STUDY OF MECHANICAL PROPERTIES OF HIGH STRENGTH CONCRETE BY USING STEEL FIBER – A REVIEW

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ABSTRACT
Concrete is the mostly used construction material in the world but there is a disadvantage of concrete that it is week in tension. This results to the brittleness of concrete. This property is not desirable for any kind of construction so there is requirement of tensile reinforce. in concrete in the previous time steel is used as tensile reinforcement in the tensile zone of concrete this steel is specifically designed but in case of fibres, fibres are short thin and uniformly or randomly distributing in the concrete steel fibres are basically defined as fibres that are short in length and having different cross sections according to the length and diameter (Aspect ratio) from 20 to 100 these are of small size due to which they can be easily distributed in the fresh controlled mix. this random distribution shows loss of efficiency but the addition of fibres in concrete shows improvement in toughness and tensile properties of concrete with the help of resistance to cracking, with the help of different researches it is found that there is improvement in the properties of concrete and further development of steel fibre reinforced concrete is going on since last three decades this paper presents review of mechanical property of steel fibre reinforced concrete its benefits and its uses.

Key words: concrete, brittleness, steel fibre, aspect ratio, SFRC.

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1. INTRODUCTION
One of the most undesirable properties of the concrete is its brittleness and it is basically due to its low tensile strength. Due to which it needs reinforcement in order to use it in a better way. Basically the reinforcement is the placing of continuous steel in the concrete in a defined position to withstand the tensile strength. But in case of fibres the fibres are discontinuous short in size and randomly distributed in the concrete and this constructed material is known as steel fibre reinforced concrete (SFRC). Fibres are having the property to control cracking due to the more closely spaced steel fibres then in case of
conventional reinforced steel bar there is different roles of steel bars and fibres in advanced concrete technologies and the different applications of both fibres and steel bars. According to the results of previous researchers steel fibre is found to be the most popular type of fibre with the reference of different researcher it is revealed, that there is increase in flexural strength, ductile property of concrete, reduction in cracking and other durability property of concrete. This paper presents the effect of steel fibres on the mechanical properties of concrete and application of steel fibres reinforced concrete.

Steel fibre in concrete is firstly suggested by the porter in 1910. The first scientific research on steel fibre was done in 1963 in United States. Steel fibres are of short lengths having aspect ratio from 20 to 100. (Ratio of length to diameter) with different cross sections. For the enhancement in workability super plasticizers can also be added.

Steel fibre reinforced concrete (SFRC) is basically divided into three groups according to its use, fibre volume, percentage, and fibre effectiveness in case of fibre volume percentage according to the previous researches less than 1% addition of steel fibre reinforced concrete is defines as very low volume fraction. 1 to 2% addition of SFRC is moderate volume fraction. This can improve impact resistance modulus of rupture, flexural strength and other mechanical aspects of concrete. More than 2% addition of steel fibre is high volume fraction and it is basically use for blast resistance structure. According to the previous researches steel fibre can be used along with the steel bars. And the addition of more than 2% steel fibre shows excellent mechanical properties and can be used for special applications of concrete due to its better properties then the conventional properties.

Different types of steel fibres according to their shape are as shown in fig. 1:

2. BENEFITS OF STEEL FIBRES

The addition of steel fibre in the concrete has following advantages:-

- Increase in tensile strength and flexural strength.
- Reduction in cracking due to the distribution of stress.
- High increase in ductility of concrete.
- Steel fibre reinforced concrete is having better properties than conventional reinforced concrete. All these benefits are due to the various factors such as shape, types, cross section, length, strength, fibre content, mix design, mixing of concrete.

The one and only disadvantage of steel fibre reinforced concrete is the reduction in workability. This problem can be overcome by the use of different super plasticizers which could helps in regaining the workability properties of concrete.

3. STEEL FIBRE REINFORCED CONCRETE APPLICATIONS

Due to the various applications of steel fibre reinforced concrete its use is increasing day by day. Some of the applications are:-

3.1. Highways

The use of steel fibre reinforced concrete in the construction and repair of highways is increasing due to higher flexural strength and impact resistance. With the help of steel fibre reinforced concrete there is increasing tensile capacity which helps in decreasing the crack width than the plain concrete.

3.2. Hydraulic Structures

The one of the most important benefits of using steel fibre reinforced concrete is the cavitations resistance due to the velocity of water as compare to normal reinforced concrete.
3.3. Tunnel Lining and Bridge Repairing
For the tunnel lining and bridge repairing fibre Shot-Crete is used which helps in preventing surface staining due to rusting of steel fibres. This method can also be used for the protection of steel structures.  

3.4. Refractory Concrete
This concrete is more durable than unreinforced concrete and it helps in increasing the life span of concrete due to the factors like crack control, enhancement in toughness and abrasion resistance.  

3.5. Precast Products
The precast products are manhole covers; machine bases concrete pipes and frames. With the use of steel fibre reinforced concrete in these precast products helps in flexural strength improvement and impact resistance.  

3.6. Structural Benefits
Some of the benefits of use of steel fibre in concrete are;  
- Increase in impact resistance as compare to conventional reinforced concrete. This helps in decreasing the damage to the structure.  
- Decrease in the crack width and crack growth as compare to conventional reinforced concrete.  
- Increase in the ductility of the concrete and finally improve the stability of structure under any conditions.  
- Increase in the shear strength which helps in decreasing the sudden failure of the structure.  

4. MECHANICAL PROPERTIES OF SFRC
According to the previous researches SFRC shows enhancement in the mechanical properties of the concrete. Firstly SFRC decreases the flexural cracking and enhance the cracking behavior of concrete. It shows better energy abortion capacity that is increase in toughness of the structure.

4.1. Compressive Strength
According to the previous studies it has been found that addition of maximum 1.5% of steel fibre shows increase in compressive strength upto 15% it also shows improvement spalling resistance, ductility and toughness. Effect of SF on compressive strength is shown in fig-2.  

4.2. Shear Strength
According to the previous studies it has been found that with the addition of steel fibre there is increase in the shear strength of concrete. The reinforced concrete containing 1% steel fibre shows increase in shear strength upto 170% as compare to the reinforced concrete without steel fibre. So, it is proved that the addition of steel fibre is helpful in enhancing the shear strength of concrete, and with the reference of previous researches it is found that the combination of steel fibre with different expect ratio is better in improving the mechanical properties of concrete.  

4.3. Tensile Strength
According to the previous studies it has been found that there is 40% improvement in the tensile strength of the concrete with the addition of 1.5% by volume of steel fibre. The steel fibres which are aligned in the tensile stress direction shows increase in the tensile strength of concrete upto 135% with the addition of 6% of steel fibre by wait of different steel fibre it is also concluded that if the distribution of fibres is less or more random then the increase in strength is smaller. The split tensile strength of steel fibre reinforced concrete similar results thus addition of fibres in concrete is better to enhance the tensile property of
concrete, but in comparison steel fibre shows more increase in the post cracking or toughness. Effect of SF on tensile strength is shown in fig-3.47-49

4.4. Impact Resistance
In case of impact resistance it has been found that it is 8 to 10 times higher than the plain concrete. According to the previous studies crimped steel fibre with the diameter of 0.50mm indicates improvement about 400% and increase in strength with the increase in steel fibre has also been found.47-49

4.5. Durability
The main factor which affects the durability of concrete structure is corrosion and the corrosion is due to the cracks in the concrete. It is found that a well compacted steel fibre reinforced concrete shows less corrosion then in case of conventional reinforced concrete. One of the researchers conducted an experimental research for the investigation of the corrosion due to the cracks steel fibre with the dimension of 60 mm length and 0.8mm diameter were prepared. After that the specimen with cracks were exposed to the environment for one year. After one year load deflection graphs were plotted and it is computed that the crack of 2 to 3mm exhibited corrosion and no corrosion was in the case of 0.1mm cracks. It is also found that there is no concrete bursting was found due to the corrosion of fibres. Durability of concrete can also be observed by the measurement of electrical resistivity due to the conductivity of the steel fibre. it is found that with 1% addition of steel fibre concrete electrical resistivity is found to be 20kΩ-cm.10,12,13,16,32,44,50-55

4.6. Flexural Strength and Toughness
According to the previous researchers it has been found that with the addition of steel fibre in the concrete the flexural strength shows improvement more than its affect on direct tension and direct compression. It is found that there is 55% increase in flexural strength with the addition of 2% of steel fibre. One of the researchers done an experimental research on twelve different steel fibre reinforced concrete specimen and concluded that there is maximum improvement in the flexural strength in case of less dosage of steel fibre. Effect of SF on flexural strength is shown in fig-4.55-60

5. CONCLUSION
This paper presents review of the mechanical properties of SFRC its benefits and its uses on the basis of previous researches. Steel fibre reinforced concrete is basically defined as a composite material which consist of steel fibre of specific characteristics like random distribution and specific size and volume as compare to the conventional reinforced steel bars the steel fibre are thin, short and randomly distributed in the concrete. The steel fibre is the most popularly used fibre then the other type of fibre due to its better properties the use of steel fibre reinforced concrete shows improvement in flexural strength and other mechanical properties of concrete as compare to the conventional reinforced concrete.
6. FIGURES

Figure 1 Shows different type of fibres according to their shape. \(^{61}\)

- Hooked
- Crimped
- Deformed end (usually coned)
- Deformed wire (usually flattened)

Figure 2 Shows effect of steel fibre on compressive strength. \(^{62}\)
Figure 3 Shows effect of steel fibre on tensile strength.62

Figure 4 Shows effect of steel fibre on flexural strength.62

REFERENCES
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