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Experimental Study on Strength Behavior of Steel Fiber Chips for Different Grades of Reinforced Concrete

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ABSTRACT

The present work describes the experimental study of steel fibre chips reinforced concrete withM-25, M-30 and M-35 grade concrete in addition of steel fibre chips with different % .To over-come the difficulties due to optimum percentage of steel fibre chips for maximum strength in concrete and high performance concrete. The main objective of this thesis work is to investigate the optimum percentage of steel fibre chips on M-25, M-30 & amp; M-35 grade concrete and develop a high performance concrete. It is proposed to determine and compare compressive strength, split tensile strength, flexural strength and slump test of concrete grade- M-25, M-30 and M-35 having different percentage of steel fibre chips (0%, 2%, 4% and 6%). Compressive strength split tensile strength and flexural strength increases up to 6 % steel fibre chips for M-25, M-30& M-35 grade of concrete. The experimental investigation is carried out on a total no of 108 specimens for compressive strength, split tensile strength and flexural strength each.

KEYWORDS- Steel fibre chips, Slump value, Compressive strength, Split tensile strength, Flexural strength, RCC,

Introduction

The Plain concrete has a very low tensile strength, limited ductility, and little resistance to cracking. Internal micro cracks are inherently present in the concrete and its poor tensile strength is due to the propagation of such micro cracks, eventually leading to brittle failure of the concrete. The most widely accepted remedy to this flexural weakness of concrete is the conventional reinforcement with high strength steel. Although these methods provide tensile strength to members, they however do not increase the inherent tensile strength of concrete itself. Also the reinforcement placing and efficient compaction of RCC is very difficult if the concrete is of low workability especially in the case of heavy concrete (M-25, M-30 & M-35). In plain concrete and similar brittle materials, structural cracks (micro- cracks) develop even before loading, particularly due to drying shrinkage or other causes of volume change. The width of these cracks seldom exceeds a few microns, but their two dimensions may be of higher magnitude.

Objectives of the Study

The objectives of the thesis are outlined below:

- To achieve the desire strength in high performance concrete.
- To find out the dosage of the steel fibre chips at which the concrete gain the higher strength.
- Determination of the compressive strength split tensile strength, and flexural strength of the concrete.
- Steel fibre chips is also industrial waste by the use of it we can reduced the environmental degradation.

LITRATUREREVIEW

{1.}Hoe KwanMahyuddin Ramli, (2016) In addition to being exposed to chloride and sulphate attacks, marine structures are subject to seismic and impact loads resulting from waves, impact with solid objects, and water transports. Therefore, the flexural behavior and impact resistance of Fiber-Reinforced Concrete (FRC) in marine environment must be elucidated. However, such information is scarcely reported. Therefore, this study aims to explore the effects of simulated aggressive environmentsonflexuralstrengthandimpactresistanceofFRCandtoidentify the relationship between the two parameters. Three types of fibers, namely, coconut fiber, Bar chip fiber (BF), and alkali-resistant glass fiber, were used in this study. The fiber dosage ranged from0.6%to 2.4% ofthe binder volume. All mixes have constant water/binder ratio of 0.37 and their compressive strengths were all exceeding 60 MPa.

{2} Athira Omanakuttan (2017) Hybrid Fiber-reinforced concrete is a composite material consisting of mixtures of cement, fine aggregate, coarse aggregate, steel fiber and glass fiber. The hybrid fiber reinforced concrete exhibits better fatigue strength and increased static and dynamic tensile strength. In this project, the strength of fiber reinforced concrete was investigated with partial replacement of cement with rice husk ash and fly ash. Steel fiber and glass fiber was added in the order of0.25%, 0.5% and 0.75% by volume of concrete and 0.25%, 0.5% and 0.75% by weight ofcement. Rice Husk Ash was used to replace ordinary Portland cement by 20% and fly ash 20% by weight of cement proportion.

{3}Aswani Sabu,ThomasPaul,(2018), Fibres are generally used as a common engineering material for crack resistance and strengthening of concrete. Their properties and characteristics greatly influence the properties of concrete which has been proved already in many previous researches. Accordingly it has been found that steel fibres give the maximum strength incomparable is on to glass and polypropylene fibres. In this experimental study, two types of steel fibers namely hooked end and crimped fibers are used. The volume fractions taken are 0.75%, 1.0% and 1.25% and M30 grade concrete is adopted. Cement has been replaced with 25% of Class F fly ash. The primary focus is to compare the mechanical properties of concrete using both fibres.

{4}Omanakuttan Athira, (2019) Hybrid Fiber-reinforced concrete is a composite material consisting of mixtures of cement, fine aggregate, coarse aggregate, steel fiber and glass fiber. The hybrid fiber reinforced concrete exhibits better fatigue strength and increased static and dynamic tensile strength. In this project, the strength of fiber reinforced concrete was investigated with partial replacement of cement with rice husk ash and fly ash. Steel fiber and glass fiber was added in the order of0.25%, 0.5% and 0.75% by volume of concrete and 0.25%, 0.5% and 0.75% by weight of cement.

{5}Badrinarayan Rath (2021), Chhattisgarh ranks 3rd in coal production in India and plenty of coal is mined daily in the central Chhattisgarh region of India. Hence a lot of steel and power plants have been established in this region. From these power plants, a huge amount of fly ash and pond ash is generated daily and these ashes are occupying large landfill areas. The carbon dioxide released from the chimneys of these plants not only polluted the local air mass but also creates a problem of carbonation to the local concrete structure.

{6}Ahmmad A. Abbass 1 , Sallal R. Abid (2022) , The ACI 544-2R repeated impact test is known as a low-cost and simple qualitative test to evaluate the impact strength of concrete. However, the test's main deficiency is the high variability in its results. The effect of steel fibers and the compressive strength of concrete on the variability in repeated impact test results was investigated experimentally and statically in this study. Two batches from four mixtures were prepared and tested for this purpose. Hooked-end steel fibers were utilized in the fibrous mixtures.

{7}Yongtao Gao (2023) Recycled steel fiber comes from the waste produced by machining. Adding recycled steel fiber into concrete can significantly enhance the toughness of concrete. In order to study the impact toughness of recycled steel fiber-reinforced concrete, the drop weight repeated impact experiment method was used to study the performance of recycled steel fiber-reinforced concrete under repeated impact load. Four kinds of recycled steel fiber-reinforced concrete samples with different volume contents were designed and made, and the loading impact experiments under five working conditions were carried out.

MATERIALS & PROPERTIES-

- **(i) Cement**
- **(ii) Aggregates**
- **(iii) Water**
- **(iv) Steel Fibre Chips**

Cement - cement is a binder, a chemical substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete. Concrete is the most widely used material in existence and is behind only water as the planet's most-consumed resource. Cements used in construction are usually inorganic, often lime or calcium silicate based, which can be characterized as hydraulic or the less common non-hydraulic, depending on the ability of the cement to set in the presence of water.

They are two types – **(i)** Hydraulic cements

(ii) Non-hydraulic cement

Hydraulic cements- Hydraulic cements (e.g., Portland cement) set and become adhesive through a chemical reaction between the dry ingredients and water. The chemical reaction results in mineral hydrates that are not very water-soluble and so are quite durable in water and safe from chemical attack. This allows setting in wet conditions or under water and further protects the hardened material from chemical attack.

Figure no. 1 Portland cement

Non-hydraulic cement - Non-hydraulic cement (less common) does not set in wet conditions or under water. Rather, it sets as it dries and reacts with carbon dioxide in the air.

Figure no.2 Non-hydraulic cement

Portland cement- Table no.1 Physical Properties of 43 Grade Portland Cement

S. No.	**Physical Properties**	**Values of Portland Cement used**	**Requirements as Per IS8112-1989**
1	Standard Consistency	29.2%	-
2	Initial Setting Time	45 Minutes	Minimum of 30 Minutes
3	Final Setting Time	265 Minutes	Maximum of 600 minutes
4	Specific gravity	3.15	-
5	Compressive strength in N/mm 2 at3 days	29	Not less than
6	Compressive strength in N/mm2at7days	38.5	Not less than
7	Compressive strength in N/mm2 At 28days	48	Not less than

Table no. 2Composition of Ordinary Portland Cement

Constituent	**Composition (%)**	**Properties**
Tricalcium Silicate(C3S)(Allite)	**30-50**	Responsible for early strength development of cement and increased resistance to freezing and thawing.
Dicalcium Silicate(C2S) (Bellite)	**20-45**	It hardens slowly; however, leads to the development of ultimate strength. It also makes cement resistant to chemical attacks.
Tricalcium Aluminate (C3A) (Cellite)	**8-12**	It results in the flash setting of cement and has the highest heat of hydration.
Tetracalcium Aluminoferrite (C4AF) (Fellite)	**6-10**	It contributes to flash set to some extent.

Water- Water plays an important role in the formation of concrete as it participates in chemical reaction with cement. Potable water is generally considered satisfactory for mixing.

Aggregates - Aggregates are raw materials that are produced from natural sources and extracted from pits and quarries, including gravel, crushed stone, and sand. When used with a binding medium, like water, cement, and asphalt, they are used to form compound materials, such as asphalt concrete and Portland cement concrete.

They are two types – (i) Fine Aggregate (ii) Coarse Aggregate

Fine Aggregate - Fine aggregates are essentially any natural sand particles won from the land through the mining process. Fine aggregates consist of natural sand or any crushed stone particles that are ¼" or smaller. This product is often referred to as 1/4'" minus as it refers to the size, or grading, of this particular aggregate.

Figure no. 3 fine aggregate

Physical Properties of Fine Aggregate-

1. Size: The size of fine aggregate should be equal to or less than 4.75 mm.

2. Shape: Sand of irregular nodular shape is preferable to completely round grained sand. Shape of the aggregate plays a more important role in coarse aggregate rather than fine aggregate.

3. Specific Gravity: It is the ratio of density of aggregate to the density to water.

4. Bulk density: It is the ratio of weight of aggregate (including voids) to its unit volume.

5. Moisture Content (% Water absorption): It is the ratio of weight of water absorbed to weight of dry aggregate; measured in percentage.

7**. Surface Texture**: Surface texture is the property which defines whether a particular surface is polished, dull, smooth or rough. Generally rough surface aggregate is preferable to smooth aggregates.

8. **Soundness:** Soundness means the ability of aggregates to resist excessive change in volume as a result of change in physical condition.

9. **Durability:** Some of the aggregate contain reactive silica, which reacts with alkalies present in cement and hence reduce the durability. Durability is the ability to resist against the weathering actions, chemical attack, et.

Physical Properties of Coarse Aggregate- Coarse aggregates can be classified based on their shape. The four main shape classifications are rounded, irregular, elongated (long), and flaky (flat). Rounded coarse aggregates are sourced naturally. They get their smooth round shape from weathering, erosion, and attrition.

Steel Fibre Chips- Stainless steel chips were taken as steel fibres for this study. These are industrial waste of high-grade stainless steel to handle toughest jobs. Since each chip is made of a single strand of stainless steel, they will not tear or splinter. Also, they will not corrode. It has a good tensile strength and the fibre strips length vary by 25 to 50 mm. These fibers will improve toughness, durability and tensile strength of concrete.

Figure No. 4 Steel Fibre Chips

METHODOLOGY

Concrete Mix Design by IS 10262 – 2009 for Mix Proportion

Concrete mix for M-25

The process of selecting suitable ingredients of concrete and determining their relative amount with objective of producing a concrete of the required strength, durability, and workability as economically as possible, is known as the concrete mix design.

Concrete Mix Design Procedure:

The basic steps in evolved in the concrete mix design can be summarized as follows:

1. The target mean strength is calculated from the specified characteristic strength.
2. The water cement ratio is selected for the target mean strength.
3. The water content for the required workability is determined.
4. The cement content is calculated from the water cement ratio and water content and check for workability requirement.
5. The relative proportions of fine and coarse aggregates are calculated from the characteristics of coarse and fine aggregates.
6. The trial mix proportions are determined.

(A) Test data for materials:

1. Cement used : OPC 43grade
2. Specific gravity of cement : 3.15
3. Specific gravity:
   a. Corse aggregate : 2.68
   b. Fine aggregate : 2.65
4. Water absorption:
   a. Corse aggregate : 0.68%
   b. Fine aggregate : 0.84%
5. Surface moisture:
   a. Coarse aggregate : Nil
   b. Fine aggregate : Nil

(B) Design stipulations for Proportioning:(ASPERIS:10262-2009)

1. Grade Designation : M 25
2. Type of cement : OPC 43grade,IS-8112
3. Maximum normal size of aggregate : 20mm
4. Minimum cement content : 300 kg/m^3
5. Maximum water content ratio : 0.50

(IS456-2000,Table no5)

6. Workability : 75mm(slump)

7. Exposure condition : Mild

8. Type of aggregate : Crushed angular aggregate;

9. Chemical admixture : Not Used

(C) Target mean strength for Mix Proportioning:

ft=fck +1.65xS

=25+1.65×4=31.60N/mm sq

(Where ft=target mean strength,

fck= characteristic compressive strength,

S= standard deviation) By IS10262-2009 from Table–1: (Standard deviations =4 N/mm^2forM25mix)

(D) Selection of Water Content:

From table 2 of IS 10262-2009, Maximum Water Content = 186 litters (for 25mm- 50mm slump).

3% increase for every 25 mm slump over and above 50 mm slump.

Therefore w/c=186+3%of186=191.5liters

(E) Selection of Water Cement ratio:

We have adopted w/c ratio=0.44

(As perIS-456-2000, Table-5, Maximum water cement ratio=0.5)

(F) Calculation of Cement Content:

We have adopted w/c ratio=0.44

So cement content=Total Water Content/ w/c ratio

(As per IS456-2000, Table-5–Minimum cement content=300Kg/$m^3$for mild exposure condition)

So cement content=191.5/0.44 =435.4 Kg/m3

(G) Proportions of volume of Coarse Aggregate and Fine Aggregate:

From Table -3 of IS 10262-2009, Volume of Coarse Aggregate of 20 mm size and Fine aggregate , for Water cement ratio 0.5 will be =0.62

In present case, w /c ratio 0.44.

It is lessby0.06, so coarse aggregate is to be increased @0.01forevery decrease in w/c ratio of 0.05. Therefore 0.01/0.05×0.06 = 0.012.

Therefore corrected proportion of volume of coarse aggregate= 0.62+0.012= 0.632,

Therefore volume of fine aggregate= 1-0.632 = 0.368

(H) Mix Calculations:

The mix calculations per unit volume of concrete will be as follows

1. Volume of concrete(a) =1m3
2. Volume of water (b) =Mass of water/Specific gravity of water x(1/1000) So Volume of Water=191.5/1 x (1/1000) = 0.192 m3
3. Volume of Cement (c) =Mass of cement/ Specific gravity of cement x (1/1000)

= 435.4/3.15x (1/1000)

So Volume of Cement=0.138m3

4. Volume of Chemical Admixture(d)=0(Admixture not use)
5. Volume of all in aggregate = a-(b+ c+ d)=0.701m^3

1-(0.138+0.192+0)

So volume of all in aggregate =0.67m3

6. Volume and Wt of Fine Aggregate:

Volume of fine aggregate = volume of all in aggregates x proportion of fine aggregate

$=0.67x0.368m^3=0.246m^3$

Wt of fine aggregate =volume of fine aggregate x specific gravity of fine

aggregatex1000

=0.246x2.65x1000=651.9Kg/m3

7. Volume and wt of Coarse Aggregate;

Volume of coarse aggregate=volume of all in aggregate x proportion of coarse

aggregate

=0.67x0.632=0.423m3

Wt of coarse aggregate = Volume of coarse aggregate x specific gravity of coarse aggregate x 1000

$=0.423x2.68x1000Kg/m^3$

$=1133.78Kg/m^3$

Mix Proportion

A mix was designed as per IS 10262 – 1982 to achieve minimum target strength of 25 N/mm^2, 30 N/mm^2 and 35 N/mm^2 (Grade M-25, M-30 and M-35). The different percentage of steel fibre was used for all type of Conventional concretes. The mix proportion was 1:1.48:2.6, 1:1.38:2.45 and 1:1.296:2.33.

Preparation of test specimens

Table no. 3 Specimen Cubes Casted forM-25 (with OPC43 grade)

Sr. No.	Test	Cubes Sets	%of Steel Fibre chip	7days	14days	28days
SET I	M-25 Grade Compressive strength	B1	0%	3	3	3
		B2	2%	3	3	3
		B3	4%	3	3	3
		B4	6%	3	3	3
Total cubes				12	12	12

Casting of concrete cubes

First of all, lubricating oil is applied to all the moulds so that during opening time (after 24 hrs) mould will open easily without damaging the concrete cube and before pouring ensures that all the bolts of cubes are tight. This prevents the leakage of concrete mix and help in setting of perfect cube shape (150 mm × 150 mm × 150 mm). The concrete mix of M-25, M-30 and M-35 grade was designed. All the concrete mixes were mixed in Institute laboratory. Slump test was conducted on fresh concrete to determine slump and compaction factor test for Workability. From each mix three 150 mm cubes were cast for determination of compressive strength, 100mm×100mm×700mm beam was cast for the determination of flexural strength. After casting the strength of concrete is determined at the age of 7 days,14 days and 28 days.

Figure no. 4.6 Casting of Concrete

RESULTS AND DISCUSSIONS-

Workability Properties

Fresh mix characteristics are more emphasized in fibre concrete compared to the plain concrete, generally increasing weight fraction of fibres results in further reduction of fresh concrete workability. In this study, fibres as steel fibre chips of different volume fractions like 2 %, 4 %, and 6 % and length of fibre lengths is 25 mm to 40 mm.

Slump Test **Table No. 4**

Slump Test Results

S. No.	% Replacement of Steel fibre chip	Slump for M25	Slump for M30	Slump for M35
1	0%	66	63	59
2	2%	63	60	56
3	4%	60	57	53
4	6%	58	55	51

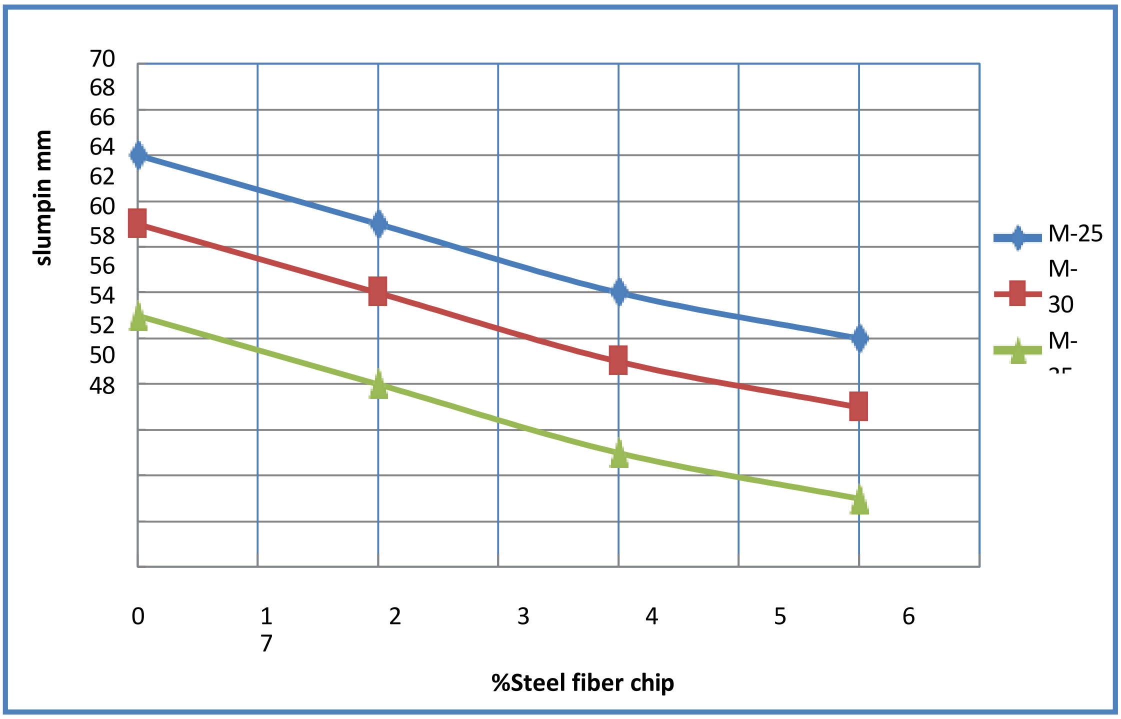

Figure no. 5.slump value with steel fiber (GradeM-25, M-30&M-35)

Discussion:- Slump test value for M-25, M-30 and M-35 grade of concrete mix with 0%,2

%, 4 %, and 6 % steel fibre chip mixes are shown in table & graph. Table-4.1 shows the slump values of M-25, M-30 and M-35 grade concrete and steel fibre concrete proportion. Their values are observed to be vary from66mmto 58 mm from0% to 6% steel fibre chips for M25 grade concrete, 63 mm to 55 mm from 0% to 6% steel fibre chips for M30 grade concrete and 59 mm to 51 mm from 0% to 6% of steel fibre chips for M35 grade concrete mixes. It is observed that with the increase in the addition of steel fibre chips, workability reduces gradually for M-25, M-30 and M-35 grade concrete respectively.

Mechanical Strength

To evaluate the mechanical strength characteristics of concrete reinforced with steel fibres chips materials, detailed experimental investigation was carried out and the results are discussed in the forthcoming sections.

Cube Compressive Strength

Totally 108 cube specimens of size 150 mm x150 mm x 150 mm with 3 mixes were casted and tested. Three volume fractions were considered for steel fibre chips (2%, 4% and 6% of steel fibres chip). Results for compressive strength based on the average values of three test data are shown in Table 4.2, 4.3, and 4.4.Asample comparisons graph for steel fibres chip concrete is plotted to study the effect of fibre reinforcement on conventional concrete strength which is shown in Graph 4.2, 4.3, and 4.4

Table no. 5–Compressive Strength of M25 Grade concrete in N/ mm^2

S. No.	%of Steel fibre chip	Grade of Concrete		
		7Days	14Days	28Days
1	0%	18.11	22.24	25.17
2	2%	19.77	25.40	29.30
3	4%	20.40	26.90	30.80
4	6%	20.88	27.40	31.25

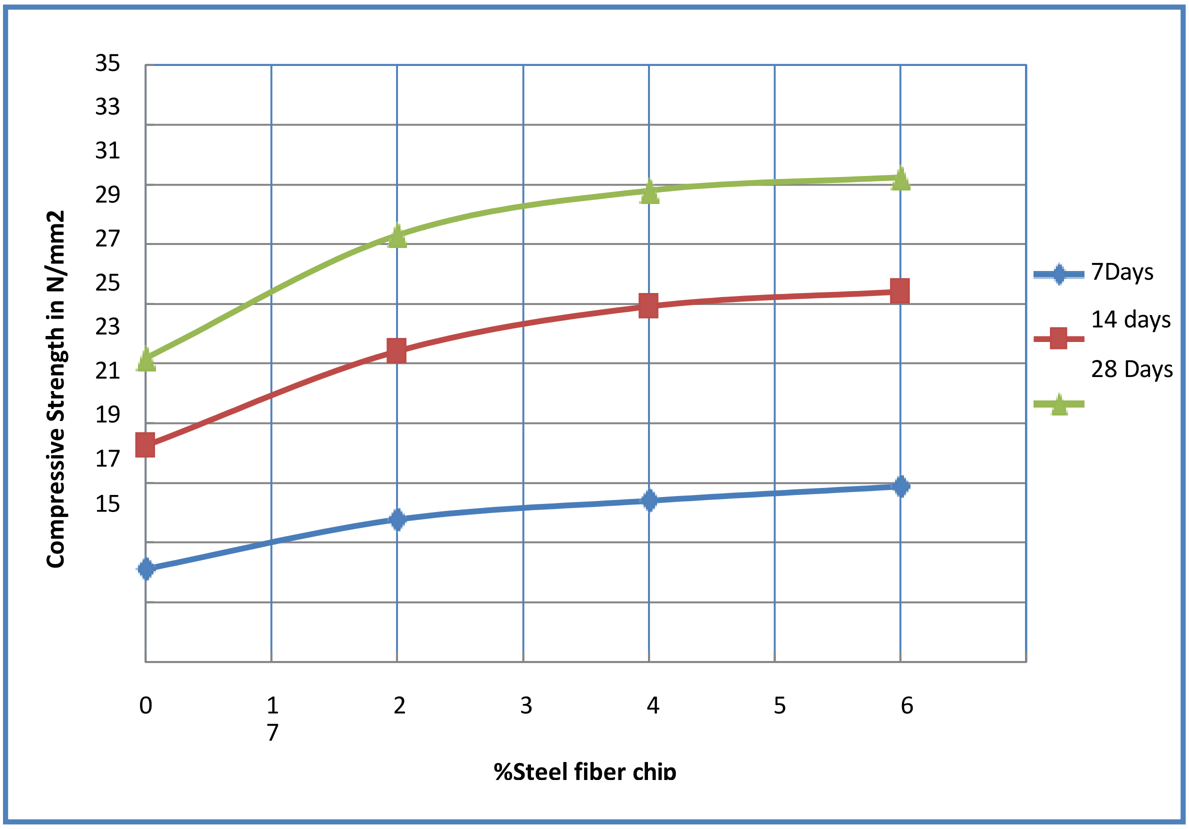

Figure no. 6. –Compressive Strength of M25 Grade concrete

Discussion: The Result of compressive strength for M-25 grade of concrete on cube specimen with 0%, 2%, 4%, and 6% steel fiber chip mixes are shown in table & graph. Table-4.2 gives the compressive strength values ofM-25 grade concrete and steel fiber chip concrete mixes at 7, 14 and 28 days curing and their values are observed .With addition of steel fiber chips, compressive strength gradually increases from 18.11 N/mm^2 to 31.25 N/mm^2 with 0 %to 6% of steel fiber chips.

Table no 6 –Compressive Strength of M30 Grade concrete in N/mm^2

S. No.	%of Steel fibre chip	Grade of Concrete		
		7Days	14Days	28Days
1	0%	21.40	27.50	30.60
2	2%	22.54	29.10	32.90
3	4%	23.35	30.40	34.70
4	6%	23.78	31.30	35.86

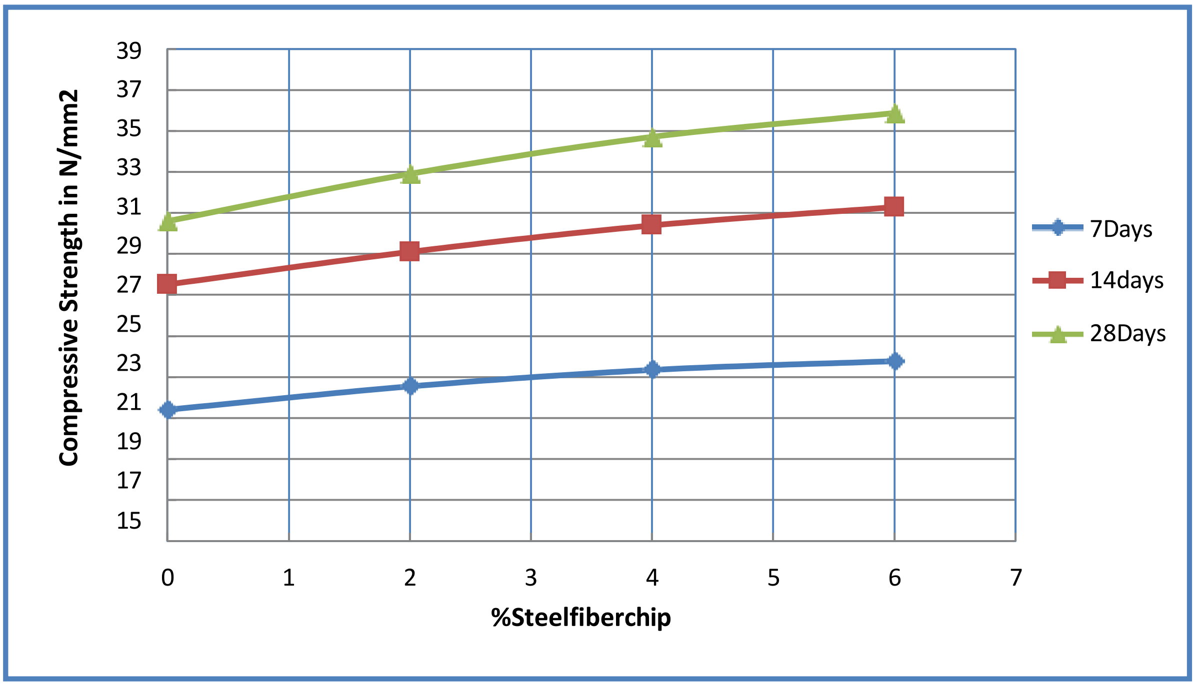

Figure no 7 Compressive Strength of M30 Grade concrete

Discussion: The Result of compressive strength for M-30 grade of concrete on cube specimen with 0%, 2%, 4%, and 6% steel fiber chip mixes are shown in table & graph. Table-4.3 gives the compressive strength values ofM-30 grade concrete and steel fiber chip concrete mixes at 7, 14 and 28 days curing and their values are observed. With the addition of steel fiber chips, compressive strength gradually increases from 21.4N/mm^2 to 35.86 N/mm^2 with 0% to 6% of steel fiber chips.

Table no. 7 –Compressive Strength of M35 Grade concrete in N / mm^2

S. No.	% of Steel fibre chip	Grade of Concrete		
		7Days	**14Days**	**28Days**
1	0%	23.00	30.92	35.66
2	2%	24.26	33.16	39.12
3	4%	25.45	34.44	41.62
4	6%	26.88	35.47	43.25

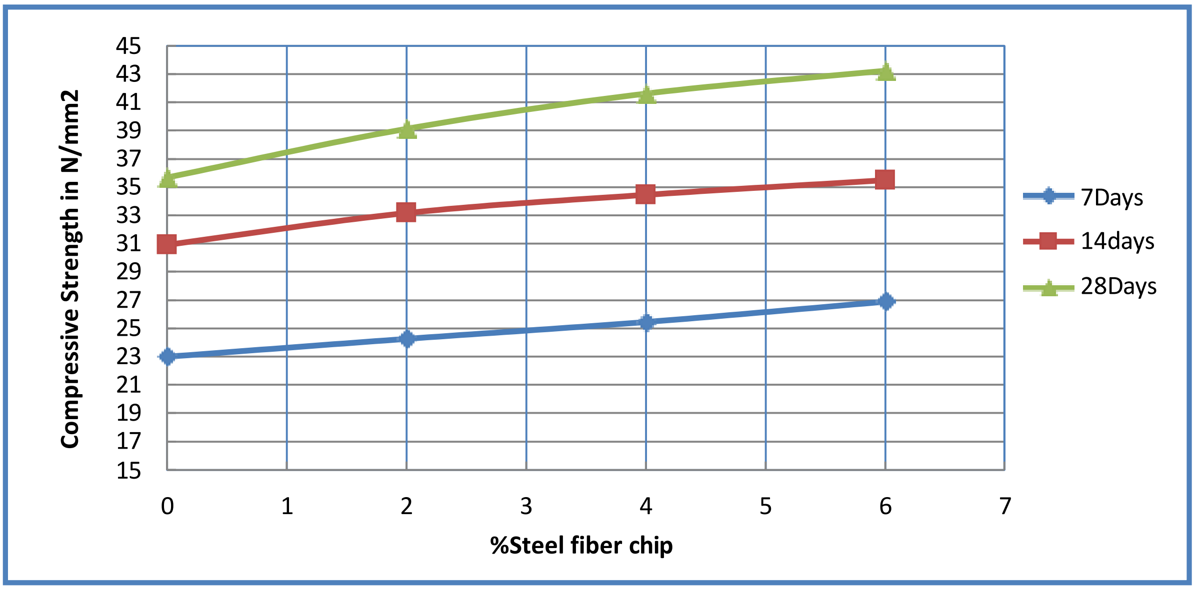

Figure no. 8 Compressive Strength of M35 Grade concrete

Discussion: The Result of compressive strength for M-35 grade of concrete on cube specimen with 0%, 2%, 4%, and 6% steel fiber chip mixes are shown in table & graph. Table-4.4 gives the compressive strength values ofM-35 grade concrete and steel fiber chip concrete mixes at 7, 14 and 28 days curing.

With addition of steel fiber chips, compressive strength gradually increases from 23N/mm^2 to 43.25N/mm^2 with 0% to 6 % of steel fiber chips for M35 grade concrete.

Split Tensile Strength

Totally 108 cylinder specimens of size 100 mm diameter and 300 mm height with 3 different % mixes were casted and tested. Three weight fractions were considered for steel chip fibres of constant length. Results for split tensile strength based on the values of test data. A sample comparison graph for steel fibres chip concrete is plotted to study conventional concrete strength which is shown in Fig. 4.5.The values of the split tensile strength of different mixes are shown in Table-8

Table no.8 –28 days Split tensile strength of Cylinder in N/ mm^2

S. No.	%of Steel fibre chip	Grade of Concrete		
		M25	M30	M35
1	0%	2.4	3.10	3.82
2	2%	3.3	4.22	4.50
3	4%	3.8	4.50	4.92
4	6%	4.20	4.80	5.38

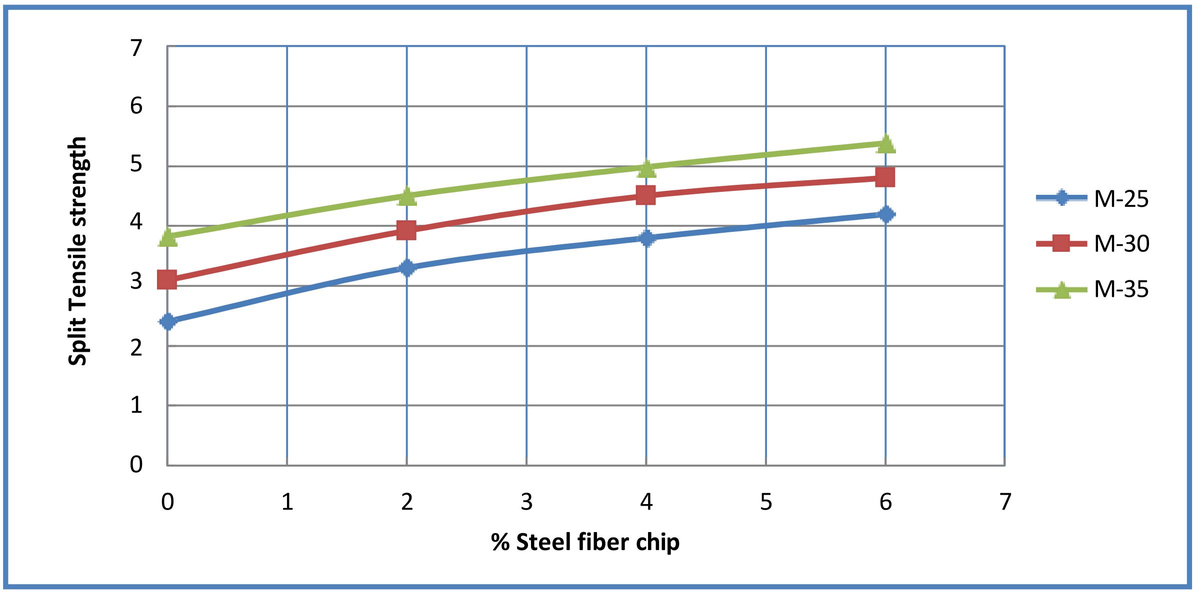

Figure no. 9 28 - days Split tensile strength of Cylinder

Discussion: The Result of split tensile strength for M-25, M-30 and M-35 grade of concrete on cylinder specimenwith0%, 2%, 4%, and 6% steel fibre chip mixes are shown in table & graph. Table-4.5 shows the split strength values of M-25, M-30 and M-35 grade concrete and steel fibre chip concrete mixes at 28days curing and their values are observed. With the addition of steel fibre chips, the split tensile strength of cylinder increasing gradually from 2.4N/mm^{2}to5.38 N/mm^2 with 0% to 6% of steel fibre chips.

Flexural strength of Concrete:

The determination of flexural strength of the prepared samples is carried out as per IS code. The following table shows the flexural strength of various samples using different percentage of steel fibre chips.

Table no. 9 –Flexural Strength of concrete Beam in N/mm^2

S. No.	% of Steel fibre chip	Grade of Concrete		
		M25	M30	M35
1	0%	3.70	4.90	5.29
2	2%	4.50	5.40	6.26
3	4%	4.90	5.70	6.67
4	6%	5.40	6.10	6.89

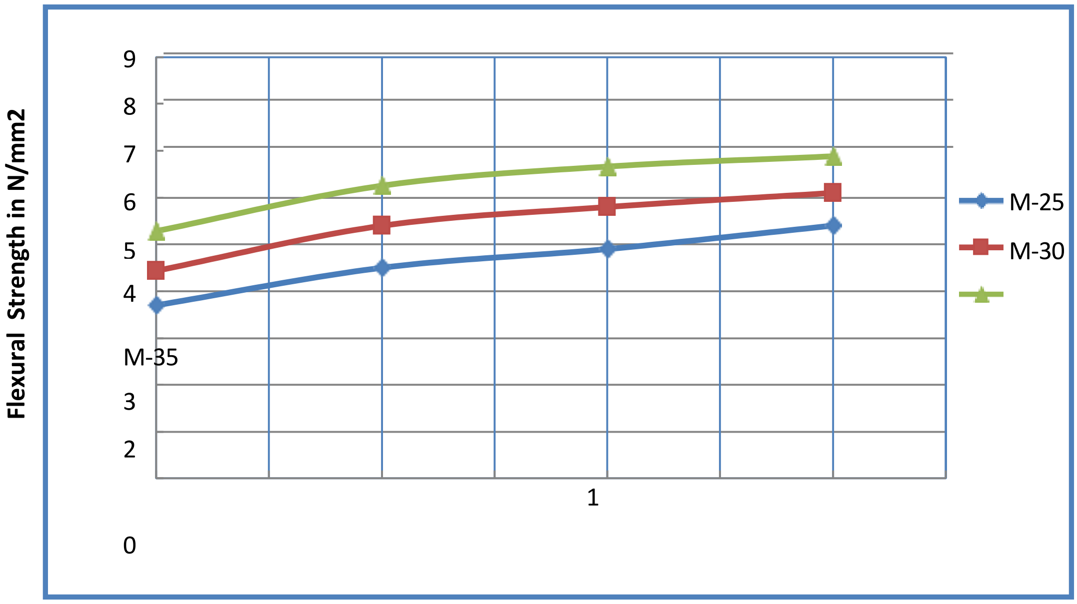

Figure no. 10–Flexural Strength of concrete Beam

Discussion: The Result of split tensile strength for M-25, M-30 and M-35 grade of concrete on beam specimen with 0%, 2%, 4%, and 6% steel fibre chip mixes after 28 days of curing are shown in table & graph. It is seen that with the addition of steel fibre chips flexural strength value increasing gradually from3.7N/mm^2 to 6.89N/mm^2 with 0% to 6 % of steel fibre chips.

CONCLUSION-

Based on the experimental investigation the following conclusion is given within the limitation of the test result.

- Addition of steel fiber chip resulted in significant improvement on the strength properties of concrete (M-25, M-30 and M-35) grade.
- Compared to plane concrete the steel fiber chip addition resulted in better strengthening (compressive, tensile and flexural) properties of concrete.
- The optimum percentage of steel fiber chip added was 6% since increased fiber addition resulted in loss of workability.
- TheSlumpoftheconcretemixreducefrom66mmto58mmonincreasingthe percentage of steel fiber (from 0% to 6%) for M-25 Concrete mix
- TheSlumpoftheconcretemixreducesfrom63mmto55mmonincreasingthepercentage of steel fiber (from 0% to 6%) for M-30 Concrete mix
- The Slump of the concrete mix reduces from 59 mm to 51mm on increasing the percentage of steel fiber (from 0% to 6%) for M-35 Concrete mix
- The Compressive strength of M25 concrete mix increases from 25.17 N/ mm^2 to 31.25N/ mm^{2}on increasing the percentage of steel fiber (from0% to 6%).
- The Compressive strength of M30 concrete mix increases from30.60N/mm^{2}to 35.86N/mm^2 on increasing the percentage of steel fiber (from 0%to6%).

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{xviii}Jian Ma, Conceptualization,[*] Yifei Huo, Formal analysis**, (2023)** Experimental Study of Dynamic Tensile Strength of Steel-Fiber-Reinforced Self-Compacting Concrete Using Modified Hopkinson Bar PMC Disclaimer.