TOWARDS THE DEVELOPMENT OF FIBRE REINFORCED ULTRA HIGH STRENGTH CONCRETE

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Abstract: In this experimental investigation an attempt has been made for the development of ultra high strength Fibre Reinforced Concrete having cube compressive strength more than 100 MPa

I. INTRODUCTION

Due to over crowding of population in town and cities, the cost of land is prohibitively high, so there is necessity for the expansion of the buildings in the vertical direction. More the height of a multistorey building bigger will be the cross section of columns of lower storeys if conventional concretes such as M20 or M25 is adopted. If high strength concrete is adopted in the column of lower storeys, there will be reduction in cross section. Consequently, the dead load transmitted to the foundation will be less resulting in overall economy in the building. At present, there is very little information available on the production and properties of ultrahigh strength concrete having compressive strength more than 100 MPa. Therefore, in this experimental investigation, an attempt has been made to examine 6 different concrete mixes for getting ultra high strength fibre reinforced concrete, the fibre content being 0.5% to 2.5% by volume of concrete.

II. LITERATURE SURVEY

The concrete mixes adopted by some of the researchers for the development of fibre reinforced ultrahigh strength concrete are briefly given below.

Quantities of materials are in kg per cubic metre of concrete

Researcher	1.H.J.H Browsers
Cement	612.4
Sand	1054.7
Coarse aggregate (12mm)	426.25
Silica fume	43.7
Water	202
Percentage of Steel fibres by volume of concrete	2.5
Super plasticizer (viscocrete 10)	45.9
Compressive strength Mpa	140

Type of curing : Normal curing(immersion curing)

Researcher	Dong joo kim
Cement	750
Sand	825
Coarse aggregate (12mm)	923
Silica fume	187.5
Water	150
Percentage of Steel fibres by volume of concrete	4
Super plasticizer (viscocrete 10)	50.25
Compressive strength Mpa	165

Type of curing : Steam curing

Researcher	Su tae kang
Cement	700
Sand	770
Coarse aggregate (12mm)	900
Silica fume	175
Water	175
Percentage of Steel fibres by volume of concrete	2
Super plasticizer (viscocrete 10)	45.6
Compressive strength Mpa	155

Type of curing : Normal curing

Researcher	R.yu
Cement	699
Sand	1054.7
Coarse aggregate (12mm)	724
Silica fume	175
Water	175
Percentage of Steel fibres by volume of concrete	2
Super plasticizer (viscocrete 10)	45.6
Compressive strength Mpa	155

Type of curing : Steam curing

Researcher	Mohammed A.arab
Cement	750

Sand	900
Coarse aggregate (12mm)	1120
Silica fume	240
Water	165
Percentage of Steel fibres by volume of concrete	2
Super plasticizer (viscocrete 10)	50
Compressive strength Mpa	150

Type of curing : Normal curing method

III. EXPERIMENTAL WORK OF THE AUTHORS

3.1.Introduction: In this investigation six concrete mixes were tried. The concrete is mixed using hand. It includes the following steps; weighing the mixture components carefully then, mixing sand and cement to obtain homogenous mix (about 1 minute) followed by adding silica fume and GGBS to the mix. After that, coarse aggregate is mixed which is followed by water and super plasticizer to the dry content and mixed thoroughly.

3.2.Casting of specimens: Thorough mixing of materials was done until the concrete mass became homogeneous, uniform in colour and consistency. After mixing, the moulds were filled immediately by pouring the concrete inside manually in three layers by using trowel. Compaction of each layer was done manually with tamping rod. Nine cubes of 100 mm sizes ; Nine prisms of size 100mm x 100mmx 500 mm and four cylinders of 150 mm diameter and 300 mm height were cast each for the mixes. The concrete specimens were demoulded after 24 hours from the time of casting.

3.3.Curing: After demoulding , the specimens were immersed in water of a curing tank and cured for 28 days before testing the specimens.

3.4.Testing of specimens:

3.4.1 Test for cube compressive strength:

The cubes were tested as per IS 516-1959 code and the test results are given below in Table 3.

Table .1: Quantities of materials used for the six mixes with steel fibres -1,2,3,4,5&6

Materials	Mix – 1	Mix - 2	Mix-3	Mix-4	Mix-5	Mix-6
Cement(kg/m^3)	800	800	800	600	600	600
Fine aggregate (kg/m^3)	1030	1030	1030	600	600	600
Coarse Aggregate (kg/m^3)	200 (6mm)	200 (6mm)	200 (6mm)	923 (6mm)	923 (6mm)	923 (6mm)
GGBS (kg/m^3)	-	-	-	180	180	180
Silica fume (kg/m^3)	80	80	80	90	90	90
% of Steel fibres by volume of concrete	1	1.5	2	1.5	2	2.5
Super plasticizer (l/m^3)	16	16	16	18	18	18
w/c ratio	0.18	0.18	0.18	0.20	0.20	0.20

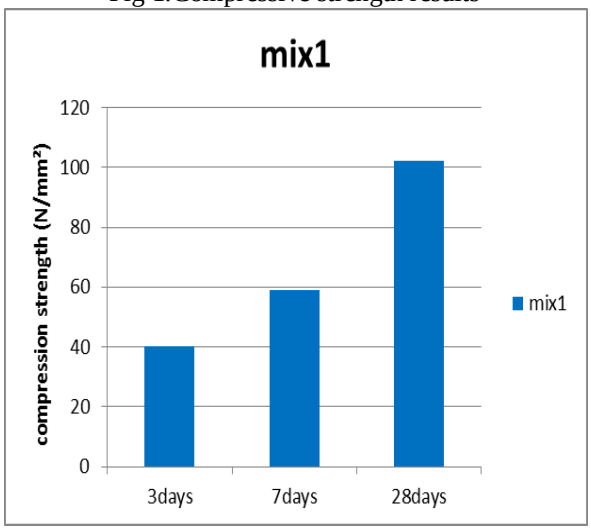
3.4. ANALYSIS OF TEST RESULTS

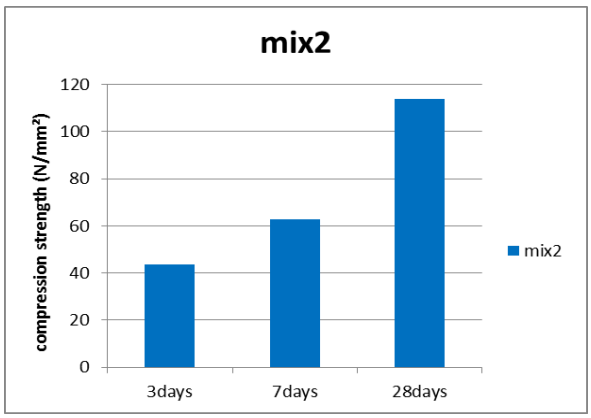
Compression test: The compression test results are given below

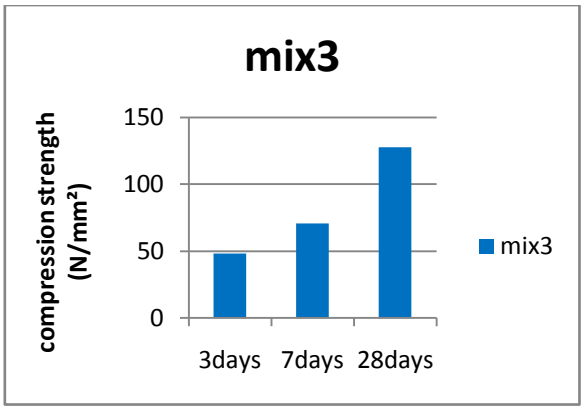
Table .2: Compression test results:

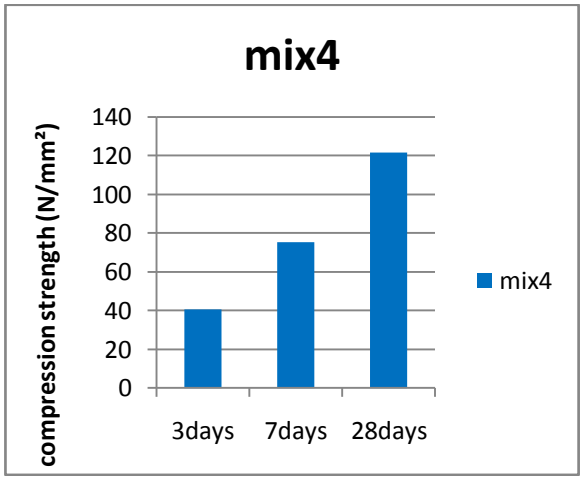
COMPRESSIVE STRENGTH RESULTS (N/mm²)			
NAME OF THE MIX	3 days	7 days	28 days
Mix 1	40.22	58.86	102.4
Mix 2	43.61	62.82	113.79
Mix 3	48.13	70.68	127.73
Mix 4	40.48	75.2	121.62
Mix 5	46.12	82.76	128.23
Mix 6	52.38	90.62	135.18

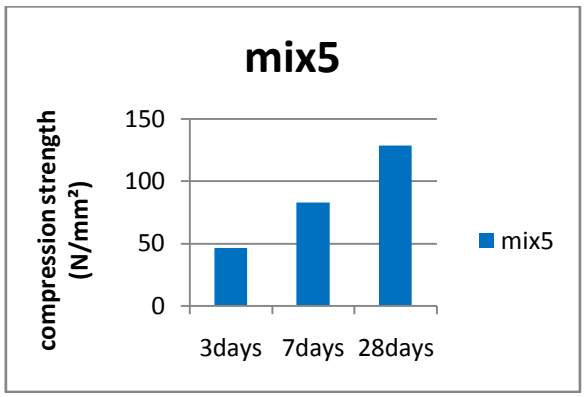
Fig 1.Compressive strength results

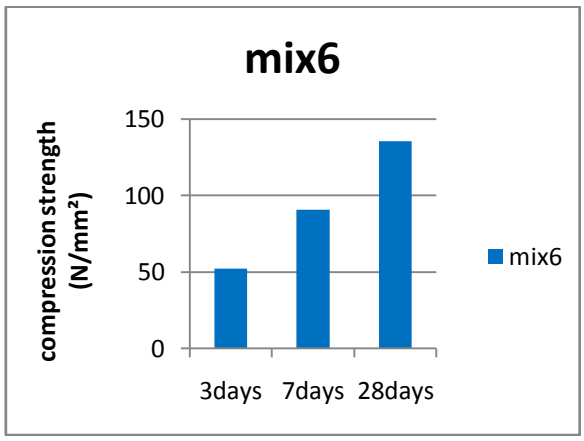










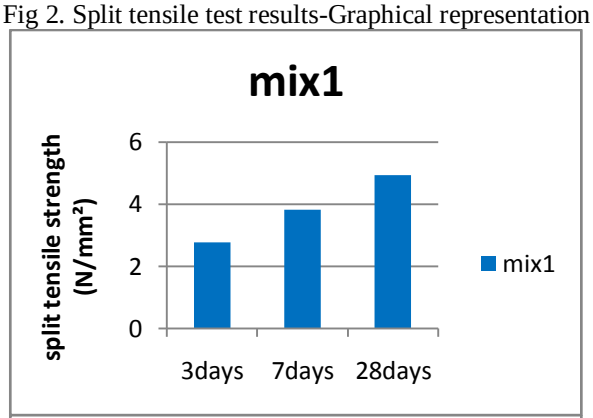


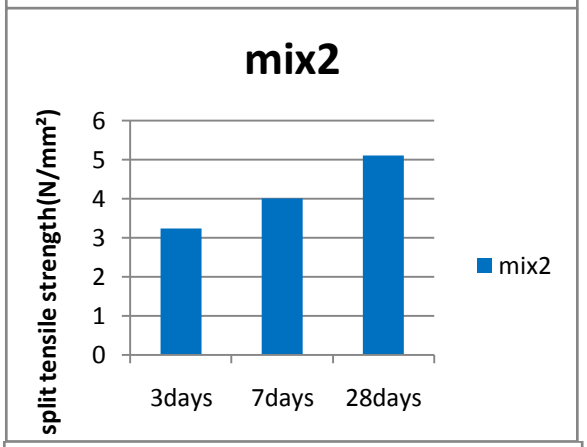
Split Tensile test: The Split tensile strength is considered as indirect tensile strength of concrete, this test was carried out as per IS5816-1999.

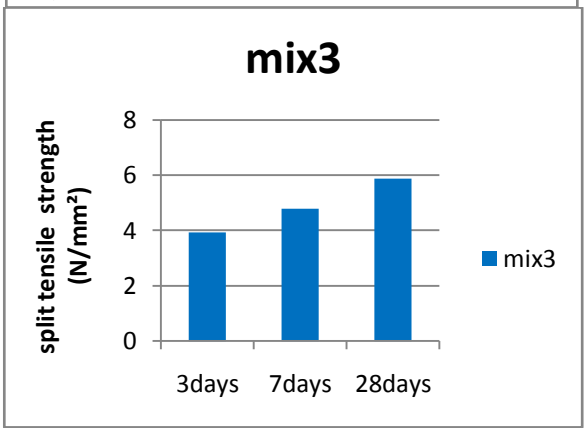
Table 4: Split tensile test results:

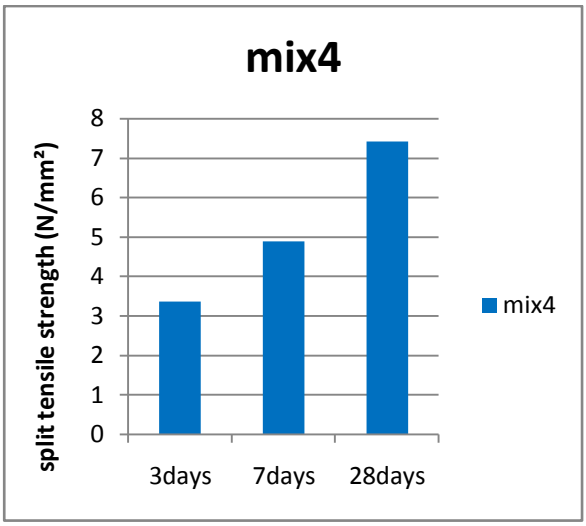
SPLIT TENSILE STRENGTH RESULTS (N/mm²)			
NAME OF THE MIX	3 days	7 days	28 days
Mix 1	2.77	3.81	4.92
Mix 2	3.23	4.0	5.1
Mix 3	3.92	4.78	5.88
Mix 4	3.36	4.88	7.42
Mix 5	4.46	5.58	8.62
Mix 6	5.42	6.46	9.32

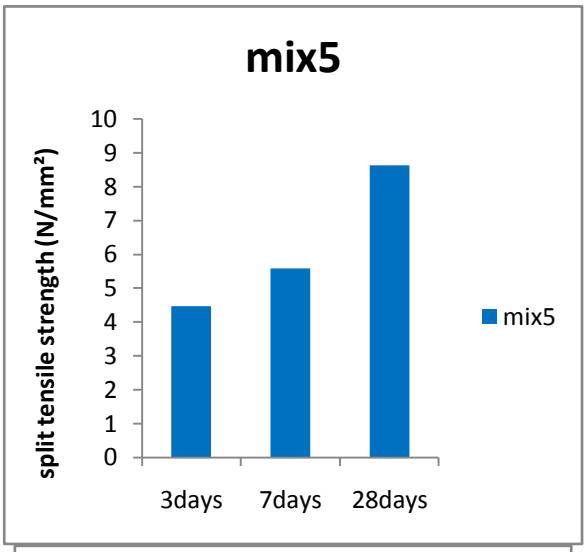
Fig 2. Split tensile test results-Graphical representation

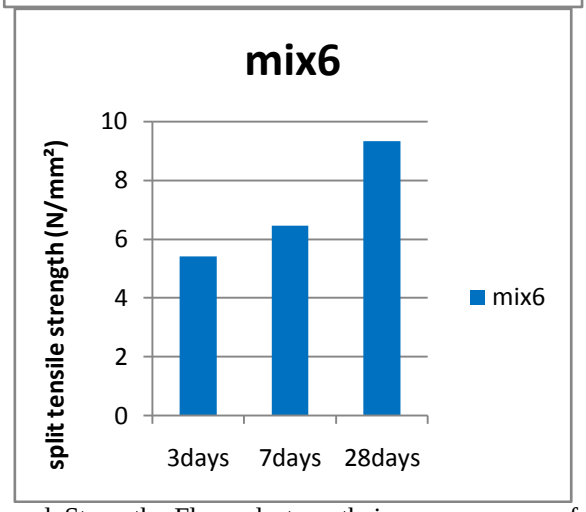








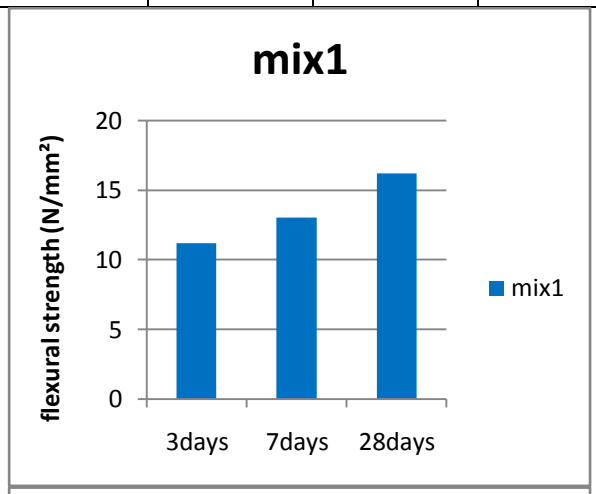


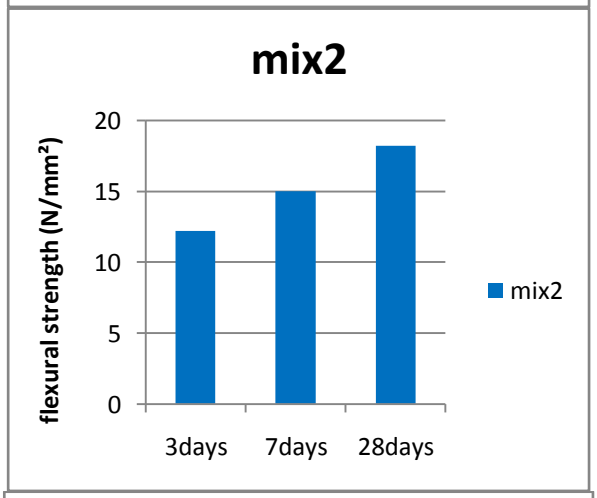


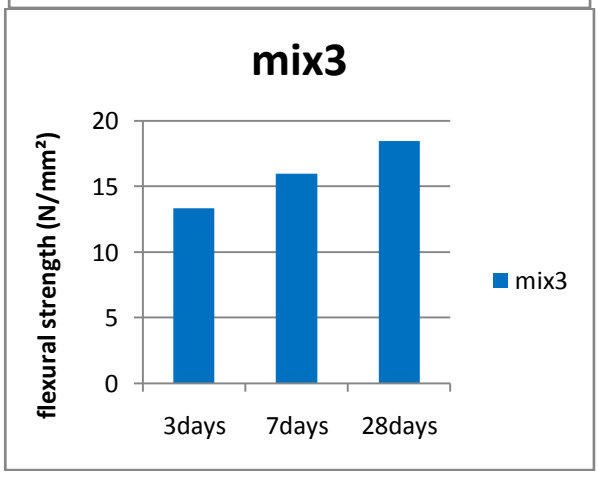
Flexural Strength: Flexural strength is one measure of the tensile strength of concrete and was found by applying two point load as per IS516-1959. It is a measure of an unreinforced concrete beam or slab to resist failure in bending. It was determined by loading 100 x 100 x 500 mm concrete beams until they failed reaching its ultimate load.

Table 5:Flexural test results:

NAME OF THE MIX	FLEXURAL STRENGTH RESULTS (N/mm²)		
	3 days	7 days	28 days
Mix 1	11.21	13.02	16.2
Mix 2	12.21	15.01	18.2
Mix 3	13.33	15.94	18.42
Mix 4	6.88	12.38	16.4
Mix 5	8.22	14.45	18.32
Mix 6	10.78	16.33	20.42







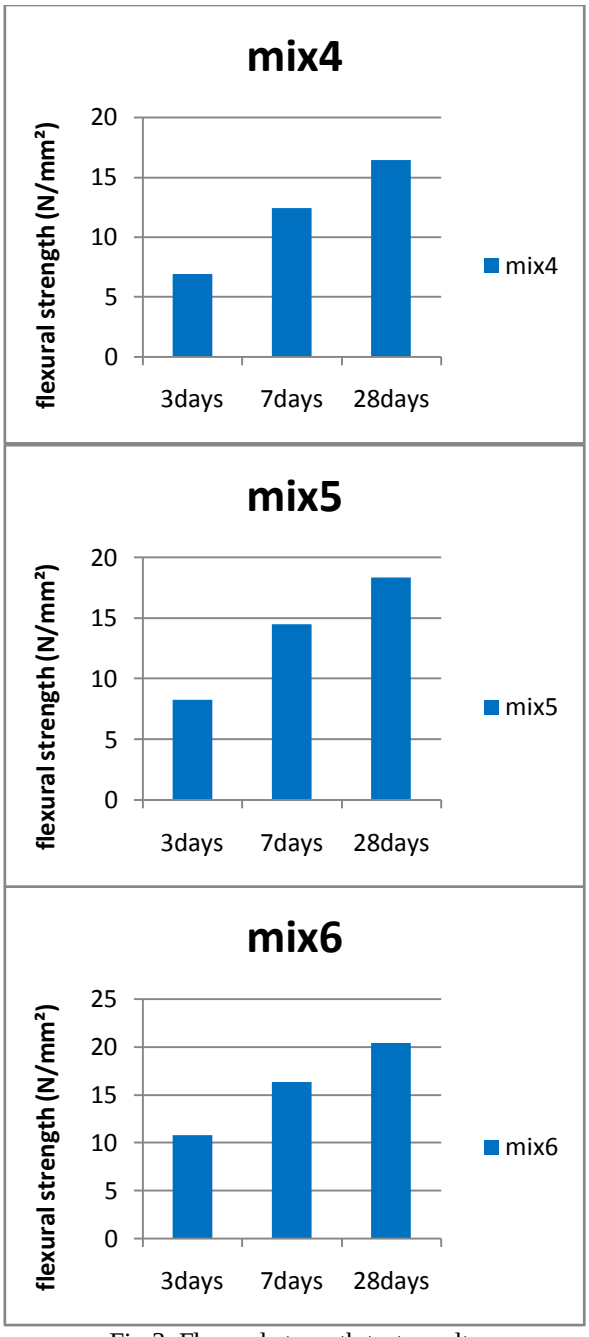


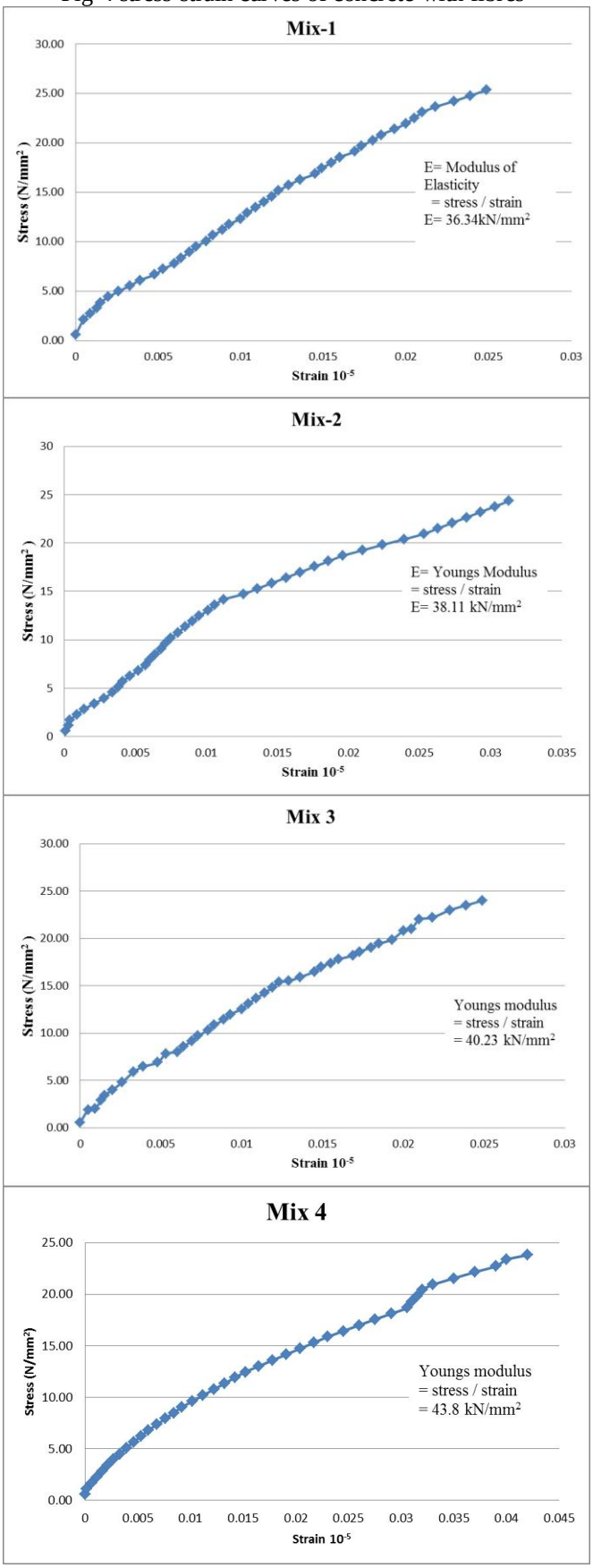
Fig 3. Flexural strength test results

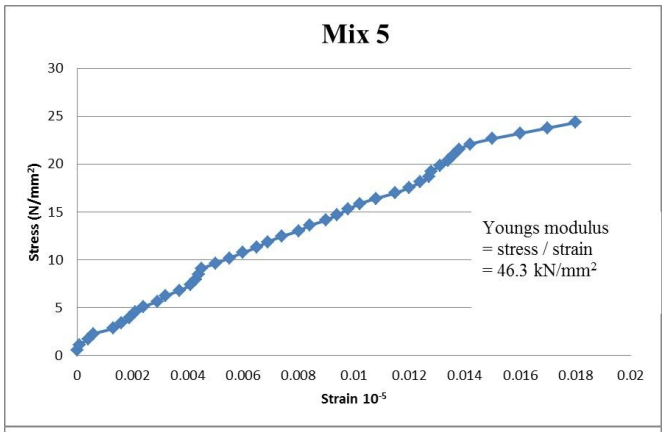
Modulus of Elasticity: Tests for stress-strain curves were was conducted on UHSFRC cylinders at the age of 28 days.

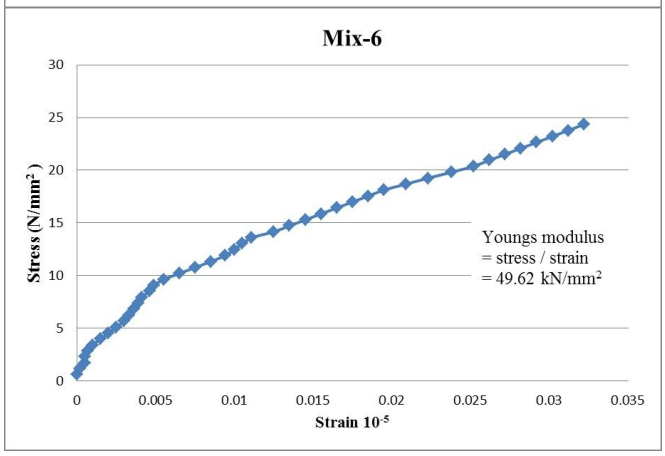
Table 6:Modulus of elasticity results:

Mix	Age of curing (days)	Modulus of elasticity(GPa)
1	28	36.34
2	28	38.11
3	28	40.23
4	28	43.8
5	28	46.3
6	28	49.62

Fig-4 stress-strain curves of concrete-with fibres







IV. CONCLUSION

Out of the six fibre reinforced concrete mixes tried in this investigation, Mix 6 gives the highest strength.

REFERENCE

[1] Mohammad Abdur Rashida and Mohammad Abul Mansurb"Considerations in producing high strength concrete" journal of Civil Engineering (IEB), 37(1) (2009) 53-63.

[2] Mahesh K Maroliya1*, Chetan D Modhera2A, "Comparative study of reactive powder concrete containing steel fibers and recron 3s fibers", Journal of Engineering Research and Studies /vol I/Issue I/July-Sept. 2010/83-89 .

[3] Srinivas Allena1 and Craig M. Newtson2, "Ultra-High Strength Concrete Mixtures Using Local Materials", 2010 concrete sustainabiliy conference.

[4] Arunachalam.K1, Vigneshwari. M2, "Experimental investigation on ultra high strength concrete containing mineral admixtures under different curing. conditions", international journal of civil and structural engineering Volume 2, No 1, 2011.

[5] S.N. Raman a,b,⇑, T. Ngo a, P. Mendis a, H.B. Mahmud c , "High-strength rice husk ash concrete incorporating quarry dust as a partial substitute for sand" Construction and Building Materials 25 (2011) 3123–3130 .

[6] Dr. Wasan I. Khalil , "Some Properties of Modified Reactive Powder Concrete" Journal of Engineering and Development, Vol. 16, No.4, Dec. 2012 ISSN 1813- 7822.

[7] Alaa A.Bas handy, "Influence of Elevated Temperatures on the Behavior of Economical Reactive Powder Concrete", Journal of Civil Engineering Research 2013, 3(3): 89-97.

[8] Mohamed Amin a,1, Khaled Abu el-hassan b, " Effect of using different types of nano materials on mechanical properties of high strength concrete". Construction and Building Materials 80 (2015) 116–124 .

[9] Prabhat Ranjan Prem, B H Bharat kumar and Nagesh R Iyer, "Influence of curing regimes on compressive strength of ultra high performance concrete" Sadhana Vol. 38, Part 6, December 2013, pp. 1421–1431.

[10] Nageh N. Melekaa, Alaa A. Bashandya*, Mohamed A. Arabb, "Ultra High Strength Concrete Using Economical Materials" . International Journal of Current Engineering and Technology 1June 2013, Vol.3, No.2 (June 2013) ISSN 2277 – 4106.

[11] Ahsanollah Beglarigale, Çağlar Yalçınkaya*,Halit Yazıcı, "Autoclaved reactive powder concrete: the effects of steel micro- fibers and silica fume dosage on the mechanical properties", Beglarigale et al. / Usak University Journal of Material Sciences 1 (2014) 7 – 14.

