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STRENGTH PROPERTIES OF FIBRE REINFORCED CONCRETE BY USING TERNARY BLENDED MATERIAL

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Abstract
Concrete is most widely used construction material around the world. Because of ease of construction it is the major material in any type of construction. Concrete has the properties of compressive strength, shear strength and durability. Here in this paper, we studied about the ternary blended system means of silica fume or other cement replacement additives are to be used with ordinary Portland cement. That it is not strictly, true ternary mixture comprise efficient system. With addition of fly ash adding in cement mix, it enhances the high early strength. When both silica fume and flash are used, the resultant strength of the mixture is much greater than the super position of contribution of each, for the respective proportions. Silica fume and fly ash result in synergic action to improve the micro structure and performance of concrete. The fibre reinforced material is distributed among in concrete matrix randomly as per the design. With these addition fibres, the compressive strength and durability of concrete may increases. To increase the properties of workability and to reduce the amount of water, a super plasticizer called Glenium B233 is added to this mix. By the tests conducted, we studied the properties of compressive strength, shear strength and flexural strength of ternary blended concrete. The present experiment is carried out to investigate the compressive strength and flexural strength and of ternary blended steel fibres reinforced concrete and addition of different percentages like 0%, 0.5%, 1% and 1.5% of crimped steel fibres with aspect ratio. Compressive strength of concrete is measured by testing standard cubes (150mmx150mmx150mm) at the age of 7 and 28 days.

Key words: compressive strength, ternary blended material, super plasticizer, steel fibres.

I. INTRODUCTION

Now a day's most of changes in concrete mixtures. Because to increase the strength and durability of concrete .In this concrete mixture we can using the super plasticizers and admixtures to reducing the water and cement quantity in concrete mixture. In developing countries like India, energy play a crucial role. In context of low availability of non renewable energy sources in generation of materials like cement and steel

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ect.,the importance of industrial wastes as building material cannot be underestimated. In India 68 major thermal power stations are produced 110million tones of fly ash, and it is increase double within next 10 years. Earlier so many research done on waste material like fly ash and silica fume. Through their use as construction materials can be converted into wealth atmosphere and living purpose. Also we can use the different technical, economical and ecological on partial replacement of cement with fly ash. Researchers have reported that silica fume have round shape and smaller size it is filled between coarse aggregate and cement to reduced the voids ratio. To improve the properties of concrete to added the proper proportional fly ash and silica fume mix and may not be achievable through use of port land cement alone. The resulting mix becomes strong durable and economical and also eco-friendly as it utilizing ecological hazardous materials.

II. NECESSITY OF STUDY

Many researchers have studied the properties of ordinary Portland cement concrete by using mineral admixtures like micro silica, rise husk ash, fly ash, GGBS as cement replacement materials. A few researchers have done work for triple blended concrete's using mineral admixtures like fly ash, micro silica. In order to increase strength and to improve durability of concrete by using mineral admixtures. some of the different mineral admixtures like Blast furnace slag, fly ash and micro silica are used in varying proportions to achieve such results. In fresh state the mineral admixtures also affect the properties of concrete, rate of strength development and durability in hardened state. Economics and environmental considerations are the key factors in the growth of mineral admixture usage. In generally to improve the concrete strength and durability by using Micro silica together with super plasticizer. Due to its finer size and higher pozzolanicity compared to other mineral additives, micro silica incorporation leads to improved mechanical properties of concrete even at early ages. Fly ash, on other hand, as mineral admixture in concrete, enhances its workability, long-term strength and durability. In generally the addition of micro silica give the high strength of the concrete. However, in some of the countries like India, micro silica is relatively expensive compared to cement. Fly ash on other hand is easily available at lower cost than cement. Moreover, micro silica due to its fine particle size increases the water demand and has tendency to consume higher dosage of super plasticizer, whereas, spherical particles that easily rollover one another reducing inner particle friction due to presence of fly ash. (Called ball bearing effect) leads to reduction in water demand, and improved workability.

Due to associated environmental pollution caused in the production of the cement to reserve the virgin raw material used in cement making for future generations and at the same time due to the availability of supplementary cementitious like fly ash, micro silica etc., with steel fibres of aspect ratio (L/d) 40. An attempt has made to study the strength properties of ternary blended steel fibre concrete.

Hence considering the gap in existing literature an attempt has made to study the compressive strength, split tensile and flexural strength of ternary blended steel fibre concrete's using micro silica and fly ash for various w/b ratios of 0.55, 0.45 and 0.35 of 28 days for steel fibres percentages of 0%, 0.5%, 1.0% & 1.5%.

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III. ADVANCES IN CONCRETE

Generally concrete made with conventional natural stone aggregates and port-land cement suffer from several deficiencies. To over-come these deficiencies have resulted in the development of special concretes. By using super plasticizers or water reducing admixtures, pozzolanas etc. In high concrete produce between 60 to 80 Mpa compressive strengths

IV. POZZOLONIC MATERIALS

The engineering benefits likely to be derived from the use of pozzolanas in concrete include improved resistance to thermal cracking because of lower heat of hydration, enhancement of impermeability and ultimate strength due to pore refinement, a better durability to chemical attacks such as acid, sulphate water and alkali-aggregate expansion.

V. FLY ASH

Depending on calcium content, fly ash can be divided into three classes, in recognition of the difference in behavior between high and low lime fly ashes. These classes are as follows:

Type F, low calcium, 8% CaO

Type CI, intermediate calcium, 20%–8% CaO

Type CH, high calcium, 20% CaO

Low CaO fly ashes generally provide good resistance to sulphate attack and alkali-silica reaction (ASR). However, strength development at early ages is typically slower than that in conventional Portland cement content, especially at higher levels of replacement. High CaO fly ashes, on the other hand, are less efficient in suppressing expansion due to ASR or sulphate action, but generally react faster than low CaO fly ashes and have less negative impact on the early strength of concrete and are less sensitive to inadequate curing.

Most fly ashes, regardless of composition, tend to reduce the water demand of concrete and increase its resistance to fluid flow and the ionic diffusion. The beneficial effects of fly ash on permeability and diffusivity tend to become more apparent with time especially in the case of the more slowly reacting low CaO fly ashes

VI. MICRO SILICA

The availability of super plasticizers (high range water-reducing admixtures) has opened up new ideas the cementing material in concrete to produce very high strength cement (> 100 MPa/15,000 psi) for the use of silica fume as part. Silica fumes or micro silica is a by-product from the reduction of high purity quartz with coal in electric arc furnaces in the manufacture of silicon and ferrosilicon alloys..

The Pozzolanic reaction may begin as early as 2 days after cement hydration and the main Pozzolanic effect of silica fume in concrete takes place between the ages of 3 and 28 days for curing at 20^{o}C.

In fresh concrete the presence of micro silica brings reduction of bleeding and in consequences, significant improvements the mechanical behavior of hardened concrete and density of the transition zone. The strength of the transition zone can be further enhanced by a Pozzolanic reaction.

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The use of Micro Silica in combination with fly ash

Fly ash from coal fired power plants and micro Silica from the Ferro-silicon industry are both important in modern concrete technology. Used in together with Portland cement, they contribute to concrete with selected properties. There are significant differences between the products; more than 600 million tons of fly ash is produced annually, while the total availability of Micro Silica is about one tenth of a percent of this volume. Also, standards for Micro Silica are relatively tight, while variations in fly ash performance parameters reflect the great variations in feedstock for the burners, in burner technology etc.

VII. TERNARY BLENDED SYSTEM

It means silica fume or other cement replacement additives are to be used with OPC only. That is not strictly true and ternary mixtures comprise efficient -systems. The primary incentive of adding limited amount silica fume –for example 5 percent with fly-ash cement mixes was to ensure high early strength research has however, shown that ternary mixtures of OPC, silica fume and fly-ash result in synergic action to improve the micro structure and performance of concrete. When both silica fume and fly-ash are used, the resultant enhancement of strength or pozzolanic activity was greater than super position of contributions of each, for the respective proportions. Such synergic effect results from strengthening the weak transition zone in aggregate cement interface, as well as segmentation and blocking of pores.

VIII. FIBRE REINFORCE

Fibre reinforced is defined as a fine, discrete or continuous material distributed in the concrete matrix either randomly or asper design. These fire presently being investigated all over the world have been produced from different types of material in various shapes and size have come in to use.

Types of Fibres :

Depends on the elastic properties, the fibres are classified into three types.

i) High modulus high strength fibres: Steel, Carbon is the under category and which produce strong composites and impart characteristics of strength and stiffness.
ii) Low modules, low strength fibres : Bamboo strips, jute, coir and other vegetable fibres.
iii) Low modulus, High elongation fibres : Nylon, polypropylene, polyethylene etc., are capable of large energy absorption characteristics but do not lead to strength improvement.

Depending upon the composition the fibres are classified into four types as follows:

i) Organic fibres : Bamboo, Tree struck, cotton, sisal, Hemp, Coir, Jute, Rayon and polyester etc.,
ii) Inorganic fibres : Asbestos (Crystalline silicate), glass and carbon
iii) Synthetic fibres : Polypropylene, Nylon and polyethylene.
iv) Metallic fibres : Steel and stainless steel have been tested from their properties as other fibres are very stiff and costly.

Fibres like steel can be adopted towards fulfilling the goal achieving higher strength considerable research is concentrated at present in the area of steel fibre reinforced concrete. Some of the properties of different fibres

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are shown in below:

IX. SUPER PLASTICIZER - GLENIUM B233:

The Glenium B233 is based on poly carboxylic ether and is supplied as a light brown liquid instantly dispersible in water. Glenium B233 has been to give high range water reducing without loss of workability and to produce high quality concrete of reduced permeability.

The properties of the Glenium B233 as specific gravity 1.08 ± 0.01 at 25^0C, The dosage of the Glenium B233 as in the range of 500 ml to 1500 ml per 100kgs of cementitious material. If an over dosage, will result in extension of initial and final settings, bleed/segregation, quick loss of workability and increased plastic shrinkage will occur. However the ultimate compressive strength will not impaired in a slight overdosing.

The BASF Company supplying Glenium B233 in 20Kgs and 225Kgs drums. Its have minimum shelf life of 12 months, when stored under normal temperature. It is any splashes in the skin should be washed immediately with water. Splashes on the eyes should be washed immediately with water and medical advice should be sought.

X. EXPERMENTAL INVESTIGATION

The present investigations are aimed at to study Basic Studies of Ternary Blended concrete, having 5% Micro silica and 15% Fly Ash by weight of cement with different W/B ratios 0.55, 0.45and 0.35 with fibre reinforcement 0%, 0.5%, 1.0% and 1.5% after the age of 28 days only.

A. METHODOLOGY:

CEMENT

Ordinary Portland Cement 53 grade (Ultra Tech Brand.) confirming to IS: 12269 was used in the investigations. Below table gives the physical properties of ordinary port land cement used in the present investigation and they conform to IS specifications.

S.No.	**Properties**	**Test Results**
1	Normal Consistency	29%
2	Initial Setting time	85 min
3	Final Setting time	285 min
4	Specific Gravity of Cement	2.95
5	Compressive Strength at 28 days	56.3 N/mm^2

Fly Ash

The fly ash is taken from Hyderabad Industries, Andhra Pradesh .Is used in the present experimental work. The chemical composition of fly ash is rich in silica content which react with calcium hydroxide to form C-S-H gel. This gel is responsible for the strength mortar or concrete. The specification of grade 1 fly ash can be used.

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S.No	Constituents	Percentage (%)
1	Silica, Sio_2	60.9
2	Alumina, Al_2O_3	31.01
3	Iron Oxide, Fe_2O_3	3.99
4	Lime, CaO	0.7
5	Magnesia, MgO	1.50
6	Sulphur Trioxide, SO_3	0.85
7	Loss on ignition	0.2
8	Surface Area m^2/kg	236
9	Drying Shrinkage	0.012
10	Bulk Density	1.25

Micro Silica

Micro Silica conforming to a standard approved by the deciding authority may be used as part replacement of cement provided uniform blending with the cement is ensured. The(very fine non-crystalline silicon dioxide) silica fume is a by-product of the manufacture of ferrosilicon ,silicon or the like, from quartz and carbon in electric arc furnace. The following are the properties of Micro Silica. The chemical composition of Micro Silica is rich in silica.

S.NO	Constituents	Percentage (%)
1	Silica, Sio_2	92.00
2	Alumina, Al_2O_3	0.46
3	Iron Oxide, Fe_2O_3	1.60
4	Lime, CaO	0.36
5	Magnesia, MgO	0.74
6	Sulphur Trioxide, SO_3	0.35
7	Loss on ignition	2.50
8	Na_2O	0.70
9	K_2O	0.90
10	P^H	7.6
11	Accelerated Pozzolanic Acidity index in 7 days	104
12	Accelerated Pozzolanic Acidity index in 28 days	117
13	Surface Area m^2/kg	18.9
14	Moisture Content	1
15	Bulk Density	450-650

B. **AGGREGATE:** The proper strength concrete depending on the aggregate shape, size and gradation. The flaky and elongated particles will lead to blocking problems in confined zones. The sizes of aggregates will depend upon the size of rebar spacing.

Fine Aggregates: The locally available sand is used as fine aggregate in the present investigation. The sand is free from clayey matter, salt and organic impurities. The sand is tested for various properties like bulk density and specific gravity etc., and in accordance with IS 2386-1963. The fine aggregate is conforming to

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standard specifications.

S.NO	Properties	Test Results
1	Fineness modulus	2.69
2	Specific gravity	2.53
3	Bulk density a) Loose b) Compacted	 1600 kg/m^3 1720 kg/m^3

Coarse Aggregates: Machine crushed angular granite metal of 20mm nominal size from the local source is used as coarse aggregate. It is free from impurities such as dust, particles ,organic matter and clay,etc. To find the properties of coarse aggregate done by different tests .The specific gravity, bulk density and fineness modules of coarse aggregate are found to be 2.70, 1560 kg/cum and 7.17 respectively.

S.No	Properties	Test Results
1	Fineness modulus	7.17
2	Specific gravity	2.7
3	Bulk density a) Loose b) Dense	 1390 kg/m^3 1560 kg/m^3
4	Flakiness index	2.41%
5	Elongation index	12.80%

C. MIX DESIGN:

Percentages of Mineral Admixtures of Ordinary Concrete Mixes and Ternary Blended Concrete Mixes.

Mix Type	W/C	% of Cement	% of Micro Silica	% of Fly ash
Ordinary Concrete Mixes	0.55	100	-	-
	0.45	100	-	-
	0.35	100	-	-
Ternary Concrete Mixes (5%Micro Silica-15% Fly ash)	0.55	80	5	15
	0.45	80	5	15
	0.35	80	5	15

Mix proportion for Ordinary concrete

S.No	W/C Ratio	Cement	F.A.	C.A
1	0.55	1.00	2.27	3.34
2	0.45	1.00	1.78	2.73
3	0.35	1.00	1.26	2.11

Mix proportion for Ternary Blended Concrete

Sl.No	W/B Ratio	Cement	Micro Silica	Fly ash	F.A.	C.A
1	0.55	0.8	0.05	0.15	2.27	3.34
2	0.45	0.8	0.05	0.15	1.78	2.73
3	0.35	0.8	0.05	0.15	1.26	2.11

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Workability of Ternary Blended Fibre Concrete

S. No	Ternary Fibre concrete		V-bee Time in Sec	Degree of Workability	Dosage of Super Plasticizer in ml/m^3 Concrete
	W/B	% of Fibre			
1	0.55	0	2.5	Medium	0
2		0.5	3.0	Medium	411
3		1.0	3.0	Medium	411
4		1.5	4.0	Medium	822
5	0.45	0	4.0	Medium	0
6		0.5	5.0	Medium	411
7		1.0	5.0	Medium	822
8		1.5	7.0	Medium	1029
9	0.35	0	9.0	Medium	2057
10		0.5	10.0	Medium	2263
11		1.0	10.0	Medium	2468
12		1.5	11.0	Medium	2674

Compressive Strength of Ternary Blended Fibre Concrete at 28 days

S. No	Ternary Fibre concrete		Compressive Strength in Mpa
	W/B	% of Fibre	
1	0.55	0	38.53
2		0.5	42.40
3		1.0	47.54
4		1.5	43.75
5	0.45	0	48.24
6		0.5	51.46
7		1.0	55.70
8		1.5	52.03
9	0.35	0	72.83
10		0.5	76.35
11		1.0	79.86
12		1.5	77.42

Split Tensile Strength of Ternary Blended Fibre Concrete at 28 days

S. No.	Ternary Fibre concrete		Split tensile Strength in Mpa
	W/B	% of Fibre	
1	0.55	0	2.61
2		0.5	3.35

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3		1.0	4.03
4		1.5	3.40
5	0.45	0	2.79
6		0.5	3.70
7		1.0	4.55
8		1.5	3.96
9	0.35	0	3.16
10		0.5	4.15
11		1.0	5.12
12		1.5	4.70

Flexural Strength of Ternary Blended Fibre Concrete at 28 days

S. No	Ternary Fibre concrete		Flexural Strength in Mpa
	W/B	% of Fibre	
1	0.55	0	4.07
2		0.5	4.58
3		1.0	5.10
4		1.5	5.39
5	0.45	0	4.49
6		0.5	5.02
7		1.0	5.52
8		1.5	5.84
9	0.35	0	4.91
10		0.5	5.47
11		1.0	6.05
12		1.5	6.35

Percentage increase in Compressive Strength of Ternary Blended Fibre Concrete w.r.t Ternary Blended Concrete

S. No.	Ternary Fibre concrete		Compressive Strength in Mpa	% Increase
	W/B	% of Fibre		
1	0.55	0	38.53	0
2		0.5	42.40	10.04
3		1.0	47.54	23.38
4		1.5	43.75	13.54
5	0.45	0	48.24	0
6		0.5	51.46	6.67
7		1.0	55.70	15.46
8		1.5	52.03	7.85
9	0.35	0	72.83	0
10		0.5	76.35	4.83
11		1.0	79.86	9.65
12		1.5	77.42	6.30

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Percentage increase in Split tensile Strength of Ternary Blended Fibre Concrete w.r.t Ternary Blended Concrete

S. No	Ternary Fibre concrete		Split tensile Strength in Mpa	% Increasing
	W/B	% of Fibre		
1	0.55	0	2.61	0
2		0.5	3.35	28.35
3		1.0	4.03	54.40
4		1.5	3.40	30.27
5	0.45	0	2.79	0
6		0.5	3.70	32.61
7		1.0	4.55	63.08
8		1.5	3.96	41.93
9	0.35	0	3.16	0
10		0.5	4.15	31.33
11		1.0	5.12	62.02
12		1.5	4.70	48.73

Percentage increase in Flexural Strength of Ternary Blended Fibre Concrete w.r.t Ternary Blended Concrete

S. No	Ternary Fibre concrete		Flexural strength in Mpa	% Increasing
	W/B	% of Fibre		
1	0.55	0	4.07	0
2		0.5	4.58	12.53
3		1.0	5.10	25.30
4		1.5	5.39	32.43
5	0.45	0	4.49	0
6		0.5	5.02	11.80
7		1.0	5.52	22.94
8		1.5	5.84	30.06
9	0.35	0	4.91	0
10		0.5	5.47	11.40
11		1.0	6.05	22.22
12		1.5	6.35	29.33

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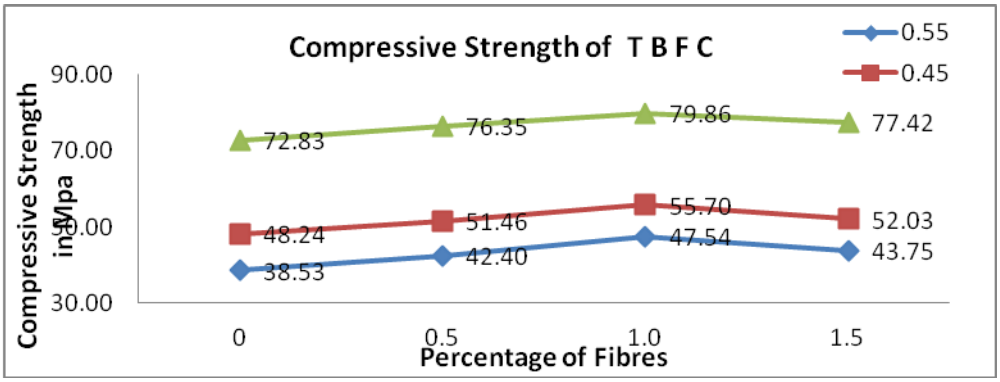
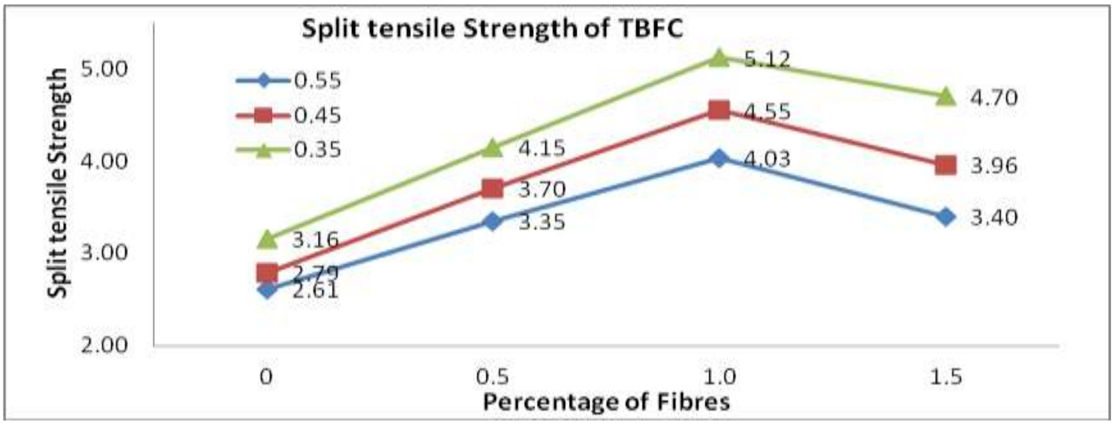
SPLIT TENSILE STRENGTH TEST **LOAD FRAME FOR FLEXURAL STRENGTH TEST**

D. GRAPHS:

Graph 1: Compressive Strength of Ternary Blended Fibre Concrete Vs Percentage of Fibres



Graph 2: Split tensile Strength of Ternary Blended Fibre Concrete Vs Percentage of Fibres



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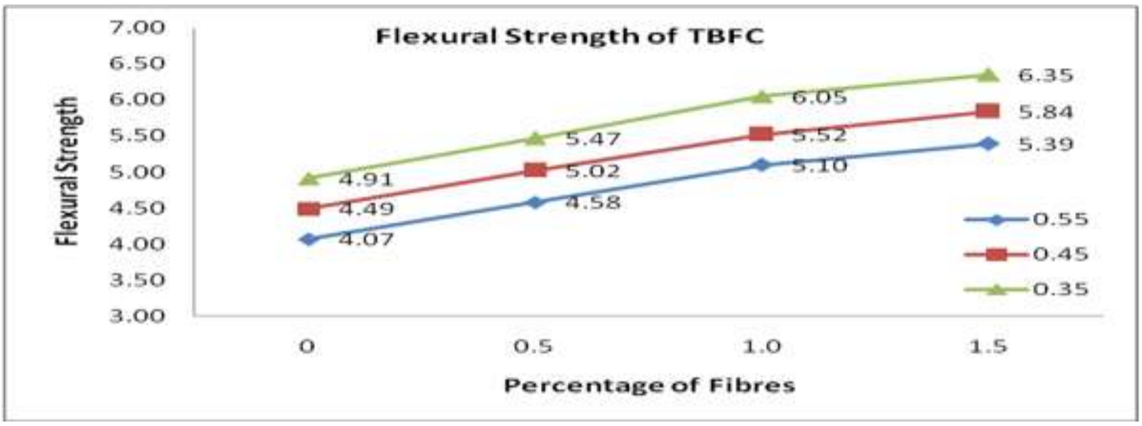
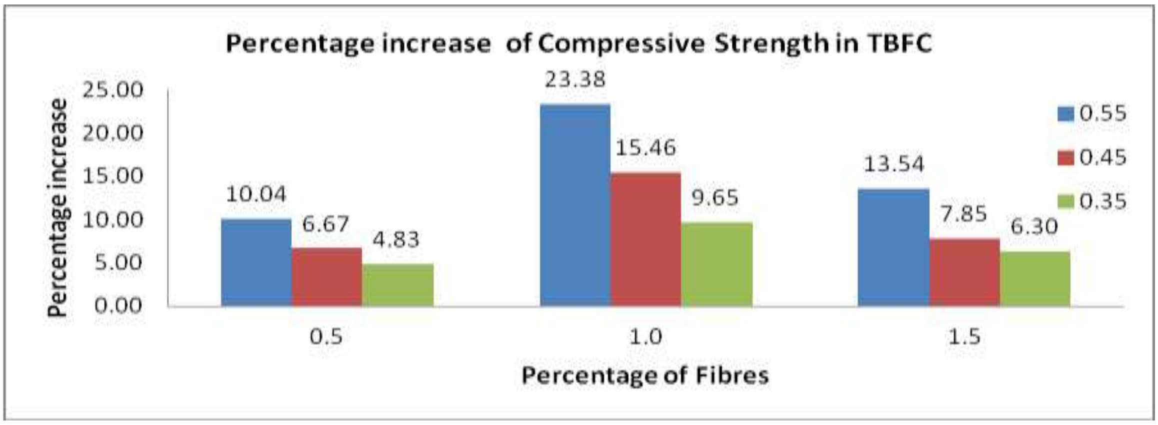
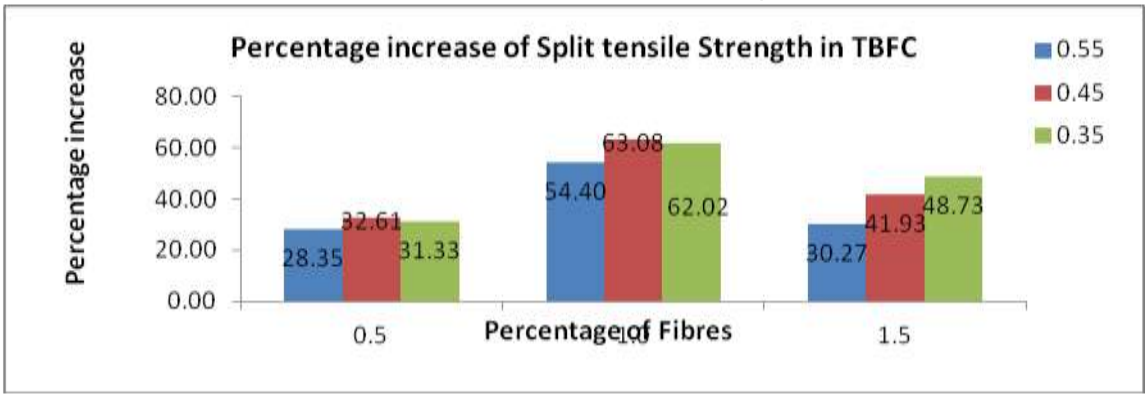
Graph 3: Flexural Strength of Ternary Blended Fibre Concrete Vs Percentage of Fibres



Graph 4: Percentage increase of Ternary Blended Fibre Concrete with different % of fibres with reference of Ternary Blended Concrete of different W/B ratios in Compressive Strength.



Graph 5: Percentage increase of Ternary Blended Fibre Concrete with different %of fibres with reference of Ternary Blended Concrete of different W/B ratios in Split tensile Strength.



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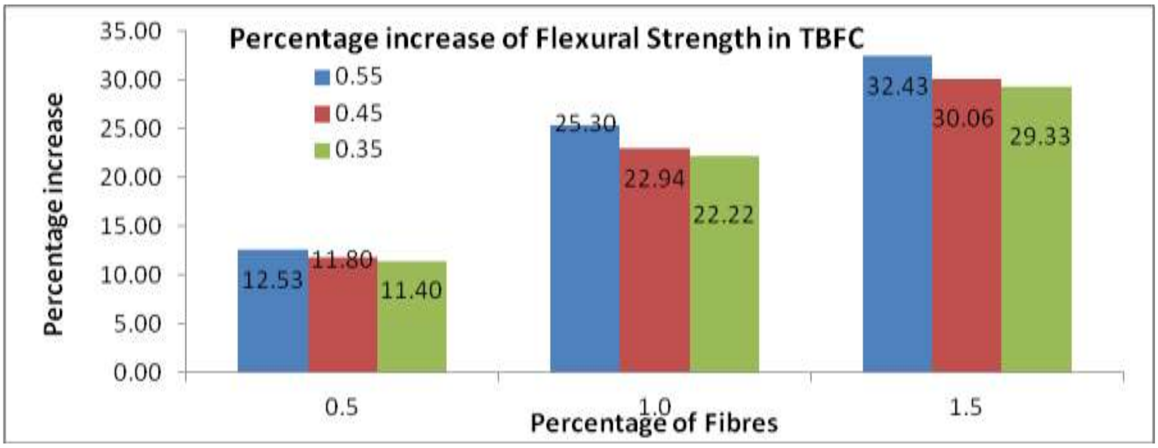
Graph 6: Percentage increase of Ternary Blended Fibre Concrete with different %of fibres with reference of Ternary Blended Concrete of different W/B ratios in Flexural Strength.



XI. CONCLUSIONS

The following Conclusions are drawn from the Experimental investigation in present Thesis:

1. The percentage increase of compressive strength of ternary blended fibre concrete of W/B ratios 0.55, 0.45, and 0.35 compared with Ternary Blended Concrete is observed to be 4.03 to 23.38 %.

2. The percentage increase of split tensile strength of ternary blended fibre concrete of W/B of ratios 0.55, 0.45, and 0.35 compared with ternay blende concrete is observed to be 28.35 to 63.08 %.

3. The percentage increase of flexural strength of ternary blended fibre concrete of W/B ratios 0.55, 0.45, and 0.35 compared with ternary blended concrete is observed to be 11.40 to 32.43 %.

4. The Compressive strength of ternary blended fibre concrete is increasing up to 1.0 % of fibres and then decrease for 1.5 % of fibres due to balling effect of fibres in concrete.

5. The Split tensile strength of ternary blended fibre concrete is increasing up to 1.0 % of fibres and then decrease for 1.5 % of fibres due to balling effect of fibres in concrete.

6. The Flexural strength of ternary blended fibre concrete is increasing with percentage increase of fibers.

7. Compressive strength, split tensile strength, flexural strength increases when W/B ratio decreases.

8. In Ternary blended fibre concrete micro silica act as filler and fly ash controls the workability. Therefore, this combination is more effective in improving the properties of ternary blended fibre concrete.

9. The combination of micro silica and fly ash leads to increase in compressive strength split tensile, flexural strength as compared to control mix irrespective of water to binder ratios.

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