Investigation the effect of percent and ratio of length to diameter (l/d) in steel fiber on the tensile strength of fiber concrete

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Abstract: Imagine of isotopic and homogeneity of the concrete section will not be very accurate for fixing the fault of reinforcing steel which is brittle. In order to create conditions for a weakness isotopic and reduces the brittle concrete object is relatively long and thin fibers that are dispersed throughout the volume of mixed concrete is homogeneous and can be used. Concrete is a concrete fibrous making use of fiber cement, water, aggregate and additives mixed with fiber. Increased fiber coherence, reduce cracking and increase the softness of concrete is concrete that is leading to changes in the mechanical properties of concrete. This paper is the result of laboratory research on the effects of the length to diameter ratio of steel fiber concrete tensile strength of the fiber is analyzed.

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Key words: Fibrous concrete, steel fiber, tensile strength, Ratio of length to diameter of the fibers

1. Introduction

Implementation of a project using appropriate materials and cost are the main factors considered resistant. One of the cheapest and most widely used materials in the world of concrete. The main advantages of concrete can be used in most geographic regions, using natural materials and its construction cost, relatively low cost compared to high volume operations, shaping it according to geometric designs, the possibility of mechanizing the operation does not require costly maintenance building during life operation. [1] Because of its tenderness naked except for the concrete application of the weighting factors are not applied in practice. [2] The major disadvantage of reinforced concrete, it actually goes through with reinforcement steel bars. But since it is only a small part of the section comprises reinforcing the notion that a concrete cross sections and isotopic homogeneity is not very accurate. In order to create conditions for a weakness isotopic and reduces the brittle concrete object as much as possible the last few decades, relatively long, thin fibers that are scattered throughout the volume of concrete is a homogeneous and mixed will be used. [3] To the problem of concrete, a brittle material with low tensile strength and resolve will be concrete crack control. [4] In recent years a new generation of fiber-ductile concrete entitled "Engineering of composite materials based on cementations' materials has been developed by Mr. Li. [5]

Fibers increases the cohesion, tensile strength, reduce cracks in concrete and concrete plasticity is increased. Fibers in concrete gel are a gel fiber for concrete, polypropylene fiber used in order to create the gel used in concrete [6] [7]. Conventional concrete is a relatively brittle material, such as concrete fibers have high strength and has the property to prevent cracking; it is compared to conventional concrete. [8] Positive effects of the use of steel fibers in concrete include increased flexural strength, shear strength, tensile strength, and increased resistance to shock loads, especially dynamic loads, increase the level of resistance against cracking, and increase in energy, a decrease in the rate of contraction, creep and wear of the surface. [9]

The use of natural fibers can also improve the mechanical properties of concrete. [10] Although fiber concrete has several advantages, it has specific concerns that are not yet fully resolved. [11] There is also the influence of steel fibers on the permeability of concrete has been done in the presence of fibers reduces the permeability of concrete. [12]

With synthetic fibers for concrete cracking can be controlled and long-term durability of concrete have. The use of fibers plays an important role in designing and manufacturing many different types of projects, including airports, tennis courts, swimming pools, warehouses and public schools played. [13]

The results of laboratory investigations at the University of Tabriz show that the effect of steel fibers in concrete is very impressive, and it's important to raise and tracheal lesions using steel as steel fibers is important not only from the increase in net concrete properties economically and to reduce environmental pollution but also a very positive effect on yield satisfactorily. According to statistics provided by an

expert Tabriz Machine Factory, 7-6 in just over an area of 400 × 500 square meters and a depth of 4 meters by these steel chips filled. [14]

Flexibility fiber concrete, plastic materials such as concrete, fiber failure can be sudden. Because of steel fibers in concrete is the three-dimensional object and the next few scattered other words, if a crack is usually expected deformation in different directions, the fibers create connections and prevents cracks from spreading. The fiber strands are actively involved in limiting the crack width and the formation of micro-cracks in the concrete operational capability much further cooperation and thereby increases [15]. The types of fibers used in concrete fibers can be plastic, glass, natural, polyethylene, asbestos, nylon and steel have been named in various shapes and sizes are produced. [16] The properties of the fibers are given in Table 1.

Table 1: Characteristics of fibers used in fiber concrete

Type of fiber	Specific Gravity	maximum elongation	Young's modulus	Tensile strength	Type of fiber
Asbestos	3.2 gr/cm3	% ~ 0.6	12-20×10-3 ksi	80-140 Ksi	Asbestos
Glass	2.5 gr/cm3	% 1.5-3.5	10×10-3 ksi	150-550 Ksi	Glass
Polyethylene	.95 gr/cm3[	%0~ 1	0.02-0.06×10-3 ksi	~ 100 Ksi	PE
Steel	7.8 gr/cm3	%0.5-35	29 ×10-3 ksi	40-400 Ksi	Steel

Steel fibers with different materials, in terms of tensile strength as well as simple right or hook to enhance adhesion to concrete stress - can be built [3]. Steel fibers having a high modulus of elasticity and strain at failure was due to the good formability and high tensile strength of the fibers is considered the best and most economical. [17] Types of steel fibers can be seen in Figure 1, and their characteristics are given in Table 2.

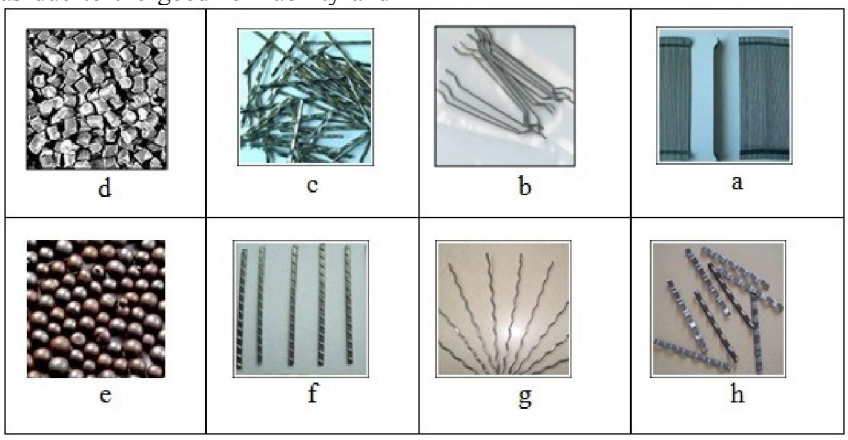


Figure 1: Types of steel fiber

Table 2: Types of steel fiber

Recommended Dosage	Discription	name	Row
$15-20kg/m^3$	After mixing glue dissolved in water, and be equally distributed.	Adhesive	a
$15-20kg/m^3$	ℓ/d Higher density phenomenon is caused	Single hook	b
$35-40kg/m^3$	With a high degree of dispersion, and can be easily combined.	corrugated	c
$20-30kg/m^3$	Shot is applicable to concrete.	Steel Shot	d-e
$30-40kg/m^3$	Used for asphalt concrete bridge deck.	Raging Belt	h
$20-25kg/m^3$	Has a high tensile strength.	Wavy tube	g
$20-25kg/m^3$	Such as cold rolled steel is produced.	Matches	f

The annular fibers which affected the fiber strength and the fiber tail, broad, wavy course and fine toothed sections with rectangular, triangular and circular fibers used in concrete. [22] Best design for

balancing fiber diameter, length, draft and maintain their shape, since these parameters affect the performance of the fiber. [14] The appropriate parameter that defines a set of fibers, the ratio of fiber length to diameter ratio is apparent fiber. Apparent ratio (ℓ / d) is usually among 30 to 150, with a length of 0.6 to 7.5 cm [23].

Overall quality of concrete fibers can mix proportions, geometric properties of steel fiber length to diameter ratio of mechanical containment and surface roughness of fibers [24], the steel fibers depends on their physical properties. [14] Other factors in fiber strength, fiber orientation angle is. [25] The elastic modulus of the fiber and the fiber strength is affected. [24]

A quick look at area landfills and adjacent roads in the industrial hub of the country, large size of these chips, the chips are made of steel shows how huge the country is on behalf of their rot and pollute the environment and due to the large size of land is occupied by games [26].

Background:

The first major attempt by the placement of concrete reinforced by steel fibers Ramualdi and Baston took place in the United States. After a lot of researches, the industrial applications on steel fiber done for reinforced concrete. [27] The use of fiber reinforced concrete began four decades ago. Fibers in concrete reduce the brittleness of concrete and provide ductile behavior instead. [8] Fibers may be of plant species, which are synthetic and metal mechanical properties of concrete under compressive loads, tensile, flexural, shear, dynamic and impact, and creep resistance to freezing, abrasion and erosion of a cohesive material improves the evoke [1].

In times past, the fibers were used to reinforce brittle mortar, the most famous and popular due to its cheapness and availability of straw is brick and mortar, bricks and thatch to enhance the coating against cracking after drying occurs and now also the cheapest type of mortar used in rural areas of the country. [28] The use of straw or horsehair or goat especially in old buildings throughout history is of particular domes insight and information about the properties of the fibers show fan owners. [12] And is currently the asbestos fiber (asbestos) for reinforced Portland cement is used. [28]

Joseph Lambot in 1847 suggested that adding continuous fiber concrete as a building material, new wire can be produced. [30] In 1911, a series of tests for strength of concrete with short fibers was conducted by Porter. Adding her stud to concrete, concrete to gain strength in tension and fragmentation is considered. [31] LA Qureshi et al. Properties of high strength concrete with steel fibers was investigated. The results showed that with the increase of steel fiber tensile strength linearly increases the speed increase is higher in the first 7 days [32].

MN Hadi, an experiment to compare the behavior of concrete slabs reinforced with steel fibers and polypropylene did. The results show that an increase of 1% by volume of steel fibers has the best effect on ductility signifiers. [33] Pour Moghaddam et al. in an article distribution and orientation of fibers in steel fiber reinforced concrete subjected respectively. [34] Vazife khah et al. in a paper tensile strength of concrete with steel fibers was subjected. [35] Sandesh D. Deshmukh et al. carried out Experimental study on properties of concrete with synthetic fibers and steel fibers made from rice husk ash, which results in greater improvement in concrete properties were reported. [36]

The use of steel fibers in the middle of the last century and was the exact date is not available using this method. However, different people using different methods such as the use of wire or cut pieces of metal inside the concrete, points to his name this type of filing. [29] Extensive use of concrete with steel fibers from the mid-1960s for road pavements, industrial floors, wall ovens, etc. has been done. [2] The experience gained from fibrous concrete using steel fiber, ordinary portland cement, aggregates, mainly in the United States. Only the application of fiber concrete spillway dam in Iran Amir Kabir is limited only by the foreign companies have been implemented. [37] Saeed Ahmed and colleagues in a paper consisting of polypropylene fibers on compressive strength, tensile cracking, shrinkage, etc., were examined and did not observe any change in compressive strength [7].

Experimental Program

The sand used in making concrete, sand, fibers with a maximum diameter of 5.9 millimeters. Sand and ordinary Portland cement was also kind. The amount of aggregate, cement and water to prepare various samples are given in Table 3. Specific gravity of sand and gravel in 1510 was 1430 kilograms per cubic meter.

Table 3: Value of fiber cement materials and water samples

Water-cement ratio	gravel kg/m^3	Sand kg/m^3	Cement kg/m^3	Type of sample
0.4	858	906	350	Stretching
0.4	715	1057	350	Cleavage

First concrete for sand and cement according to the respective proportions were weighed and then mixed together and then also with respect to the required fiber and weighing on aggregate and cement mixture was sprayed. After thorough mixing and re-mixing, water was added to the mixture and after stirring the mixture was poured onto water remaining and the mixture was stirred until the mixture is quite homogeneous in terms of moisture. In all cases the mixing process manually. Concrete vibrating table vibrating action of all samples was performed in parallel to produce a series of samples, 3 examples of pure concrete compressive cube molds of 15 cm were sampled to determine concrete strength due to changes in the aggregate.

Steel fibers used in this research is a set of redundant chip Steel the maximum diameter of 0.1 mm is equivalent to the fiber type and fiber length can be provided according to need. Since the diameter of the different fibers and is virtually inseparable. Therefore, as in the case of research and testing has been long but it is customizable. The compressive strength of net concrete is given in Table 4.

Table 4: Results of the compressive strength of concrete examples of pure

average compressive strength kg/cm^2	Compressive Strength kg/cm^2	Sample base
0.361	5.384, 3.344, 3.354	Stretching
8.434	7.448, 6.420, 1.435	Cleavage

Survey results:

One of the most important roles of steel fibers in concrete is the tensile strength of concrete by reducing the creation of micro-cracks resulting from external loading which is significant. [38] [39] if you use a fiber tensile strength concrete after cracking increases with an increase, but this increase cannot be compared with ordinary reinforcement. [40]

Two methods were tested to determine tensile strength fibrous concrete. The first method is a direct method of determining the tensile strength fiber concrete specimens were used. In the second method, using the indirect tensile strength of cylindrical samples (splitting test) was performed.

Tests to determine the tensile strength of concrete fibers directly

The cantilever test specimen cross section 5 × 5 cm was directly under tension. To determine the tensile strength fiber concrete fiber, respectively, zero, 1, 2 and 4%, respectively the fiber content of 1% is equivalent to 25 kg of fibers per cubic meter of concrete. Ratio $\ell/d = 35$ for all samples was the same. The test specimens were designed so that the jaws of certain the samples used in the two jaws, the 6-ton capacity puller accurately measured at 20 kg, were tested. In the tensile test the direct approach, pure concrete examples as cracking, from left, were two pieces. While fiber samples after cracking, in addition to the typical lack of detachment from the left, then had the ability to absorb energy, so that is able to withstand 50 to 70% of the failure force after cracking.

In Figure 1, the growth medium tensile kg/cm^2 steel fiber concrete in terms of the percentage of the volume of concrete based on fiber directly test tensile strength concrete can be observed.

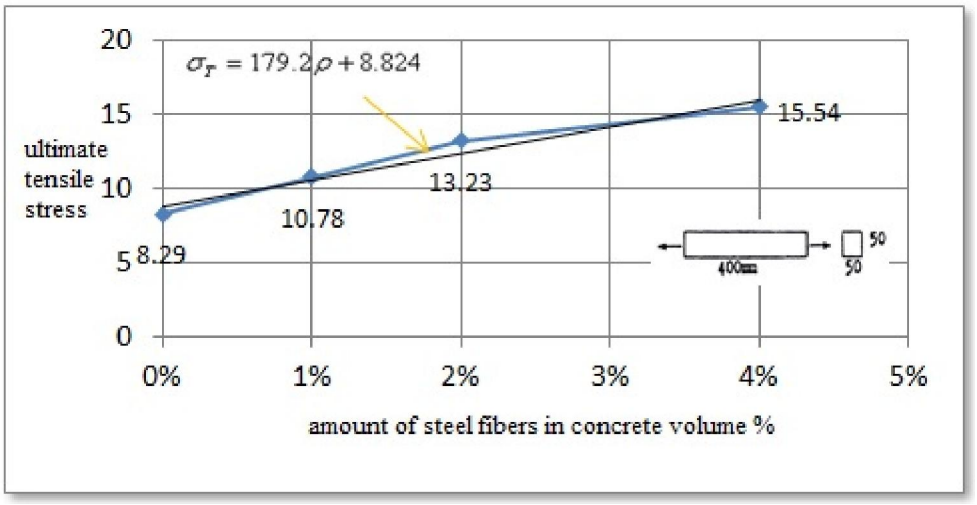


Figure 1: The ultimate tensile strength of steel fiber

Test for splitting tensile strength of concrete fibers

In this method, the sample used in standard drums was $\phi 152 \times 305\,mm$. Percentage of fibers used in these experiments was 0%, 2%, 4%, 6% and the number of samples per cent were considered. The fiber content of 1% is equivalent to 25 kg of fibers per cubic meter of concrete. Ratio $\ell/d = 35$ for all samples was the same. Splitting of the concrete samples was pressure tested in accordance with ASTM C-496, which is, cleavage experiments were performed to determine the indirect tensile strength. Concrete splitting tensile stress due is calculated from equation 1 [41], where:

σ_{sp} : Concrete splitting tensile stress by kg/cm^2

P : Maximum failure force by *kg*

L : The length of the cylindrical sample by *cm*

D : Diameter cylindrical samples by *cm*

(1) $\sigma_{SP} = \dfrac{2P}{\pi.L.D}$

In Figure 2, the growth medium tensile steel fiber concrete in terms of kg/cm^2 the percentage of concrete volume determined by the method of splitting tensile strength of concrete fibers can be observed. In Figure 3, the ratio of tensile strength to concrete and concrete fiber net with both experiments is shown. In this method, the sample used in standard drums was $\phi 152 \times 305mm$. Percentages of fibers used in these experiments were 0%, 2%, 4%, 6% and the number of samples per cent were considered.

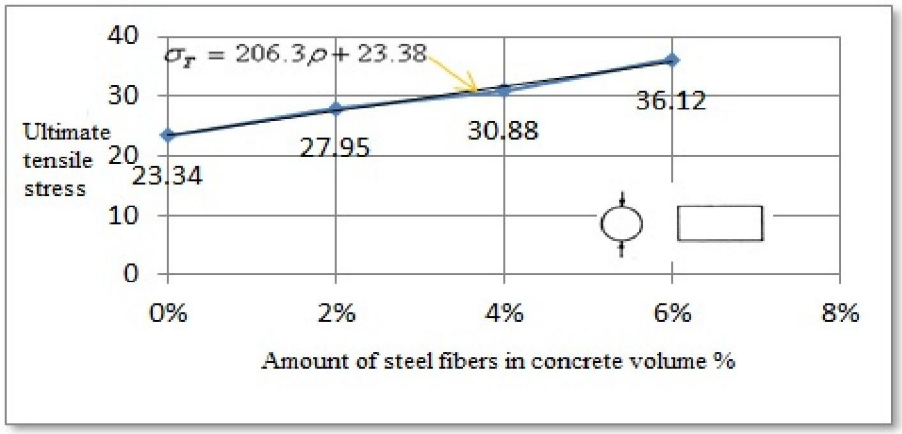


Figure 2: Ultimate tensile strength of steel fiber

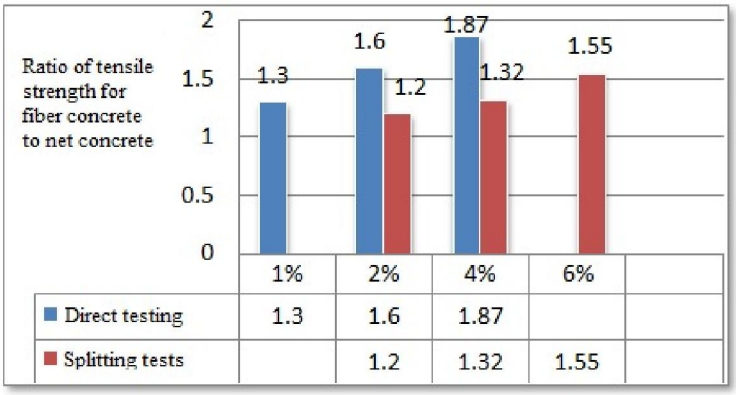


Figure 3: The ratio of tensile strength concrete, concrete fiber net two methods

In Figure 4 Splitting tests using fiber concrete examples $\phi 150 \times 305\,mm$ are given. The plot of the apparent fiber ℓ/d splitting the resistance according to kg/cm^2 the value of 80 and 120 kg/cm^3 concrete observed. In Figure 5, the ratio of splitting strength of concrete, concrete fiber net concrete and fibers for fiber 80 and 120 kg per cubic meter of concrete in front of the descent of the fibers are apparent.

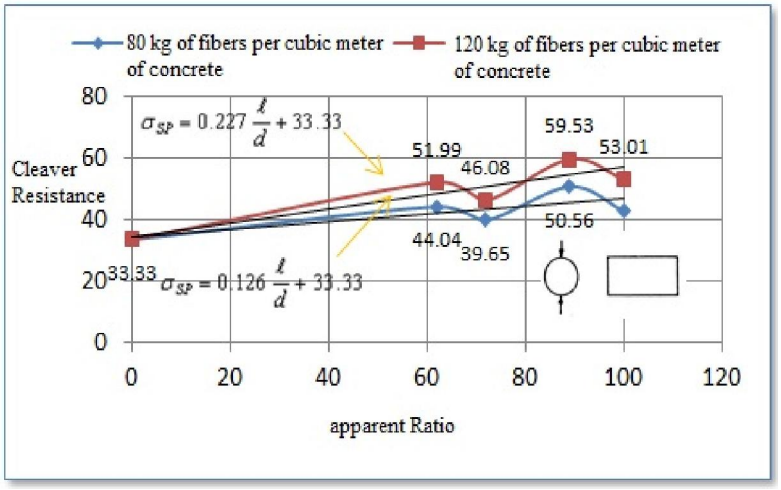
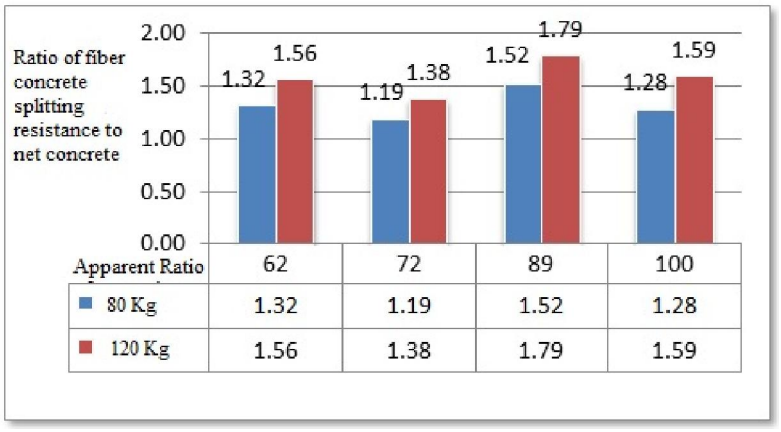


Figure 4: Results of splitting of concrete fibers



Apparent Ratio	62	72	89	100
80 Kg	1.32	1.19	1.52	1.28
120 Kg	1.56	1.38	1.79	1.59

Figure 5: Proportion of fiber concrete splitting strength to net concrete

Conclusion:

If a very small percentage of steel fibers in concrete are used, the effect of fiber on the current level or the strength of fibrous concrete cracks will be too small. An important point worth noting is that the splitting test, ductility capacity after the failure is Samples. The effect of plasticity of concrete and fiber fineness due to the influence of steel fibers in concrete objects, so the specimen after failure without the two halves of the cylinder, bearing the cross section of the cylinder so that, under the modified oval shape and the sample split is affected. According to Figure 5 shows the results of experiments conducted steel fiber tensile strength and impact resistance is quite useful and effective steel fibers can be lower than tensile steel in concrete sections.

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