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# Experimental Study on Behavior of Iron Chips for Different Grades of Reinforced Concrete

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**ABSTRACT**
The present work describes the experimental study of fiber reinforced concrete with M-25 grade concrete in addition of Iron chips with different percentages. To over-come the difficulties due to optimum percentage of fiber for maximum strength in concrete and high performance concrete. The main objective of this thesis work is to investigate the optimum percentage of Iron chips fiber on M-25 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 having different percentage of Iron chips (0%, 0.5%,1.0%,1.5%,2.0%). Compressive strength increases up to 1.5% addition of Iron then it were decreased for both concrete grade in case of 2.0% were used. But split tensile strength, flexural strength increases up to addition of 2% Iron chips. The chemical admixture is used to increase the workability of concrete. The experimental investigation is carried out on a total no of 81 specimen of compressive strength, 27 specimens for split tensile strength and flexural strength each.

**Keywords:-** Slump value, Iron chips, Compressive strength. Split tensile strength and Flexural strength.

## I INTRODUCTION

Concrete is the conventional reinforcement with high strength steel. Restraining techniques are also used to. 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 workable especially in the case of heavy concrete M-25. 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.

When loaded, the micro cracks propagate and open up, and owing to the effects of stress concentration, additional cracks form in places of minor defects. The structural cracks proceed slowly or by tiny jumps because they are retarded by various obstacles, changes of direction in bypassing the more resistant grains in the matrix. The development of such micro crack is the main cause of inelastic deformation in concrete. It has been recognized that the addition of small, closely spaced and uniformly dispersed fibers to concrete would act as crack arrester and would substantially improve its static and dynamic properties. This type of concrete is known as fiber reinforces concrete.

Fiber reinforced concrete (FRC) may be defined as a composite materials made with Portland cement, aggregate, and incorporating discrete discontinuous fibers. Now, why would we wish to add such fibers to concrete? Plain, unreinforced concrete is a brittle material, with a low tensile strength and a low strain capacity. The role of randomly distributes discontinuous fibers is to bridge across the cracks that develop provides some post cracking "ductility". If the fibers are sufficiently strong, sufficiently bonded to material, and permit the FRC to carry significant stresses over a relatively large strain capacity in the post cracking stage. There are, of course, other (and probably cheaper) ways of increasing the strength of concrete. The real contribution of the fibers is to increase the toughness of the concrete (defined as some function of the area under the load vs. deflection curve), under any type of loading. That is, the fibers tend to increase the strain at peak load, and provide a great deal of energy absorption in post-peak portion of the load vs. deflection curve. When the fiber reinforcement is in the form of short discrete fibers, they act effectively as rigid inclusions in the concrete matrix. Physically, they have thus the same order of magnitude as aggregate inclusions; steel fiber reinforcement cannot therefore be regarded as a direct replacement of longitudinal reinforcement in reinforced and pre stressed structural members. However, because of the inherent material properties of fiber concrete, the presence of fibers in the body of the concrete or the provision of a tensile skin of fiber concrete can be expected to improve the resistance of conventionally reinforced structural members to cracking, deflection and other serviceability conditions. The fiber reinforcement may be used in the form of three dimensionally randomly distributed fibers throughout the structural member when the added advantages of the fiber to shear resistance and crack control can be further utilized. On the other hand, the fiber concrete may also be used as a tensile skin to cover the steel reinforcement when a more efficient two dimensional orientation of the fibers could be obtained.

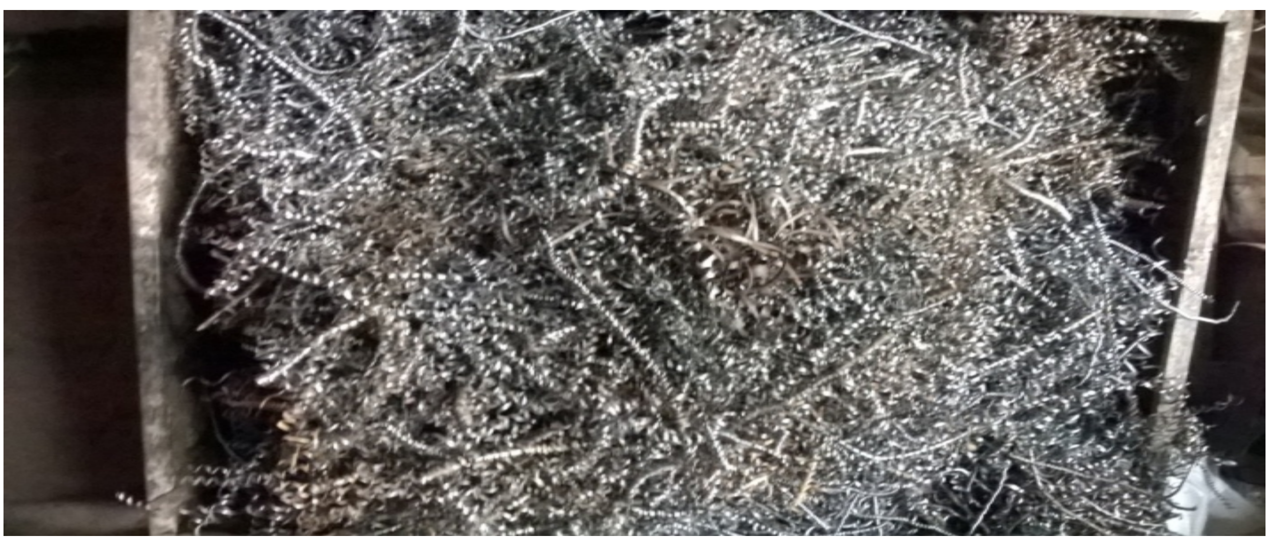


**Figure 1:** Iron chips.

## II OBJECTIVE

The aim of our project is to use the iron chips Fiber reinforcement to concrete. Our objective is to add the iron chips (chip metal) and glass fiber to the concrete and to study the strength properties of concrete with the variation in fiber content. i.e., to study the strength properties of concrete M25 Grade for fiber content of 0.5, 1.0, 1.5 & 2.0 at 7, 14 & 28 days. The strength properties being studied in our thesis are as follows:

1. Compressive strength
2. Split tensile Strength
3. Flexural strength
4. Slump test

**III LITERATURE REVIEW**

**Maher A. Adam, Mohamed Said, (2016)** this paper presents an experimental, numerical and analytical study of the flexural behavior of concrete Beams reinforced with locally produced glass fiber reinforced polymers (GFRP) bars. Glass fiber reinforced polymers (GFRP) reinforcement bars has a lower stiffness than steel reinforcement, which should be accounted for the ultimate and serviceability conditions, including the impact on member deflection and crack widths. The bars are locally produced by double parts die mold using local resources raw materials. A total of ten beams, measuring 120 mm wide _ 300 mm deep _ 2800 mm long, were cast and tested up to failure under four-point bending. The main parameters were reinforcement material type(GFRP and steel), concrete compressive strength and reinforcement ratio (lb, 1.7 lb and 2.7 lb; whereby is the reinforcement ratio at balanced condition). The mid-span deflection, crack width and GFRP the crack widths and mid-span deflection were significantly decreased by increasing the reinforcement ratio. The locally produced GFRP bars exhibit reasonable mechanical properties comparing with commercial products in terms of fiber volume fraction (70%), tensile strength (640 MPa), and elastic modulus (30,000 MPa). Increasing the concrete compressive strength in the order of 25 MPa to 45 MPa tends to reduce in the crack width by 52%, while the crack width tends to decrease by 80% when the concrete compressive strength increased from 25 MPa to 70 MPa.

**Aswani Sabu, Thomas Paul (2016)**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 in comparison 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 flyash.The primary focus is to compare the mechanical properties of concrete using both fibres.

**Wenjie Ge  Jiwen Zhang (2017)** Flexural behaviors of hybrid concrete beams reinforced with BFRP (Basalt Fiber Reinforced Plastic) bars And steel bars are studied in this paper. Tensile test, standard pull-out test of BFRP bars, and static flexural experiment of five different hybrid reinforced concrete beams were made. The tests show that BFRP bars have high tensile strength and low elastic modulus compared with steel bars. The bond strength between BFRP bars and concrete is similar to the bond strength of steel bars and concrete and shows good bond performance. The bond strength relative coefficient of BFRP bars can be considered to be 1.0. The crack spacing and crack width are analyzed and suitable formulas for calculation are proposed. The flexural capacity of appropriate hybrid reinforced beams is analyzed and a simplified formula for calculating its value is proposed. Results show that the value of the flexural capacity calculated by the proposed simplified formula is close to the experimental value. This proves that the formula can be successfully applied. By controlling the reinforcement ratio and the value of Af/As appropriately, the ductility of hybrid reinforced beams can meet the requirements of normal service conditions.

**Sumanta Das , Alyson Hendrix (2017)** This paper explores the fracture properties of a novel and sustainable glass-fiber reinforced composite, the matrix for which is formed through the aqueous, anoxic, room-temperature carbonation of (waste) metallic iron powder along with other minor ingredients. A comparison of the properties of this binder with Ordinary Portland Cement pastes, which constitutes one of the most common and economic ceramic matrices is also provided. The iron-based binder system exhibits fracture parameters (fracture toughness, KICS and critical crack tip opening displacement, CTODC, determined using two parameter fracture model, TPFM) that are significantly higher when compared to those of the OPC systems in both the unreinforced and glass fiber reinforced states. The beneficial influences of the un-reacted metallic iron particles of large aspect ratio, on the fracture parameters of iron-based binders are elucidated. The strain energy release rates show trends that are in line with the fracture parameters from TPFM. The elastic and inelastic components of strain energy release rate are separated in an effort to capture the fundamental toughening mechanisms in these systems. The fracture parameters determined using a non-contact, digital image correlation technique is found to relate well to those obtained from TPFM.

**Yeol Yoo, Goangseup Zi, Su-Tae Kang, (2018)** this study investigates the effects of fiber length and placement method on the biaxial flexural behavior and fiber distribution characteristics of ultra-high-performance fiber-reinforced concrete (UHPFRC). A number of UHPFRC panels including three different fiber lengths were fabricated using two different placement methods, and an image analysis was performed to quantitatively evaluate the fiber distribution characteristics such as fiber orientation, fiber dispersion, and number of fibers per unit area. The biaxial flexural performances including load carrying capacity, energy absorption capacity, and cracking behavior were found to be improved with the increase in fiber length up to 19.5mm. The biaxial flexural performances were also influenced by the placement method; the specimens with concrete placed at the center (maximum moment region) showed better flexural performances than those with concrete placed at the corner. These observations were confirmed by the image analysis results, which showed poorer fiber orientation and fewer fibers across the crack surfaces at the maximum moment region for the specimens with concrete placed in the corner, compared with their counterparts.

**IV MATERIALS**

Stainless iron 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 fiber strips length vary by 1, 1.5 and 2 inches. These fibers will improve toughness, durability and tensile strength of concrete

The specifications of iron chips used in this study are as follows:

- Material - Stainless Steel
- Length used - 40 to 60mm
- Diameter - 0.5mm
- Available form- winded
- Colour - silver thin wires

**I. Cement:**

Cement acts as a binding agent for materials. Cement as applied in Civil Engineering Industry is produced by claiming at high temperature. It is admixture of calcareous, siliceous, aluminous substances and crushing the clinkers to a fine powder.

**II. Fine Aggregates:**

The material we have used as fine aggregate in this project is ROBO SAND. Robo sand is an ideal substitute to river sand. It is manufactured just the way nature has done for millions of years. Robo sand is created by a rock-hit rock crushing technique using state of the art plant and machinery with world class technology.

**Figure 2:** Fine aggregate.

**III. Cube Compression Test**

This test was conducted as per IS 516-1959. The cubes of standard size150x150x150 mm were used to find the compressive strength of concrete. Specimens were placed on the bearing surface of compression testing machine, of capacity 2000 KN without eccentricity and a uniform rate of loading of 5.2 KN/s was applied till the first crack in the cube. The maximum load was noted and the compressive strength was calculated.

**Figure 3:** Dry Mixing and Compression Test.

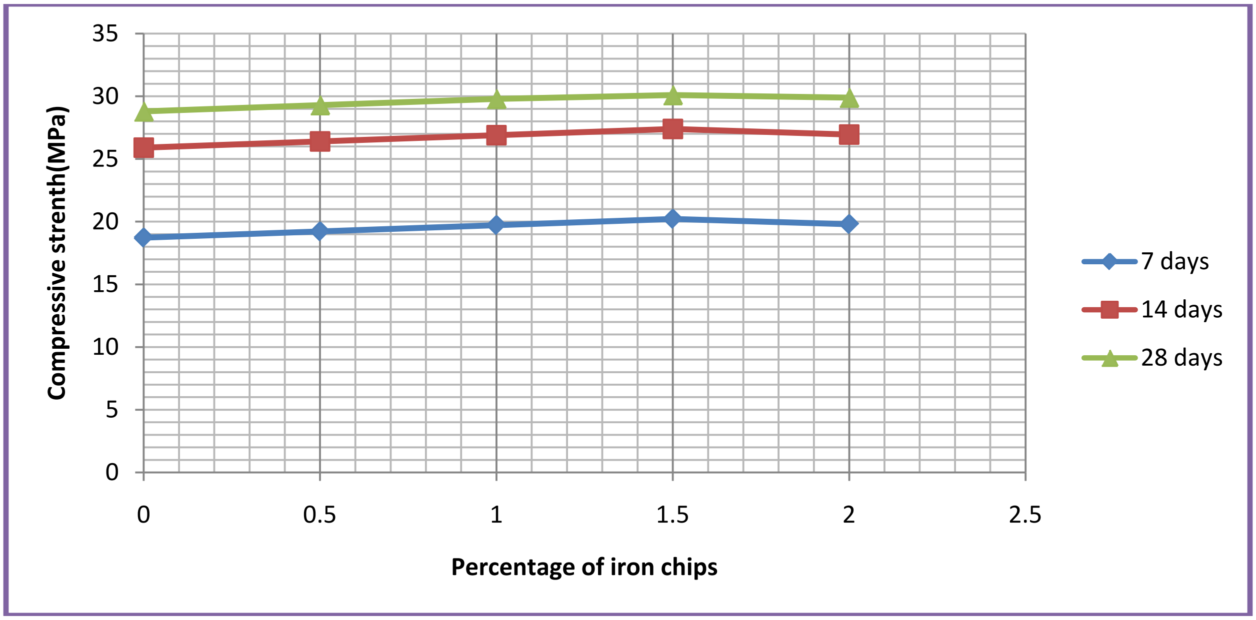
**IV. Flexural Test**
SFRC beams of size 150x150x700mm are tested using a flexure testing machine. The specimen is simply supported on the two rollers of the machine which are 600mm apart, with a bearing of 50mm from each support. The load shall be applied on the beam from two rollers which are placed above the beam with a spacing of 200 mm. The load is applied at a uniform rate such that the extreme fibers stress increases at 0.7MPa /min i.e., the rate of loading shall be 5.2 KN/s.

**V. Split Tensile Test**
SFRC cylinders of size 15cm (dia) x 30cm (height) are casted. The test is carried out by placing a cylindrical specimen horizontally between the loading surface of a compression testing machine and the load is applied until the failure of the cylinder, along the vertical diameter. When the load is applied along the generatrix, an element on the vertical diameter of the cylinder is subjected to a horizontal stress of 2P/πLD.

**V RESULT**

**Table 1: Result of cube (Grade M-25) compressive strength in Mpa**

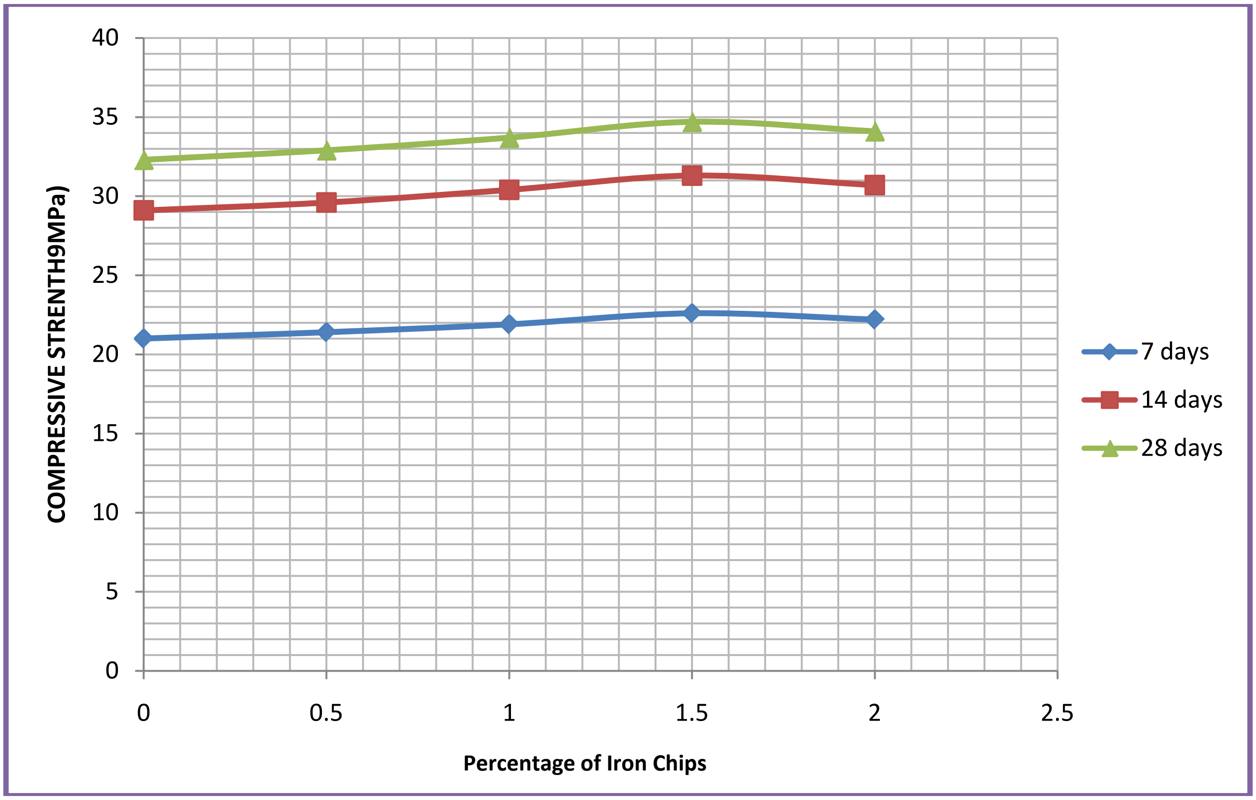
| % of iron chips | Average compressive strength in MPa | | |
|---|---|---|---|
| | 7 days | 14 days | 28 days |
| 0% | 18.72 | 25.9 | 28.8 |
| 0.5% | 19.22 | 26.4 | 29.3 |
| 1.0% | 19.72 | 26.9 | 29.8 |
| 1.5% | 20.22 | 27.4 | 30.1 |
| 2.0% | 19.8 | 26.95 | 29.9 |




**Graph 4:** Variations in compressive strength according to % of iron chips (Grade M-25).

**Table 2: Result of cube (Grade M-30) compressive strength in Mpa**

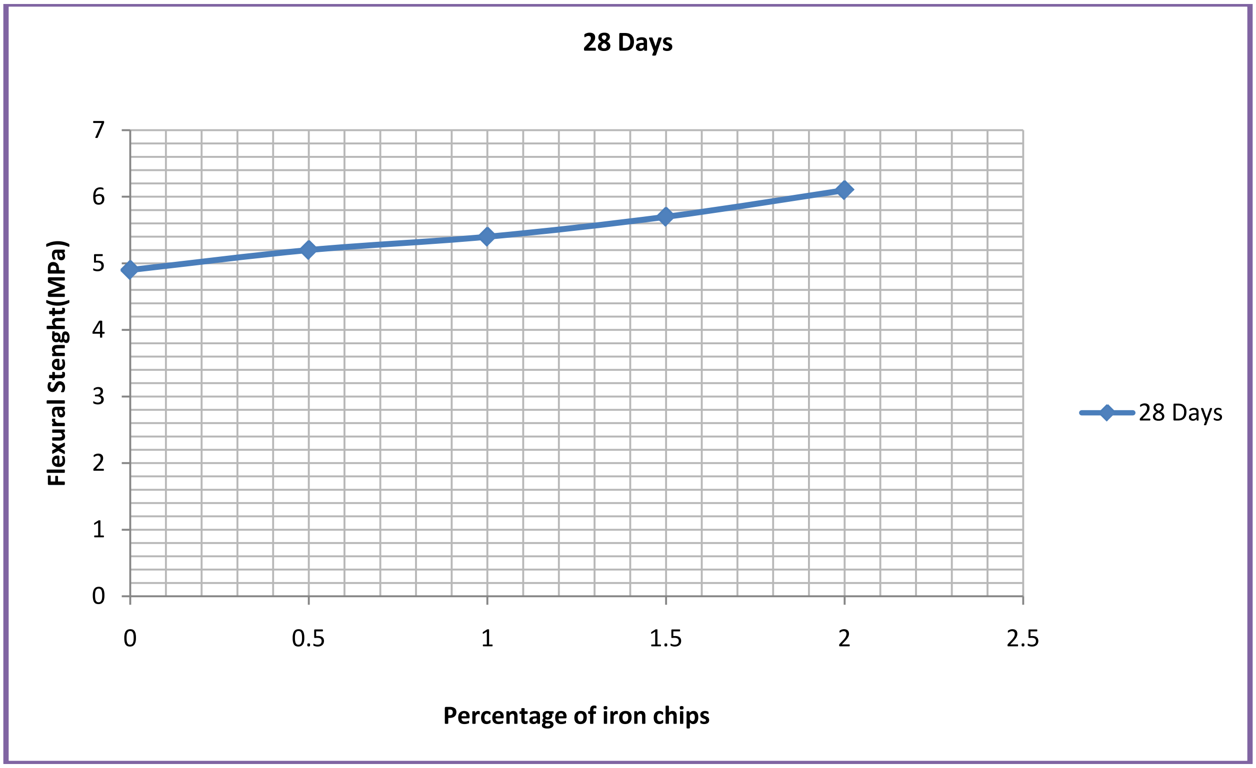
| % of iron chips | Average compressive strength in MPa | | |
|---|---|---|---|
| | 7 days | 14 days | 28 days |
| 0% | 21.00 | 29.1 | 32.3 |
| 0.5% | 21.4 | 29.6 | 32.9 |
| 1.0% | 21.9 | 30.4 | 33.7 |
| 1.5% | 22.6 | 31.3 | 34.7 |
| 2.0% | 22.2 | 30.7 | 34.1 |




**Graph 5:** Variation in compressive strength according to % of iron chips (Grade M-30).

**Table 3: Result of Beam (Grade M-25) Flexural Strength in Mpa**

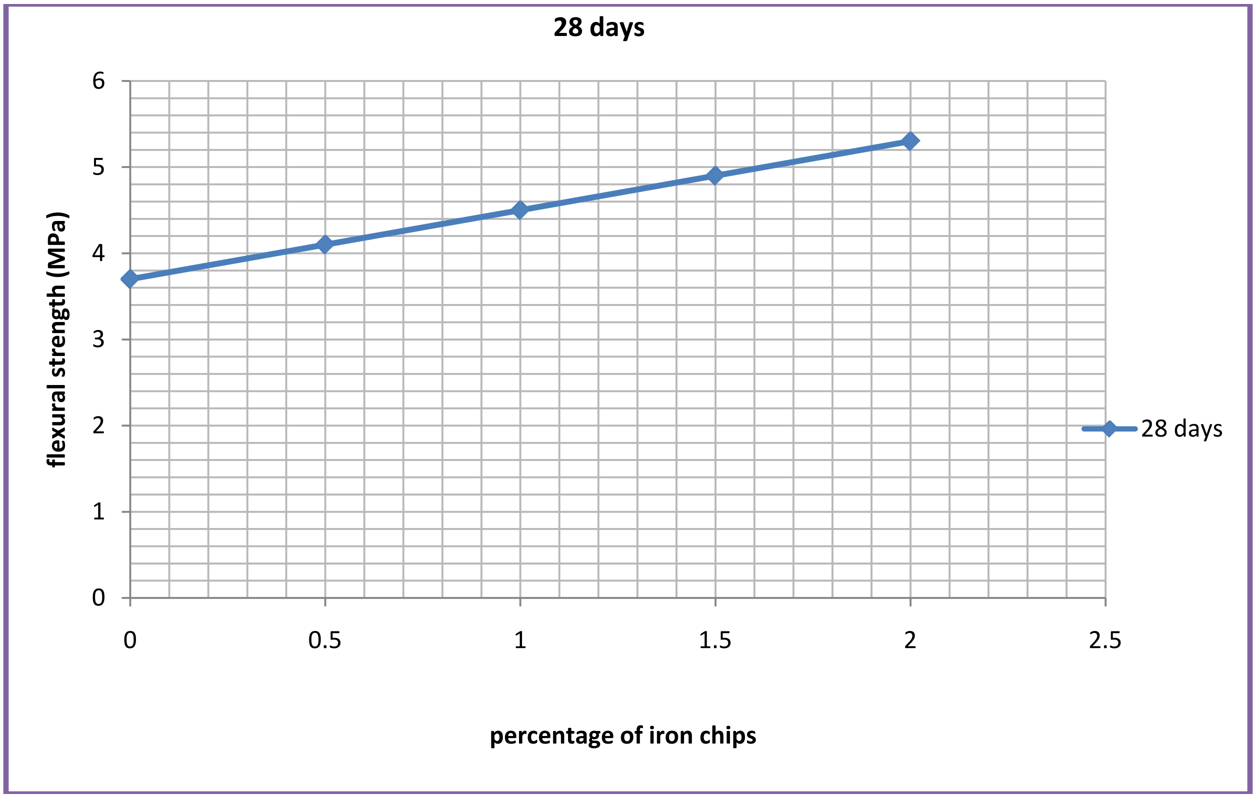
| % of iron chips | Flexural strength(MPa) | |
|---|---|---|
| | Specimen code | After 28 Days |
| 0% | S1 | 3.7 |
| 0.5% | S2 | 4.2 |
| 1.0% | S3 | 4.9 |
| 1.5% | S4 | 5.4 |
| 2.0% | S5 | 5.5 |




**Graph 6:** Variation in flexural strength according to % of iron chips (Grade M-25).

**Table 4: Result of beam (Grade M-30) Flexural strength in MPa**

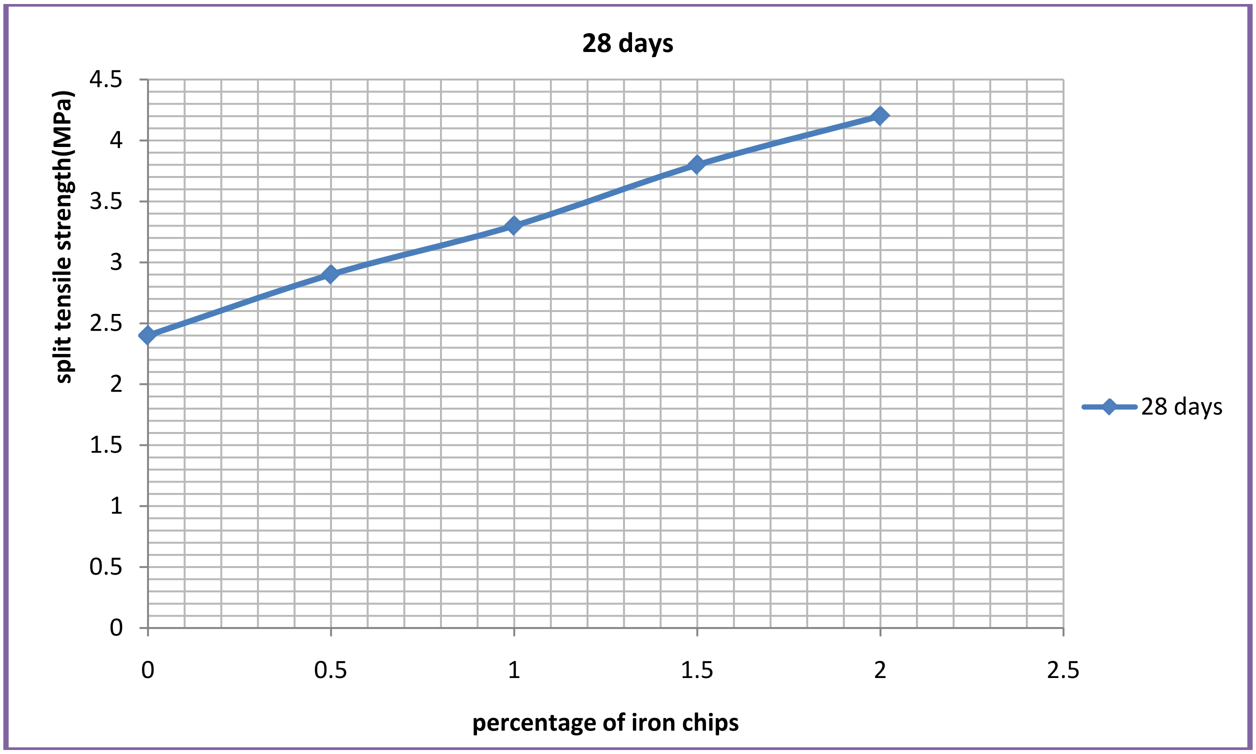
| % of steel fiber chip | Flexural strength(MPa) | |
|---|---|---|
| | Specimen code | After 28 Days |
| 0% | S6 | 4.9 |
| 0.5% | S7 | 5.2 |
| 1.0% | S8 | 5.4 |
| 1.5% | S9 | 5.7 |
| 2.0% | S10 | 6.1 |




**Graph 7:** Variation in flexural strength according to % of iron chips (Grade M-30).

**Table 5: Result of beam (Grade M-25) split tensile strength in MPa**

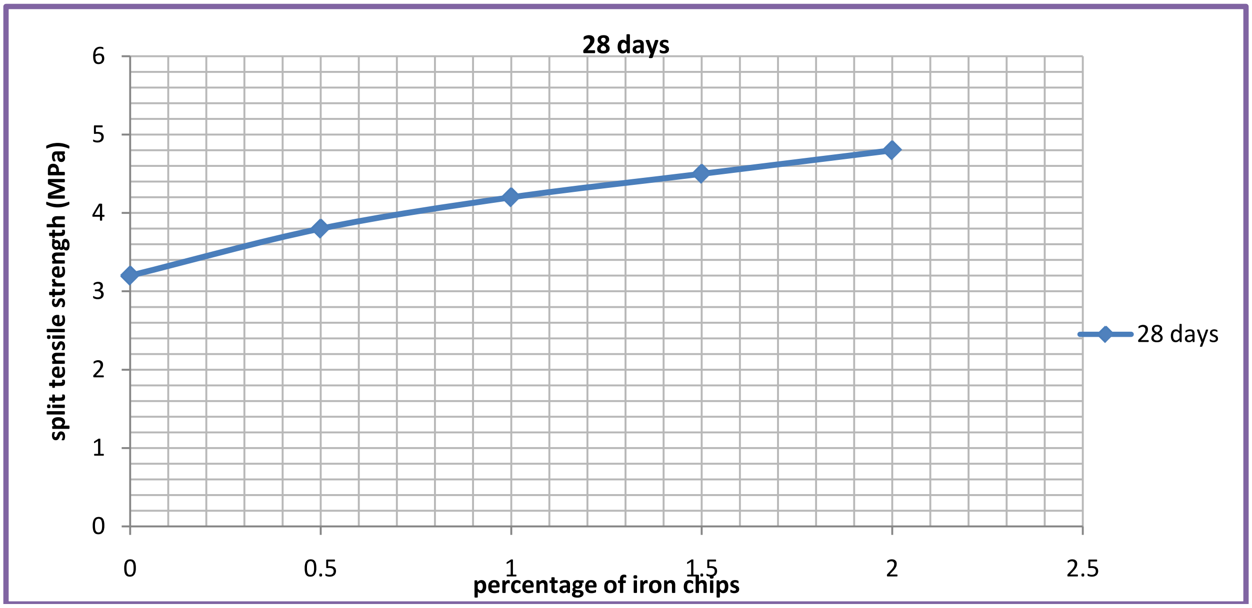
| % of iron chips | Split tensile strength(MPa) | |
|---|---|---|
| | Specimen code | After 28 Days |
| 0% | S1 | 2.4 |
| 0.5% | S2 | 2.9 |
| 1.0% | S3 | 3.3 |
| 1.5% | S4 | 3.8 |
| 2.0% | S5 | 4.2 |




**Graph 8: Variation in split tensile strength according to % of iron chips (Grade M-25)**

**Table 6: Result of beam (Grade M-30) split tensile strength in MPa**

| % of iron chips | Split tensile strength (MPa) | |
|---|---|---|
| | Specimen code | After 28 Days |
| 0% | S1 | 3.2 |
| 0.5% | S2 | 3.8 |
| 1.0% | S3 | 4.2 |
| 1.5% | S4 | 4.5 |
| 2.0% | S5 | 4.8 |




**Graph 9:** Variation in split tensile strength according to % of iron chips (Grade M-30).

**VI CONCLUSION**

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

1. Addition of iron chips resulted in significant improvement on the strength properties of concrete (M-25 and M-30) grade
2. Compared to plane concrete the fiber addition resulted in better strengthening (compressive, tensile and flexural) properties of concrete.
3. The reinforcing efficiency of fiber addition was dependent on the optimum dosages level of iron chips up to 1% to 1.5% of fibers since increased fiber addition resulted in loss workability.
4. The maximum increase in compressive strength was observed of concrete grade M-25 & M-30 respectively at 1.5% of iron chips
5. Compressive strength was decrease of both concrete grade in case of 2% steel fiber
6. Tensile strength is continuously increased with increasing the percentage of iron chips and maximum tensile strength was achieved in the case of 2% iron chips for both grade of concrete M-25 &M-30.

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