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Behavior of Concrete using Steel Fiber as a Tensile Material

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Abstract:
Concrete is widely used in all over the world. It gives a compression strength and when it is collaborate with the steel the tension strength is increased. Traditional reinforcement will takes time. So by using the steel fibers in the concrete it will gives the high strength and durability. The fiber will leads to compensate the weakness in the concrete. Steel fiber reinforced concrete (SFRC) is successfully used in the slabs, flooring, and even in beams. The formation has proved the high tensile strength when it added in the concrete. The Mix proportion followed in these is M20 and M30 mixes. By using steel fibers, concrete is cast at a rate of 0 per cent, 0.25 per cent, 0.50 per cent, 0.75 per cent and 1 per cent of the steel fibers applied. The important purpose is to provide high tensile strength and flexural strength.

Keywords: *Tensile material, Steel Fiber, Durability.*

1. Introduction:

Concrete is a construction substance composed of cement, gravel or crushed stone (coarse aggregate) and sand (fine aggregate). Concrete is strong in compression and poor in strain. Commonly said, concrete is breakable in nature. Durability is for the most part influenced because of cracks created by creep and shrinkage. So to compensate the formation of the weakness the steel fiber is added inside the concrete which offers the high tensile strength. Steel fiber reinforcement has the capacity to resist the tensile strength, fatigue resistance, ductility, crack arrest and shock resistance. Its advantages is in addition of higher compressive strength in concrete. The volume fraction is calculated 1% to 2% typically by the volume of concrete.

2. Steel fiber:

Steel fiber concrete was introduced in the year 20th century. People will heard about rebar and steel mesh, but people should also know about steel fiber is just as strong and reliable. Take random concrete structure. When subjected to loading, compressive and tensile stresses begin to build over time. There will be slight gaps in areas where tension hits a critical point. Steel fiber collaborates inside the concrete matrix. Absorbing tensile stresses anytime and toward any path therefore. Steel fiber gets little cracks a lot quicker than traditional reinforcement. At the point when the break happens, the hooked ends of the fibers remain solidly anchored on each side of the split, going about as a stress move media. The pull-out takes full effect when the maximum bond strength is reached with the concrete. This permits the subsequent fiber takes over, delaying cracks from developing. Various burdens requires distinctive steel fibers.

2.1 Hooked end steel fiber:

There are numerous sorts of steel fibers utilized in the industry however in that we are utilizing hooked end steel fibers. Hooked end steel fibers has the ability to bear the flexural stress. There are 3 types of hooked ends in the field. Each fiber has the

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different hooks, strength, and ductility. They behave slightly different when dealing with stresses. Steel fiber picks up small cracks much faster than traditional reinforcement. The steel fiber reinforced concrete is refers back to the length 20 mm, 25 mm, 35 mm, 40 mm, diameter of 0.08 mm above the normal steel fibers.

They are

2.1.1 3D- Original Anchorage
2.1.2 4D- Optimized Anchorage
2.1.3 5D- Ultimate Anchorage

2.1.1 3D Dramix:

The cost efficient fiber for standard concrete structures that are submitted to regular load bearing and dynamic loading.

2.1.2 4D Dramix:

It provides optimal crack control to concrete structures with the high requirements of serviceability.

2.1.3 5D Dramix:

This fiber is the perfect solution for the structural applications which remains firmly inside the concrete as the wire slowly elongates to compensate stress.

3. Experimental Investigation:

3.1 Cement
3.2 Fine Aggregate
3.3 Coarse Aggregate
3.4 Water
3.5 Steel Fiber

3.1 Cement:

Cement is commonly used in Portland cement (OPC 53 grade). Essentially, cement is used as a binding medium. At the point when it is utilized in the concrete it invigorates the good strength.

The basic tests like Specific gravity, Fineness test (90%), Initial test (30 mins) and Final test (600 mins), and then Normal consistency test (24%) were used.

3.2 Fine aggregate:

Manufactured sand is used. Manufactured sand which passes through a sieve of 4,75 mm according to IS: 383-1970 Zone II is used as a fine aggregate. Initial tests, such as clear and specific Gravity and Sieve Analysis, are used to assess how they continue to be used in the field of construction.

3.3 Coarse aggregate:

Maximum size of 20 mm of crushed granite stone, which goes right through 4.75 mm of sieve, will be used as a coarse aggregate. As per IS 383-1978 the initial tests like Specific gravity and Sieve analysis are conducted. According to that test results only it will be used in the construction field.

3.4 Water:

Sea water is prohibited. So, as per IS: 456-2000, mixing and curing is done by portable water as per requirements.

3.5 Steel Fiber:

Steel fiber reinforced concrete is a modified type of concrete material mixed in concrete unevenly or disorderly distributed. There are various types of steel fibers used in the concrete, they are straight, crimped, paddled ends, ringed and hooked ends. Their diameter will be ranges from 0.25 mm to 0.75 mm. Steel fibers form the reinforcement network in the entire concrete structure, increasing its overall ductility.

Advantages of fiber reinforced concrete:

- ❖ Crack arrester
- ❖ Cost efficient
- ❖ Increases toughness and tension strength
- ❖ Resistance to impact

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4. Mix Proportion:

As per IS 10262: 2019

The mixing is done by using M20 & M30 grade of concrete.

Table 4.1

Volume of concrete	Cement	Fine aggregate	Coarse aggregate	w/c
By weight (kg/m^3)	383	572.1	1161.6	0.47
Ratio	1	1.5	3.03	0.47

Table 4.2

Volume of concrete	Cement	Fine aggregate	Coarse aggregate	w/c
By weight (kg/m^3)	400	622	1227	0.47
Ratio	1	1.55	3.06	0.47

5. Casting and testing:

Specimen casting and testing was done as per IS recommendations. Cubes, Prism and Cylinders was casted. The concrete mix adopted is M20 & M30 concrete. The mixing proportion is varies from 0%, 0.25%, 0.5%, 0.75% and 1%. Adding steel fibers in concrete will increases the strength. According to the limit the steel fibers will be added.

Directionally distributed SFRC is a fascinating structure composed of concrete and unidirectionally fixed steel fibres, and its load bearing capacity and failure patterns are substantially different from those of ordinary concrete and are unexpectedly surpassed by SFRC. Owing to the spatial conveyance of the steel fibers within the concrete, the stress characteristics of the concrete are anisotropic and additionally unpredictable than those of ordinary concrete or uniformly spaced SFRC, and the resulting analysis of techniques and structures and construction processes is unique.

6. Compression strength:

In the present investigation, the cubes were cast with reinforced steel fiber and checked. The dimensions of the cube are 150X150X150 mm agreeing to IS 456-2000. By casting the 10 nominal concrete cubes and by adding 0.25%, 0.5%, 0.75% and 1% of fibers in concrete the tests will be helded for M20 and M30 grades. To conduct the compressive test in the concrete two sets of ten cubes each in M20 and in M30 the cubes will be casted without adding the fibers. Then after the nominal mixes the fibers will be added by 0.25%, 0.5%, 0.75% and 1% in the concrete. At that point the cubes will be leave for the curing in the curing tank for 7 days and 28 days. After the curing period the tests will be directed by utilizing the compression testing machine.

Table 6.1: Compressive strength of M20 grade of concrete (nominal mix)

Days	Specimen No.	Load applied (kN)	Compressive Strength (N/mm^2)	Load applied (kN)	Compressive strength (N/mm^2)
7 days	1	366.6	16	475	17.83
	2	570	18.4	483.2	19.46
28 days	3	385	15	511.3	19
	4	400	17	520	20

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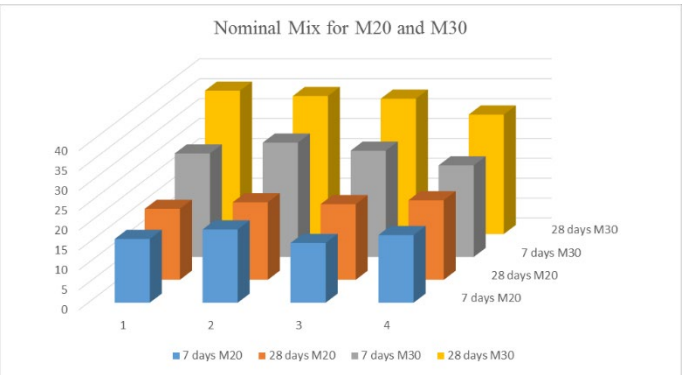
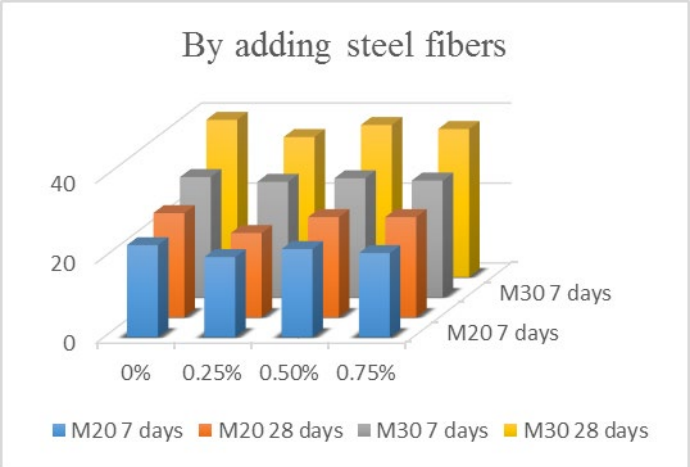


Table 6.2: Compressive strength of M30 grade of concrete (nominal mix)

Days	Specimen No.	Load applied (kN)	Compressive Strength (N/mm^2)	Load applied (kN)	Compressive strength (N/mm^2)
7 days	1	595	26	786	36
	2	541.12	28.8	694.2	34.67
28 days	3	470	26.7	546	34
	4	575	23	635	30

Table 6.3: Compressive strength of M20 and M30 grade of concrete (adding steel fibers)

Grade	Days of curing	Compressive strength (N/mm^2)			
Volume of steel fibers		0%	0.25%	0.5%	0.75%
M20	7 days	23	20	22	21
	28 days	26	21	25	25
M30	7 days	30	28.8	29.7	29.12
	28 days	39.3	35	38	37



7. Flexural strength:

Shear strength can be predicted utilizing prism in the laboratory of measurements 100X100X500. Plain cement concrete prism flops in flexure first at the same time, on the off chance that it is reasonably reinforced to care of that bending moment and flexure tension by giving steel (say 1% of cross segment) in the tension zone, than flexural strength is increments and subsequently the prism fails in shear. If stirrups or shear steel isn't given then the reinforcing bars are immaterial in taking dowel force (i.e. shear force). Hence shear strength of concrete can be predicted. Included steel fibers in concrete significantly builds the flexural strength, flexural strength and steel fiber substance to a limited degree, they are emphatically related. Tests indicated that after the concrete cracking, keep conveying its load is applied to the crack width increments, and when it arrives at the ultimate load, the crack width isn't expanded, gradually unload steel fiber reinforced, not like ordinary concrete as out of nowhere broken. By casting the 10 nominal concrete prism and by adding 0.25%, 0.5%, 0.75% and 1% of fibers in concrete the tests will be helded for M20 and M30 grades. Then after the nominal mixes the fibers will be added by 0.25%, 0.5%, 0.75% and 1% in the concrete. At that point the prism will be leave for the curing in the curing tank for 7 days and 28 days. After that the tests will be helded.

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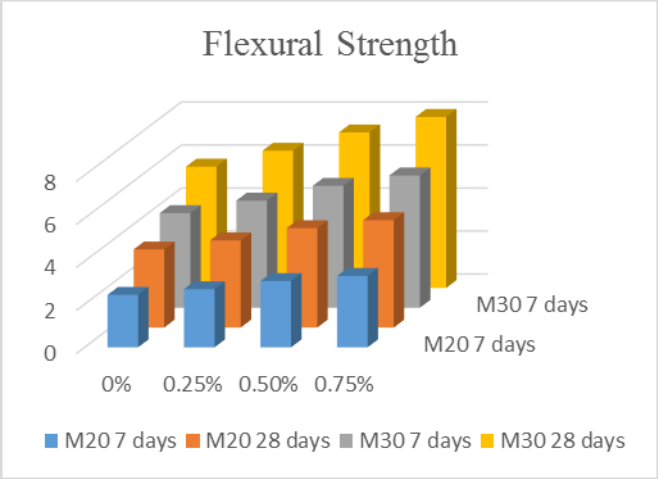
Table 7: Flexural strength of M20 and M30 grade of concrete (adding steel fibers)

Grade	Days Of curing	Flexural strength (N/mm²)			
Volume of steel fibers		0%	0.25%	0.5%	0.75%
M20	7 days	2.44	2.7	3.08	3.32
	28 days	3.63	4.05	4.62	4.99
M30	7 days	4.4	4.98	5.67	6.15
	28 days	5.64	6.38	7.23	7.95



8. Tensile strength:

The tensile strength is the essential properties of the concrete. Tensile strength is an enormous parameter in the study of the failure mechanism of the concrete and the important strength theory. In addition, tensile strength directly influences the rupture, distortion, and resilience of concrete structures. As far as tensile strength, steel fibers added to concrete splitting tensile strength is still evident reinforcing. Tests displayed that the splitting tensile strength of steel fiber reinforced concrete is higher than ordinary concrete and steel fiber content expansion, splitting tensile strength will be lengthened. By casting the 10 nominal concrete cylinders and by adding 0.25%, 0.5%, 0.75% and 1% of fibers in concrete the tests will be helded for M20 and M30 grades. To conduct the split tensile test in the concrete two sets of ten cylinders each in M20 and in M30 the cylinders will be casted without adding the fibers. Then after the nominal mixes the fibers will be added by 0.25%, 0.5%, 0.75% and 1% in the concrete. At that point the cylinders will be leave for the curing in the curing tank for 7 days and 28 days. After that the tests will be helded.

Table 8.1: Tensile strength of M20 grade of concrete (nominal mix)

Days	Specimen No.	Load applied (kN)	Split tensile Strength (N/mm²)	Load applied (kN)	Split tensile strength (N/mm²)
7 days	1	68.23	0.85	160.4	1.85
	2	110	1.4	170	2.08
28 days	3	140	1.93	190	2.48
	4	90	1.28	180	2.36

Table 8.2: Tensile strength of M30 grade of concrete (nominal mix)

Days	Specimen No.	Load applied (kN)	Split tensile Strength (N/mm²)	Load applied (kN)	Split tensile strength (N/mm²)
7 days	1	80.34	0.96	173	2.24
	2	100.3	1.45	196	2.44
28 days	3	125	1.41	200.32	2.97
	4	103.1	1.23	176	2.4

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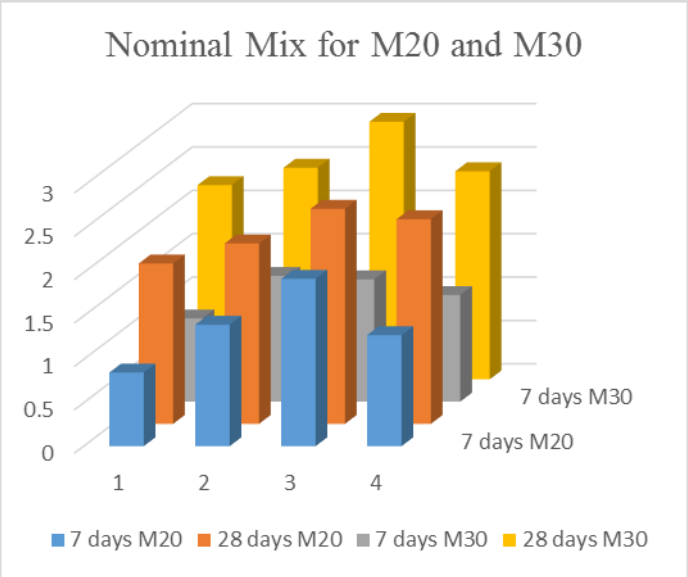
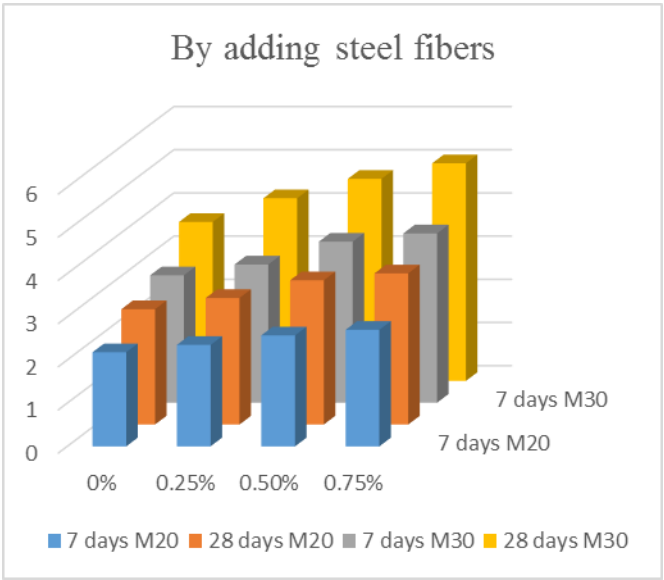


Table 8.3: Tensile strength of M20 and M30 grade of concrete (adding steel fibers)

Grade	Days of curing	Split tensile strength (N/mm^2)			
Volume of steel fibers		0%	0.25%	0.5%	0.75%
M20	7 days	2.18	2.35	2.57	2.7
	28 days	2.67	2.93	3.34	3.5
M30	7 days	2.95	3.2	3.73	3.92
	28 days	3.68	4.23	4.68	5.04



9. Result:

If the compression test, flexural strength, and tensile strength is satisfied that concrete is said to be the strong, durable, high strength, workability. Thus it functions the accurate results of the formation. It can define the usages of the concrete and its workability. The change of direct compressive strength for concrete cubes were seen as contradictory with the increase in level of strands. The splitting tensile strength was lengthened by 20-22% for concrete cylinder tests with 0.5% fiber content in M20 and M30 Grade concrete mixes.

Table 9

Specimen test	7 days	28 days
Compression test	17	25
Flexural test	2.68	3.68
Split tensile test	1.82	2.88

Conclusion:

Steel fiber concrete has many excellent properties, such as: crack resistance, toughness and resistance to bending forces, impact resistance, etc., but also drawbacks, steel fibers are too costly, steel fiber reinforced concrete costs Increase, economy. By using steel fiber it gives durability, workability, crack resistance and good flexural strength. The steel fibers are the most part utilized fiber for fiber reinforced concrete out of accessible fibers in the market. The compressive strength of concrete increases considerably as the amount of steel fibers increases from 0.5 per cent to 1 per cent. When we increase the volume of fibers the shear strength gets improved. Due to the excellent properties of fiber it can be used for important construction materials. Since the steel fiber is economic and having the good tensile strength.

REFERENCES

1. Avinash Joshi, Pradeep reddy ,Punith kumar and Pramod hatker, “Experimental Work On Steel

May-June 2020
ISSN: 0193-4120 Page No. 6665 - 6672

fiber Reinforced Concrete"- Proc IMechE Part L: J Materials: Design and Applications 233(9) 2018.

2. Y. Gündüz, E. Taşkan & Y. Şahin, "Using Hooked-end fibers On High Performance Steel fiber Reinforced Concrete" 2016-This paper is part of the Proceedings of the 2nd International Conference on 2nd High Performance and Optimum Design of Structures and Materials (HPSM 2016).
3. Faisal Fouad Wafa, "Properties and Applications of Fiber Reinforced Concrete"- Division, Technical Report No. 2-48, Ohio River, Cincinnati, Ohio (January, 1966).
4. Fangyuan Li , Yunxuan Cui, Chengyuan Cao and Peifeng Wu, "Experimental study of the tensile and flexural mechanical properties of directionally distributed steel fiber-reinforced concrete"-International Journal of Scientific & Engineering Research, Volume 7, Issue 10, October-2016 971 ISSN 2229-5518
5. Y. Gündüz, E. Taşkan & Y. Şahin, "Using Hooked-end fibers On High Performance Steel fiber Reinforced Concrete" 2016-This paper is part of the Proceedings of the 2nd International Conference on 2nd High Performance and Optimum Design of Structures and Materials (HPSM 2016).
6. Masoud Ahmadi, Ali Kheroddin, Ahmad Dalvand, "New Emperical Approach For Determining Nominal Shear Capacity Of Steel Fiber Reinforced Concrete Beams"-Construction and Building Materials,234 2020 117293.
7. TIAN SING NG BOSFA, "Steel fiber Concrete Pavements: Thinner And More Durable" 2018-Concrete in Australia Vol 44 No 1
8. Vakacharla Veera Mnikanta Srikar & G.Kalyan, International Journal Of Engineering Sciences & Research Technology- " Performance Of Concrete With Adding Of Steel Fibers" 2016
9. Vasudev R, Dr. B G Vishnuram, Studies on Steel fiber Reinforced Concrete – "A Sustainable Approach"-International Journal of Scientific & Engineering Research, Volume 4, Issue 5, May-2013 1941 ISSN 2229-5518
10. Vikrant S. Vairagade, Kavita S. Kene,"Introduction to Steel Fiber Reinforced Concrete on Engineering Performance of Concrete"-International Journal of Scientific & Technology Research Volume 1, Issue 4, May 2017
11. IS 10262-2009 CODE OF PRACTICE OF CONCRETE MIX PROPORTIONING
12. IS 456-1978 CODE OF PRACTICE OF PLAIN AND REINFORCED CONCRETE
13. IS 456-2000 CODE OF PRACTICE OF PLAIN AND REINFORCED CONCRETE
14. R. D. Neves and J. C. O. Fernandes de Almeida "Compressive behaviour of steel fibre reinforced concrete".
15. R. D. Neves and J. C. O. Fernandes de Almeida "Flexural behaviour of steel fibre reinforced concrete".
16. Er. R. K. Rajput and S. Chand "Strength of Materials".
17. A.M. Shende, Comparative Study on Steel Fiber Reinforced cum Control Concrete, University of France, France, 2011.
18. Faisal FW, Samir AA. Mechanical properties of high-strength fiber reinforced concrete. ACI Mater J 1992;89(5):449–55.
19. Kurihashi, Y.; Taguchi, F.; Kishi, N.; and Mikami, H., "Experimental Study on Static and Dynamic Response of PVA Short-Fiber Mixed RC Slab," fib Proceedings of the 2nd International Congress, ID 13-20, Naples,Italy, 2006, 10 pp.
20. Cucchiara, C.; Mendola, L. L.; and Papia, M., "Effectiveness of Stirrups and Steel Fibres as Shear Reinforcement," Cement and Concrete Composites, V. 26, 2004, pp. 777-786.
21. M. Maalej, S.T. Quek, Zhang J Behavior of hybrid-fiber engineered cementitious composites subjected to dynamic tensile loading and projectile impact, J. Mater.
Civ. Eng. 17 (2005) 143–152.
22. IS 269:1989 SPECIFICATIONS FOR ORDINARY PORTLAND CEMENT, 33 GRADE
23. IS 383:1970 SPECIFICATIONS FOR COARSE AND FINE AGGREGATES FROM NATURAL SOURCES FOR CONCRETE
24. Wals HN "How to make good concrete" ACI Publications 1969
25. Shacklock BW "Concrete constituents and mix proportions" Cement and concrete associations

May-June 2020
ISSN: 0193-4120 Page No. 6665 - 6672

UK 1974

26. Venkateshwaran, A.; Tan, K.H.; Li, Y. Residual flexural strengths of steel fiber reinforced concrete with multiple hooked-end fibers. Struct. Concr. 2018, 19, 352–365.
27. A. H. Akca and N. ¨ Ozyurt, “Effects of re-curing on residual mechanical properties of concrete after high temperature exposure,” Construction and Building Materials, vol. 159, pp. 540–552, 2018.
28. H. N. He and W. Dong, “Experimental study on long-term restricted expansive deformation of steel fiber reinforced expansive concrete,” in Proceedings of the 6th International Specialty Conference on Fiber Reinforced Materials, pp. 139–142, Sherbrooke, QC, Canada, July 2017.
29. A.M.Niville “Concrete Technology” ELBS with Longman 1987.