A Study on Electro-Magnetic Properties of Concrete by Using Steel Fiber and Graphite

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Abstract. This research paper describes the properties of electromagnetism of concrete mix that are sustained to make “Electrically Conductive Concrete”. Thus, the values provide various information on the behaviour of concrete mix and its relation with electromagnetic waves. Steel Fiber and Graphite are conductive materials. The properties of conductive concrete mix that is coarse aggregates, sand and cement can be measured. In the physical significance, the data calculated in X-ray diffraction and Scanning Electronic Microscope was discussed. The contact between the Steel Fiber and graphite is improved to make electrically conductive concrete. The strength is gained continuously till 3% where the maximum strength is gained which is 9.77% higher than the strength achieved by controlled sample. The control sample achieved 26.60MPa, with addition of 1% steel fibers the concrete achieved 29.40MPa, further increase in steel fiber content to 2% gained higher strength of 30.50MPa. The maximum compressive strength of 31.50MPa was achieved with the addition of 3% steel fibers. Further increase in steel fiber content resulted in decrease in strength, though 4% steel fiber reinforced concrete achieved 30.70MPa

1. INTRODUCTION

Relative to the reinforcement of the present invention materials with fibers, whereby the fibers are oriented by an electric field. In this way, the fibers can also be concentrated, specially where this invention is subjected to stress, resulting in a significantly greater strength increase from a smaller amount of reinforcing fibers than used in conventional methods. Exposing the method of combining fiber reinforced concrete without forming fiber balls. The method includes depositing a substantially uniform layer of individual concrete reinforcing fibers on an elongated web, winding the web to include the fibers, and placing a coiled web near a concrete mixing device. And the phase of slow unraveling the web at a certain speed that the fibers are released to the layer mixer. A special package for concrete reinforcing fibers has also been revealed for use in connection with the above [1–4] method. The technique for blending steel fiber supported cement incorporates withdrawing steel strands, each having a surface weight proportion of more noteworthy than 900 mm, to orient the steel fibers in a predetermined direction and randomly
orienting them. A steel fiber penetration grid has a grid space of about 2 to 4 times the length of each of the steel fibers, thereby implying the introduction of the steel fibers into a concrete component or hardened concrete consisting thereof. The method of combining steel fibers into concrete or mortar is to describe the spread and spread of the steel fiber mass. This method involves rotating the disc with radial bass on its surface, supplying a steel fiber lump in the center of the brass rotating disk, and permeating the steel fiber lump into smaller pieces. By extracting the mass of steel fiber at the bass, it breaks through the disk, while dispersing the expanded steel fiber, with the help of a centrifugal force caused by radial, uncoated concrete or mortar disk. Another structure is given, consisting of a cast, a pedestal, and a comprehensive cast with high steel fiber reinforced concrete. The fenced in area segment has dividers that form the essential security compartment. An entryway that can be moved among accessible and shut area is joined to the shaped body. The entryway is also made of high steel fiber reinforced concrete. Entryways and dividers of the shaped solid body are in any event 3 inches thick and withstand light and apparatus assaults for at any rate 15 min. High security is accommodated on cardboard and important records dwelling in the essential security cell because they are added in or distributed from the essential security compartment. The solid strengthened steel fiber has an exchanging course of action of essential bits relating to the body of the steel fiber material and a cross-area shaped by squeezing the steel fiber material between a furrowed framing roller and a toothed shaping roller. It expresses that each segment molded area has a level top, side bulges, and a round base. The total of all the weight bolster zone B of the cross-sectional shape parcel, that is, the cross-sectional territory of the sidelong distension and the region of the end face of the essential part adjoining the cross-sectional shape partition is in the accompanying extent. 0.2A to 0.5A (A = cross segment of essential part). The absolute weight bearing territory B of the steel fiber is in the scope of 3A to 8A and furthermore in the scope of 0.02T to 0.08T (T = elasticity of steel fiber). A minimal [7,8] fortified composite containing a network with a support installed in that, the grid being a composite structure involving a base lattice which is strengthened with fortifying bodies as strands. The transverse element of being at any rate multiple times as extensive as the transaction measurement. A method and apparatus for manufacturing a conductive concrete product used in electromagnetic shielding has been stated that the invention also includes a product shaped by the strategy. Solid articles framed by the strategy for the present development are fortified with charged metal filaments, ideally steel strands, with a critical segment of the strands in contact with close by strands to give electrical coherence all through the article. According to the present invention, the contact between the fibers is enhanced by the fluctuation about the solid/fiber blend during development of the conductive solid material. The protecting viability of solid structures is a central part of the engineering configuration period of a devoted control place. These structures are planned with useful necessities to suit fragile control hardware [9,10]. Failing of such gear can bring about loss and effect on income administrations. This paper proposes a straightforward scientific way to deal with impact the plan of the structure so the structure appropriately weakens the adversary's electromagnetic condition and potential electromagnetic heartbeats. Correlations with numerical techniques are given. A review of the impact of dampness content on the protecting adequacy of solid dividers In this study, steel fibers, carbon fibers, and synthetic polyvinyl alcohol (PVA) fibers reinforced concrete to examine the electromagnetic protecting effect and absorption equity about fibers reinforce concrete. The outcomes indicated that as the fiber volume portion increases, the tendency of SE and frequency changed of the comparing fiber reinforce solid, concrete expanded. With a steel fiber total content of 3%, the electromagnetic shielding of cement surpasses 50 decibel [11–13] and their recurrence surpasses 1.8 Gigahertz. What's more, in the scope of 8-18 Gigahertz, steel fiber, carbon fiber and polyvinyl alcohol fiber could all improved the microwave assimilation ability of concrete. Concrete containing 0.5% carbon fiber had furnished the best retention properties with a base
The reflectivity of about -7 dB. The ideal volume part of steel fiber was 2%. The reflectance bend for PVA fiber strengthened cement fluctuated with recurrence, with least reflectance esteem not exactly -10 dB. The outcomes demonstrated that fiber strengthened cement can be utilized as an electromagnetic interference anticipation working by weakening and reflecting electromagnetic wave energy. Investigated that the electric resistivity of normal weight concrete ranges from 6.54 to 11 KΩ·m. However, conductive concrete can attain relatively high [14,15] conductivity by adding a certain amount. Suggested that synthesized by mixing a special blend of carbon powder and steel fibers in concrete to attain high and stable electrical conductivity. The main objective of the paper is to determine the increase the conductivity of concrete by using steel fiber and graphite [16–18], see figure 1.

Figure 1: Stee Fibre used for testing

Figure 2 represent Graphite is a crystalline form of the carbon element. Its atoms arranged in a hexagonal structure. It is the naturally occurring form of graphite. It is the most stable form of carbon under some standard condition. Under high atmospheric pressure and temperature, it becomes diamond. Graphite is used in pencils as pencil lead and lubricants. Its high conductivity makes it useful in electronic conductive items such as electrodes, batteries and solar panels Its properties are: It is a good conductor of electricity, It is good in thermal conductivity and It gives more properties to radiation-shielding.
3. Testing Program

For the Compressive Strength, the control mixtures and five conductive mixtures adding 1% steel fiber by weight of coarse aggregate and using graphite as fine aggregates replacement at the level of 0%, 0.5%, 1%, 1.5% and 2% by weight were produced in the laboratory. The water to binder ratio was chosen as 0.5. Cement content was kept at a constant of 420 kg/m³. Cylinders of 100 mm in diameter and 200 mm in height were cast for the compressive strength test [19–22]. Concrete blocks were fabricated for the electrical and thermal tests. All the Specimen preparation has been conducted in an accordance with ASTM 2012. Three cylindrical specimens of 100 mm diameter and 200 mm height were prepared and tested for each mixture at the ages of 7, 14, 28 days, respectively. The alternating current voltage regulator can be used to supply a wide voltage range. In this study, four test voltage levels, 48 V, 60 V, 110 V, and 220 V, were applied. An autotransformer was connected to the electrodes of the concrete block by cables. All test voltage levels were adjusted through the autotransformer. The ampere recorder and the temperature recorder automatically record the current and temperature for every five minutes for 5 hours. X-Ray Diffraction Analysis (XRD)- XRD is a significant technique utilized for the quantitative and subjective investigation of different concrete samples. It depends on the principle of Bragg’s Law. By doing X-Ray Diffraction test, the resultant will be the graphical representation of the angle of wave diffracted and intensity X-Ray was determined. Scanning Electronic Microscope (SEM)- SEM examination was utilized to decide the microstructure of the hard-bitten concrete with Steel fibres and Graphite. The samples of concrete were breakdown in small size of 5mm, which comprise of mixing proportions of Steel fibre and Graphite at an optimum combination.

4. Test Result

In this, the test results for the virgin sample with the additive materials in different combinations used in this study and their characteristics have been discussed. Different samples based on additives of various proportions of steel fiber in an increment of 1% and graphite in an increment of 0.5 % were obtained to understand the effect of electromagnetic properties of Concrete to conduct X-Ray Diffraction (XRD) and SEM specially, see table 1 Also, Concrete Mix design of a sample M30 grade was conducted to check out the compressive strength of
sample with various proportions as-

**Table 1. Mix design proportion as per IS 10262**

| Stipulations for Proportions |  |
|------------------------------|---|
| Grade Designation            | M30 |
| Type of Cement               | OPC 53 Grade |
| Max. Nominal Size            | 20 mm down |
| Water Cement Ratio           | 0.45 |
| Workability                  | 75 mm Slump |
| Concrete Placing             | Manual |
| Fine Aggregate Zone          | Zone 1 |
| Admixtures                   | Steel Fibre and Graphite |
| Specific Gravity of Cement   | 2.857 |
| Characteristic Strength      | 32.25 MPa |

**Compressive Strength characteristics**

In this, the test results for the virgin sample with the additive materials in different combinations used to check out an effect for Compressive Strength of Concrete. Different samples based on additives of various proportions of steel fiber in an increment of 1% and graphite in an increment of 0.5 % were obtained, see table 2 and Figure 3 & 4.

**Table 2. Compressive Strength of Concrete using Steel Fiber**

| S No. | Mix Proportions (C: SF) | Compressive Strength (MPa) |
|-------|-------------------------|-----------------------------|
| 1     | 100:00                  | 26.60                       |
| 2     | 99:01                   | 29.40                       |
| 3     | 98:02                   | 30.50                       |
| 4     | 97:03                   | 31.50                       |
| 5     | 96:04                   | 30.70                       |

| Mix Proportions (C: G) | Compressive Strength (MPa) |
|------------------------|-----------------------------|
In this world, Concrete is mostly used as a binding material with a combination of Cement with Course and Fine Aggregates. Strength, Durability and Workability are the main advantages. Due to weak tensile strength, Concrete is generally reinforced with Steel for its strength increment. That is the reason; Steel Fibers represent a considerable improvement in the strength of Concrete. M30 Grade of Concrete has been used with 1% increment of Steel Fibers to check out the strength. From Table 2, Out of all the prescribed results, there is an effective increase of Compressive Strength up to 3% Steel Fiber, After than there will be a decrement in the Strength due to the fact that higher fiber content may cause congestion of fibers, thus resulting in balling effect and improper bonding with concrete which represents 3% as an optimum value with Steel Fiber. Also, From the Table 3, It has been observed that Compressive Strength will increase with an increasing amount of Graphite. Initially, up to 1.5% of Graphite, Compressive Strength will increase but at 02% Content, it will be decreased due to a closed packing of particles to fill up the voids.

|   | C:SF   | COMPRESSIVE STRENGTH (MPA) |
|---|--------|-----------------------------|
| 1 | 99.5:0.5 | 28.25                       |
| 2 | 99:01   | 29.75                       |
| 3 | 98.5:1.5 | 32.89                       |
| 4 | 98:02   | 30.40                       |

Figure 3. Represents an effect of Steel Fiber on Compressive Strength of Concrete
5. XRD Analysis of Concrete

Identifying materials on the basis of their diffraction patterns is one of the most common applications of X-ray diffraction analysis (XRD). XRD provides information on how the actual structure differs from the ideal structure due to internal stresses and imperfections, in addition to phase identification. X-rays can be thought of as waves of electromagnetic radiation while crystals are regular fields of atoms. The interaction of X-rays obtained by the electricity of crystal atoms scatters the photons. This event is called elastic scattering, and the electron is straw. A regular scattering matrix generates a constant spherical wave series; these waves cancel in most directions due to destructive interference, Bragg's law states that they contribute constructively in a few specific directions, see Figure 5.

6. SEM Analysis of Concrete

SEM report gives details regarding the microstructure and surface morphology of calcium silicate hydrate and ettringite in concrete. It was seen that SEM Analysis of concrete having small porous structure because the development of needles in voids as compared to normal concrete at water binding ratio. Therefore, Concrete will provide maximum strength than Normal Concrete.
due to a continuous increase in the strength as per SEM Analysis, see table 3 and figure 6 & 7.

![Figure 6. Represents SEM Image of Concrete](image)

**Table 3. SEM Analysis of Concrete using Steel Fiber and Graphite**

| S No. | Mix Proportions (C: SF: G) | W/B Ratio |
|-------|---------------------------|-----------|
| 1     | 98.05:01:0.05             | 0.60      |
| 2     | 98:01:01                  | 0.76      |
| 3     | 97.5:01:1.5               | 0.98      |
| 4     | 97:01:02                  | 0.83      |

![Figure 7. Represents SEM Analysis of Concrete with Steel Fiber and Graphite](image)
7. Conclusions and Future Scope

An investigational study was performed on the role of the electromagnetic properties of concrete on various proportions of graphite and steel fibre. The test series was carried out with SEM, XRD and compressive strength analysis. The testing was done with variable water cement ratio. The hydration of the glues was likewise recreated in a miniature underlying displaying stage with different exploratory outcomes.

The main conclusions from this study are listed below:

- The strength is gained continuously till 3% where the maximum strength is gained which is 9.77% higher than the strength achieved by controlled sample. The control sample achieved 26.60MPa, with addition of 1% steel fibers the concrete achieved 29.40MPa, further increase in steel fiber content to 2% gained higher strength of 30.50MPa. The maximum compressive strength of 31.50MPa was achieved with the addition of 3% steel fibers. Further increase in steel fiber content resulted in decrease in strength, though 4% steel fiber reinforced concrete achieved 30.70MPa

- Relation between the early age strength improvement and the warmth delivered from hydration was found. In the long haul too, the level of hydration estimated utilizing synthetic shrinkage related well with the strength improvement of the electromagnetic properties

- Due to a property of Graphite as a good conductor of electricity, it plays an important role to increase electromagnetic properties of Concrete

- It has been observed that XRD, SEM Analysis provided an effective implementation in the process of Cement hydration

In the Present Study, it has been concluded that Steel Fiber and Graphite are good additives to check out the electromagnetic properties of Concrete. But, their effect on other properties can be carried out as a future scope are: An effect of steel fibre on Mortar’s pore size distribution, Characteristics of Hydration on effect of Graphite, Temperature and Replacement level for electromagnetic properties and Reactivity of Additives on their physical characteristics.
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