

Towards The Development of 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 concrete having cube compressive strength more than 100 MPa. The technology development of concrete and demand for high strength construction materials give momentum to the development of Ultra-High Strength Concrete (UHSC). This new type of concrete is characterized with very high compressive strength i.e., strength higher than 100 MPa. Current UHSC preparation methods require costly materials and relatively sophisticated technology. In this project, study on Ultra-High Strength Concrete has been made. Concrete mix design and experimentation on Ultra-High Strength concrete have been carried out. The mechanical properties such as compressive strength, split tensile strength, Modulus of elasticity and flexural strength of ultra-high strength concrete have been researched.

KEYWORDS: Ultra-High Strength Concrete, 100 MPa, Compressive strength, Split tensile strength

I.INTRODUCTION

Due to overcrowding 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 M20 or M25 is adopted. If high strength concrete is adopted in the columns of lower storeys, there will be reduction in cross section. Consequently, the 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 properties of ultra-high strength concrete having compressive strength more than 100 MPa. Therefore, in this experimental investigation, an attempt has been made to examine 6 concrete mixes for getting ultra-high strength concrete.

II.LITERATURE SURVEY

The concrete mixes adopted by some of the researches for the development of ultrahigh strength concrete are briefly given below. Quantities of materials are in kg per cubic metre of concrete SP-Super plasticizer

Type of curing : Normal Curing

Researcher	Cement	Silica fume	Sand	12mm Coarse aggregate	Water	SP (daracem)	Compressive strength MPa
1 Halit Yazici	550	60	620	1120	122	10	127

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Type of curing: Steam Curing

Researcher	Cement	Silica fume	Sand	W/C	SP	Compressive strength MPa
3 Mahesh K Maroliyal (Mix by ratio)	1	0.32	1.50	0.20	0.032	106

Type of curing : Standard Water Curing

Researcher	Cement	Silica fume	Sand	4mm Basalt	Quartz	Water	W/C	SP (Sulfonated naphthalene formaldehyde)	Compressive strength MPa 28 days
2 Mohammad Abdur	510	260	340	724	212	170	0.33	45	170

Researcher	Cement	Silica fume	Sand	6mm Coarse aggregate	W/C	SP(HRWRA) (Glenium3030 NS from BASF chemicals)	Compressive strength MPa
4 Srinivas Allenal	890	222	837	1146	0.25	29.64	161.90

Type of curing : Hot Water curing 50⁰C

Researcher	Cement	Rice husk ash	Silica fume	Quartz flour	Quartz Sand	Water	SP	Compressive strength MPa
5 Arunachalam.k	692.8	173.2	216.5	346.4	952.6	182	43.3	104

Type of curing : Normal Curing

Researcher	Cement	Silica fume	4.75mm Coarse aggregate	W/C	Compressive strength MPa
6 Adel A. A-Azzawi	900	90	550	0.18	154

Type of curing : Steam Curing

Researcher	Cement	Sand	Coarse aggregate	Water	SP (polycarboxylic ether)	Compressive strength MPa
7 S.N. Raman	483	687	1075	145	13.03	100

Type of curing : Normal Curing

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Researcher	Cement	Sand	12.5mm Coarse aggregate	W/C	SP(HRWRA) (Flocrete SP95)	Compressive strength MPa
8 Dr.Wasan I.Khalil	900	585	1029	0.23	3% by wt of cement	139

Type of curing : Steam Curing 90⁰C

Researcher	Cement	Sand	Silica fume	Water	SP (naphthalane sulphonate)	Compressive strength MPa
9 Alaa A. Bas handy	800	1250	240	144	80	139.15

Type of curing : Hot Water Curing for 3 days at 75⁰C and for 3 days at 25⁰C

Researcher	Cement	Sand	Crushed dolomite	Silica fume	Water	SP (viscocrete 10)	Compressive strength MPa
10 Mohamed Amin	500	706	1058	85	120	80	139.15

Type of curing : Normal curing

III. EXPERIMENTAL WORK OF THE AUTHORS

3.1.Introduction: In this investigation six concrete mixes were tried. Hand mixing was adopted. 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 the addition of 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 a trowel. Compaction of each layer was done manually with a tamping rod. Nine cubes of 100 mm size, nine prisms of size 100mm x 100mm x 500mm and four cylinders of 150 mm dia and 300mm height were cast using each of the 6 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 stored in 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 2.

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Table-1: Quantities of materials for six mixes – 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)	830	630	430	600	600	600
Coarse Aggregate(kg/m ³)	400 (6mm)	600 (6mm)	800 (6mm)	923 (6mm)	923 (12mm)	923 (20mm)
GGBS (kg/m ³)	-	-	-	180	180	180
Silica fume(kg/m ³)	80	96	112	90	90	90
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

IV. ANALYSIS OF TEST RESULTS

Compression test: The compression test is used to find the compressive strength values of the cubes at ages of 3 days, 7 days and 28 days respectively and their result is plotted in the graph below.

Table-2: Compression test results:

Mix	Compressive Strength N/mm ²		
	3 days	7 days	28 days
Mix 1	38.26	58.86	86.83
Mix 2	42.18	62.78	95.16
Mix 3	53.96	68.67	110
Mix4	49.89	87.1	130.27
Mix5	41.5	72.66	104.68
Mix6	37.51	60.23	90.81

Following Figures show the compressive strength of concrete mixes in N/mm²

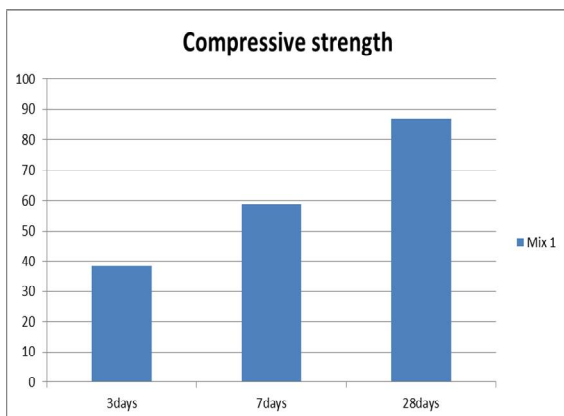


Fig 1

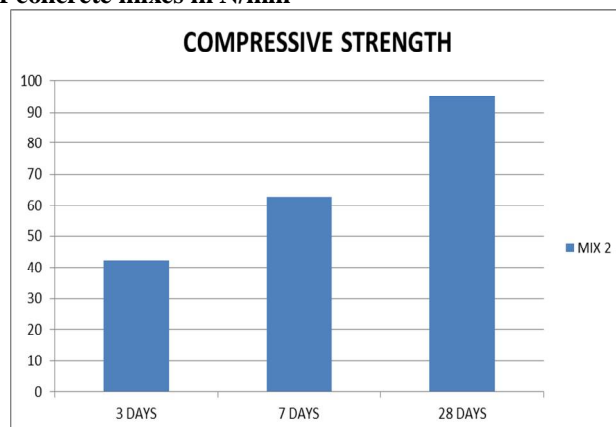


Fig 2

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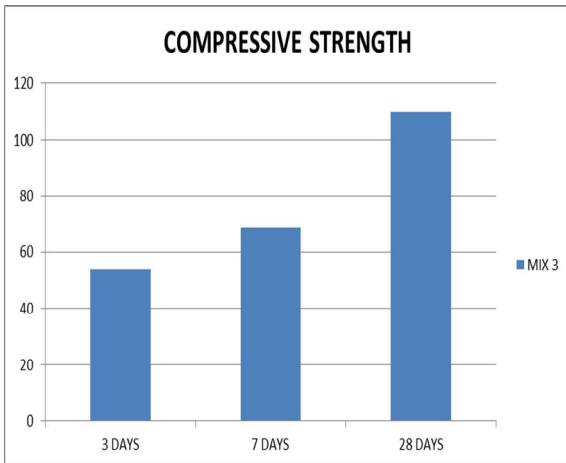


Fig 3

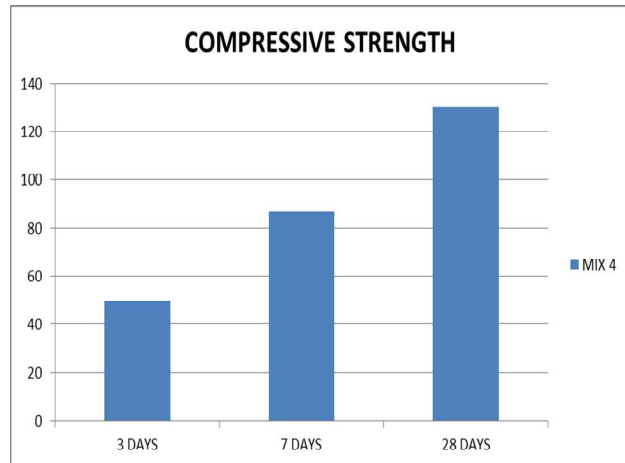


Fig 4

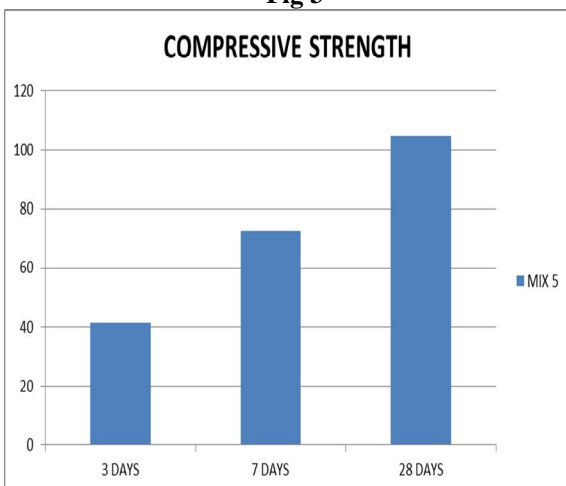


Fig 5

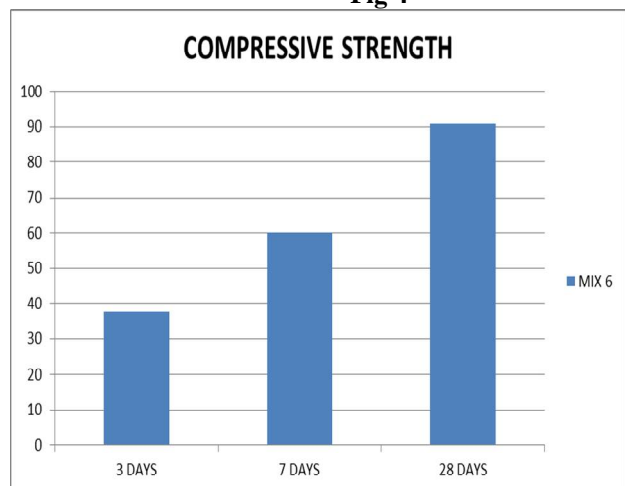


Fig 6

Split Tensile test: The Split tensile strength is considered as indirect tensile strength of concrete which involves the cylinder to be tested for splitting tension after 3days, 7days, and 28 days of casting .The test results are shown in Table:3

Table-3:Split tensile test results:

Mix	Split tensile strength (N/mm ²)		
	3 days	7 days	28 days
Mix 1	2.16	2.87	3.42
Mix 2	2.32	3.01	4.11
Mix 3	2.99	3.8	5.08
Mix4	4.82	5.91	8.92
Mix5	3.6	4.59	6.46
Mix6	2.75	3.52	5.23

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Following Figures show the Split tensile strength of concrete mixes in N/mm^2

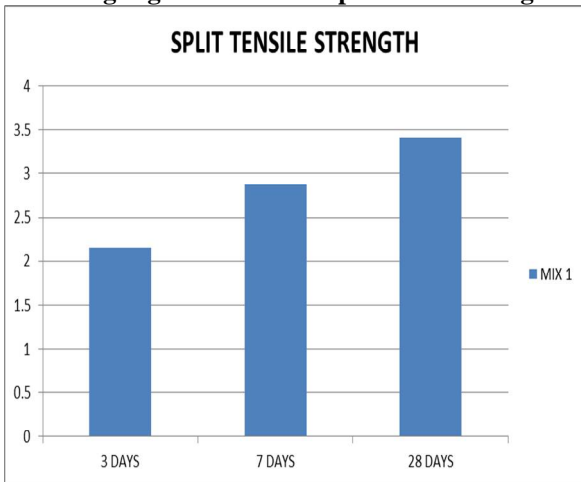


Fig 7

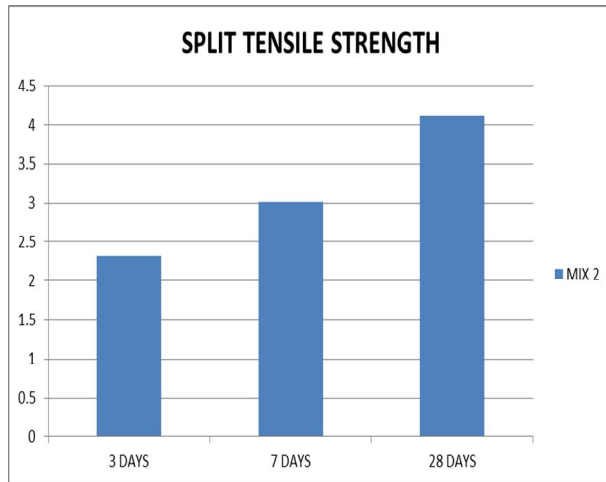


Fig 8

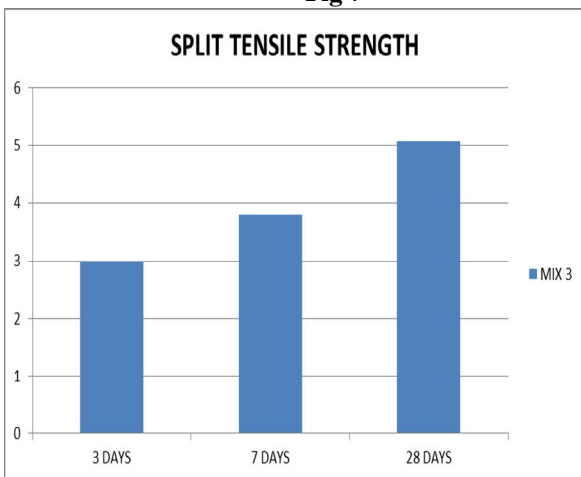


Fig 9

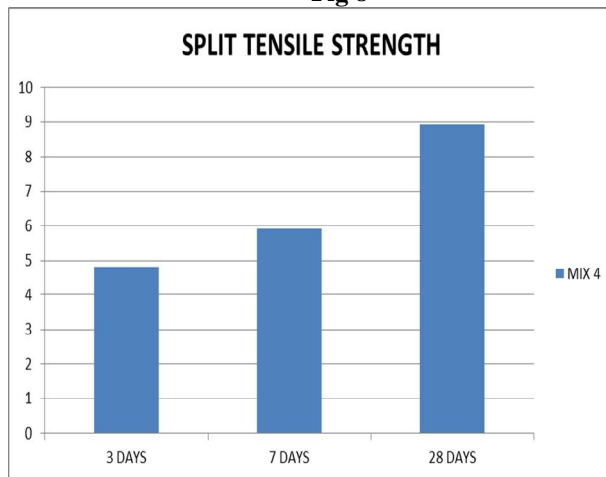


Fig 10

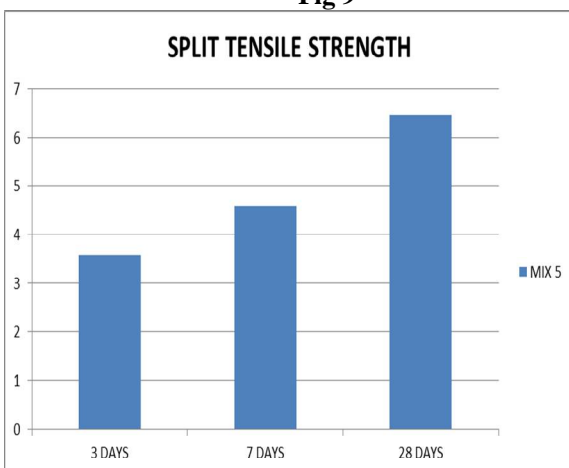


Fig 11

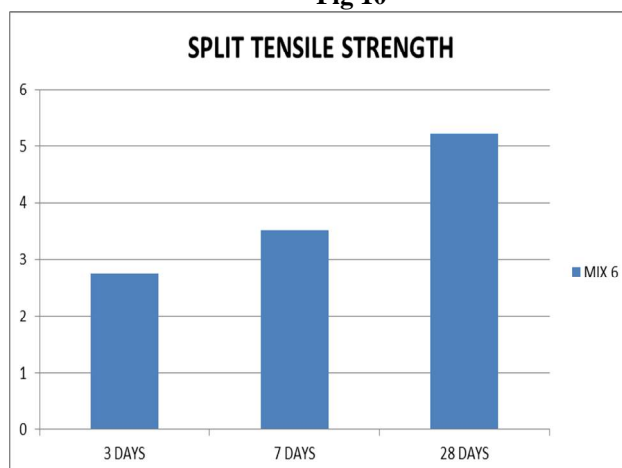


Fig 12

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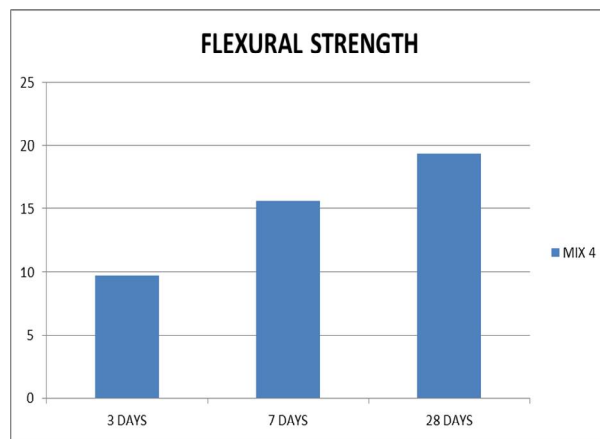
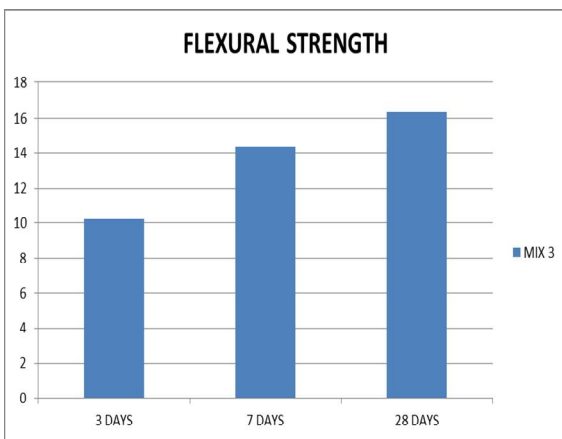
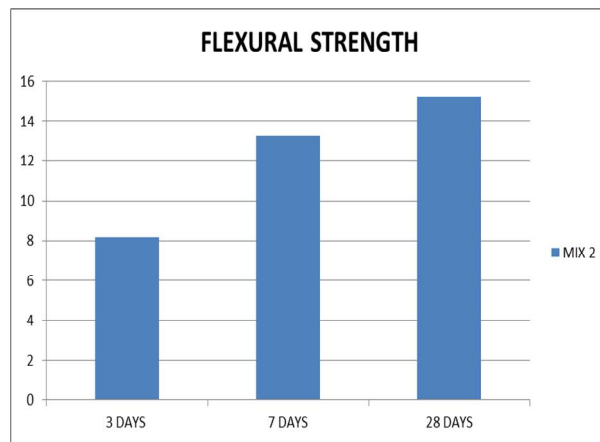
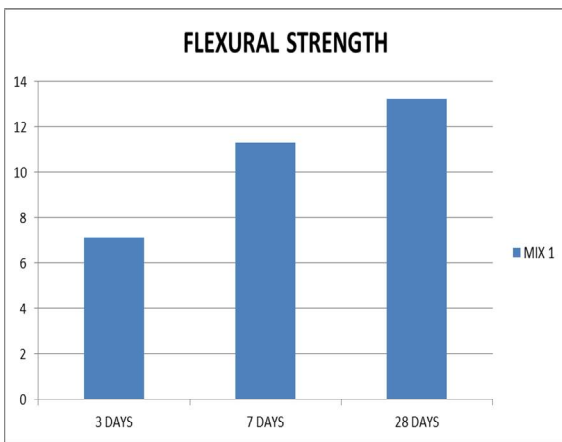
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Flexural Strength: Flexural strength is one measure of the tensile strength of concrete found using two point load method. It is a measure of an unreinforced concrete beam or slab to resist failure in bending. It is measured by loading 100 x 100 x 500 mm concrete beams until it fails by applying two point load.

Table-4: Flexural test results:

Mix	Flexural strength (N/mm ²)		
	3 days	7 days	28 days
Mix 1	7.15	11.35	13.25
Mix 2	8.17	13.28	15.22
Mix 3	10.22	14.38	16.36
Mix4	9.72	15.6	19.42
Mix5	7.28	13.1	16.17
Mix6	6.4	9.76	11.96

Following Figures show the Flexural strength of concrete mixes in N/mm²



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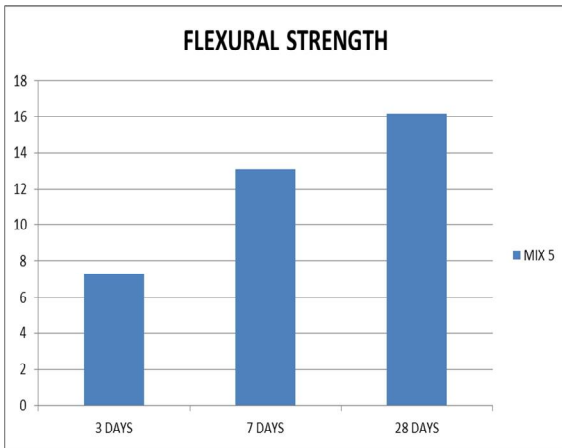


Fig 17

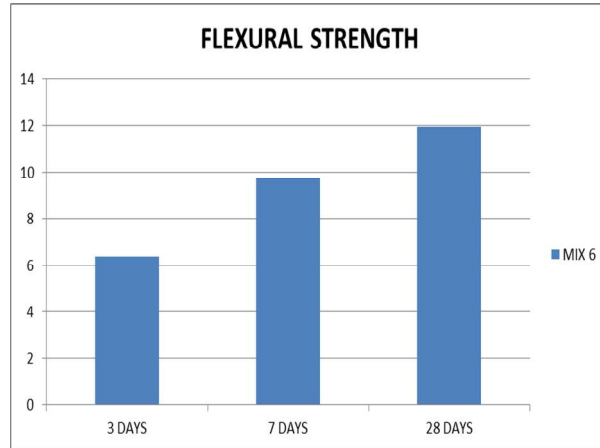


Fig 18

Modulus of Elasticity: The Modulus of elasticity of concrete was determined by testing cylinders at the age of 28 days.

Table-5: Modulus of elasticity results:

Mix	Modulus of elasticity(GPa)
1	35.28
2	36.17
3	37.5
4	49.27
5	42.18
6	38.90

Following figures show the modulus of elasticity of all concrete mixes in GPa

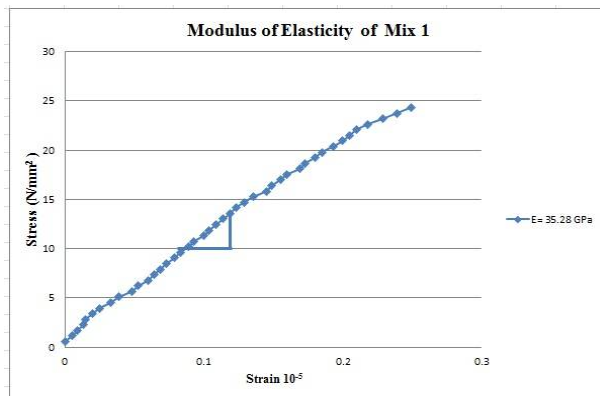


Fig 19

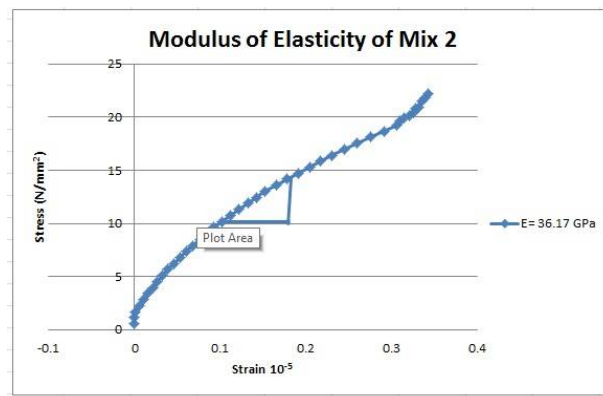


Fig 20

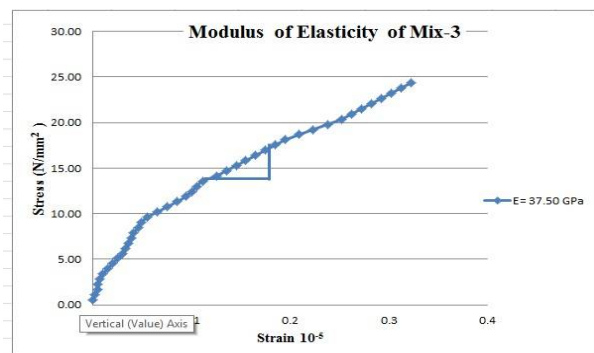


Fig 21

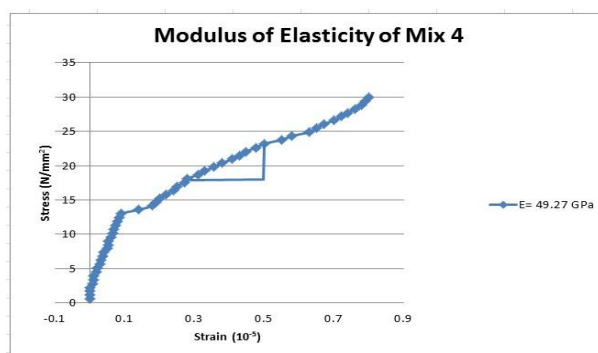


Fig 22

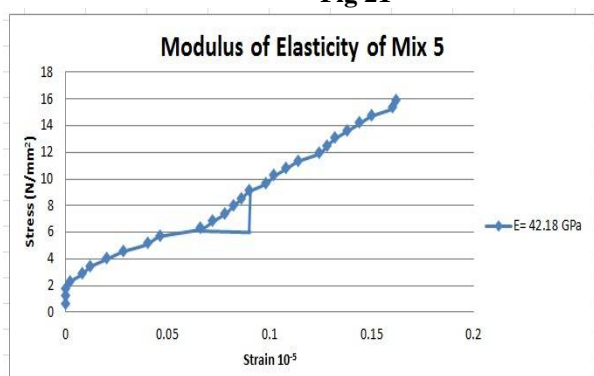


Fig 23

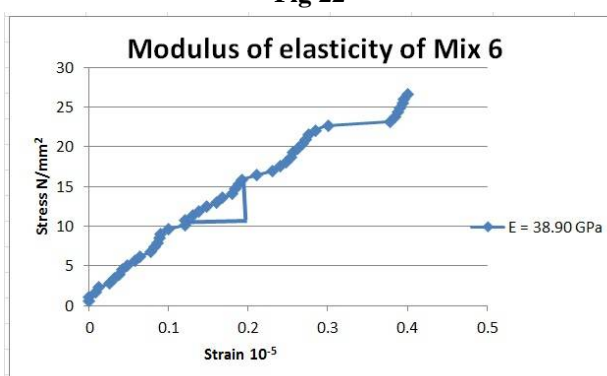


Fig 24

IV.CONCLUSION

Intensive literature survey has been made on various types of concrete mixes adopted by earlier research workers for a development of ultra-high strength concrete, i.e. concrete having strength more than 100 MPa.

In this investigation 6 types of concrete mixes have been tried for getting ultra-high strength. Let we found that the mixes give cube compressive strength in the range of 87 to 130 N/mm² at 28 days strength. The split tensile strength and modulus of rupture of these concretes have also been determined experimentally. In addition the modulus of elasticity of concrete of all these 6 mixes has been determined after getting stress strain curve of concrete.

REFERENCES

- [1]. Halit Yazıcı, "The effect of curing conditions on compressive strength of ultra high strength concrete with high volume mineral admixtures" Building and Environment 42 (2007) 2083–2089.
- [2]. Mohammad Abdur Rashida and Mohammad Abul Mansurb"Considerations in producing high strength concrete" journal of Civil Engineering (IEB), 37(1) (2009) 53-63.
- [3]. 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 .
- [4]. Srinivas Allena1 and Craig M. Newton2, "Ultra-High Strength Concrete Mixtures Using Local Materials", 2010 concrete sustainability conference.
- [5]. 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.
- [6]. Adel A. Al-Azzawi, Ahmed Sultan Ali and Husam K. Risan, "Behavior of ultra high performance concrete structures", ARPN Journal of Engineering and Applied SciencesVOL. 6, NO. 5, MAY 2011.
- [7]. S.N. Raman a,b,f,t, 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 .
- [8]. 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.
- [9]. 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.
- [10]. 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 .