OPTIMIZATION OF MECHANICAL PROPERTIES FOR LIGHTWEIGHT HYBRID FIBRE REINFORCED CONCRETE (LWHFRC)

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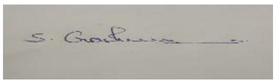

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ABSTRACT:

Many research works has been carried out on concrete which had encouraged the development of material with replacement of aggregate in order to reduce their weight which resulted in lightweight concrete. For lightweight concrete, weight of the aggregate should be reduced so that the self weight of the structural members is reduced and helps in constructing of larger precast units where reduction of self weight is an important factor which may increases thermal insulation .Fibre reinforced concrete (FRC) is a concrete consists of fibrous material which increases the tensile strength of the concrete members with distributed and oriented fibres. In this investigation the strength and durability properties of lightweight concrete by replacement of light weight aggregates will be studied and also discussed 4 types of lightweight aggregates. The properties of conventional concrete are compared with properties of light weight FRC . An optimum control mix is designed based on light weight concrete using the light weight aggregates and mechanical behaviour of fibre reinforced lightweight concrete with composition of various fibres and nature of fibres. For this purpose hybrid of hooked steel fibres of length 50mm and chopped glass fibres used for polymer products. This study results in the optimisation of fibres and lightweight aggregates with comparison of the concrete specimen strength at 7and 28 days with improved specific properties of FRC composites showing the compressive strength, ,flexural strength, split tensile strength of the specimen.

Key words: lightweight concrete, fibres, lightweight aggregates, Compressive strength fibre reinforced concrete, tensile strength

RESEARCH SIGNIFICANCE

Lightweight concrete was developed to reduce concrete density and and to improve thermal and sound insulation properties, while improving strength. The reduced weight has numerous advantages, a reduced demand on energy during construction. Hybrid Fibres are used in concrete is to enhance controlled cracking due to drying shrinkage and to plastic shrinkage. If the modulus of elasticity of the fibre is higher than the matrix ,they help to carry the load by increasing tensile strength of the FRC. Increase in fibre content of FRC increases the Modulus of elasticity of FRC. The addition of steel fibres helps in converting the properties of brittle concrete to a ductile material but addition of steel fibres with glass fibre makes the results better than that and generally it enhance the compressive strength and flexural strength of plain concrete but improvement in strength does not always increase with a larger dosage of fibres which need to detect the optimum fibre content in FRC in this experiment.

1. INTRODUCTION:

Generally, concrete member is strong in compression and weak in tension. Concrete is brittle and will crack with increasing tensile force. Once concrete cracks it cannot withstand longer tensile loads. In order to make concrete capable of carrying tension at strains greater than those at which cracking initiates, it is necessary to increase the tensile strength by adding fibres. Lightweight concrete mixture is made with a lightweight aggregate instead of normal aggregates. For the most part light weight concrete is not as strong as concrete made with lightweight aggregates. Because of high density of traditional concrete with ordinary aggregates, a few endeavours have been made in the past to decrease the density and self weight of concrete called light weight concrete which is lighter than the conventional concrete made with lightweight aggregates.

It is extremely hard to design steady light weight concrete. One specific issue is that numerous light weight aggregates have high water absorption property. It is unenviable to utilize aggregates in the immersed, surface-dry condition ensuring to the water substance of the aggregates should be minimized with a specific goal to keep the concrete density low. For the most part dry lightweight aggregates are utilized. Furthermore, the amount of water consumed by the lightweight aggregates in the time of middle of blending and setting of the concrete, which will differ generally indicated by conditions, must be determined.

The major benefit in endorsing the light weight concrete mixes is of reducing the dead load of the structure up to 15% or more. When there is reduced unit weight of aggregate then comparatively the unit weight of concrete will be reduced and it is done by replacing the normal weight aggregate to the light weight aggregates. More research work is being carried out because of its lower density, porous and high volume occupancy. It includes an enlarging agent which increases the volume of the mixture. It is having low-density by maintaining large voids and when placed on the wall it forms cement films.

For a hybrid concrete , more than two different fibres are mixed with a concrete matrix to produce a composite concrete. Use of both steel and glass fibre can give potential advantages in improving the performance and properties of concrete matrix. Hence, this experiment proves the feasibility of HFRC with required grade of the concrete matrix with a weight of cement fraction of 1-4% in construction fields in future

There are two different methods to categorize fibres according to their elastic modulus or their origin. In the view of modulus of elasticity, fibres can be classified into two basic categories, one having a higher modulus of elasticity than concrete mix (called hard intrusion) and those with lower modulus of elasticity than the concrete mix (called soft intrusion).

Steel, carbon and glass have higher modulus of elasticity than cement mortar matrix, and polypropylene and vegetable fibres are classified as the low elastic modulus fibres with less tensile strength. High elastic modulus fibres simultaneously can improve tensile, flexural and impact resistance; whereas, low elastic modulus fibres can improve the impact resistance of concrete but do not contribute much to its tensile and flexural strength.

As more experience is gained with Steel FRC, more applications are accepted by the engineering community. ACI Committee 318 "Building Code Requirements for Reinforced Concrete" does not yet concede the enhancements that SFRC makes accessible to structural elements. Then more data will be available to contribute to the recognition of magnified SFRC properties in this and other codes. The most considerable properties of SFRC are the improved flexural toughness (such as the potential to absorb energy after cracking), impact resistance, and flexural fatigue endurance.

2. MATERIAL AND METHODOLOGY:

CEMENT: Ordinary portland cement was used in this experimentation conforming to IS. – 12269- 1987.

Compound Composition	(%)
Al_2O_3 Aluminum Oxide	5.8
SiO_2 Silicon Dioxide	21.35
Fe_2O_3 Iron Oxide	2.6
CaO Lime	62.3
SO_3 Sulphur Trioxide	2.5
MgO Magnesium Oxide	3.33
C_3S	41.5
C_2S	30
C_3A	10.9
C_4AF	7.9

PERLITE:

Perlite is an amorphous volcanic glass occurred due to volcanic activity that has relatively high water content. It occurs naturally and has the property of expanding when heated sufficiently. It is an industrial mineral and a commercial product useful for its light weight after processing the product expands 4-20 times its original volume.

S.NO.	Property	Result
1	Specific gravity	0.4
2	Nature of Physical state	Micronized powder
3	Water absorption capacity	6.5%

FIG-1 PERLITE

PUMICE:

Pumice stone is a consistent material formed from rapidly cooling molten rock by trapping gas bubbles which led to the formation in a foamy whipped glass. It is even formed in deep undergrounds and when the magma erupts from a vent by forming the gases which leaves a foamy structure. The transformed magma is the or pumice. Pumice is found in various textures such as pyroclastic flows, accumulated drifts, piles and at the river banks by the action of wind the pure pumice is obtained in a floating mass or near the shore as it saturates by sinking and near the water bodies by the action of wind.

S.NO.	property	Result
1	Specific gravity	0.9
2	Physical state	White granules
3	Dry density	574.5kg/m^3

FIG-2 PUMICE

PORAVER:

Poraver expanded glass is adaptable lightweight aggregate for high-quality building materials and industrial products. Poraver offers a mix of formidable characteristics which no other product in this spectrum has. Despite its low density, Poraver is impenetrable to pressure. It not only acts as thermal insulation but also absorbs sound, dimensionally stable over the long term, and resistant to moisture, fire and chemicals. Poraver composed of recycled glass and is 100 % mineral.

FIG-3 PORAVER

M-SAND:

Manufactured sand is a substitute for river sand for concrete construction . Manufactured sand is produced by crushing of hard granite stone . The crushed sand is of cubical shape with grounded edges, graded and washed to as a construction material. The size of manufactured sand is less than 4.75mm so it seized and used.

LECA :

The expansion of LECA is Light weight expandable clay aggregate. LECA is produced of clay with low lime content, which is dried and fired in rotary kilns. The stove shape the clay into pellets and at high temperature of 1.150 °c gas is formed. The pellets expanded by the gas emerge in the property of high porosity and low weight properties. The porosity is caved in by a matrix of solid brick like ceramic material with upright compressive strength.

Sl.no	Property	Value
1	Specific gravity	0.56
2	Water absorption	18%

FIG-4 LECA

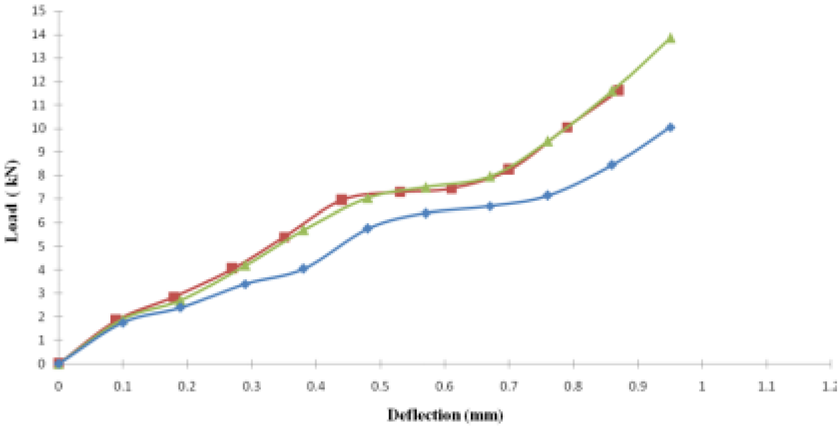
Load Vs. Deflection Behaviour

The load - deflection response for various percentages of LECA 10%,20%,30% replacement to coarse aggregate were as follows:

The experimental investigation is divided into two phases.

- In the first phase, pumice stone and LECA were replaced to coarse aggregate of percentages 0%,10%,20% and 50% and the mechanical properties were studied. By replacing LECA, load vs displacement behaviour was studied. In this phase, the mechanical properties were lowered to some extent but whereas the dead weight of the concrete found to be reduced than conventional concrete.
- In the second phase of work, the mineral admixture Silica Fume is replaced by 5-10% weight of cement and with same percentages of pumice stone were taken and the mechanical properties and also load - deflection behaviour were studied.

The load - deflection response for various percentages of LECA 10%,20%,30% replacement to coarse aggregate were as follows:



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SUPERPLASTICIZER:

Water-reducing admixtures are primarily used to reduce the water-cement ratio content of concrete, thus increasing strength. In some cases, they can be used to increase the workability or slump of the concrete providing for smoother placement.

SILICA FUME:

Silica fume increases the compressive strength of concrete significantly (6-57%). The increase depends upon the replacement level. The tensile and flexural strength of silica fume concrete is almost indistinguishable to the referral concrete. By considering this result 5-10 % silica fume is replaced in cement content.

FIG-4 SILICAFUME

FLY ASH :

FIG-5 FLYASH

Fly ash induced on the properties of concrete with a view to improving the level of fly ash used for a given application. The optimum amount of fly ash differ not only with the application, but also with proportions and also composistion of all the materials in the concrete mixture (especially the fly ash), the conditions during placing (temperature), construction practices (finishing and curing) and the exposure conditions. Fly ash contents of up to 0-50% may be suitable for most elements provided the early-age strength requirements of the project can be met and provided that adequate moist-curing can be made certain. Thus fly ash content of 10% is replaced in cement content.

FIBERS USED:

STEEL FIBERS: - In this investigation Hooked Steel fibres were used with length 50 mm with diameter 0.70mm.

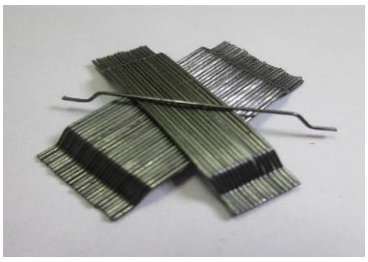


FIG-6 STEEL FIBRES

GLASS FIBRES:

In concrete structure, efficiency of fibres depends based on their orientation. When the fibres are lined up perpendicular to the crack openings in the direction of stress, the positive effect of fibres on the performance of tensile strength is increased.

FIG-7 GLASS FIBRES

3. MIX PROPORTIONS AND CASTING OF LIGHTWEIGHT CONCRETE:

The casting is done by mixing appropriate materials such as Cement, aggregate, fibres, superplasticizer and water in required volume and only aggregate volume is changed by lightweight aggregate.

MIX TYPE	CEMENT (kg/m^3)	SILICAFUME (kg/m^3)	FLYASH (kg/m^3)	WATER (l/m^3)
MIX 1	425.96	26.62	79.86	212.98
MIX 2	425.96	26.62	79.86	212.98
MIX 3	425.96	26.62	79.86	212.98
MIX 4	425.96	26.62	79.86	212.98

PROPORTIONS OF AGGREGATE IN PERCENTAGE OF VOLUME:

MIX TYPE	LECA	PUMICE	POROVER	MSAND	PERLITE
MIX 1	50%	40%	0	10%	0
MIX 2	40%	0	20%	0	40%
MIX 3	50%	35%	15%	0	0
MIX 4	50%	20%	15%	0	15%

FINAL MIX PROPORTIONS:

CONVENTIONAL	FINE AGGREGATE	-743 kg/m3
	COARSE AGGREGATE	-1155 kg/m3
MIX 1	LECA	-288.55 kg/m3
	PUMICE	-207.64 kg/m3
	M-SAND	-150 kg/m3
MIX 2	LECA	-230.55 kg/m3
	POROVER	-55.40 kg/m3
	PERLITE	-138.50 kg/m3
MIX 3	LECA	-288.55 kg/m3
	PUMICE	-181.75 kg/m3
	POROVER	-41.55 kg/m3
MIX 4	LECA	-288.55 kg/m3
	PUMICE	-103.87 kg/m3
	POROVER	-41.5572 kg/m3
	PERLITE	-51.93 kg/m3

4.SPECIMEN TESTING AND RESULTS:

1.COMPRESSIVE STRENGTH:

The compressive strength of cubes is obtained after curing of 7 and 28 days and 28 days compressive strength will increases in a long period of time and exceeds the compressive strength values of conventional concrete.

FIG – 8 COMPRESSIVE TEST ON CUBE

TABLE - 1 COMPRESSIVE TEST ON LIGHTWEIGHT CONCRETE CUBES.

TYPE OF MIX	COMPRESSIVE STRENGTH		DENSITY (Kg/m^3)
	7 days(N/mm^2)	28 days(N/mm^2)	
CONVENTIONAL CONCRETE	27.36	44.85	2488
MIX 1	18.35	30.72	1396
MIX 2	10.62	18.86	1175
MIX 3	14.67	25.86	1262
MIX 4	13.24	22.84	1236

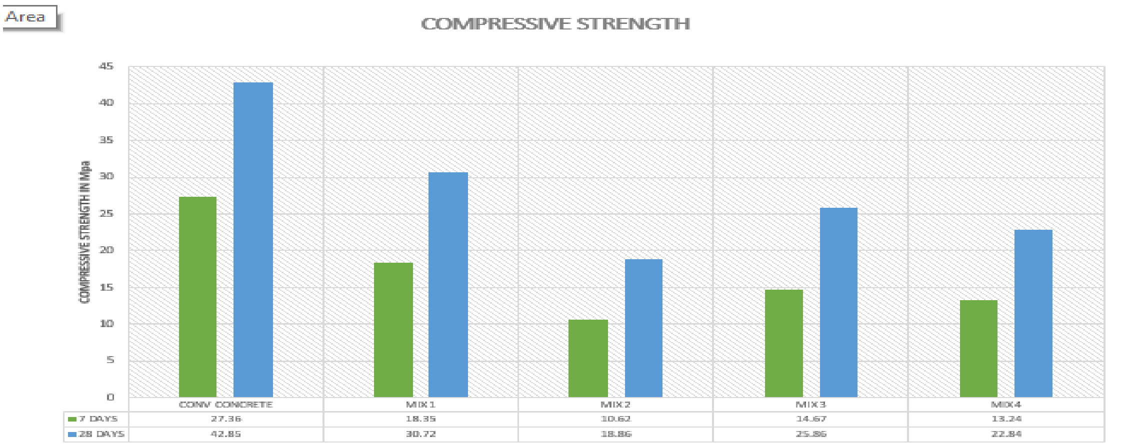


FIG-9 COMPRESSIVE TEST ON LIGHTWEIGHT CONCRETE CUBES

2.SPLIT TENSILE STRENGTH:

The concrete is weak in tension due to its brittleness . Hence. It is not expected to resist the direct tension when tensile forces exceed its tensile strength concrete cracks. Therefore, it is required to determine tensile strength of concrete to determine the maximum load at which the concrete members induce crack.

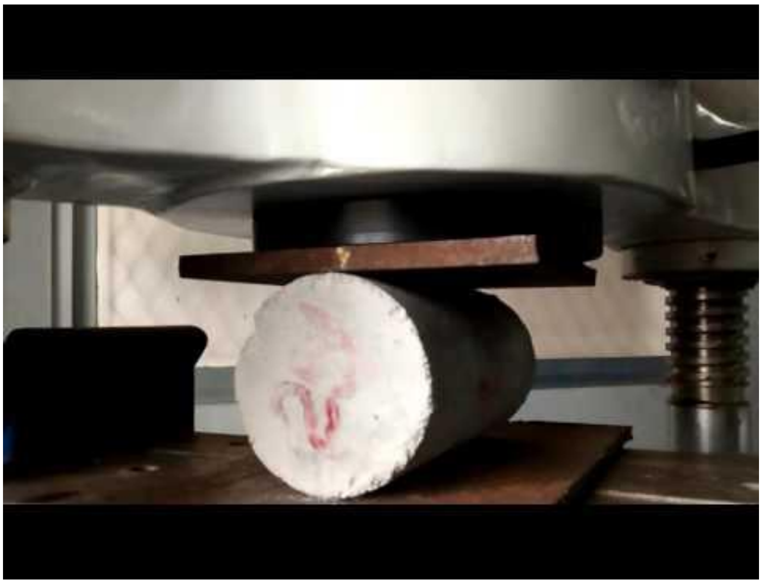


FIG -10 SPLIT TENSILE STRENTH OF CYLINDER

TABLE-2   SPLIT TENSILE STRENGTH FOR LIGHTWEIGHT FRC SPECIMEN

TYPE OF MIX	SPLIT TENSILE STRENGTH		DENSITY (Kg/m^3)
	7 days(N/mm^2)	28 days(N/mm^2)	
CONVENTIONAL CONCRETE	3.03	3.86	2488
MIX 1	2.24	2.94	1396
MIX 2	1.38	1.97	1175
MIX 3	1.84	2.26	1262
MIX 4	1.63	2.08	1236

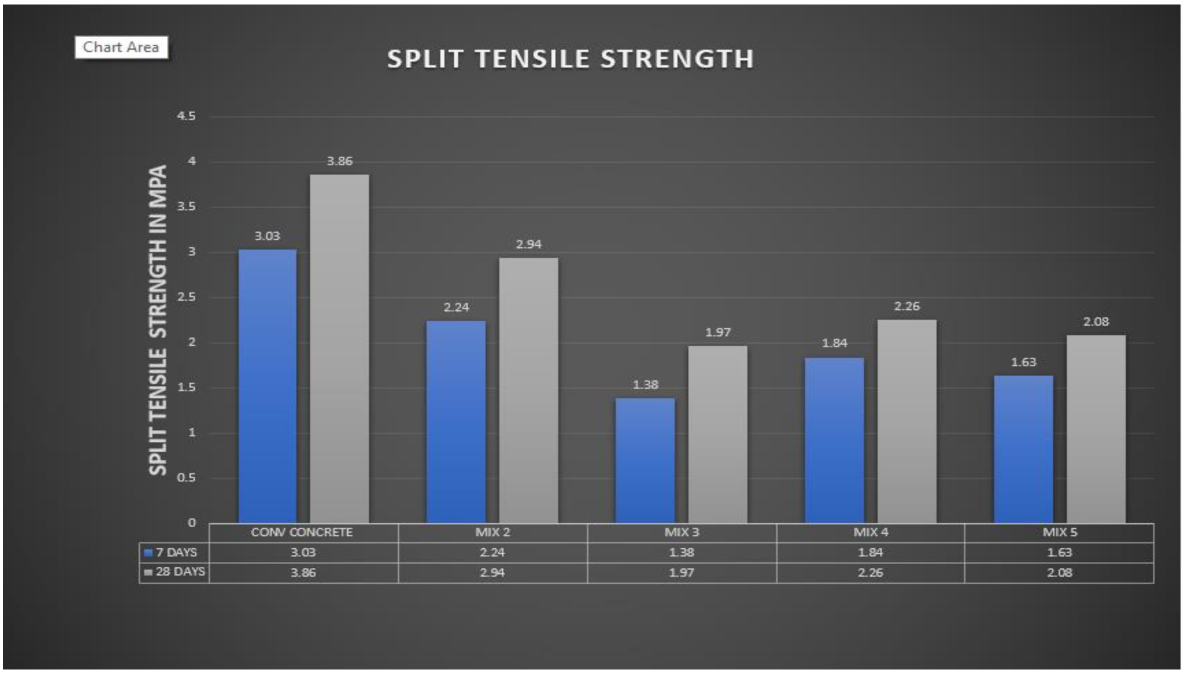


FIG-11 SPLIT TENSILE STRENGTH TEST ON LIGHTWEIGHT CONCRETE

3. FLEXURAL STRENGTH:

Flexural test assess the tensile strength of concrete indirectly. It tests the ability of unreinforced concrete beam or slab to withstand failure in bending applied by a point load. The flexural test on concrete can be conducted using neither three point load test (ASTM C78) nor center point load test (ASTM C293).

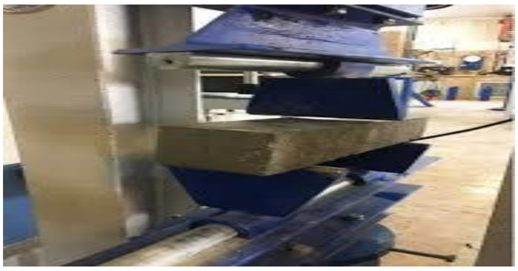


FIG -12 FLEXURE TEST

TYPE OF MIX	FLEXURAL STRENGTH		DENSITY (Kg/m^3)
	7 days(N/mm^2)	28 days(N/mm^2)	
CONVENTIONAL CONCRETE	3.74	4.68	2488
MIX 1	2.82	3.61	1396
MIX 2	1.74	2.48	1175
MIX 3	2.15	2.98	1262
MIX 4	1.92	2.76	1236

TABLE -3 FLEXURAL STRNGTH OF LIGTWEIGHT CONCRETE

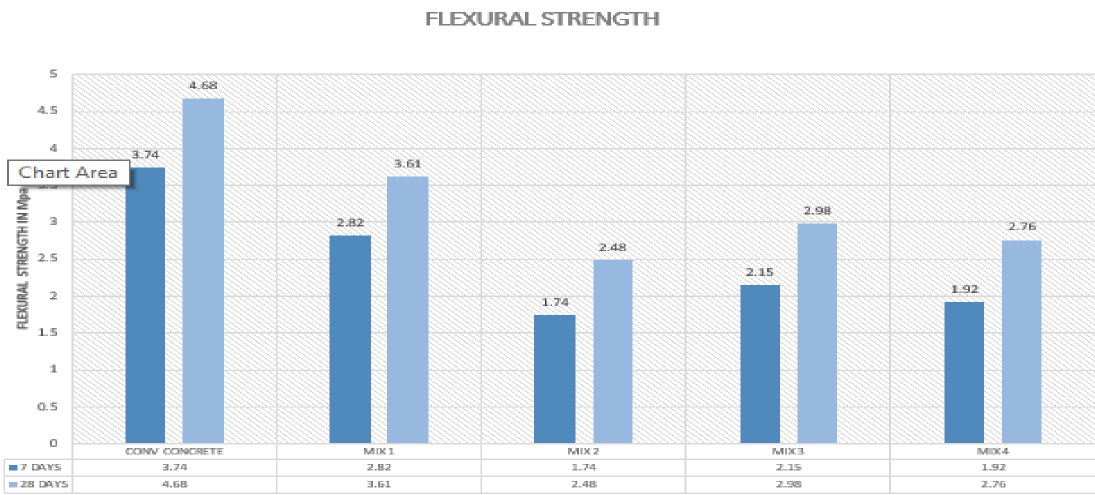


FIG -13 FLEXURAL STRENGTH TEST ON LIGHTWEIGHT CONCRETE

RESULT FOR LIGHTWEIGHT WEIGHT CONCRETE:

1. The concrete density set up to be decreased with the increase in percentage replacement of light weight aggregate (LECA and pumice stone).

2. With the use of LECA and pumice stone , compressive strength and split tensile strength were increased , and with the use of silica fume as mineral admixture 5-10% replacement to cement, it showed increased strength values.

5.FIBRES MIXING AND PREPARATION OF LWHFRC:

From the above results the optimum mix is identified. LECA and pumice are the lightweight aggregates that replaced normal coarse and fine aggregates with improved performance in test on concrete.

Mixing of FRC is practised by many methods. The mix should have a uniform dispersion of the fibres in order to prevent bleeding, segregation or balling of the fibres during mixing. Most balling happens in the course of fibre addition process. By the Increase of aspect ratio, volume percentage of fibre, and quantity and size of coarse and fine aggregate will intensify the balling tendencies and reduce the workability. To coat the large surface area of the fibres with paste, experience indicated that a water cement ratio of 0.4 - 0.6, and minimum cement content of 400 kg/m^3 are necessary.

Process of vibration is used to prevent fibre segregation. Tube floats ,Metal trowels and rotating power floats can be used to finish the surface. Mechanical Properties of FRC by Addition of fibres to concrete cause its effect on mechanical properties which significantly depend on the type and percentage of fibre added . Fibbers with end anchorage and Properties and Applications of Fibre Reinforced Concrete. High aspect ratio were found to have enhanced effectiveness.

MODULUS OF ELASTICITY :

Modulus of elasticity of FRC increases a bit with an increase in the fibre content. It was found that for each increase in fibre content by 1% volume there is an increase of 3 % in the elastic modulus.

COMPRESSIVE STRENGTH:

The presence of fibre alter the failure mode of cylinders, but the fibre effect will be result in slight improvement of compressive strength values (0 - 15 %).

FLEXURE STRENGTH :

The flexural strength was reported to be increased by 2.5 times using 4 % addition of fibres.

SPLIT TENSILE STRENGTH :

The presence of 3 % fibre volume was reported to increase the splitting tensile strength of mortar about 2.5 times that of the unreinforced one.

STEEL FIBRES:

Some steel fibres with hooked ends to improve resistance to pull out from a cement matrix. These are Most commonly used fibre. Their shape will be Round of diameter 0.25- 0.75mm. They Enhances impact, fatigue and flexural strength of concrete and Used for-overlays of roads, pavements, bridge decks.

SHAPES OF STEEL FIBRE ASTM A 820:

1.Cold-drawn wire fibres are the most commonly available, manufactured from drawn steel wire.

2.Cut sheet fibres are manufactured as the name by laterally shearing off steel sheets.

3. Melt-extracted fibres are manufactured with a relatively complicated technique where a rotating wheel is used to lift liquid metal from a molten metal surface by capillary action. The extracted molten metal is then quickly frozen into fibres and thrown off the wheel by centrifugal force. The resulting fibres look like crescent-shaped cross section.

4. Other fibres are manufactured for tolerances in length, diameter, and aspect ratio, as well as minimum tensile and flexural strength, and bending requirement. The amount of fibres added to a concrete mix is measured as a percentage of the total volume of the cement composite (concrete).

GLASS FIBRE:

Glass fibres are used because of their high ratio of surface area to weight. By trapping air within them, blocks of glass fibre are considered as good thermal insulation, with a thermal conductivity of order of 0.05. The freshest and thinnest fibres have more ductile property. The resulting tenacity is less with scratched surface. Because glass has an amorphous structure, its properties remain unchanged along the fibre and across the fibre. Humidity is an important factor in the tensile strength and Moisture is easily absorbed also it can worsen microscopic cracks and surface defects, and lessen tenacity. Glass fibres improve the strength of the material by increasing the force needed for deformation and enhance the toughness by increasing the energy required for crack propagation.

PROPERTIES OF FIBRE REINFORCED CONCRETE:

1.VOLUME OF FIBRES:

The optimum fibre content in FRC is obtained as 40-65kg/m^3 and varies according to the volume of fibre content added. In this experiment both steel and glass fibres are used in the volume of 1.5% and 2% respectively.

The optimum fibre content for steel fibres is 1-2% of total volume of cement and for glass fibres it is about 1.5-3% of fibres enhanced effect of properties of concrete.

2. ASPECT RATIO OF FIBRE:

Structural behaviour of steel fibre reinforced concrete depends on different parameters such as aspect ratio of fibre, the geometrical shape of fibre and orientation of fibre in concrete and the effect of aspect ratio of fibres on resistance characteristics in fibre reinforced concrete such as concrete workability, compressive strength, tensile strength and resistance against impact by considering that steel fibres length were 3.5, 6.5 and 8 cm at 1.5% volume of cement. Results indicate that the uses of steel fibres don't have a specific effect on compressive strength of concrete but it has a significant increase in its tensile strength and toughness. Also by increasing the aspect ratio of fibre slump will be decreased. Steel fibres will improve impact resistance, and reduces crack expansion.

PHYSICAL PROPERTIES OF FIBRES:

TYPE OF FIBRE	STEEL FIBRE	AR- GLASS FIBRE
ELASTIC MODULUS (Gpa)	210	72
TENSILE STRENGTH (Mpa)	410	1700
DIAMETER (mm)	0.7	0.014
LENGTH (mm)	35-80	3.5-7
ASPECT RATIO	50-114	25-50

RESULTS:

COMPRESSION STRENGTH:

In this test, 150×150×150 cubic specimens after 28 days of curing are tested. These specimens were broken by compression testing machine. According to the results, the compressive strength of fibre reinforced concrete towards plain concrete didn't show any major changes.

COMPRESSION STRENGTH FOR STEEL FIBRE

SPECIMEN [STEEL FIBRE]	COMPRESSIVE STRENGTH	ASPECT RATIO	WEIGHT OF SPECIMEN
SF-35mm	43.6	50	8.205
SF-65mm	47.8	92.8	8.2
SF-80mm	46.1	114.2	8.1

COMPRESSION STRENGTH FOR GLASS FIBRE

SPECIMEN [GLASS FIBRE]	COMPRESSIVE STRENGTH	ASPECT RATIO	WEIGHT OF SPECIMEN
GF 3.5mm	39.6	25	8.105
GF 5.3mm	42.4	38	8.095
GF 7.0mm	41.3	50	8.090

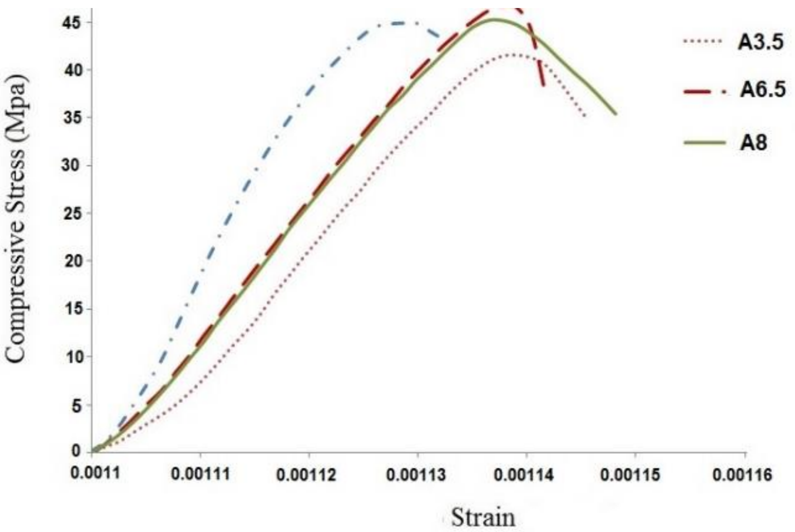


FIG-14 COMPRESSION TEST

TENSILE STRENGTH:

This test is according to ASTM C496-71. Tensile strength is determined by the split tensile method. 30cm×15cm cubic specimens are used three fibre reinforced concrete specimens. According to the table tensile strength test indicates that fibre reinforced concrete has more tensile strength than plain concrete.

TENSILE STRENGTH FOR STEEL FIBRE

SPECIMEN [STEEL FIBRE]	TENSILE STRENGTH [Mpa]	ASPECT RATIO	WEIGHT OF SPECIMEN
SF-35mm	2.70	50	13.42
SF-65mm	3.10	92.8	13.33
SF-80mm	3.63	114.2	13.26

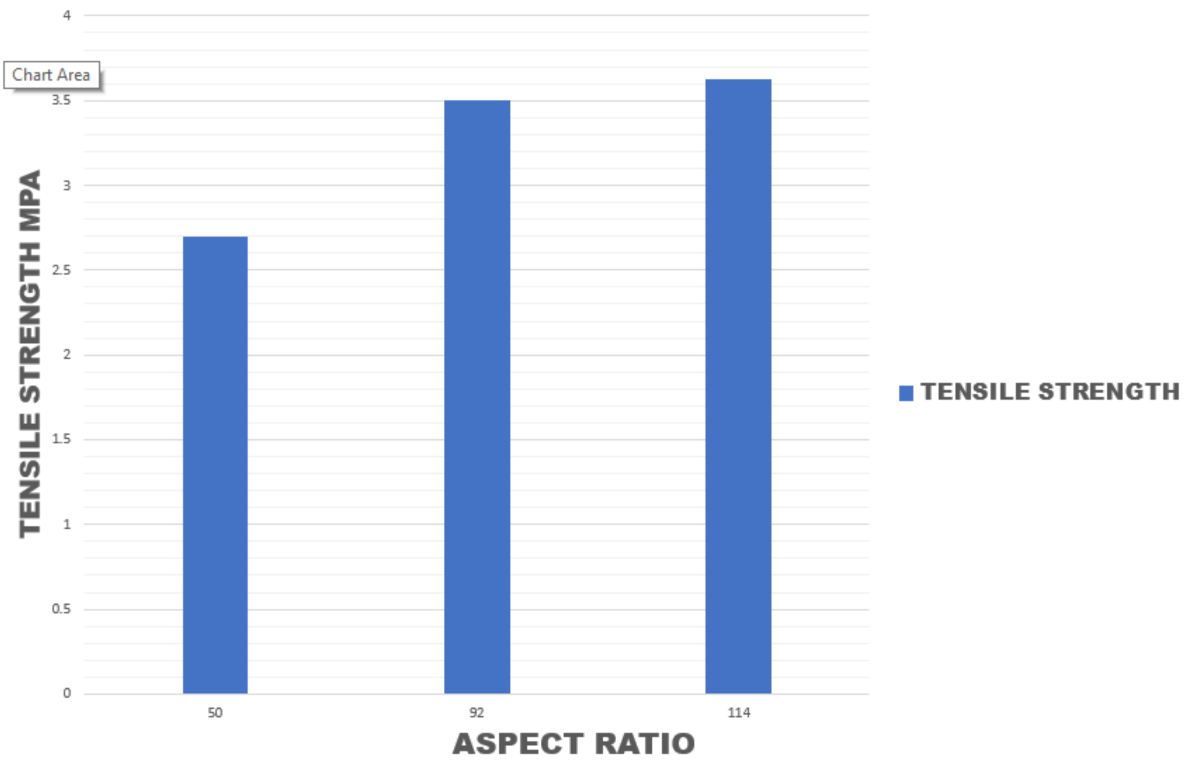


FIG-15 TENSILE STRENGTH

FLEXURAL STRENGTH:

The flexural strength on prisms is obtained after curing at7 and 28 days and it will increases in a long period of time and increase the split tensile strength values of nominal concrete.

SPECIMEN [STEEL FIBRE]	FLEXURAL STRENGTH [Mpa]	SPECIMEN [GLASS FIBRE]	FLEXURAL STRENGTH [Mpa]
SF-35mm	10.05	**GF 3.5mm**	8.96
SF-65mm	8.1	**GF 5.3mm**	7.65
SF-80mm	7.76	**GF 7.0mm**	7.44

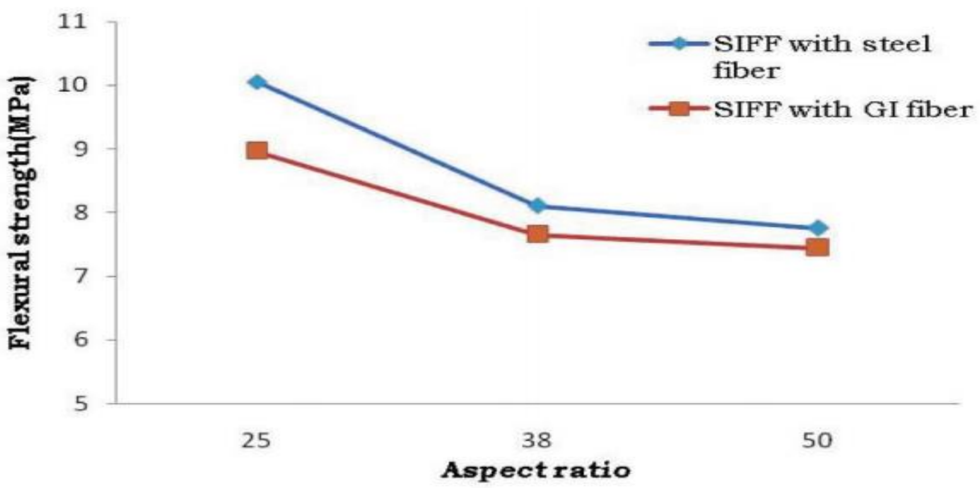


FIG- 16 FLEXURAL STRENGTH

Impaction Strength Test

In this test, 150×20 mm disc specimens are used which one of them having zero fibres and the other three specimens have reinforced with fibres with different aspect ratio. This test is done by dropping an 8.5 kg weight from 250mm perpendicular distance on the specimens that concrete strength against impact is determined by number of impacts till initiating a first crack and complete crack(rupture). Results of this test according to the bar graph indicate that fibres increase the first crack strength Also, rupture strength of fibre reinforced concrete towards plain concrete has recovered considerably and as the aspect ratio of fibres increasing rupture.

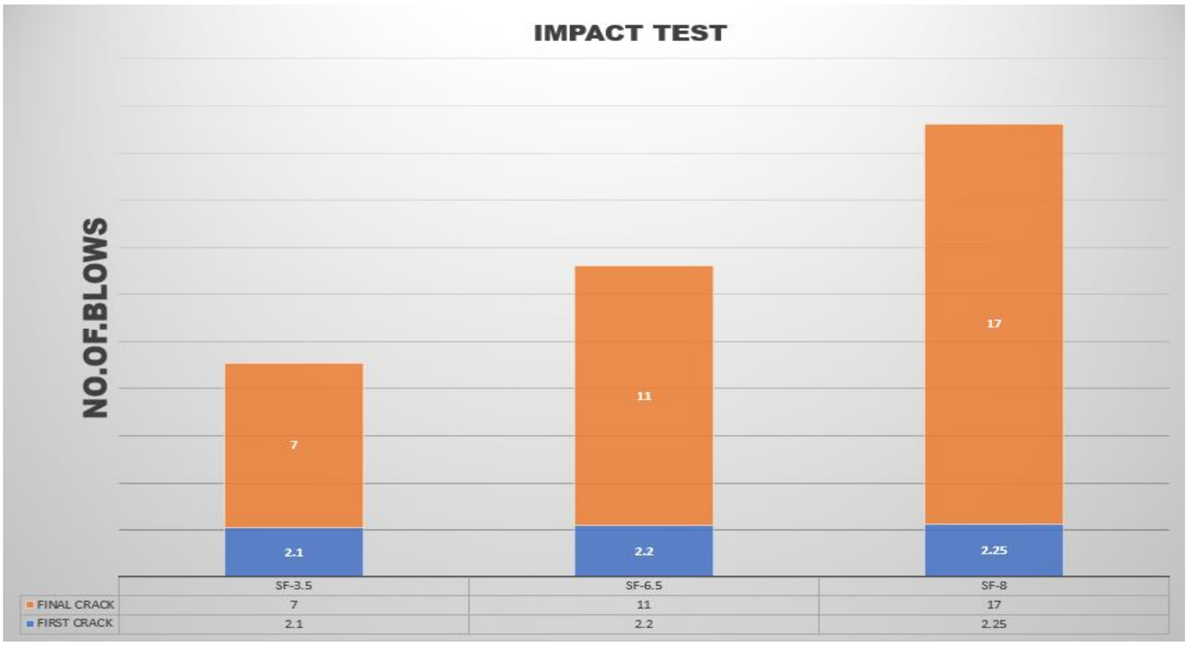


FIG- **17 RESULTS OF IMPACT STRENGTH TEST**

3. WORKABILITY OF FRC:

Concrete slump cone test is to determine the workability or consistency of concrete mix prepared at the laboratory during casting. Concrete slump test is carried out from batch to batch to check the uniform quality of concrete . In FRC the slump value differs from 70-100mm.

FIG- 18 SLUMP CONE TEST

6. CASTING OF SPECIMENS :

The materials are weighed accurately using a digital weighing machine and mixed with the mixture machine and mixed thoroughly. Steel fibres were mechanically scattered inside the mixture machine after thorough mixing of the ingredients of concrete. For preparing the specimen for compressive, tensile, and flexure strength steel moulds of their specific purpose were used.

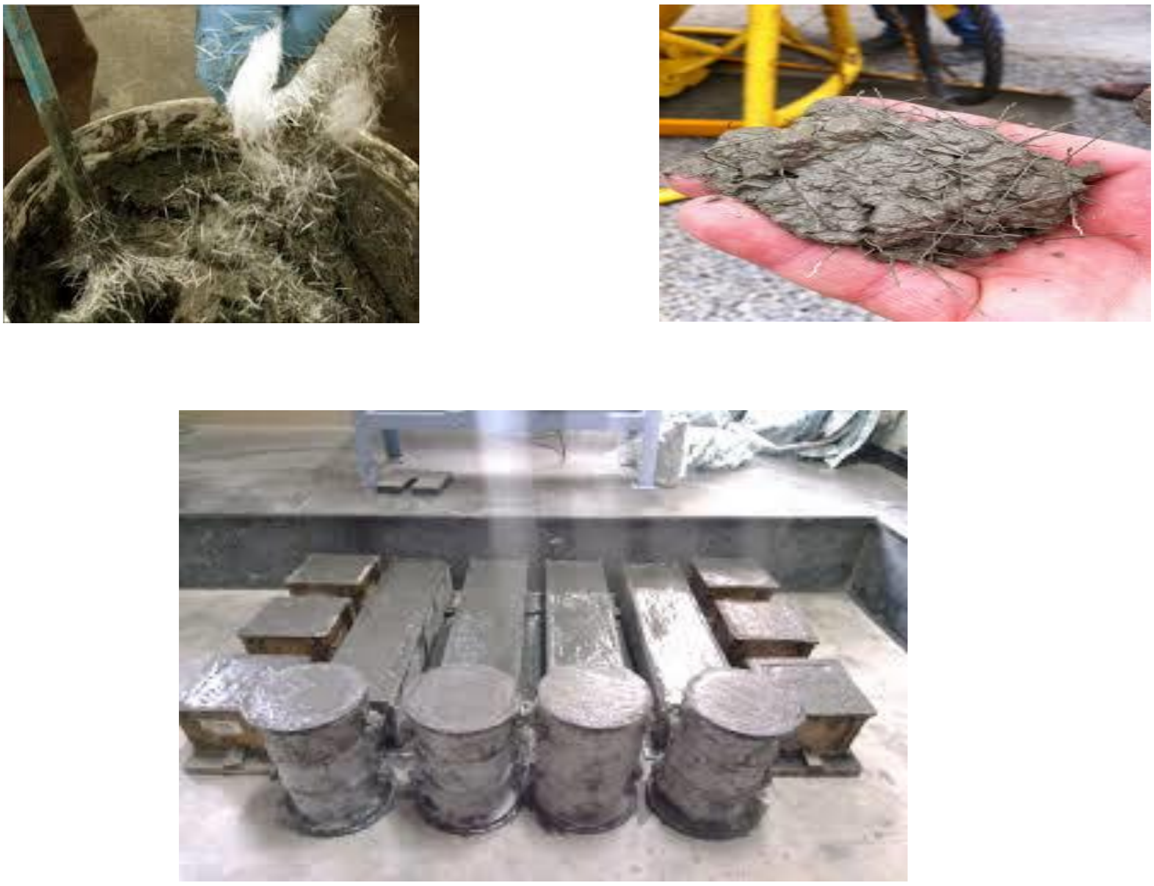


FIG-19 CASTING OF SPECIMEN

7. CURING OF SPECIMEN:

The test specimens were stored in place free from vibration and kept at a room temperature of 27˚±2˚C for 24 hours ± ½ hour from the time of addition of water to the dry ingredients. After this period, the specimen is marked and removed from the moulds and immediately submerged in clean fresh water and kept there until taken out prior 2-3 hours to test. The specimens were allowed to become dry before testing. The panels were cured by dry curing method, i.e. Moist gunny bags were used to cover over the panels.

8.SPECIMEN TESTING AND RESULTS:

1.COMPRESSIVE STRENGTH:

The compression strength on cubes is obtained after curing at 7 and 28 days and the specimen is tested and resultant values are noted. The compressive strength will increases in a long period of time and increase the compressive strength values of nominal concrete.

MIX TYPE	COMPRESSION STRENGTH(MPa)	
	7 days	28 days
CONV CONCRETE	29.89	49.34
MIX 1	20.65	34.40
MIX 3	15.36	28.96

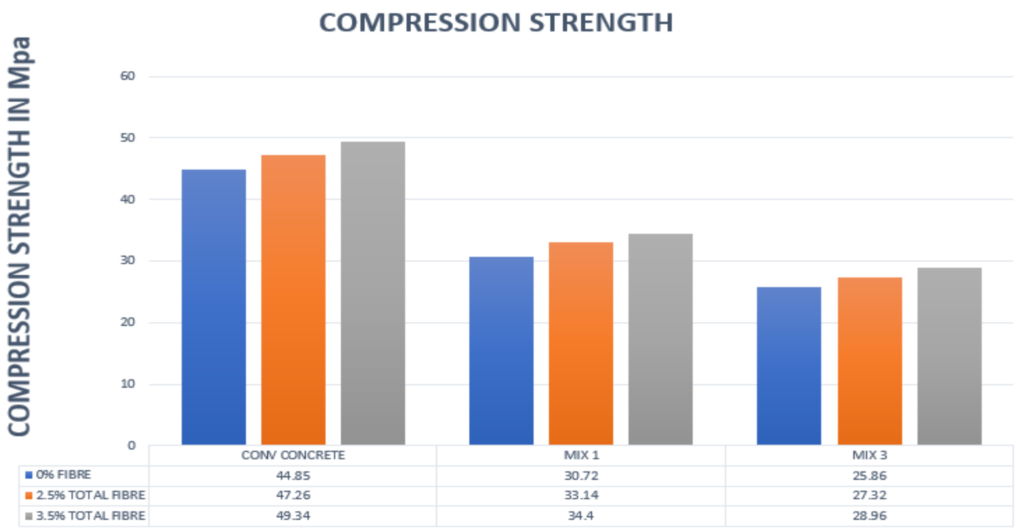


FIG-20 COMPRESSIVE STRENGTH TEST ON LIGHTWEIGHT FRC

SPLIT TENSILE TEST

The split tensile strength on cylinders is obtained after curing at 7 and 28 days and it will increases in a long period of time and increase the split tensile strength values of nominal concrete.

MIX TYPE	SPLIT TENSILE STRENGTH(MPa)	
	7 days	28 days
CONV CONCRETE	4.95	6.52
MIX 1	4.42	5.29
MIX 3	3.11	3.84

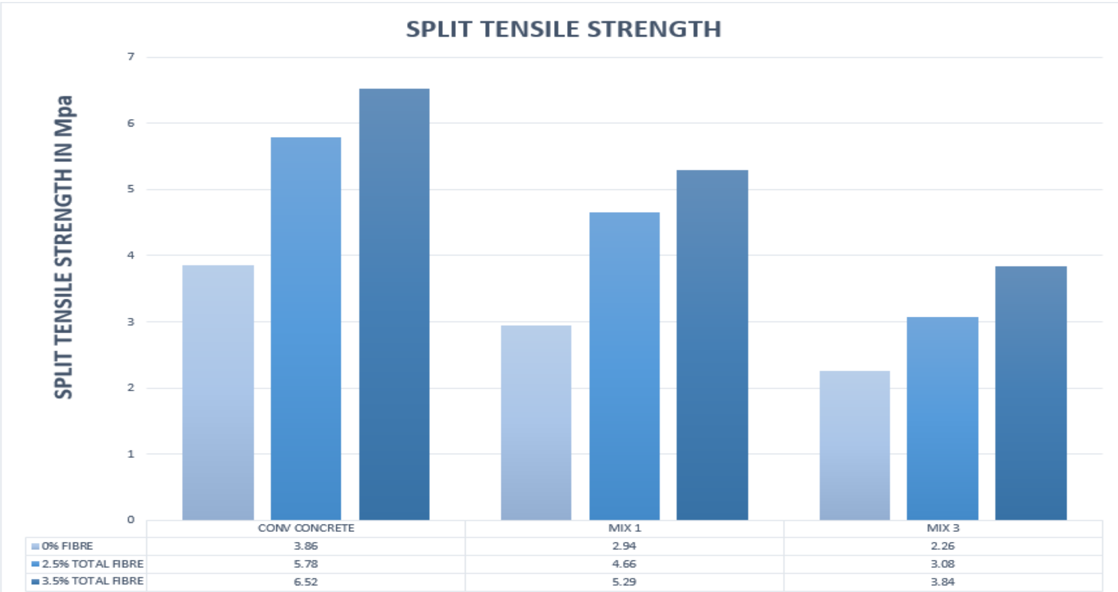
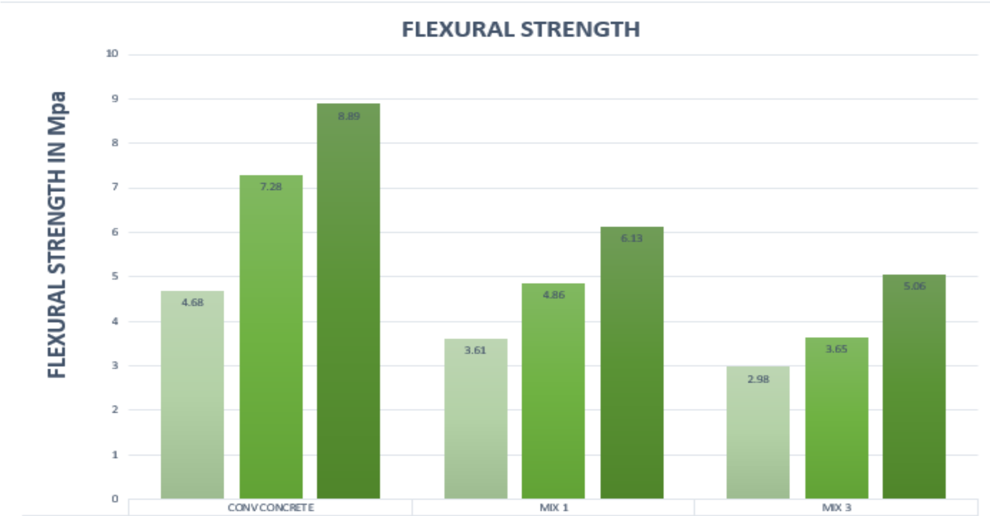


FIG-21 SPLIT TENSILE STRENGTH TEST ON LIGHTWEIGHT FRC

3. FLEXURAL TEST

The flexural strength on prisms is obtained after curing at7 and 28 days and it will increases in a long period of time and increase the split tensile strength values of nominal concrete.

MIX TYPE	FLEXURAL STRENGTH(MPa)	
	7 days	28 days
CONV CONCRETE	6.85	8.89
MIX 1	4.96	6.13
MIX 3	4.24	5.06

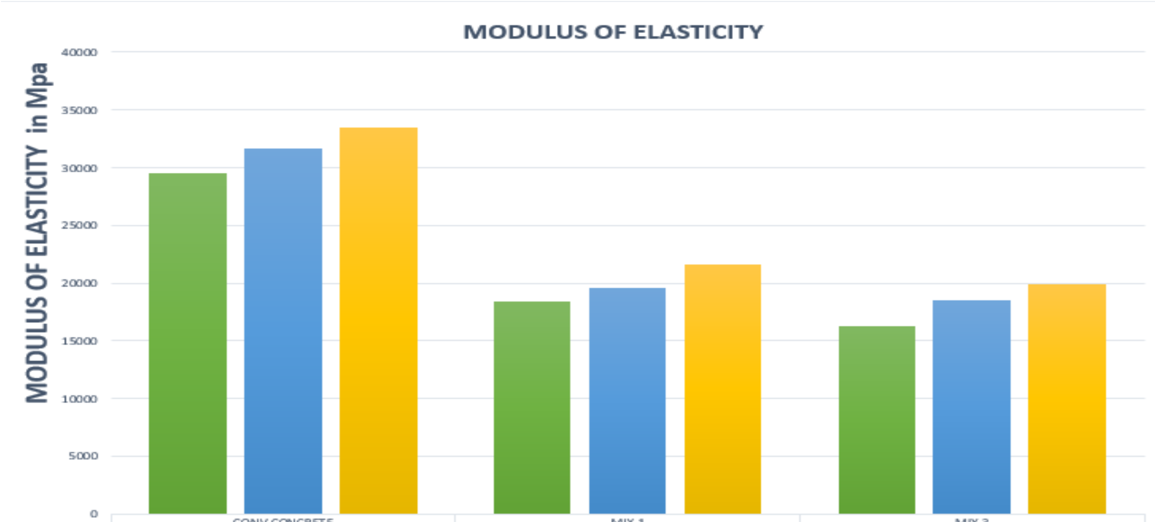


	CONV CONCRETE	MIX 1	MIX 3
0% FIBRE	4.68	3.61	2.98
2.5% TOTAL FIBRE	7.28	4.86	3.65
3.5% TOTAL FIBRE	8.89	6.13	5.06

FIG -22 FLEXURAL STRENGTH TEST ON LIGHTWEIGHT FRC

MODULUS OF ELASTICITY:

Fibres are added to concrete with optimum fibre range of 30-50kg/m^3. Steel fibres are added with 1% and 1.5% and glass fibre content of 1.5% and 2% .



	CONV CONCRETE	MIX 1	MIX 3
0% FIBRE	29571	18419	16239
2.5 FIBRE	31643	19567	18495
3.5% FIBRE	33432	21584	19905

FIG-23 MODULUS OF ELASTICITY OF FRC

9.CONCLUSION:

1.The main aim of the project is to reduce the weight and density of the concrete. from the above report we achieved a compressive strength value of **44.85 N/mm^2** with conventional concrete and also achieve **30.72 N/mm^2** with lightweight concrete fully replaced with lightweight aggregates such as LECA, M-sand and pumice with low density of 1396 kg/m^3.

2.By reducing the weight of concrete we can reduce the dead load of concrete and reduce the energy cost of construction by reducing the cost spend on foundation. There is reduction in density of light weight concrete by adding LECA and pumice as compared to conventional concrete.

3. A brief report on fibre reinforced concrete is given out . Our understanding of fibre concrete matrix interaction, mechanism of reinforced concrete and performance characteristics is fairly advanced. Fibre reinforced concrete is a favourable material to be used in the Middle-East for sustainable, durable and long-lasting concrete structures. Its performance has already been proven in other hot and arid climates and in other chemically harmful environments.

FIBRES CONTENT:

Steel fibres :**1.5 %** total volume of cement content which is about **19.7 kg/m^3** with aspect ratio 92.

Glass fibre: **2%** of total volume of cement content which is about **10.6 kg/m^3** with aspect ratio of 38.

Increased fibre availability in hybrid fibre concrete, addition to the ability of non-metallic glass fibre in bridging smaller micro-cracks, could be the reasons for the enhancement in strength and flexural properties. Among hybrid fibre combinations, the steel and glass fibres combination performed better in all respects compared to the mono-steel fibre concrete and ordinary concrete.

4. Compressive strengths of about **34.4 MPa** can be obtained for concrete density 1396 kg/m3 with addition of hybrid fibre of total content about **30kg/m^3** (3.5% of total volume of cement).

5. The increase of compression strength by addition of fibres results in 10% for conventional concrete and 12% increase for lightweight concrete, in splitting tensile strength about 1.7 times

for conventional concrete and 1.8 times for lightweight concrete, in flexural strength 1.9times increase for both conventional and lightweight concrete and modulus of elasticity by 10%.

6.Thus the optimum mix for lightweight concrete and optimum fibre content is determined from the observed results.

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