength many times. Shape, dimension and length of fiber is important.

2. LITERATURE REVIEW

For the purpose and to defend the research work, a number of research papers are analyzed. Following are the excerpts from the different research work performed by number of academicians and researchers.

In his studies **Pammar P.R. et al.** observed that the specimens made with 0.525% and 0.3% steel and glass fibers gives the more strength compare to other mix proportion and from normal concrete. Increase in % of glass reduces the compressive strength. Workability of normal concrete is more compare to fiber reinforced concrete; it was observed that % of steel increase means there is reduced in workability. From acid test it was observed that the specimens exposed to acid shows lesser compressive strength compare to unexposed to acid. The specimens made with 0.525% and 0.3% steel and glass fiber shows the better compressive strength compare to other specimens. And loss of weight was more in increased percentages of glass fiber.

Prasad M.C. et al. in their studies found that the concrete mixed with dual fiber would also have much more life in comparison with the conventional concrete. The fibrous concrete is found to have maximum ultimate load carrying capacity as conventional concrete. The fibrous concrete is stiffer than the conventional concrete in appreciable way. For the nominal M25 mix with a water cement ratio of 0.5 used in the present investigation, the workability of concrete is only marginally affected even with a total fiber content of 1.0 percent by volume. The compressive strength of dual fiber concrete is found to be maximum at 1.0% total fiber content of steel at 28 days compared to plain concrete. There is substantial increase in the compressive strength for mixed fiber combination. As the percentage of steel fiber is reduced and glass fiber is increased, the compressive strength is getting reduced compared to that of 100% steel fiber in the matrix. Steel fiber of 1 mm diameter and length of 50 mm having an aspect ratio of 50 can be satisfactorily mixed along with glass fiber having an aspect ratio of nearly 800 to increase the strength and other characteristics. The split tensile strength of dual fiber concrete is found to be maximum at 1.0 % total steel fiber content at 28 days compared to plain cement concrete.

Patil T.R. and Burile A.N. in their studies concluded that the addition of steel fibers at 0.5 % by volume of concrete reduces the cracks under different loading conditions. The brittleness of concrete can also be improved by addition steel fibers than glass fibers. Since concrete is very weak in tension, the steel fibers are beneficial in axial-tension to increase tensile strength. Also, the ratio of compressive strength of cylinders to the compressive strength of cube was found to be nearly 3:4. Workability of concrete affected by addition of fibers. Addition of Steel fiber reduces workability of concrete in comparison to other fibers for different volume fraction. It was found that while using glass fiber in Split Tensile test the crack width goes on reducing with increasing of fiber dose.

While performing tests on the mechanical properties of concrete **Kene K.S. et al.** in their studies concluded that Max compressive strength for M20 grade of concrete was obtained by addition of 0.5%, 50 mm length, hook end steel fibers. Max split tensile strength for M20 grade of concrete was obtained by addition of 0.5%, 50 mm length, hook end steel fibers. They also said that the addition of steel fibers at 0.5 % by volume of concrete reduces the cracks under different loading conditions.

Using fibers, while experimenting on high end concrete **Ragi S** found that the increasing percentage of compressive strength of hooked end steel fiber reinforced concrete cubes when compared to the conventional concrete cubes at 28 days is 7.3%. And the increasing percentage of compressive strength of crimped steel fiber reinforced concrete cubes when compared to the conventional concrete cubes at 28 days is 6.08%. Also, the increasing percentage of split tensile strength of hooked end steel fiber reinforced concrete cylinders when compared to the conventional concrete cylinders at 28 days is 4.54%.

In their studies **Khan.Y et al**. found that the compressive strength of fibre reinforced concrete composite with various mix designation found higher as compared to normal conv'entional concrete for 7 and 28 days of curing and the split Tensile strength of fibre reinforced concrete composite with various mix designation showed higher strength as compared to normal conventional concrete. Also, The Compressive strength of fibre reinforced concrete composite for mix designation with (steel 2% & glass 2.5%) showed higher strength compared to other mix designation and conventional concrete.

Varma A.U and Kumar A.D found that the percentage increase of compressive strength of various grades of glass fibre concrete mixes compared with 28 days compressive strength is observed from 10 to 20%. A reduction in bleeding improves the surface integrity of concrete, improves its homogeneity and reduces the probability of cracks.

Kumar J.D. in their studies found that the addition of glass fibres at 0.5%, 1%, 2% and 3% of cement reduces the cracks under different loading conditions. It has been observed that the workability of concrete increases at 1% with the addition of glass fibre. The increase in compressive strength, flexural strength, split tensile strength for M-20 grade of concrete at 7 and 28 days are observed to be more at 1%. We can likewise utilize the waste product of glass as fibre.

3. CONCLUSIONS

From the studies carried out by various researchers and scholars, following conclusions can be drawn: -

a. The use of glass and steel fibres in replacing cement definitely increases the fundamental properties of concrete but could only be done up to a certain percentage after which the concrete starts to loose strength.

b. Use of fibres reduce workability of concrete and hence could only be used in little amount.

c. Improvement in the surface integrity and reduction in bleeding is observed in most of the cases when using fibre reinforced concrete.

d. The brittleness of concrete could be improved with addition steel fibres and not so much with glass fibres.

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