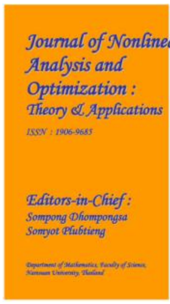

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EFFICIENT APPLICATION OF A TERTIARY MIXTURE OF CONCRETE IN RIGID PAVEMENT

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ABSTRACT

Across the world, concrete is the most often used construction material. Every kind of construction uses it as the main building material due to how easy it is to assemble. The physical properties of concrete include durability, shear strength, and compressive strength. In this study, we examined the ternary blended system, which is the process of mixing regular portland cement with additives such as silica fume or other cement replacements. It is important to acknowledge that this particular ternary combination does not constitute an efficient system. If fly ash is added to the cement mix, the early strength may be increased. When silica fume and fly ash are combined, the strength of the resultant mixture is much more than the total of the contributions from each material, even when accounting for their respective percentages. Fly ash and silica fume work in concert to enhance the performance of concrete overall as well as its microscopic structure. The material used to strengthen concrete is supposed to be dispersed randomly throughout the concrete's matrix according to the design. It's likely that adding these extra fibres will improve the concrete's durability and compressive strength. Additionally, this combination has a super plasticizer called Glenium B233, which enhances the workability of the mix while reducing the amount of water needed. Through the trials we conducted, we looked at the compressive, tensile, and flexural strengths of ternary mixed concrete. The goal of the present experiment is to investigate the effects of adding different percentages of crimped steel fibres with aspect ratios, such as 0%, 0.5%, 1%, and 1.5%, on the compressive strength, flexural strength, and tensile strength of ternary blended steel fibre reinforced concrete. Concrete's compressive strength may be assessed by testing standard cubes (150 mm x 150 mm x 150 mm) at seven and twenty-eight days following placement.

Here, some important considerations include steel fibres, super plasticizer, ternary blended material, and compressive strength.

I. INTRODUCTION

1.1. GENERAL

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 use the super plasticizers and admixtures to reducing the water and cement quantity in concrete mixture. In developing countries like India, energy plays a crucial role. In context of low availability of non renewable energy sources in generation of materials like cement and steel 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.

1.2. 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 pozolanicity 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 fibres 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 fibres 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%.

1.3. 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, pozzolonas etc. In high concrete produce between 60 to 80 Mpa compressive strengths.

1.4. POZZOLONIC MATERIALS

The engineering benefits likely to be derived from the use of pozzolonas 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.

1.5. 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 alkali-silica reaction(ASR) and good resistance to sulphate attack . 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 the react faster than low CaO fly ashes and have less sensitive to inadequate curing, less negative impact on the early strength of concrete.

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

1.5.1. Fly Ash Applications

Some of the most important specific areas where fly ash can be utilized are as follows.

1. In the manufacture of building materials, such as Activated pozzolona, Portland pozzolona cement, pozzolona metallurgical cement, masonry cement and FaL – G cement etc.
2. To construct structural gills, highway embankments, dams and for filling of mines.
3. As construction materials for highways.
4. For land reclamation and soil modification.
5. In mortars, grouts and concrete such as mass concrete, structural concrete etc.
6. In fly ash based bricks/blocks cellular or aerated concrete blocks/slabs.
7. As filler in fertilizer plants and in recovery of material like iron, aluminum, titanium etc.
8. For manufacturing of Cleaning/washing powder, polypropylene, asbestos.
9. As light weight aggregate in high strength concrete in distempers and sanitary products.
10. For lining of drains and canals.

1.6. MICRO SILICA

The availability of super plasticizers (high range water-reducing admixtures) has opened up new ideas in concrete the high strength produce by the cementing material, the strength of 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 ferrosilicon and silicon alloys..

The Pozzolanic reaction may begin as early as 2 days after hydration of cement 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.

1.7. TERNARY BLENDED SYSTEM

The other cement replacement additives it means silica fumeare to be used with OPC only. That is not strictly true and ternary mixtures comprise efficient -systems. The primary quantity of adding limited amount silica fume –for example 5 percent with fly-ash cement mixes was gain high early strength research has however, shown that ternary mixtures of OPC, fly-ash and silica fume result in synergic action to improve the micro structure and performance of concrete. When both fly-ash and silica fume are used, the resultant increase of strength and 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.

Fig 1.8.1 Chopping the steel fibre with shear cutting machine.

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 are shown in below table -

Table 1.8.1 Different types of fibres

TYPES OF FIBRES	SPECIFIC GRAVITY	YOUNGS MODULES KN/MM^2	TENSILE STRENGTH KN/MM^2	ELONGATION
1. ORGANIC				
Cotton	1.5	490	42 to 70	3 to 10
Bamboo	0.8	14 to 19.6	15 to 32	-
Polyester	1.4	840	74 to 88	11 to 13
Sisal	1.5	-	0.8	3.0
Rayon	1.5	7 to 8	0.4 to 0.6	10 to 25
2. IN ORGANIC				
Glass	2.60	70 to 80	2 to 4	2 to 3.5
Asbestos	3.20	8 to 14	0.56 to 0.99	0.6
Acrylic	1.10	2.1	0.2 to 0.4	25 to 45
3. SYNTHETIC				
Poly Propylene	0.91	6 to 7	0.5 to 0.7	20
Polyethylene	0.95	0.15 to 0.4	0.7	3.0
Nylon	1.10	4.2	0.78 to 0.85	16 to 80
4. METALLIC				
Steel	7.845	200	1 to 3	3 to 4
Polycrystalline	3.90	245	0.65	-
Graphite Type I	1.9	380 to 415	1.5 to 2.1	0.5
Graphite Type II	1.9	240 to 280	2.4 to 2.6	1.0

1.9. 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 reduced the permeability to achieve the high quality concrete.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 20 Kgs and 225 Kgs drums. Its have minimum 12 months self life, when stored under normal temperature conditions. It is any splashes in the skin should be washed immediately with water. immediately wash eye with water if any Splashes on the eyes and medical advice should be sought.

1.9.1. Advantages of Glenium B233

The advantage of Glenium B233 is the following cases:

i. Elimination of vibration and reduced labour cost in placing.
ii. Marked increasing in early and ultimate strengths.
iii. Higher Modulus of Elasticity.
iv. Improved addition to reinforcing and stressing steel.
v. Better resistance to carbonation and other aggressive atmospheric conditions.
vi. Lower permeability – Increased durability.
vii. Reduced shrinkage and creep.

1.10. ENVIRONMENTAL BENEFIT

The principal ingredients of concrete are gravel, sand, water and Portland cement. Cement composes only 10 to 15% of concrete by weight but its production is responsible for most of concrete's environmental impacts.Apart from the fact that fly ash concrete is superior to normal Portland cement in almost all aspects, there are also significant environmental benefits.

The production of one tonne of Portland cement results in the release of about one tonne of CO_2 into the atmosphere. Thus if this expensive cement can be replaced by very low cost fly ash it can significantly contribute to the greenhouse gas emissions.India's annual Portland cement clinker production is of the order of 90 million tones, and thus releases about 90 million tonnes of CO_2 into atmosphere. Only if 25 percent of cement is replaced by fly ash, there will be a potential reduction of 25 million tones of CO_2. In this manner the cost of disposal of fly ash is saved and at the same time it contributes to the reduction of CO_2 emissions.

II. EXPERIMENTAL INVESTIGATION

2.1. INTRODUCTION

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 0.35with fibre reinforcement 0%, 0.5%, 1.0% and 1.5% after the age of 28 days only.

2.2. MATERIALS

2.2.1. Cement

Locally available 53 grade of Ordinary Portland Cement (Ultra Tech Brand.) confirming to IS: 12269 was used in the investigations.

Fig.3.2.1 Cement

Table 4.1 gives the physical properties of OPC used in the present investigation and they conform to IS specifications.

2.2.2. Fly ash

The fly ash obtained from Hyderabad Industries, Andhra Pradesh is used in the present experimental work.

Fig. 3.2.2 Fly ash

Table 4.4 gives properties of fly ash. 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 fly ash used to the specification of grade 1 fly ash.

3.2.3 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 silica fume (very fine non-crystalline silicon dioxide) is a by-product of the manufacture of silicon, ferrosilicon or the like, from quartz and carbon in electric arc furnace.

Fig 3.2.3 Micro silica

Table 4.5 gives properties of Micro Silica. The chemical composition of Micro Silica is rich in silica.

2.2.4. AGGREGATE

The size, shape and gradation of the aggregate play an important role in achieving a proper concrete. 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.The coarse aggregate chosen for Ternary Blended Concrete is typically angular in shape, is well graded, and smaller in maximum size that suited for conventional concrete; typical conventional concrete should have a maximum aggregate size of 20mm. Gradation is an important factor in choosing a coarse aggregate, especially in typical uses of Ternary Blended. Gap-graded coarse aggregate promotes segregation to a greater degree than the well graded coarse aggregate.

2.2.4.1.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 specific gravity, bulk density etc., and in accordance with IS 2386-1963. The fine aggregate is conforming to standard specifications

2.2.4.2. Coarse Aggregates

Machine crushed angular granite metal of 20mm nominal size from the local source is used as coarse aggregate.

Fig 3.2.4.2 Coarse aggregate

It is free from impurities such as dust, clay particles and organic matter etc. The course aggregate is also tested for its various properties. The specific gravity, bulk density and fineness modules of coarse aggregate are found to be 2.70, 1560 kg/cum and 7.17 respectively.

3.3. PREPARATION OF TEST SPECIMENS

3.3.1. Mixing

Mixing of ingredients is done in a rotating drum. Thorough mixing by hand, using trowels is adopted.

The cementitious materials are thoroughly blended with hand and then the aggregate is added and mixed followed by gradual addition of water and mixing. Wet mixing is done until a mixture of uniform color and consistency are achieved which is then ready for casting. Before casting the specimens, workability of the mixes was found by compaction factor test.

Fig 3.3.1 concrete mixing drum

3.3.2. Workability Test:

Immediately after mixing each of concrete, was tested for workability by Vee bee apparatus in the laboratory.

Fig 3.3.2 Vee bee apparatus

Table 4.7 gives the Vee bee time value for different mixes, and the Degree of Workability of mixes is medium for W/B 0.55, 0.45 and 0.35 of Ternary Blended Fibre Concrete.

3.3.3. Compaction

Compaction of concrete is the process adopted for expelling the entrapped air from the concrete. In the process of placing and mixing of concrete, air is likely to get entrapped in the concrete. If this air is not removed fully, the concrete losses strength considerably.

Fig 3.3.3.Needle vibrator

3.5. TESTS CONDUCTED

3.5.1. Compressive Strength of concrete specimens

The cube specimens cured as explained above are tested as per standard procedure after removal from curing water and allowed to dry under shade.

The compression testing machine employed to determine the compressive strength of cube specimens under micro process based compression testing machine of ELE international Ltd., UK. The capacity of the testing machine was 2000KN. The machine has the facility of a clutch & control valve by means of which the rate of loading can be adjusted. The machine has been calibrated to standard rate of loading. The platens are cleaned, oil level is checked and it is kept ready in all respects for testing.

Fig 3.5.1 Compressive strength testing machine

After the required period of curing specimens are removed from the curing tank just before testing and cleaned to wipe off the surface water. The cube specimen is placed on the lower platen in such a manner that load is applied centrally and right angles to that as cast. According to IS 1881 –1970 (part-4), the rate of applied load is equal to 5 k.n/sec or 0.22 N/mm^2/sec. The oil pressure valve is closed and the machine switched on. The top platen of the compression-testing machine is brought in to contact with the surface of the cube specimen then operate the clutch with suitable rate of loading, the load improvements displaying on digital screen system. When the load goes on increased to ultimate load, the specimen breaks and the digital screen reading starts moving back, then immediately switch off the machine, the pressure valve is released then automatically the ultimate load is displayed and the platterns are also loosened, then the noted the ultimate load reading and the crushed specimen is removed. The compressive strength is calculated as P/a^2 . Where P is ultimate load reading and a is the cube size.

The same procedure is repeated for testing the other specimen and the average compressive strength of the cube specimens tested for various mixes have been presented in table no. 4.8

3.5.2. Split Tensile strength of Concrete Specimens

The test is carried out by placing a cylindrical specimen (150 mm in diameter and 300 mm long) horizontally between the loading surfaces of a compression testing machine (Microprocessor based) and the load is applied until failure of the cylinder, along the vertical diameter. When the load is applied along the generatrix, an element on the vertical diameter of the cylinder is subjected to a vertical compressive stress and a horizontal stress of 2P/∏ LD. It is observed that cylinder did split into two halves

Split Tensile Strength = 2P/∏ LD

Where P is the Maximum compressive load in the cylinder

L is the length of cylinder, D is its diameter.

The loading conditions produce a high compressive stress immediately below the two generators to which the load is applied. But the larger portion corresponding to depth is subjected to a uniform tensile stress acting horizontally. It is estimated that the compressive stress is acting for about 1/ 6 depth and the remaining 5/ 6 depth subjected to tension.

Fig 3.5.2 Split tensile strength for cylinders

In order to reduce the magnitude of the high compression stress near the points of application of the load, narrow packing strips of suitable material such as plywood are placed between the specimen and the loading platens of the testing machine. The packing strips should be soft enough to prevent large contact area.

The same procedure is repeated for testing the other specimen and the average Split tensile strength of the cylinder specimens tested for various mixes have been presented in table no. 4.9

3.5.3. Flexural Strength of Concrete Specimens

Concrete is relatively strong in compression and weak in tension. In reinforced concrete members, little dependence is placed on the tensile strength of concrete since steel reinforcing bars are provided to resists all tensile forces. However, tensile stresses are likely to develop in concrete due to drying shrinkage, rusting of steel reinforcement, temperature gradient and many other reasons.

Direct measurement if tensile strength of concrete is difficult. A number of investigations involving the direct measurement of tensile strength have been made. Beam test are found to be dependable to measure flexural strength property of concrete.

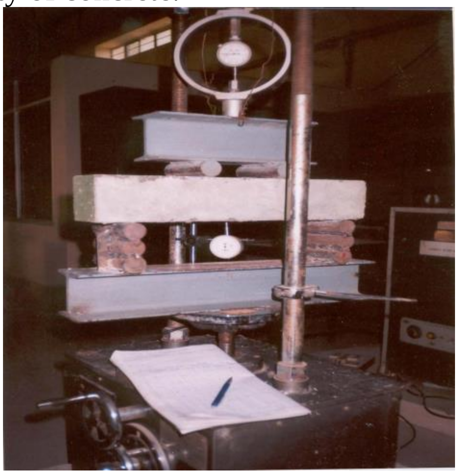


Fig 3.5.3.1. Flexural testing for beams

Fig 3.5.3.2. Universal testing machine

EXPERIMENTAL RESULTS

4.1. CEMENT

Portland cement is the most commonly used type of cement in the world today. Portland cement can be found in both concrete and mortar, not to mention other construction mediums such as stucco and some types of grout, where it acts as a binding agent.

8.1.1 Normal Consistency of Cement

N ormal consistency of cement sample was determined as per IS: 269-1976 and IS: 4031-1968.

Table 8.1 Normal Consistency of Cement

TRAIL NO	WEIGHT OF CEMENT	% OF WATER ADDED	DEPTH OF PENETRATION (mm)
1	400	28	15
2	400	30	10
3	400	32	7

Hence the consistency of cement = 32%

8.1.2 Initial Setting Time of Cement

The initial setting time of cement sample was determined as per IS:269-1976 and IS: 4031-1968.

Weight of cement sample taken = 400g

Consistency of cement =32%

Volume of water to be added = $\frac{0.85\times P}{400}$ (as above)

Initial setting time obtained = 85 minutes.

8.1.3 Final Setting Time of Cement

The final setting time of cement sample was determined as per IS:269-1976

Weight of cement sample taken =400g

Consistency of cement =32%

Volume of water to be added =$\frac{0.85\times P}{400}$

Final setting time = 285 minutes.

8.1.4 Specific Gravity of Cement

Specific gravity of cement can be determined as per IS standards as follows

Weight of empty specific gravity bottle W1 =44.1 g

Weight ofspecific gravity bottle + cement W2 =70.00 g

Weight of specific gravity bottle + cement + kerosene W3 = 106.20 g

Weight of specific gravity bottle+ kerosene W4 = 83.80 g

Specific gravity of kerosene = 0.79

Specific gravity of cement = (W2-W1)/{(W4-W1)-(W3-W2)} = 2.95

COMPRESSIVE STRENGTH OF CEMENT

SL.No	7 days strength N/mm2	28 days strength N/mm2
Specimen 1	40.20	55.18
Specimen 2	41.44	56.26
Specimen 3	41.80	57.19
Average	41.14	56.3

Table : 4.1 Physical Properties of Ordinary Portland Cement

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

4.2 FINE AGGREGATE

SPECIFIC GRAVITY OF FINE AGGREGATES

Weight of empty pycnometer W1 = 610 g

Weight of pycnometer + fine aggregate W2 = 1110 g

Weight of pycnometer + fine agg + water W3 = 1769.2 g

Weight of pycnometer + water W4 = 1450 g

1) Dry weight of aggregate =W2-W1

2) Weight of equivalent volume of water = (W2-W1)-(W3-W4)

Specific gravity = (W2-W1)/(W2-W1)-(W3-W4) = 2.69

Table 4.2.1.Physical Properties

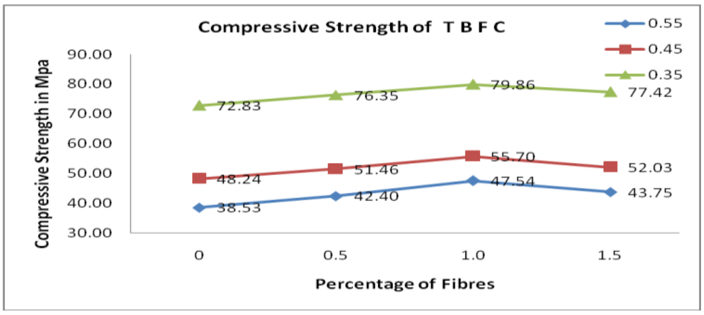
S.No	PROPERTIES	TEST RESULTS
1	Fineness modulus	2.69
2	Specific gravity	2.53
3	Bulk density	
	a)Loose	1600 kg/m³
	b). Compacted	1720 kg/m³

Table 4.2.2. Sieve analysis: Sample 1000 gms

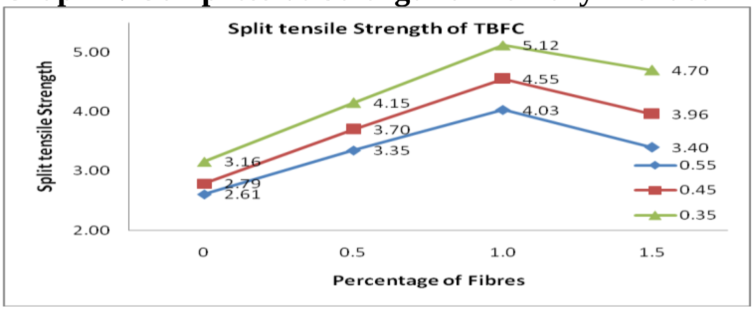
S.No.	I.S Sieve Size	Weight Retained (gms.)	Cumulative Weight Retained (gms.)	Cumulative % of weight Retained	% Passing
1	4.75 mm	21	21	2.1	97.9
2	2.36 mm	31	52	5.2	94.8
3	1.18 mm	104	156	15.6	84.4
4	600µ	405	561	56.1	43.9
5	300µ	350	911	91.1	8.9
6	150µ	86	997	99.7	0.3
7	<150µ	3	1000	100	0
	Total	1000	--	269.9	--

Fineness modulus fine aggregate = 269.9/100 = 2.69

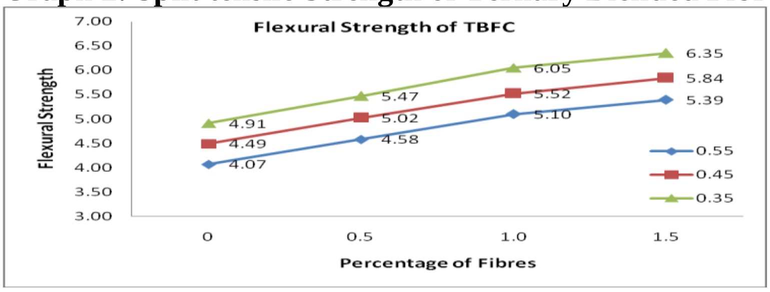
GRAPHS



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



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

DISCUSSION OF TEST RESULTS

5.1 COMPRESSIVE STRENGTH OF TERNARY BLENDED FIBRE CONCRETE.

Table 4.8 gives the compressive strength values for ternary blended fibre concrete of 0.55, 0.45, and 0.35 W/B ratios. These values are observed for W/B ratio 0.55 was 38.53, 42.40, 47.54 & 43.75 is respectively fibre ratios of 0, 0.5, 1.0 & 1.5 percentages, for W/B ratio 0.45 was 48.24, 51.46, 55.70 & 52.03 is respectively fibre ratios of 0, 0.5, 1.0 & 1.5 percentages and for W/B ratio 0.35 was 72.83, 76.35, 79.86 & 77.42 is respectively fibre ratios of 0, 0.5, 1.0 & 1.5 percentages. These variations are observed as in Graph 1.

5.2 SPLIT TENSILE STRENGTH OF TERNARY BLENDED FIBRE CONCRETE.

Table 4.9 gives the Split tensile strength values for ternary blended fibre concrete of 0.55, 0.45, and 0.35 W/B ratios. These values are observed for W/B ratio 0.55 was 2.61, 3.35, 4.03 & 3.40 is respectively fibre ratios of 0, 0.5, 1.0 & 1.5 percentages, for W/B ratio 0.45 was 2.79, 3.70, 4.55 & 3.96 is respectively fibre ratios of 0, 0.5, 1.0 & 1.5 percentages and for W/B ratio 0.35 was 3.16, 4.15, 5.12 & 4.70 is respectively fibre ratios of 0, 0.5, 1.0 & 1.5 percentages. These variations are observed as in Graph 2.

5.3. FLEXURAL STRENGTH OF TERNARY BLENDED FIBRE CONCRETE.

Table 4.10 gives the Flexural strength values for ternary blended fibre concrete of 0.55, 0.45, and 0.35 W/B ratios. These values are observed for W/B ratio 0.55 was 4.07, 4.58, 5.10 & 5.39 is respectively fibre ratios of 0, 0.5, 1.0 & 1.5 percentages, for W/B ratio 0.45 was 4.49, 5.02, 5.52 & 5.84 is respectively fibre ratios of 0, 0.5, 1.0 & 1.5 percentages and for W/B ratio 0.35 was 4.91, 5.47, 6.05 & 6.35 is respectively fibre ratios of 0, 0.5, 1.0 & 1.5 percentages. These variations are observed as in Graph 3.

CONCLUSIONS

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

1. When ternary blended fibre concrete with W/B ratios of 0.55, 0.45, and 0.35 is compared to ternary blended concrete, the percentage improvement in compressive strength is found to be 4.03 to 23.38%.
2. Compared to ternary blende concrete, the percentage improvement in split tensile strength of ternary blended fibre concrete of W/B of ratios 0.55, 0.45, and 0.35 is seen to be between 28.35 and 63.08 percent.
3. When compared to ternary blended concrete, the percentage increase in flexural strength of ternary blended fibre concrete with W/B ratios of 0.55, 0.45, and 0.35 is found to be between 11.40 and 32.43%.
4. The balling action of the fibres in the concrete causes the compressive strength of ternary blended fibre concrete to increase up to 1.5% of the fibres and then decrease for the remaining 1.5% of the fibres.
5. Because of the balling action of the fibres in the concrete, the split tensile strength of ternary blended fibre concrete increases up to 1.5% of the fibres and then decreases for the remaining 1.5% of the fibres.
6. As the amount of fibres increases, so does the ternary blended fibre concrete's flexural strength.
7. As the W/B ratio falls, the compressive strength, split tensile strength, and flexural strength all rise.
8. Fly ash regulates the workability and micro silica serves as a filler in Ternary mixed fibre concrete. Consequently, this combination works better to enhance the characteristics of concrete with ternary mixed fibres.
9. Regardless of the water to binder ratios, the addition of micro silica and fly ash increases the compressive strength, split tensile strength, and flexural strength when compared to the control mix.

SCOPE OF FURTHER STUDY :

The current research may be used to examine the long-term strength of concrete with ternary mixed steel fibre at 180 and 360 days.

Durabulity tests of ternary mixed steel fibre concrete may be conducted further.
The flexural strength of ternary mixed steel fibre concrete at 180 and 360 days may be further studied.

REFERENCES

1. **Tahir Kemal Erdem, Onder Klrca. "** Use of Binary and Ternary Blended in high strength concrete'. Construction and Building materials 22(2008) Pg 1477-1483.
2. **M.D.A. Thomass, M.H. Shehata, S.G. Shaishiprakash, D.S.Hopkins, K.Cail**. "Use of Ternary cementitious system containing Silica fume and Fly ash in Concrete". Cement and concrete Research 29(1999) Pg 1207-1214.
3. **Roland Bleszynski, R. Doug Hooton, Michael D.A Thomas, and Chris A. Rogers** " Durabilty of Ternary Blended concrete with Silica Fume and Blast-Furnace Slag: Laboratory and Outdoor Exposure Site Studies". ACI materials journals September-October 2002.
4. **ShwetaGoyal, Maneek Kumar and B.Bhattacharjee. "** Potential Benefits of incorporating fly ash in Silica fume concrete". The INDIAN Concrete Journal, August 2008.
5. **A.K. Mullick. "**Performance of Concrete with Binary and Ternary cement blends". The INDIAN Concrete Journal, January 2007.
6. **M.I.Khan, C.J. Lynsdale, P.Waldron**. " Porosity and Strength of PFA/SF/OPC Ternary blende paste". Cement and Concrete Research 30(2000) Pg 1225-1229.
7. **Mohd Shariq a, Jagdish Prasad b, Amjad Masood c: "**Effect of GGBFS on time dependent compressive strength of concrete "Construction and Building Materials 24 (2010).
8. **Tahir Kemal Erdem a Onder Kırcab "** Use of binary and ternary blends in high strength concrete" Construction and Building Materials 22 (2008).
9. **G. Men_endez , V. Bonavetti, E.F. Irassar "**Strength development of ternary blended cement with lime stone filler and blast-furnace slag" Cement and Concrete Composites (2003).