The Effect of Size of Fibres on Compressive Strength of M-20 Concrete Mix

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ABSTRACT

The present scenario highlights the depleting non renueable resources, followed by a drastic escalation in the cost of building materials. With the population explosion also the construction activity is in its boom, resulting in variety of buildings being constructed globally. As we all know concrete is one of the most important and versatile material playing an important role in the construction industry, being recognized world -wide. So an effort has been made in this research to make a concrete mix using, waste cycle spokes as reinforcement so as to make it easily available to the general public at a reduced cost for specified type of construction works, depending upon its strength requirement. Different type of concrete mix was proportioned with varying quantity of Ordinary Portland Cement and steel fibres and studied. The result depicted the variations in concrete strength with the gradual increase in the long steel fibres. The present research work highlights as to how the compressive strength of the concrete can be increased thus increasing its strength and durability.

***Keywords* -** Concrete, Steel Fibres, Cycle spokes, Strength, Steel Fibres Size, Durability, Economy

1. INTRODUCTION

Concrete is the most important construction material, which is manufactured at site. Concrete required for extensive construction activity can always be made available since all the ingredients of concrete are materials of geological origin. Various research and effort have been made to obtain a durable, strong and economical concrete mix.

Figure1.1 Bicycle Spokes

The investigation reported in present work was carried out to study the feasibility of using waste steel fibres in two different sizes viz. 30 mm and 50 mm in fibre reinforced concrete. Waste Spokes of bicycle (shown in Figure 1.1) are cut in particular sizes for using as steel fibre. A total of 99 numbers of concrete cube specimens were casted with and without fibres and were tested under compression as per relevant Indian standard specifications. Test result indicated that addition of steel fibres from lathe increased the strength and many other properties of concrete but only up to certain limit of percentage.

Figure 1.2 After Cutting

1.1 CONCRETE MIX DESIGN

The Concrete mix design can be defined as the art of obtaining a concrete of the required properties, at the lowest cost, by suitable choice and proportions, of available materials. Needless to say, a property designed concrete mix for the specified strength requirements should have the minimum cement content to make mix economical. It should, however, be stressed that the precise relationship falls between the properties of concrete and the specific characteristics such as water cement ratio, aggregate cement ratio and grading, apart from such elusive quantities as aggregate-particle shape and texture. Hence, concrete mix design cannot be mechanically done and is likely to remain an art, rather than a science, for some time to come. The purpose of concrete mix design is to ensure the most optimum properties of the constituent materials to meet the requirements of the structure being built. Mix design should ensure that the concrete: Complies with the specifications of structural strength laid down, which is usually stated in terms of the compressive strength of standard test specimens. Complies with the durability requirements to resist the environment in which the structure will serve its functional life. Be capable of being mixed, transported, and compacted as efficiently as possible without undue labour. And last, but not least, be as economical as possible. The design of concrete is science that can be described here only in its broad outlines. The starting point of any mix design is to establish the desired workability characteristics of wet concrete, the desire physical properties of the cured concrete and the acceptable cost of the concrete.

2. MATERIALS USED FOR MIX DESIGN

2.1 AGGREGATE

The aggregate is the matrix or principal structure consisting of relatively inert fine and coarse material. The aggregate for concrete varies in sizes, but in any mix the particles of different sizes are used. The particles size distribution is called the grading of the aggregate. While producing good quality concrete the aggregate is used at least from two size groups.

2.1.2 FINE AGGREGATE

IS:-383-1963 destines the fine aggregate as the aggregate which will pass through 4.75 mm IS sieve. The fine aggregate is often termed a sand size aggregate.

2.2.2 COARSE AGGREGATE

Coarse aggregate shall consist of crushed or broken stone and be hard, strong, dense, durable, clean or proper gradation and free from skin and coating likely to prevent proper adhesion of mortar. The aggregate shall generally be cubical in shape as far as possible flaky, elongated pieces shall be avoided. Unless special stone of particular quarries are mentioned in the special provisions, aggregate shall be broken from the best trap/granite/quartzite/geness stones in that order available in the region and approved by the Engineer.

The maximum size may be up to 80 mm and well graded between the size 5mm to 80mm in such proportion as to give maximum density to the concrete. The maximum size should be as large as possible within the above limit but should not exceed 1/4 of minimum thickness of the member provided. However, this size presents no difficulty in the case of R.C.C. to surround the reinforcement thoroughly and fill up the corners of the formwork satisfactorily.

In the case of general concrete work, maximum size of 40 mm is used and in R.C.C. work a maximum size of 20 mm (about 3/4) will be found satisfactory but it should be restricted to 6 mm (about 1/4) less than the minimum lateral cleat distance between bars or 6 mm (about11/4) less than the cover whichever is smaller. The crushing strength of aggregate will be such, as to allow the concrete in which it is used to build up the specified strength of concrete.

To know more about the concrete it is very essential that one should know about aggregate, which constitute major volume in concrete. For testing, the study of aggregates has been done under the following subheadings:

Size
Specific Gravity
Moisture Content
Sieve Analysis
Grading

2.2.3 SIZE

The largest maximum size of aggregate practicable to handle under a given set of condition should be used. Using the largest possible maximum size will result in:

Reduction of cement content
Reduction in water requirement
Reduction of drying shrinkage

However, the maximum size of aggregate that can be used in any given condition may be limited by the following condition:

Thickness of section
Spacing of reinforcement
Clear cover
Mixing, handling and placing techniques

Generally, the maximum size of aggregate should be as large as possible within limits specified, but in any case not greater than one-fourth of the minimum thickness of the member provided.

2.2.4 SPECIFIC GRAVITY

Specific gravity of aggregate is made use of, in design calculations of concrete mix. With the specific gravity of each constituent known, its weight can be converted into solid volume and hence a theoretical yield of concrete per unit volume can be calculated. Average specific gravity of the rock varies from 2.6 to 2.8.

2.2.5 MOISTURE CONTENT

Some of the aggregate are porous and absorptive. Porosity and absorption of aggregate will affect the water cement ratio and the workability of concrete and sometimes also affect the durability of concrete.

2.2.6 SIEVE ANALYSIS

Sieve analysis is the name to the operation of dividing a sample of aggregate into various fraction each consisting of particles of the same size. The sieve analysis is conducted to determine the particle size distribution in sample of aggregate, which is called gradation. In this connection a term known as “Fineness Modulus” is being used. The fineness modulus is a numerical index of fineness, giving some ideas of the mean size of the particles present in the entire body of the aggregate. Hard and bitter water containing more than p.p.m. of sulphates shall not be used for curing purpose. Probable water generally is found suitable for curing cement concrete.

Type of sand	Fineness Modulus
Fine sand	2.2 - 2.6
Medium sand	2.6 - 2.9
Coarse sand	2.9 - 3.2

2.2.7 GRADATION

The particle size distribution of an aggregate as determined by sieve analysis is termed as grading of aggregate. The grading of aggregate is expressed in terms of percentage by weight, retained on or passing through a series taken in order, 80mm, 40mm, 20mm, 10mm, 4.75mm, for coarse aggregate and 10mm, 4.75mm, 2.36mm, 1.18mm, 600 microns, 300microns, for fine aggregate. The grading of aggregate affects the workability, which in turn, controls the water and cement requirements, segregation and influences the placing and finishing of concrete. There is no universal ideal grading curve. However, IS:383-1970 has recommended certain limits within which the grading must lie to produce satisfactory concrete, subjected to the fulfillment of certain desirable properties of aggregate, such as shape, surface texture, type of aggregate and amount of flaky and elongated materials.

3. PROPERTIES OF FRESH CONCRETE

Fresh concrete is a mixed material, which can be, moulded into any shape. The relative quantities of cement, aggregate and water mixed together control the properties of concrete in the wet set state as well as in the dry state. It depends upon the water cement ratio and the workability of concrete.

3.1.1 Water for mixing cement concrete

Water for mixing cement concrete shall not be salty or brackish but shall be clean/reasonably clear, free from objectionable quantities of silt and traces of oil, acid and injurious alkali, salts, organic matter and other such materials which will either weaken the mortar or cement or cause efflorescence or attack steel in R.C.C. Water should be maintained in such a manner so as to exclude silt, mud, grass or other foreign materials. Containers for transport, storage and handling of water shall be clean. Water fit for drinking shall generally be found suitable for mixing cement/lime concrete or mortar.

3.1.2 Curing cement concrete

Water for curing mortar or concrete should not be too acidic or too alkaline. It shall be free of element, which significantly affect the hydration reaction or otherwise interfere with the hardening.

4. STEEL FIBRES FOR CONCRETE REINFORCEMENT

Steel fibers are made of cold drawn steel wire with low content of carbon (C) or stainless steel wire (SS 302/ SS 304). Steel fibers are manufactured in different types: hooked, undulated or flat, according to the construction project. These fibers are used in construction, for concrete reinforcement.

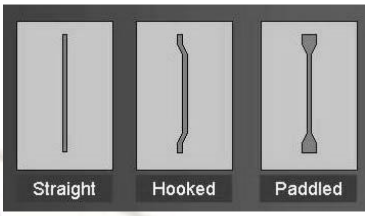

Figure 4.1.1 - Types of Steel Fibers

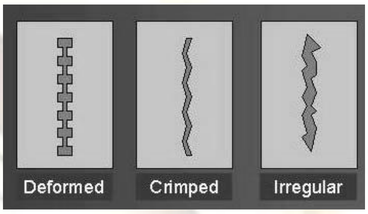

Figure 4.1.2 – Types of Steel Fibres

Fiber-reinforcement is mainly used in shotcrete, but can also be used in normal concrete fiber; Steel fibers reinforced concrete are less expensive than hand-tied rebar, while still increasing the tensile strength many times; Shape, dimension and length of fiber are important A normal size fibre is 30 to 60 mm. Steel fibers can only be used on surfaces that can tolerate or avoid corrosion and rust stains

4.2 SHAPES AND SIZES OF STEEL FIBRES

Figure 4.2[a]

Figure 4.2 [b]

Figure 4.2 [c]

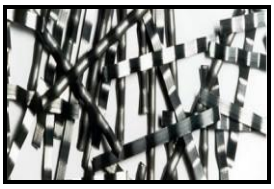

Figure 4.2 [d]

Steel Fibres are available in different shape and size. Figure 4.2 [a,b,c,d] shows different type of steel fibres.

5. LABORATORY TEST & OBSERVATIONS

The total 99 numbers of concrete cube specimens were casted with using waste steel fibres (bicycle Spokes). Cubes of without fibres and with fibres were tested under compression as per relevant Indian standard specifications Comparative Test results in figures were represented below:

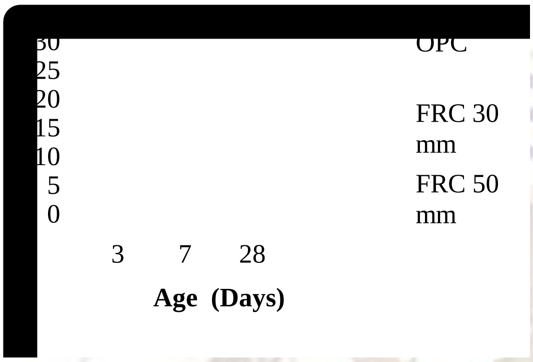

Figure- 5.1 Comparison of Average Comp. Strength of Concrete Mix [M-20] made by using OPC, and OPC with 5% Steel Fibres

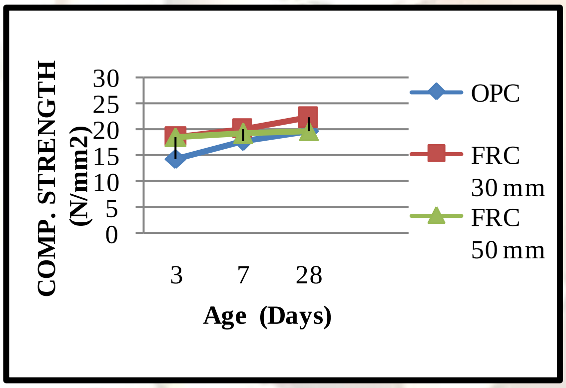

Figure- 5.2 Comparison of Average Comp. Strength of Concrete Mix [M-20] made by using OPC, and OPC with 10% Steel Fibres

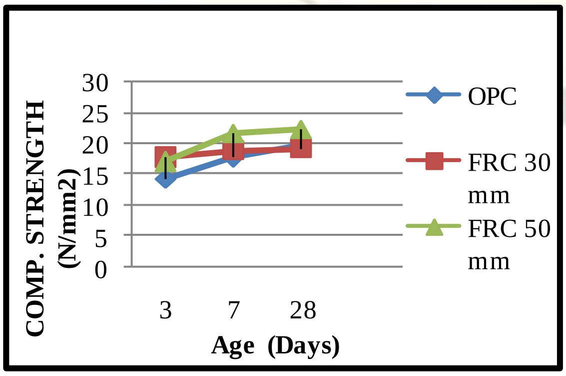

Figure- 5.3 Comparison of Average Comp. Strength of Concrete Mix [M-20] made by using OPC, and OPC with 15% Steel Fibres

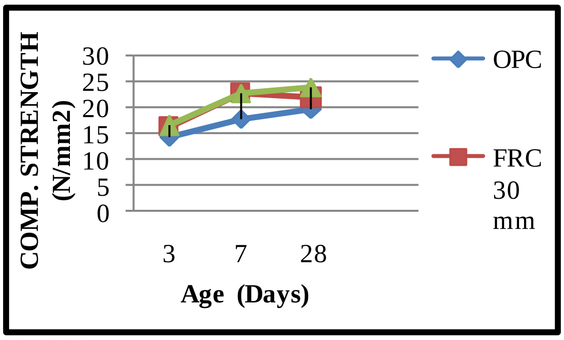

Figure- 5.4 Comparison of Average Comp. Strength of Concrete Mix [M-20] made by using OPC, and OPC with 20% Steel Fibres

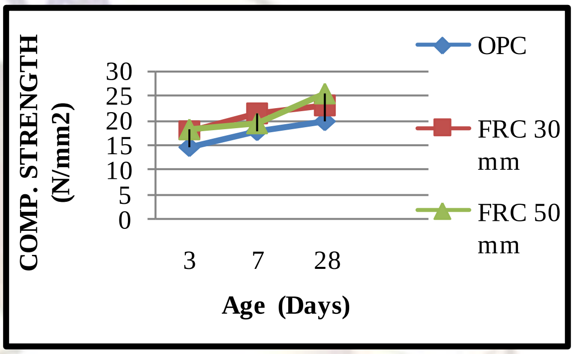

Figure- 5.5 Comparison of Average Comp. Strength of Concrete Mix [M-20] made by using OPC, and OPC with 25% Steel Fibres

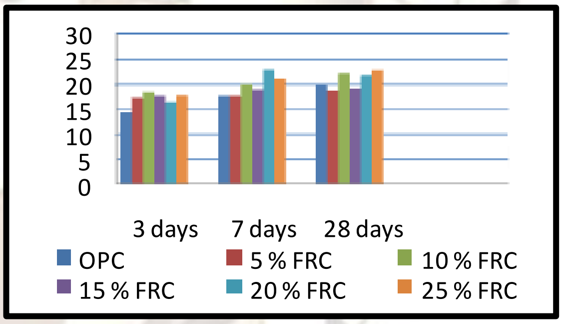

Figure- 5.6 (a) Comparison of Average Comp. Strength of Concrete Mix [M-20] made by using OPC, and 30 mm size Steel Fibres with different %

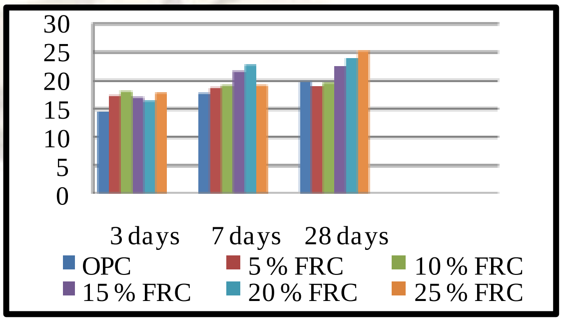

Figure- 5.6 (b) Comparison of Average Comp. Strength of Concrete Mix [M-20] made by using OPC, and 50 mm size Steel Fibres with different %

(a) (b)

Figure 5.7 – 30MM Fibres (a) & 50MM Fibres (b) used for Concrete Mix [M-20]

Figure 5.8 –Mixing of Fibres

Figure 5.9 –Cube Test of Fibres Mixed Concrete

6. CONCLUSIONS

The aim of Mix Design was to make a concrete of desirable strength, durability and economy. The present study reveled the effect of size of fibres on compressive strength of M-20 concrete mix design. The waste product "steel fiber from bicycle spokes" were mixed as ingredients of concrete and were studied in terms of strength of concrete and following results were obtained-Figure- 5.1 shows that when 5% of 30 mm & 50 mm long Steel Fibre by weight were allowed to mix with OPC for making concrete, its strength increased up to 7 days as compared to plain cement concrete and then strength decreased after 28 days curing.

When 10% of 30 mm & 50 mm long Steel Fibre by weight was allowed to mix on OPC for making concrete, its strength increased up to 7 days as compared to plain cement concrete but strength increased only in 30 mm long Fibre and strength decreased when 50 mm long Fibre were used for 28 days of curing represented by Figure- 5.2.

Figure- 5.3 shows that when 15% of 30 mm & 50 mm long Steel Fibre by weight was allowed to mix with OPC for making concrete, its strength increased up to 7 days as compared plain cement concrete and also strength increased after 28 days curing. When 20%, 25% of 30 mm long Steel Fibre by weight was allowed to mix in OPC for making concrete its strength increased for 7 days and 28 days as compared to plain cement concrete represented by Figures- 5.4 & 5.5.

When 15%, 20% & 25% of 50 mm long Steel Fibre by weight was allowed to mix with OPC for making concrete its strength also increased for 7 days and 28 days as compared to plain cement concrete.

Thus from above study it was concluded that the 28 days compressive strength of concrete mixed (M20), containing Steel Fibre in varying percentage of steel Fibre (viz. 5% & 10%) was slightly less than the strength of Plain Cement Concrete.

But it was possible to increase other properties of concrete like durability, cracking resistance, fire resistance property etc. The present study showed that compressive strength increased when we allow more than 10 % with size 30mm & 50mm long Steel Fibres were used.

The present study indicates that to increase compressive strength of concrete when the steel fiber from bicycle spokes were used. For making higher strength at nominal mix proportion by allowing 25%, 50 mm long Steel Fibre in Plain M-M-20 grade of concrete & save the cement quantity.

For different concrete structural works we hope that present study will act as guidance for the fiber use in concrete for strength, durability and economy.

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