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Experimental Utilization of Concrete Using M-Sand Aa A Replacement of Fine Aggregate

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ABSTRACT

Concrete generally uses natural sand as fine aggregate due this more amount of river sand is consumed for the construction we planned to use M sand as fine aggregate m sand in order to attain its uniformity of gradation due to its uniformity the achieve the higher gradation level that means these falls at Zone 2 and these due to not have any impurities such like that natural sand due to the deposition of the clay and slit due to the low tensile strength of concrete its necessary to increase the strength by addition of reinforcement but this may increase the cost but by addition of steel fibre we can increase the strength at low cost.

In this paper presenting literature review of research and publications published in past.

Keywords: Concrete, review, msand, strength, durability, brittle

I. INTRODUCTION

Sand serves as the fine aggregate of concrete, which also contains gravel or crushed stone as a coarse aggregate and hydrated cement as a binder. In order to alter certain specific qualities of the concrete mix in both the fresh and hardened states, a fourth component known as "admixtures" is utilised. Concrete mixes are created to have the appropriate qualities in the fresh and hardened states, as the circumstance requires, by carefully using the components that are accessible for manufacturing concrete and their proportioning. Take note of the sporadic coarse aggregates and the matrix that surrounds them. Sand, hydrated cement, and small voids make up the matrix.

Fibre Reinforced Concrete

Concrete that has been reinforced with fibrous material (FRC) has a higher structural integrity. It has uniformly distributed, short discrete threads that are randomly orientated. Steel, glass, synthetic, and natural fibres are examples of fibres. The characteristics of fibre reinforced concrete vary among these various fibres depending on the concrete, fibre materials, geometries, distribution, orientation, and densities. Fibre reinforced concrete can also be defined as a composite material made of Portland cement, aggregate, and discrete discontinuous fibres. Why, then, would we want to incorporate these fibres into concrete? Concrete that is plain and unreinforced is fragile and has a poor tensile strength and strain capacity. Discontinuous fibres that are distributed at random serve as a bridge over developing cracks and add "ductility" after cracking. In the post-cracking stage, the FRC can carry substantial loads over a reasonably large strain capacity if the fibres are suitably strong and connected to the material. In terms of the area under the load vs. deflection curve, the main benefit of the fibres is to make the concrete more resilient to all types of loading. In other words, the fibres have a tendency to raise the strain at the maximum load while greatly absorbing energy after the maximum load has been reached.

II. LITERATURE REVIEW

The research paper from different authors are summarised in this section who have worked upon analyzing the behaviour of concrete with different admixtures in using natural or artificial fibres to strengthening the concrete.

Anup Krushnarao Chitkeshwar and P. L. Naktode (2022) In this study author studied the effect of m-sand and dune sand in strengthening the concrete and to enhance its properties. This research provides him a better solution and replacement of sand which is drained out of river, this material defines the stability of concrete considering all these manifesting upgradations of concrete.

Here results stated that compressive strength of concrete increased by 12% whereas flexural strength increases by 8% which stated that overall properties of concrete enhances and developed a new way to prepare enhanced concrete.

Ashish Kumar Yadav et.al (2022) In this study creator concentrated on the impact of m-sand and ridge sand in fortifying the substantial and to upgrade its properties. This examination gives him an improved arrangement and substitution of sand which is depleted out of waterway, this material characterizes the security of cement thinking about every one of these showing upgradations of cement.

Here results expressed that compressive strength of cement expanded by 12% though flexural strength increments by 8% which expressed that general properties of substantial upgrades and fostered a better approach to plan improved concrete.

Kalayane Vishwanath (2022) The purpose of the research was to evaluate the strength performance of concrete that has been partially replaced with GFRC and SFRC and to compare it to conventional concrete.

Regardless of the fibre type or w/c ratio, the results showed that adding fibres increases compressive strength. After seven days, GFRC has a 25% higher compressive strength than regular concrete.

Madhuri Sagar and N. Manoj Kumar (2022) In this study creator concentrated on the impact of m-sand and ridge sand in fortifying the substantial and to upgrade its properties. This examination gives him an improved arrangement and substitution of sand which is depleted out of waterway, this material characterizes the security of cement thinking about every one of these showing upgradations of cement.

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N. Nageswari and Dr. R. Divahar (2022) In this study creator concentrated on the impact of m-sand and ridge sand in fortifying the substantial and to upgrade its properties. This examination gives him an improved arrangement and substitution of sand which is depleted out of waterway, this material characterizes the security of cement thinking about every one of these showing upgradations of cement.

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Nunsavathu Srinu Naik and Parsineni Balakrishna (2022) In this study creator concentrated on the impact of m-sand and ridge sand in fortifying the substantial and to upgrade its properties. This examination gives him an improved arrangement and substitution of sand which is depleted out of waterway, this material characterizes the security of cement thinking about every one of these showing upgradations of cement.

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B.Naga Prasad and Guttula swath (2021) In this study creator concentrated on the impact of m-sand and ridge sand in fortifying the substantial and to upgrade its properties. This examination gives him an improved arrangement and substitution of sand which is depleted out of waterway, this material characterizes the security of cement thinking about every one of these showing upgradations of cement.

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D Florence More and Dr. S Senthil Selvan (2021) In this study creator concentrated on the impact of m-sand and ridge sand in fortifying the substantial and to upgrade its properties. This examination gives him an improved arrangement and substitution of sand which is depleted out of waterway, this material characterizes the security of cement thinking about every one of these showing upgradations of cement.

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Dr. K. Suresh et.al (2021) In this study creator concentrated on the impact of m-sand and ridge sand in fortifying the substantial and to upgrade its properties. This examination gives him an improved arrangement and substitution of sand which is depleted out of waterway, this material characterizes the security of cement thinking about every one of these showing upgradations of cement.

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Nagajothi Subramaniana and Elavenil Solaiyanb (2020) In this study creator concentrated on the impact of m-sand and ridge sand in fortifying the substantial and to upgrade its properties. This examination gives him an improved arrangement and substitution of sand which is depleted out of waterway, this material characterizes the security of cement thinking about every one of these showing upgradations of cement.

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P.Deepa and M. Arul Kumar (2018) In this study creator concentrated on the impact of m-sand and ridge sand in fortifying the substantial and to upgrade its properties. This examination gives him an improved arrangement and substitution of sand which is depleted out of waterway, this material characterizes the security of cement thinking about every one of these showing upgradations of cement.

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Saravanya.R and Vinitha.M (2018) In this study creator concentrated on the impact of m-sand and ridge sand in fortifying the substantial and to upgrade its properties. This examination gives him an improved arrangement and substitution of sand which is depleted out of waterway, this material characterizes the security of cement thinking about every one of these showing upgradations of cement.

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Shafeeq Ahamed et.al (2017) In this study creator concentrated on the impact of m-sand and ridge sand in fortifying the substantial and to upgrade its properties. This examination gives him an improved arrangement and substitution of sand which is depleted out of waterway, this material characterizes the security of cement thinking about every one of these showing upgradations of cement.

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Tamilarasan A et.al (2016) In this study creator concentrated on the impact of m-sand and ridge sand in fortifying the substantial and to upgrade its properties. This examination gives him an improved arrangement and substitution of sand which is depleted out of waterway, this material characterizes the security of cement thinking about every one of these showing upgradations of cement.

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Shivang D Jayswal et.al (2015) In this study creator concentrated on the impact of m-sand and ridge sand in fortifying the substantial and to upgrade its properties. This examination gives him an improved arrangement and substitution of sand which is depleted out of waterway, this material characterizes the security of cement thinking about every one of these showing upgradations of cement.

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Vimarsh S.P et.al (2014) In this study creator concentrated on the impact of m-sand and ridge sand in fortifying the substantial and to upgrade its properties. This examination gives him an improved arrangement and substitution of sand which is depleted out of waterway, this material characterizes the security of cement thinking about every one of these showing upgradations of cement.

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III. PROBLEM IDENTIFICATION AND OBJECTIVES OF THE RESEARCH

3.1 Problem Identification

Because it can be used to partially replace river sand in a concrete mix, past studies have found that manufactured sand is significant in concrete. However, in the current experiment, synthetic sand rather than natural sand was used as the fine aggregate. Prior study only partially replaced river sand with industrial wastes; no studies were done to evaluate the long-term performance and structural behaviour of concrete built with these industrial wastes in M sand. There is therefore a lot of room to explore how M-Sand as a partial replacement for natural sand affects the mechanical, durability, structural behaviour, and microstructural properties of concrete.

3.2 Objectives of the Research

The aim project is to have a study comparison between mechanical performance of crimped SF reinforced concrete in different proportion with additional replacement of natural sand by Manufacturing sand in various proportion for M30 grade concrete mix with that of the normal concrete. The experimental investigation includes the test being carried on hardened concrete. The test carried out are for the workability of concrete, compressive strength, tensile strength, and flexural strength.

- decreasing the amount of river sand used in building and protecting the environment M-Sand is therefore required.
- Study on flexural behaviour of concrete with steel fibre in different proportion.
- Study on properties of hardened concrete on variation of fine Aggregate using M Sand in various proportion.

IV. MATERIAL AND PROPERTIES

4.1 General

This section presents the physical and chemical properties of the materials used in this experimental analysis.

4.2 Cement

UltraTech -53 grade cement confirming to IS 12269-1987 was been used for the current project to complete the investigation process. The laboratory test conducted on cement are as given be below.

Table 4.1 Properties of Cement.

Properties	Results	Permissible Limits as per IS Standard
Fineness	3%	<10%

Specific Gravity	3.15	3.5
Initial Setting Time	30 min	<30 min
Final Setting Time	550 min	<600 min

4.3 Fine Aggregates

The natural sand was obtained from the local origin. The river sand brought was free from all the silt, clay and other impurities. The natural fine aggregate (sand) passed the sieve analysis and was found to comply with Zone II IS: 383(1970). The tabular column in the following image contains the physical characteristics of fine aggregates.

Table Properties of Fine Aggregate

Properties	Result
Shape of aggregates	Angular
Specific gravity	2.67
Fineness Modulus	2.7
Compacted bulk density	1760 kg/m3

4.4 Manufacturing Sand (M-Sand)

The Manufacturing sand used is 50% replacement for the natural sand and was brought from , finely crushed basaltic stone. The lab test conducted on the M-sand confines it to Zone II origin and other properties being tabulated below

Table Properties of M-Sand

Properties	Result
Zone of M-sand	II
Specific gravity	2.7
Fineness Modulus	2.75
Bulk density	1705 kg/m3

4.5 Coarse Aggregate

The locally available coarse aggregate, crushed basalt stone angular in shape with size 20mm down size were utilized for the project work. The test conducted in laboratory on it and their following values are represented below (within Limits of IS:383-1970)

Table Properties of Coarse Aggregates

Properties	Results
Shape of aggregates	Angular
Specific gravity	2.67
Fineness Modulus	6.75
Compacted bulk density	1760 kg/m3

4.6 Water

Portable tap water was used for the preparation of specimens and for the curing of specimens.

4.7 Steel Fibres

A metal reinforcement is called steel fibre. Steel fibre for reinforcing concrete is defined as short, discrete lengths of steel fibres with an aspect ratio (ratio of length to diameter) ranging from approximately 20 to 100, with different cross-sections, and that are sufficiently small to be randomly dispersed in an unhardened concrete mixture using the customary mixing techniques. Concrete's physical characteristics can be qualitatively altered by the addition of steel fibres, considerably enhancing the material's tenacity, durability, and resistance to cracking, impact, fatigue, and bending, among other features. According to the manufacturing technique and the shape or section of the steel fibre, it can be divided into five general categories: cold-drawn wire, cut sheet, melt-extracted, mill cut, and modified cold-drawn wire.

4.8 Admixture

To improve the workability of fresh concrete, Conplast SP-430 super plasticizer, a commercial product, is utilised.

4.9 Mix Design

utilising the aforementioned test results and the IS 10262 - 2019 code. The concrete grade M30 was used in the mix design production. A trail mix for M30 grade concrete was created using the concrete mix design and the M30 grade concrete's mix proportion.

V. EXPERIMENTAL INVESTIGATION

5.1 Slump Test

The slump test, which can be completed in a lab or on-site, is used to determine the consistency of concrete. If concrete in multiple batches is uniform, it can be determined by the results of a slump test. Concrete slumps' shapes reveal information about the nature and application of the material. It is also possible to evaluate the characteristics of concrete with relation to its propensity to separate by giving it a few tamping or blows by tapping a rod on the base plate. Because the equipment is inexpensive and the process is straightforward, this test has been in use since 1922. The Slump cone's design demonstrates how easily concrete can be worked. Indian standard for slump cone testing is IS 1199-1959.

5.1.1 Principle of Slump cone test

The slump value of concrete is only a gravity flow theory that measures how much water has been added to the concrete mix and how much of it is in a workable state.

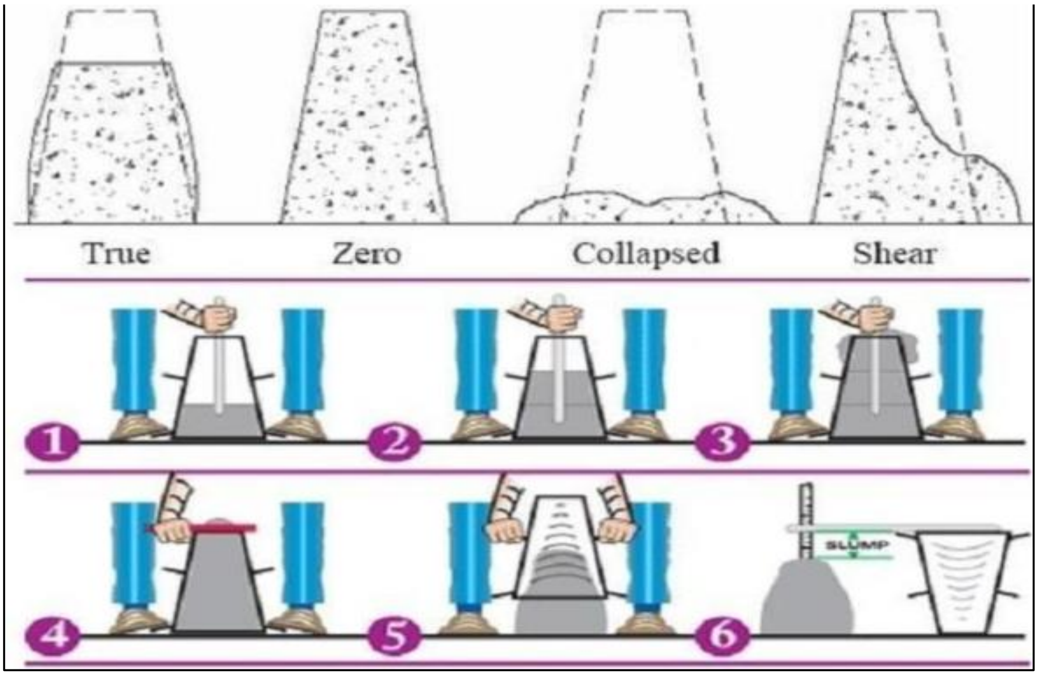

Fig 5.1 Slump Cone Test

5.1.2 Apparatus for Slump Test

Concrete slump tests are conducted using the following equipment:

- Metal mould with a frustum-shaped base measuring 20 centimetres (8 inches), a top diameter of 10 centimetres (4 inches), and a height of 30 centimetres (12in).
- Steel tamping rod with a bullet end that is 0.6 m (2 ft) long and 16 mm (5/8 in) in diameter.

5.1.3 Procedure of Slump Test

The steps for the Slump test are as follows:

- The internal surface of the mould is first cleaned, made dry, and free of any other previous concrete sets.
- After that, set the mould on the flat, straight, absorbent surface.
- Fresh concrete is then poured into the mould in four levels, each of which is tapped 25 times with a tapping rod before the top is levelled with a trowel.
- In order to avoid disturbing the concrete cone, the mould is then gradually pushed vertically and removed from the concrete.
- Due to the effect of gravity, this unbound concrete deformed the entire surface, causing it to subside.
- There is an SLUMP of concrete in the area where the concrete is subsiding.
- The sinking value of concrete is the height difference, expressed in millimetres, between the mould cone and the height of the concrete.

The sample's recorded slump value is = 121.32 mm with compaction factor of 0.95.

5.1.4 Uses and Drawbacks of Slump Test

For very wet and dry concrete, this test does not provide favourable findings. It is not sensitive at all for stiff-mix. The table below displays different slump levels together with concrete's workability.

Table 5.1.1 Value of Slump at different degree of Workability

Degree of workability	Placing conditions	Slump(mm)
Very Low	Binding concrete (member of concrete by spreading, shallow sections, pavements using pavers (mixer with spreading arrangements)	< 25
Low	Mass concrete, lightly reinforced slab, beam, wall,column sections, canal lining, strip footing	25-75
Medium	Heavy reinforced section in slab, beam, walls, columns, slip formwork(slope concrete), pumped concrete	50-100
High	Trench fill in-situ piling	100-150
Very High	Tremie concrete (concreting in water by using water tight pipe to pour concrete)	

The highest category of workability, the flow value test is more suitable for workability measurement.

Table 5.1.2 Slump Cone test of concrete

Workability for M30 concrete without 5% red mud	
Initial time in min.	Collapse in mm.
After 30 min.	190 mm
After 60 min.	170 mm
After 90 min.	155 mm
After 120 min.	140 mm

5.2 Compressive Strength

The capacity to support loads on the surface of a material or structure without breaking or deforming is known as compressive strength. An object's size will decrease when it is compressed, but it will extend when it is under tension. Compressive strength of concrete is evaluated in accordance with (IS:516-1959).

Compressive Strength = Load / Cross-sectional Area.

5.2.1 Importance of Compressive Strength in Concrete

Sand, cement, and aggregate are the main components of concrete. The compressive strength of each of the concrete's constituent parts (cement, sand, and aggregates), as well as the materials' quality, curing techniques, water-to-cement ratio, air-entrainment mixture ratio, and a number of other variables, all affect the concrete's strength. temperature effects.

We can learn more about overall strength and the aforementioned parameters by using the compressive strength test. This test makes it simple to assess the concrete's psi strength and the level of quality being produced.

For residential concrete, the compressive strength varies from 15 MPa (2200 psi) to 30 MPa (4400 psi), and it is high in commercial constructions. In certain situations, forces up to 10,000 psi are used (70 MPa).

5.2.2 Apparatus for Compressive Strength Test

Fig 5.2 Compressive Strength Test

Mixing of Concrete

Concrete can be manually mixed or put via a batch mixer in a lab.

Hand Mixing

Until a homogenous mix is achieved, the procedure must be carried out on the G.I. Sheet (For Making Concrete).

- Cement and fine aggregate are first combined in a dry state.
- Second, distribute the coarse aggregates equally.
- Once stability has been achieved, add the necessary amount of water to the container.

Machine Mixing

The following procedure should be used, and the component shouldn't be rotated for longer than two minutes.

- Amount of Water
- Coarse Aggregate 50%
- Fine aggregate
- Cement

5.2.3 Procedure for Concrete Cube Test

- After the designated curing time, remove the samples from the water, and wipe off any excess water from the surface.
- The samples' size was measured to the closest 0.2m.
- The testing device's bearing surface has to be cleaned.
- Place the sample in the apparatus so that the opposing sides of the cube's cast receive the load.
- Align the sample's centre with the base plate of the device.
- Turn the movable part slowly by hand until it reaches the specimen's top side.
- until the sample fails, gradually apply load at a rate of 140kg/cm2 per minute.
- The failure's maximum load as well as any odd activity are noted.

Calculation

Compressive Strength of concrete = Maximum compressive load carried by specimen / Cross sectional area surface of specimen.

Cross sectional Area = 150mm X 1500mm = 22500 mm^2 or 225 cm^2

Assume the compression load is 400 KN,

Compressive Strength = (400000 /22500) = 17.77 /9.81 = 181.22 kg/cm^2.

Note – 1 kg is equal to 9.81 N.

Fig 5.3: Testing results

Table 5.3 Compressive Strength of Different Grade of concrete at 7, 14, 21 and 28 Days.

Concrete Grade	Compressive Strength in N/mm2 at 3 days	Compressive Strength in N/mm2 at 7 days	Compressive Strength in N/mm2 at 14 days	Compressive Strength in N/mm2 at 28 days
M10	4	6.5	9	10
M15	6	9.75	13.5	15
M20	8	13	18	20
M25	10	16.25	22.5	25
M30	12	19.5	27	30
M35	14	22.75	31.5	35
M40	16	26	36	40

M45	18	29.25	40.5	45
M50	20	32.5	45	50

5.3 Split Tensile Strength

Tensile strength is one of the crucial characteristics of concrete because structural loads render it susceptible to tensile cracking. Steel is utilised to handle the tension stresses since the tensile strength of concrete is substantially lower than its compressive strength. According to estimates, the tensile strength of concrete is equivalent to around 10% of its compressive strength. Due to the complexity of the direct approach, indirect methods are used to calculate the tensile strength. It should be noted that the results of these procedures are better than the results of the uniaxial tensile test. These indirect methods include: Tests 1 and 2 are flexural and split cylinder tests.

5.3.1 Equipments

Machine for testing compression, two packing strips of plywood 30 cm long and 12 mm wide, moulds, a tamping bar (a steel bar 60 cm long and 16 mm in diameter), a trowel, and a piece of glass or metal.

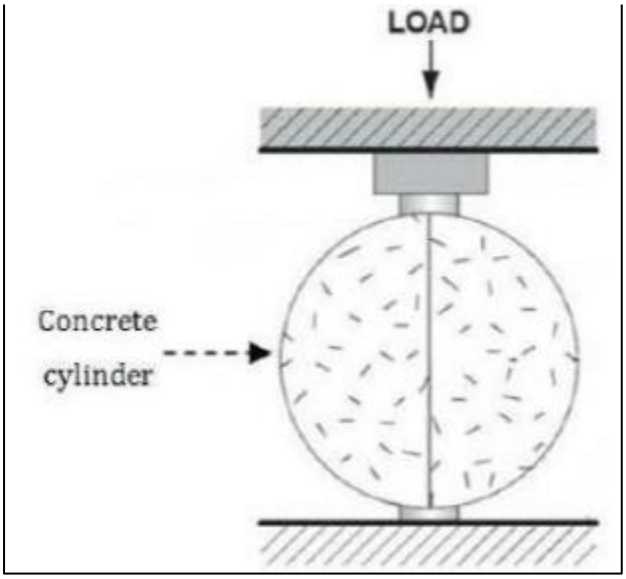

Fig 5.4 Splitting Tensile Strength Test

5.3.2 Preparation of Sample

- The sample size is a cylinder with a 15 cm diameter and 30 cm height. The employed metal mould has a height of 30 +/- 0.1 cm and an average interior diameter of 15 cm 0.2 mm. Before used, the mould should be covered with a small layer of mould oil to prevent concrete from sticking to it..

- The mould is filled with layers of concrete that are each about 5 cm thick. Either by vibration or by hand, each layer is compressed. The tamping bar is used while compacting by hand, and the stroke of the bar must be dispersed uniformly. Each layer's stroke count shouldn't be less than 30. The bottom layer should be rodded throughout its depth and the stroke should reach the underlying layer.

- After compacting the top layer, the concrete surface should be completed with a trowel to be level with the top of the mould and covered with a glass or metal plate to prevent water evaporation.

- The test specimen should be kept for 24 hours at a temperature of 27° +/- 2°C as part of the curing process. After this time, specimens are taken from the moulds and allowed to cure for the designated amount of time in saturated lime solution or clean fresh water (such as 7 or 28 days). Every seven days, the water or solution has to be changed.

5.3.3 Preparation of Sample for Split Tensile Strength

- Wipe any remaining moisture off the specimen's surface after curing.

- To ensure that the specimen's two ends are on the same axial location, draw diametrical lines on them with a marker.

- The specimen's dimensions should be measured.

- Place the specimen on the lower plate while keeping the plywood strip in place.

- Orient the specimen such that the vertical, centred lines on the ends are over the bottom plate.

- Place the second piece of plywood over the specimen, then lower the upper plate until it touches the plywood strip.

- Apply the load continuously without shock at a rate of roughly 14 to 21 kg per cubic centimetre per minute (which translates to a total load of 9.9 to 14.85 tonnes per minute).

    - Observe the Breaking Load (P).

5.3.4 Calculation of Split Tensile Strength

Range Calculation for testing machine.

According to IS456, split tensile strength of concrete = 0.7 * F_{ck}

The splitting tensile strength, $T_{sp} = 2P / \pi DL$.

Where P is the applied load, D is the diameter of the specimen and L is length of the specimen.

Accordingly $P = 0.7 Fck \times \pi DL / 2$.

Expected load = P x factor of safety.

Range to be selected for loading = (689 to 1380 kPa/min).

Splitting Tensile Strength.

$T_{sp} = 2P/\pi DL$ where P here is the actual failure load.

5.4 Flexural Strength Test

The tensile strength of concrete is indirectly assessed by the flexural test in accordance with (IS:516-1959). It evaluates a concrete beam or slab's resistance to failure due to bending. Flexural test findings for concrete are represented as a rupture modulus, abbreviated as (MR) in MPa or psi.

The modulus of rupture value obtained by the centre point load test arrangement is approximately 15% lower than that obtained by the three-point load test configuration, it should be noted. Additionally, it has been demonstrated that smaller rupture moduli are caused by larger concrete specimen sizes. Furthermore, the rupture modulus of the concrete is between 10 and 15 percent of its compressive strength. It is influenced by size, mixing ratios, and how much coarse material is used to assemble the specimens. Finally, although its significance for the design must first be proven by laboratory testing, the modulus of rupture may be determined using the following equation:

Test of flexural strength The following equation is used to determine flexural strength:

$$F = PL/(bd^2)$$

F = Concrete's Flexural Strength (in MPa). Failure load is P. (in N). L is the beam's effective span (400mm).

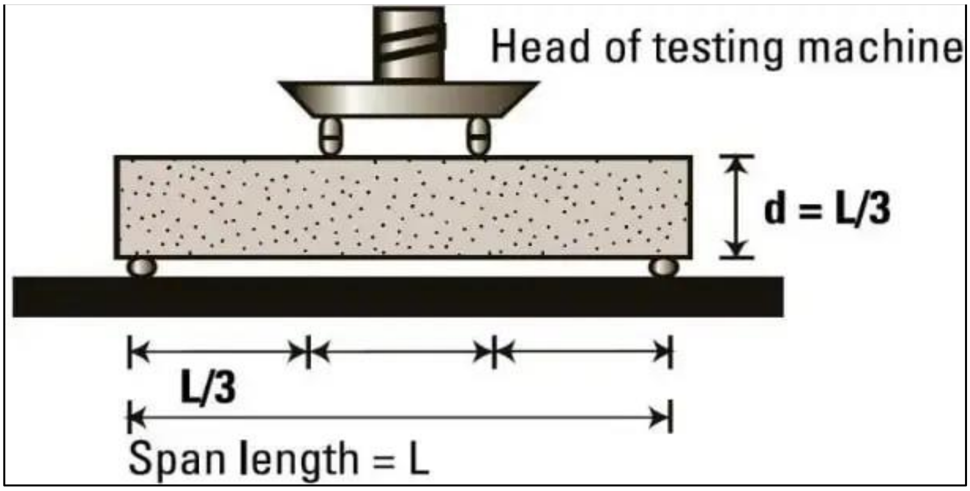

Fig 5.4 Flexural Strength Test

5.4.1 Application of Flexural Strength of Concrete

The applications of flexural test are stated below:

- Defining standards compliance
- It is a crucial prerequisite for the design of the concrete mix.
- It is used to test concrete before it is used to build pavement and slabs.

5.4.2 Size of Concrete Specimen for Flexural Test

According to ASTM, the specimen must be 150 mm wide, 150 mm deep, and its length must not be more than three times its depth. The concrete example has dimensions of 150 mm in width, 150 mm in depth, and 700 mm in span according to Indian standards. Additionally, it indicates that a dimension of 100 mm in width, 100 mm in depth, and 500 mm in span may be used as long as the maximum aggregate size is 19 mm. The British standard calls for square specimen cross sections with dimensions of 100 or 150 mm, and spans that are four to five times the depth of the specimen. However, it desired the specimen to be 750mm in length, 150mm wide, and 150mm deep.

5.4.3 Apparatus for Flexural Strength of Concrete

I. moulds made of non-absorbing materials such as steel, iron, or cast with a size of (150mmX150mmX 750mm)

II. Tamping sticks Large rods (16 mm in diameter and 600 mm long) and tiny rods are specified by ASTM (10mm diameter and 300mm long)

III. Testing device that can apply weights consistently without interrupting shocks

IV. Scoop

V. Trowel Balance with a 1 g accuracy

VI. concrete mixer with power

VII. Table vibration when compacting concrete in moulds with vibration

5.4.4 Sample Preparation of Concrete

- Calculate the ratios of the ingredients cement, sand, aggregate, and water.
- Mix the ingredients in batches that are 10% larger than the moulding test specimen, either by hand or using an appropriate mixing equipment.
- After blending, determine the slump of each batch of concrete.

- Place the moulds on a flat surface, lubricate the inside surfaces with the appropriate lubricant, and avoid over-lubricating.
- Three layers of new concrete should be poured into the moulds.
- Use a 16mm rode and 25 strokes to compact each layer, or completely fill the mould with concrete and compact it using a vibration table.
- Remove any extra concrete from the top of the mould, level it out, and do not apply pressure.
- Specimens in moulds should have the tops covered and be kept in a temperature-controlled space for 24 hours.
- Until the time of testing, remove the mould and moisten cure the specimens at 23+/-2^{o}C.
- There are two test ages: 14 days and 28 days, and each test requires the preparation of three specimens (according to Indian Code, the specimen is stored in water at 24-30oC for 48 hours and then tested).

5.4.5 Procedure of Flexural Strength of Concrete

- To avoid surface drying, which reduces flexural strength, the specimen should be tested as soon as it is removed from the curing environment.
- To the loading points, place the specimen. Loading points should not be in contact with the specimen's hand-finished surface. This will guarantee that the specimen and loading points make acceptable contact.
- In proportion to the applied force, centre the loading system.
- At the loading places, bring the block's applying force into contact with the specimen's surface.
- Applying loads ranging from 2 to 6% of the calculated ultimate load
- Determine whether any space between the specimen and the load-applying or support blocks is greater or less than each of the 0.10 mm and 0.38 mm leaf-type feeler gauges throughout a length of 25 mm or more.
- Use leather shims (6.4mm thick, 25–50mm long), extending the whole breadth of the specimen, to fill in any gaps more than 0.10mm.
- Gaps more than 0.38mm should be eliminated via capping or grinding, if possible.
- The specimen should be loaded steadily and without interruption until it fails (the Indian standard calls for loading rates of 400 kg per minute for specimens 150 mm in diameter and 180 kg per minute

for specimens 100 mm in diameter; the British standard calls for a stress increase rate of 0.06 +/- 0.04 N/mm2/s).

- To determine the average depth and height, measure the cross section of the tested specimen at both ends and in the middle.

5.4.6 Computation of Modulus of Rupture

For calculating the modulus of rupture, the following expression is used:

$$M.R. = \frac{3PL}{2bd^2}$$

The location is MR: modulus of rupture. P: the maximum load indicated by the testing device. L: the length of the span; b: the typical specimen breadth at the fracture d: the specimen's typical depth at the fracture.

5.5 Mix Proportion

Mix Design of M30 Grade Concrete

Cement type: OPC 53 grade

20 mm is the maximum size of coarse aggregate.

Condition of exposure: moderate

Crushed angular form coarse aggregate type

Zone-II fine aggregate

Design mix slump goal: 125 mm

Cement's specific gravity is 3.15.

C.A. specific gravity is 2.67.

C.A. specific gravity is 2.7.

Admixture's specific gravity: 1.12

0.6 percent of coarse aggregate absorbs water.

Fine aggregate water absorption: 0.8 percent

Standard deviation(S) for M30: 5 N/mm^2.

5.5.1 Target mean strength of concrete

fm = f_{ck} + 1.65S Or,

= f_{ck} + X (X=6.5 for M30 from Table 1 IS 10262:2019) whichever is higher

fm = 30 + 1.65x5=38.25 Or, fm = 30+6.5 = 36.5 whichever is higher

fm = 38.25 N/mm^2

5.5.2 Determination of water content

From table 2 of IS 10262:2009, maximum water content required for 20 mm size coarse aggregate is 186 lit/m^3

Estimated water content for 125mm Slump = (186+ $\frac{3*3}{186} * 100$) = 202.74 Lit

As Superplastizer is used water content can be reduced upto 20%

Water content = 202.74 x 0.8 =162.2 lit

5.5.3 Determination of Water Cement Ratio

As per table 5 of IS 456:2000 for moderate exposure, max water cement ratio for target mean strength is 0.50.

From Fig 1 IS 10262:2019 W/C Ratio= 0.47 by observation form curve 3

Taking W/C Ratio = 0.42 as we are using admixture.

5.5.4 Calculation of Cement Content

Minimum Cement Content for M30 = 320kg/m3

water cement ratio = 0.42 and water content = 162.2 kg/m3

cement content required= 162.2/0.42 = 386 kg/m3 > 320 kg/m^3

5.5.5 Calculation of volume of coarse & fine aggregate

Coarse Aggregate/ Fine Aggregate =0.62 for Zone II form IS10262 :2019 Table-5

For Pumpable concrete C.A. can be reduced upto 10% A/c to IS- 10265:2009 Cl 5.5.2

Volume of Coarse Aggregate = 0.62*0.9 = 0.558 m^3

Volume of fine Aggregate = 1-0.552 =0.442 m^3

5.5.6 Design Mix Calculation

Volume of cement = $\frac{Mass}{Specific\ Gravity*1000}$

$= \frac{386}{3.16*1000} = 0.123$ m³

Volume of Water = $\frac{162.20}{1*1000}$ = 0.162 m³

Volume of Admixture(Mass of Admixture = 1.1% of Cement) = $\frac{1.1*386}{100*1.12*1000}$ =0.00386 m3

Volume of all aggregate = 1- (0.123+0.162+0.00379) = 0.711 m3

Mass of Coarse aggregate = Volume of all aggregate * Volume of Coarse aggregate *Sp Gravity of Coarse aggregate*1000

= 0.711*0.558*2.67*1000 =1060kg

Mass of Fine aggregate = 0.711*0.442*2.46*1000 = 773kg

5.5.7 Mix Proportion of M30 Grade Concrete

Quantity of cement used= 386 kg

Quantity of water= 162 lit

Quantity of fine aggregate= 773 kg

Quantity of coarse aggregate= 1060 kg (20mm- 60% & 10mm- 40%)

Quantity of 20mm Coarse aggregate = 0.6*1060kg =636kg

Quantity of 10mm Coarse aggregate = 0.4*1060kg = 424kg

Admixture = 1.0 % of cement = 3.85kg/m3

W/C ratio =0.42

The design ratio to be followed = 1:2.00:2.78

5.6 Casting of Specimen

To achieve the specified qualities, three sets of concrete specimens were produced and evaluated. Cubes, beams, and cylinders are produced for compressive, flexural, and split tensile strengths, respectively, with natural sand replacement percentages of 0%, 10%, 20%, 30%, 40% and 50% replacement percentages with M-Sand, as well as additions of 0%, 0.3, 0.6%, 0.9% and 1.2% of steel fibres.

5.7 Test Specimen

Cast iron steel moulds were utilised to create 150mm x 150mm x 150mm cube test specimens for the compressive strength test. Three numbers of cubes were cast for each mix percentage, and they were evaluated at 3, 7 and 28 days of age. Cast iron moulds that were 300mm high were used to create the test specimens for the split tensile strength test, which were formed of cylinders with a 100mm diameter. Three numbers of cylinders were cast for each mix percentage, and after 28 days, they were examined. Cast iron and steel moulds were used to create the test specimens for the Flexural strength test, which were prisms with dimensions of 500 mm by 100 mm by 100 mm. Three numbers of prisms were cast for each mix percentage and examined after 28 days. The table below displays the test specimen's details.

Table 5.7 Test Specimen

Name of Test	Size of Specimen (mm)	No. of Specimen
Compressive Strength	150 x 150 x 150	63
Split Tensile Strength	150 x 300	63
Flexural Strength Test	750 x 150 x 100	63
Total		189

Fig 5.5: Cubes Casting and setting

RESULTS AND DISCUSSION

The samples are tested on grounds of compressive strength, split tensile strength and flexural Strength test. The variation of fine Aggregate is done using M-Sand in proportion 0%, 20%, 30%, 40% and 50%. The use of Steel Fibre in the mixture is even done in proportion of 0.3%, 0.6%, 0.9% and 1.2% in weight to concrete.

6.2 Compressive Strength

Table 6.1 Compressive Strength of concrete with 0.3% Steel Fibre

Compressive Strength of Concrete with 0.3% Steel Fibre			
Mix	3 days	7 days	28 days
M30	19.35	25.25	41.75
M30+20% M-Sand+0.3%SF	19.25	24.08	40.75
M30+30% M-Sand+0.3%SF	19.95	24.65	41.58
M30+40% M-Sand+0.3%SF	18.26	23.25	39.55
M30+50% M-Sand+0.3%SF	18.01	22.85	37.45

Fig 6.1 Compressive Strength with 0.3% Steel Fibre

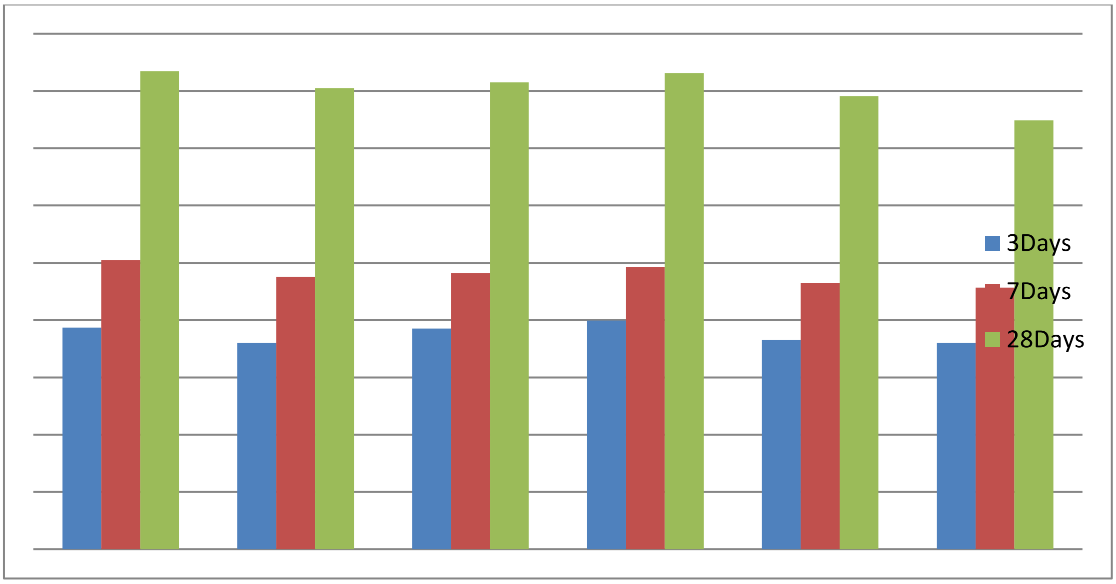

Table 6.2 Compressive Strength with 0.6% Steel Fibre

Compressive Strength of Concrete with 0.6% Steel Fibre			
Mix	3 days	7 days	28 days
M30	19.35	25.25	41.75
M30+20% M-Sand+0.6%SF	19.95	24.78	41.45
M30+30% M-Sand+0.6%SF	20.65	25.35	42.28
M30+40% M-Sand+0.6%SF	18.36	23.95	40.25
M30+50% M-Sand+0.6%SF	18.1	23.05	38.92

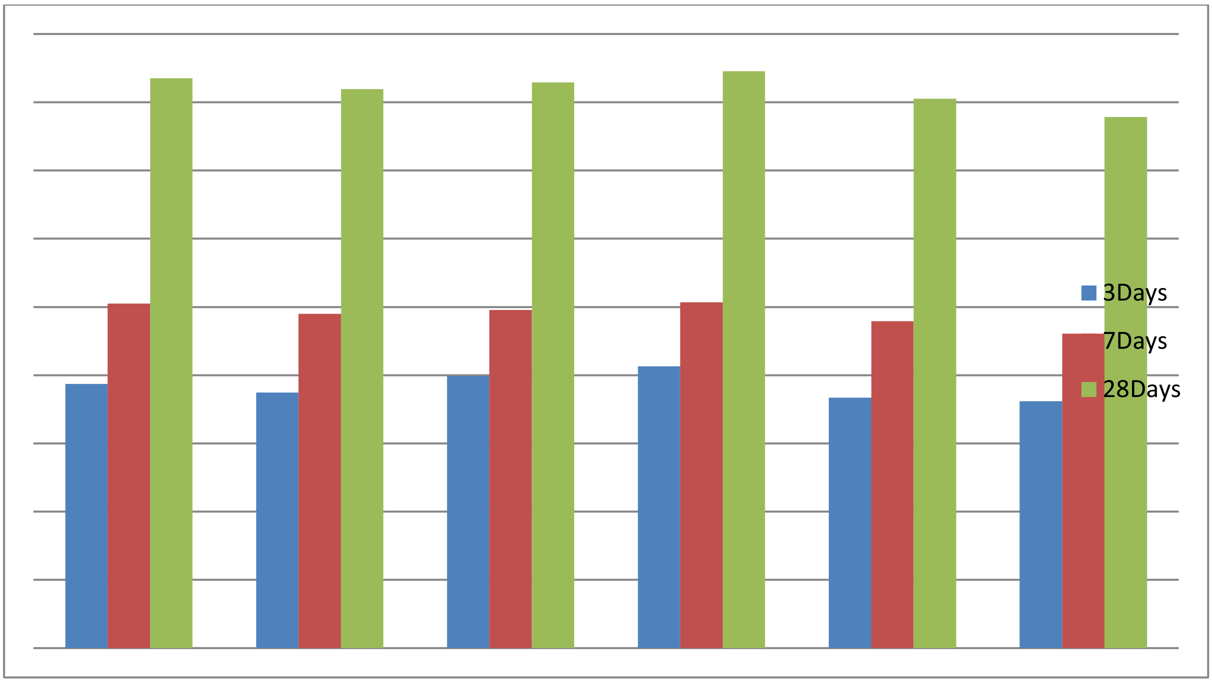

Fig 6.2 Compressive Strength of Concrete with 0.6% Steel Fibre

Table 6.3 Compressive Strength of Concrete with 0.9% Steel Fibre

Compressive Strength of Concrete with 0.9% Steel Fibre			
Mix	3 days	7 days	28 days

M30	19.35	25.25	41.75
M30+20% M-Sand+0.9%SF	20.55	25.38	42.05
M30+30% M-Sand+0.9%SF	19.56	24.55	40.85
M30+40% M-Sand+0.9%SF	18.26	23.91	39.9
M30+50% M-Sand+0.9%SF	18.24	23.85	39.79

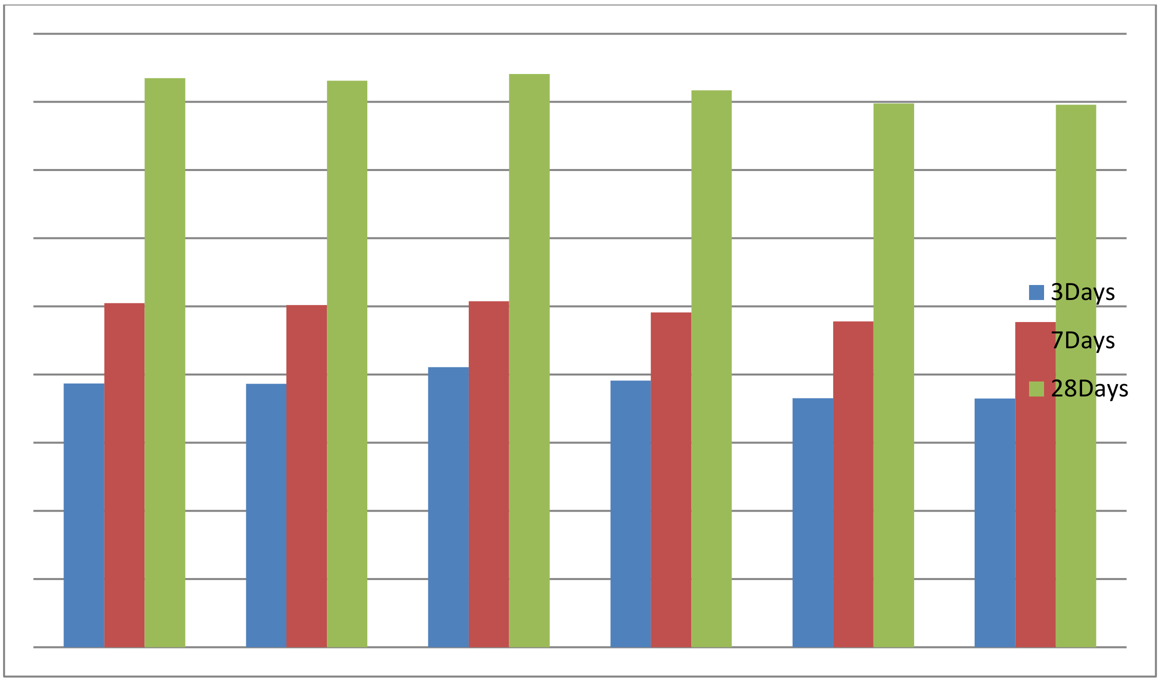

Fig 6.3 Compressive Strength of Concrete with 0.9% Steel Fibre.

Table 6.4 Compressive Strength of Concrete with 1.2% Steel Fibre

Compressive Strength of Concrete with 1.2% Steel Fibre			
Mix	3 days	7 days	28 days
M30	19.35	25.25	41.75
M30+20% M-Sand+1.2%SF	21.35	26.18	42.85
M30+30% M-Sand+1.2%SF	22.05	26.75	43.68

M30+40% M-Sand+1.2%SF	20.36	25.35	41.65
M30+50% M-Sand+1.2%SF	18.35	24.12	40.14

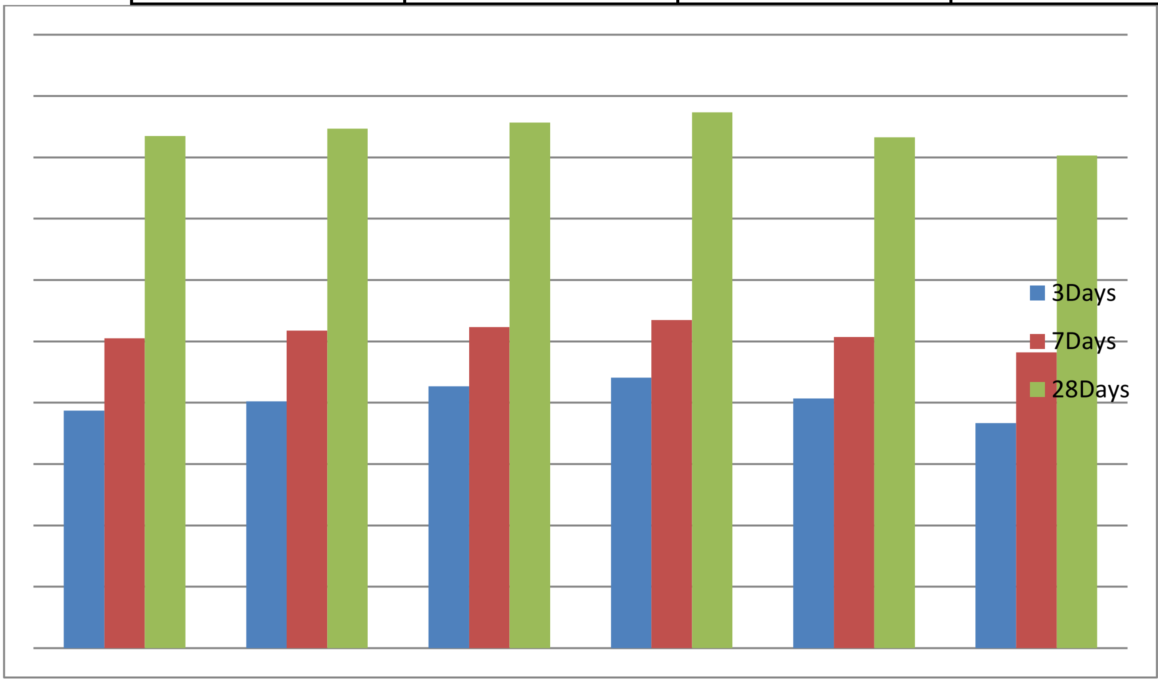

Fig 6.4 Compressive Strength of Concrete with 1.2% Steel Fibre

Inference- The Compressive-strength of concrete depends on various factors, quality of the aggregate, water-cement ratio, quality of cement, temperature conditions etc. Compressive test is done either on cylinder or cube specimen. Here as per the tabulated results the maximum strength is visible with 30% M Sand and increase in any further percentage reduces the strength of concrete while the most appropriate values of compressive strength if received with 30% M Sand and 1.2% Steel Fibre when cured for 24 days as 43.68 N/mm2.

6.3 Split Tensile Strength Test of Concrete

Table 6.5 Split Tensile Strength Test with 0.3% Steel Fibre

Split Tensile Strength of Concrete with 0.3% Steel Fibre			
Mix	3 days	7 days	28 days
M30	1.9	2.12	2.8
M30+20% M-Sand+0.3%SF	2.1	2.2	2.9
M30+30% M-Sand+0.3%SF	2.2	2.3	3

M30+40% M-Sand+0.3%SF	2	2.2	2.8
M30+50% M-Sand+0.3%SF	1.8	2.2	2.7

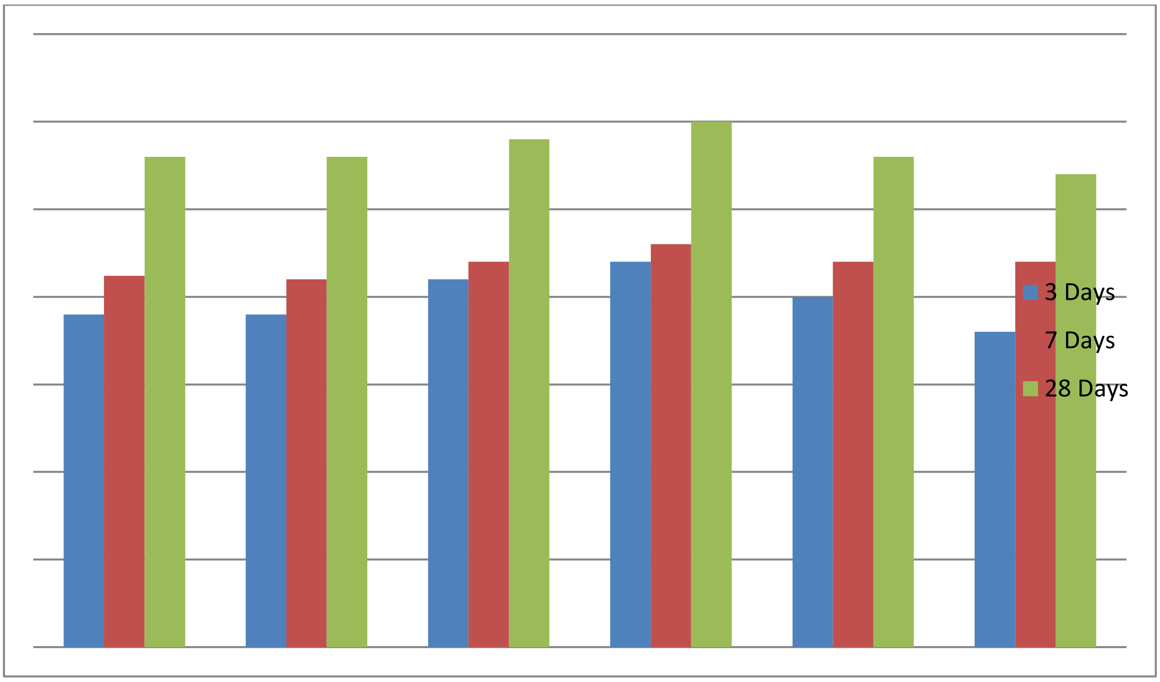

Fig 6.5 Split Tensile Strength with 0.3% Steel Fibre

Table 6.6 Split Tensile Strength with 0.6% Steel Fibre

Split Tensile Strength of Concrete with 0.6% Steel Fibre			
Mix	3 days	7 days	28 days
M30	1.9	2.12	2.8
M30+20% M-Sand+0.6%SF	2.1	2.2	2.9
M30+30% M-Sand+0.6%SF	2.2	2.3	3
M30+40% M-Sand+0.6%SF	2	2.2	2.8

M30+50% M-Sand+0.6%SF	1.8	2.2	2.7

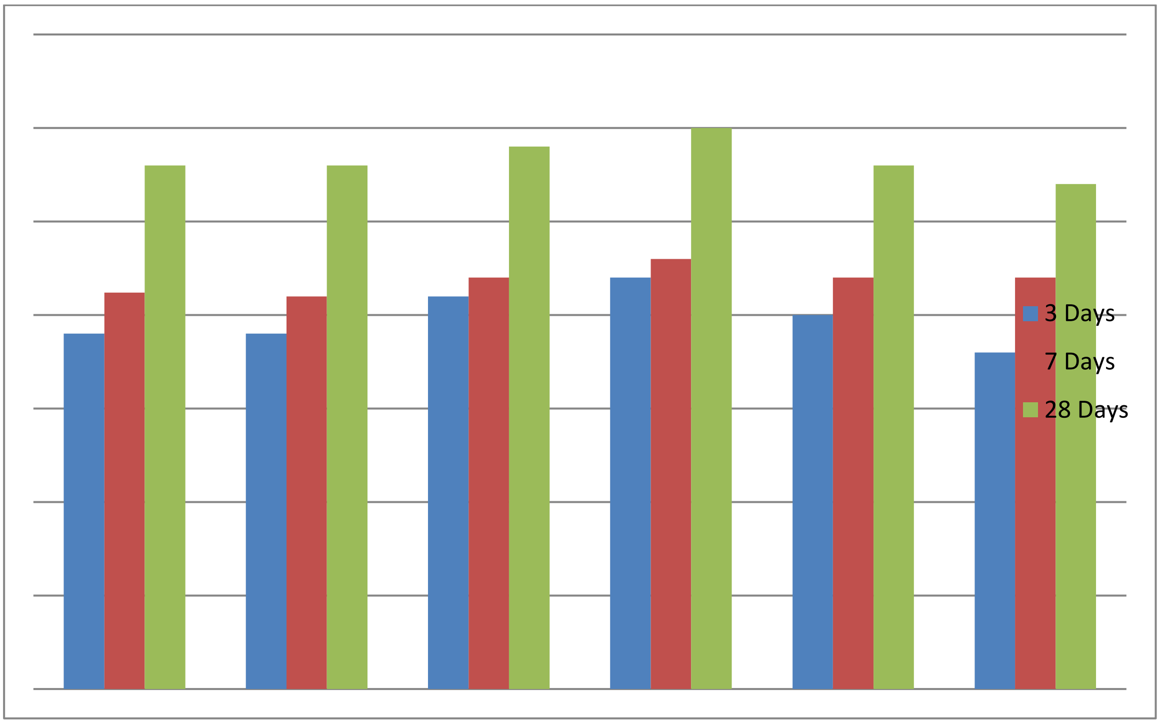

Fig 6.6 Split Tensile Strength of Concrete with 0.6% Steel Fibre

Table 6.7 Split Tensile Strength of Concrete with 0.9% Steel Fibre

Split Tensile Strength of Concrete with 0.9% Steel Fibre			
Mix	3 days	7 days	28 days
M30	1.9	2.12	2.8
M30+20% M-Sand+0.9%SF	2.2	2.3	3
M30+30% M-Sand+0.9%SF	2.3	2.3	3
M30+40% M-Sand+0.9%SF	2.1	2.3	2.7
M30+50% M-Sand+0.9%SF	1.8	2.2	2.7

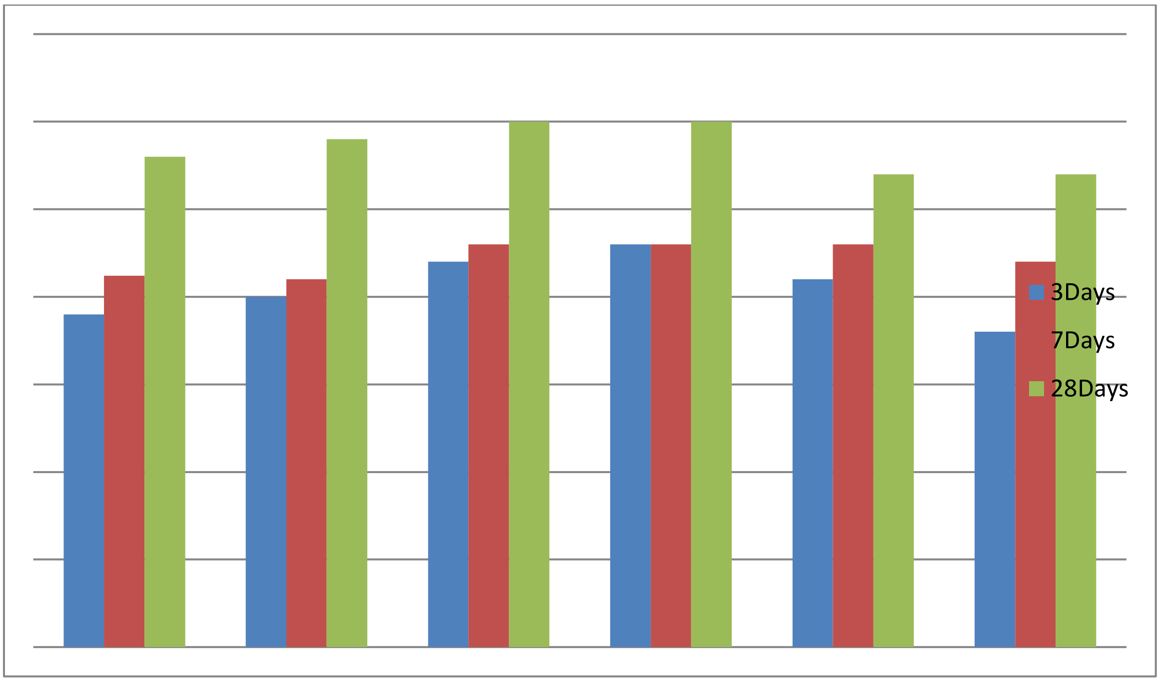

Fig 6.8 Split Tensile Strength of Concrete with 0.9% Steel Fibre.

Table 6.8 Split Tensile Strength of Concrete with 1.2% Steel Fibre.

Split Tensile Strength of Concrete with 1.2% Steel Fibre			
Mix	3 days	7 days	28 days
M30	1.9	2.12	2.8
M30+20% M-Sand+1.2%SF	2.2	2.3	3
M30+30% M-Sand+1.2%SF	2.3	2.4	3.1
M30+40% M-Sand+1.2%SF	2.1	2.3	2.8
M30+50% M-Sand+1.2%SF	1.8	2.2	2.7

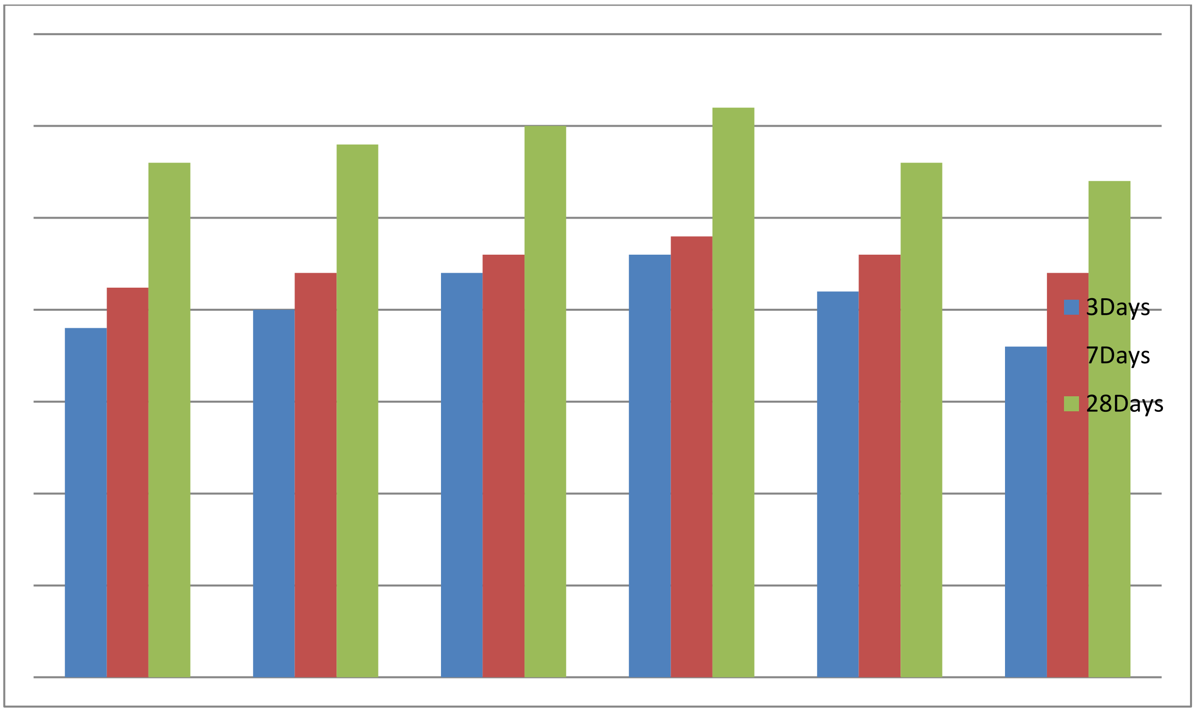

Fig 6.8 Split Tensile Strength Test of Concrete with 1.2% Steel Fibre.

Inference- The split Tensile Test determines the tensile strength parameter of concrete which is the important basic property. The concrete is good in compression and weak in tension, it develops cracks when subjected to direct tension. Thus, by inducing certain fibres such as steel, the tensile property of the concrete can be enhanced. The maximum strength is achieved with the concrete mix with 30% M-Sand as fine Aggregate and 1.2% Steel Fibre at 3.1 N/mm2.

6.4 Flexural Strength of Concrete

Table 6.9 Flexural Strength of Concrete with 0.3% Steel Fibre

Flexural Strength of Concrete with 0.3% Steel Fibre			
Mix	3 days	7 days	28 days
M30	3.07	3.51	4.52
M30+20% M-Sand+0.3%SF	3.18	3.51	4.53
M30+30% M-Sand+0.3%SF	3.24	3.53	4.57
M30+40% M-Sand+0.3%SF	3.1	3.47	4.46
M30+50% M-Sand+0.3%SF	2.87	3.38	4.39

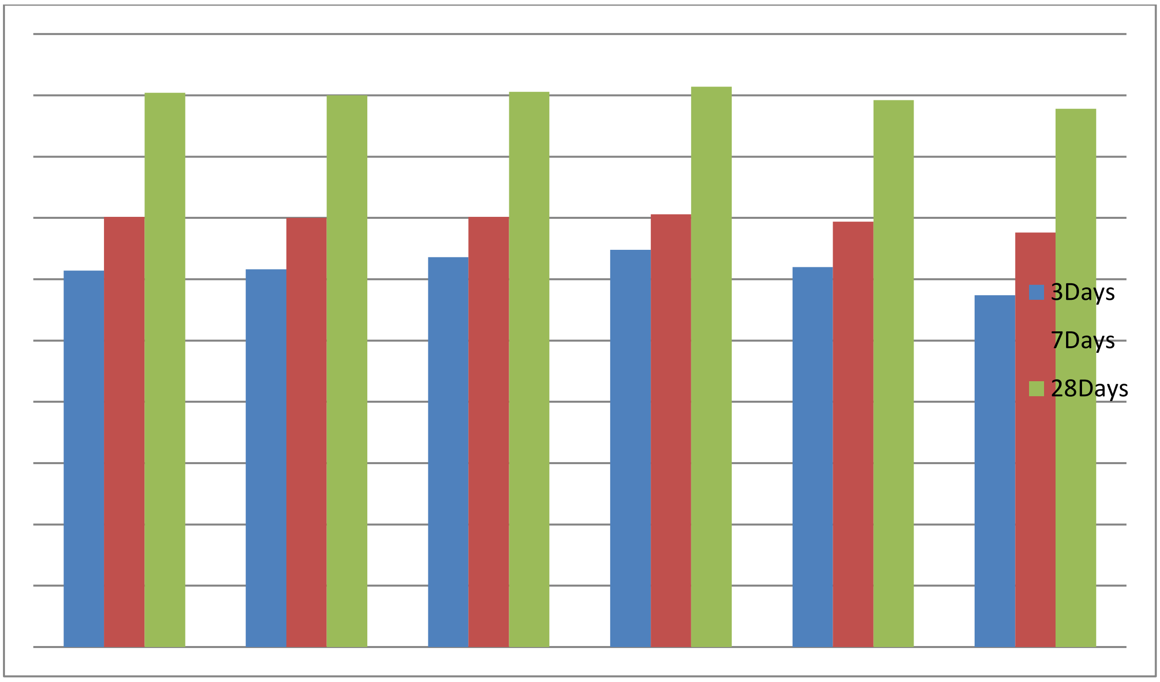

Fig 6.9 Flexural Strength Test of concrete with 0.3% Steel Fibre.

Table 6.10 Flexural Strength Test of concrete with 0.6% Steel Fibre

Flexural Strength of Concrete with 0.6% Steel Fibre			
Mix	3 days	7 days	28 days
M30	3.07	3.51	4.52
M30+20% M-Sand+0.6%SF	3.19	3.52	4.54
M30+30% M-Sand+0.6%SF	3.25	3.54	4.58
M30+40% M-Sand+0.6%SF	3.11	3.48	4.47
M30+50% M-Sand+0.6%SF	2.87	3.38	4.39

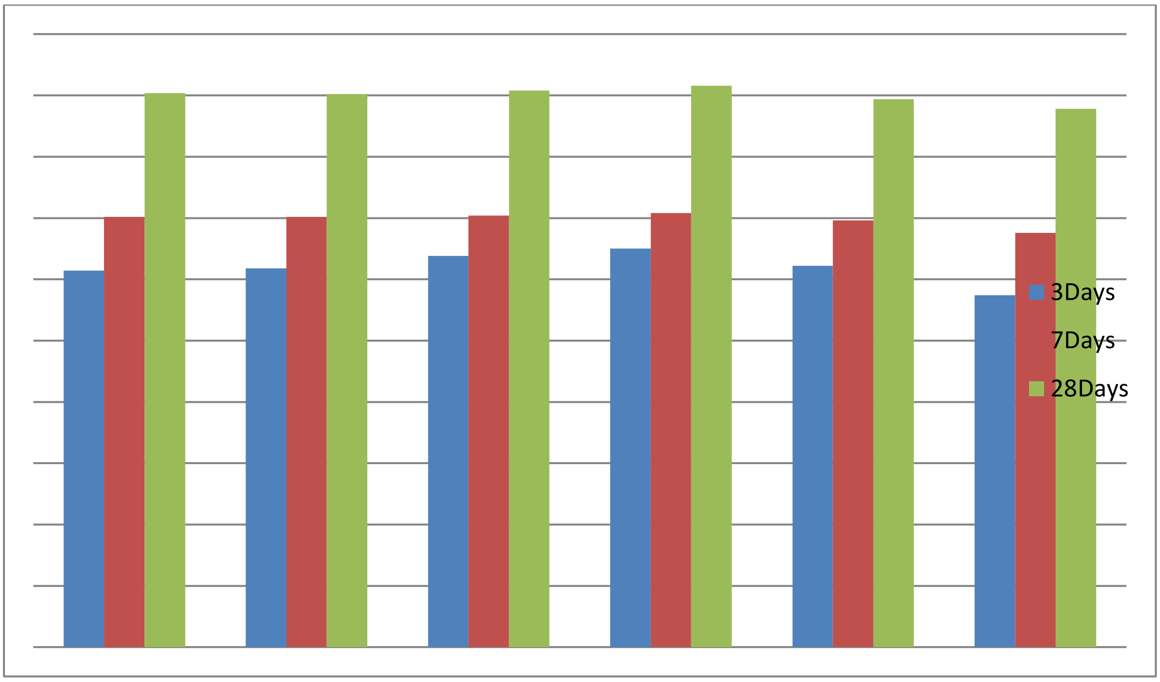

Fig 6.10 Flexural Strength of Concrete with 0.6% Steel Fibre.

Table 6.11 Flexural Strength of Concrete with 0.9% Steel Fibre

Flexural Strength of Concrete with 0.9% Steel Fibre			
Mix	3 days	7 days	28 days
M30	3.07	3.51	4.52
M30+20% M-Sand+0.9%SF	3.21	3.54	4.56
M30+30% M-Sand+0.9%SF	3.27	3.56	4.6
M30+40% M-Sand+0.9%SF	3.13	3.5	4.49
M30+50% M-Sand+0.9%SF	2.87	3.4	4.41

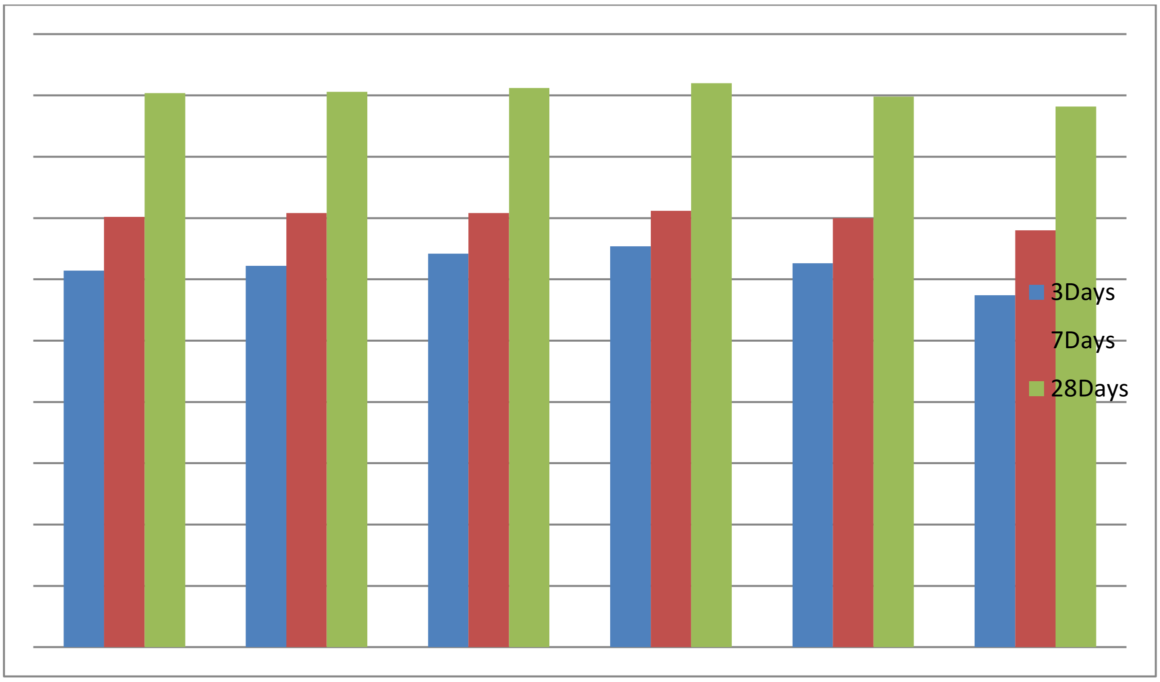

Fig 6.11 Flexural Strength of Concrete with 0.9% Steel Fibre.

Table 6.12 Flexural Strength of Concrete with 1.2% Steel Fibre

Flexural Strength of Concrete with 1.2% Steel Fibre			
Mix	3 days	7 days	28 days
M30	3.07	3.51	4.52
M30+20% M-Sand+1.2%SF	3.23	3.58	4.58
M30+30% M-Sand+1.2%SF	3.29	3.58	4.62
M30+40% M-Sand+1.2%SF	3.15	3.52	4.51
M30+50% M-Sand+1.2%SF	3	3.43	4.43

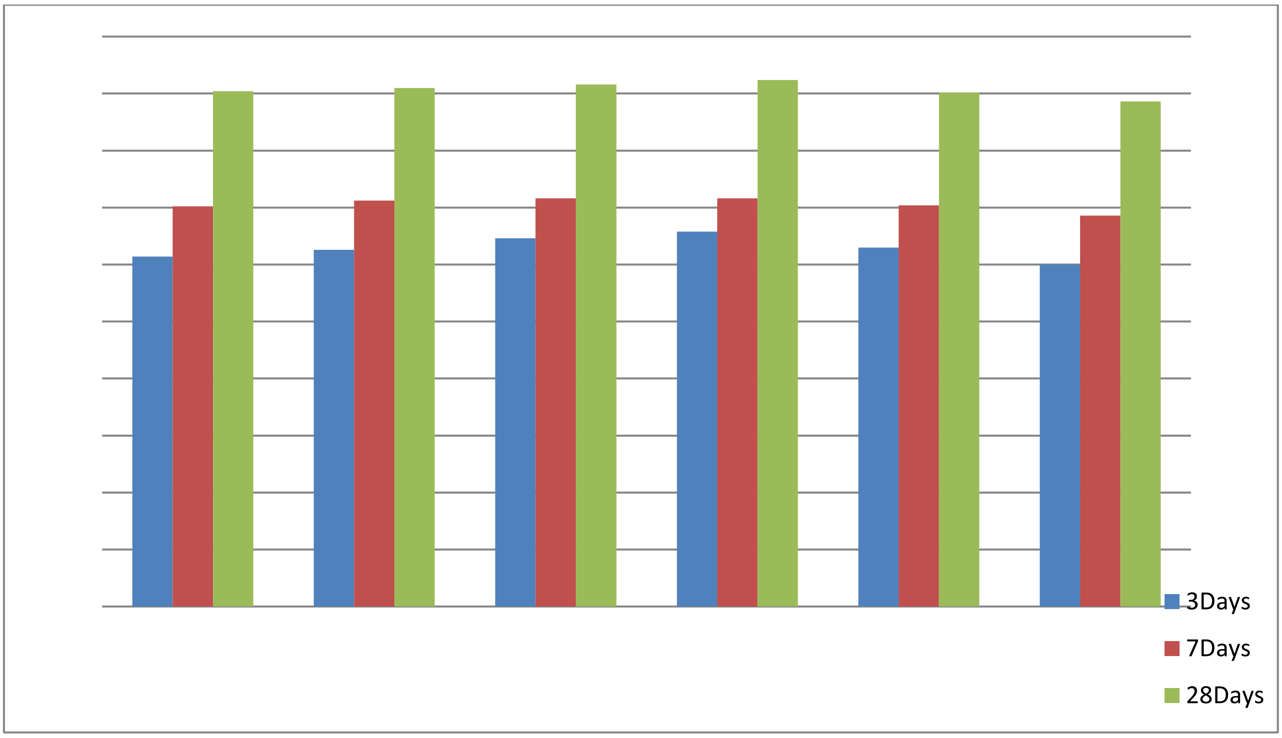

Fig 6.12 Flexural Strength of Concrete with 1.2% Steel Fibre.

Inference-

VI. CONCLUSION AND FUTURE SCOPE

7.1 Conclusion

The correlation was among ordinary and FRC-MS (with 1% steel filaments and half substitution of regular sand to that of Assembling sand) and the experimental outcomes demonstrated that the inciting of the strands of pleated steel and normal sand supplanted by M-Sand has a more prominent qualities on all the part of the review made contrasted with the typical M30 grade configuration blend concrete. The examples are tried on grounds of compressive strength, split rigidity and flexural Strength test. The variety of fine Total is finished involving M-Sand in extent 0%, 20%, 30%, 40% and half. The utilization of Steel Fiber in the combination is even finished in extent of 0.3%, 0.6%, 0.9% and 1.2% in weight to concrete.

Compressive Strength

The Compressive-strength of cement relies upon different elements, nature of the total, water-concrete proportion, nature of concrete, temperature conditions and so forth. Compressive test is done either on chamber or 3D shape example. Here according to the organized outcomes the greatest strength is apparent with 30% M Sand and expansion in any further rate decreases the strength of cement while the most fitting upsides of compressive strength whenever got with 30% M Sand and 1.2% Steel Fiber when restored for 28 days as 43.68 N/mm2.**Split Tensile Strength**

The split Pliable Test decides the rigidity boundary of substantial which is the significant fundamental property. The substantial is great in pressure and frail in strain, it creates breaks when exposed to coordinate pressure. Accordingly, by instigating specific strands, for example, steel, the elastic property of the substantial can be upgraded. The greatest strength is accomplished with the substantial blend in with 30% M-Sand as fine Total and 1.2% Steel Fiber at 3.1 N/mm2.

Flexural Strength

The flexural strength of cement is a significant property to be resolved particularly for changes in the volume of cement because of temperature variety or shrinkage, for the street section performed on to the vehicular burdens.

The flexural Strength was greatest with 30% M-Sand as fine Total with 1.2% Steel Fiber as 4.62 N/mm2 and with later expansion of m sand extent prompted decrement in strength of substantial shapes.

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