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## “Experimental Investigation on the Performance of Steel Fiber Reinforced Concrete with Partial Replacement of Natural Sand by Manufactured Sand (M-Sand)”

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**Abstract:** Concrete is the main construction material in the world. It consist of cement, fine aggregate, coarse aggregate and water as main ingredients. Now days due to high global consumption of natural sand, sand deposit are being depleted and causing serious threat to environment as well as society. River sand is becoming a scarce commodity and hence an exploration alternative to it has become imminent. Manufactured sand is the good alternative to river sand and it is purposely made, fine crushed aggregate produced under controlled conditions from a suitable sand source rock.

In present study the detailed experimental investigation is carried out on steel fiber reinforced concrete by partial replacement of natural sand by manufactured sand with different percentages (0%, 5%, 15%, 25%, 35%, 45%) and adding steel fiber has a 0.5mm diameter with 1% of weight of cement. The mechanical properties of concrete like Compressive Strength, Flexural Strength and Split Tensile Strength are studied here.

In our work, want to know the optimum percentage of steel fiber, we performed some test with mixing of different % of steel fibers in concrete and then fix 1% Steel Fiber for all mix in concrete cube, beam and cylinder. Total 54 cubes were casted for compressive strength, 54 Beams were casted for Flexural Strength and 54 Cylinders were casted for Split Tensile Strength for M20 grade of concrete. **Keywords:** Fiber reinforced concrete, manufactured sand, compressive strength, split tensile strength, flexural strength, steel fiber, and workability of concrete.

### I. INTRODUCTION

Concrete is a most versatile construction material since it is intended to withstand the hazardous situations, with satisfactory strength and durability. Due to overutilization of the concrete material winds up plainly frightened, and furthermore, the generation at bigger rate make numerous perilous to the earth. On opposite side, the waste presented to our condition is an effect to biological cycle, among all mechanical waste, is the significant wellspring of waste which will influence the earth Cement and aggregate, which are the most basic constituents used in concrete production, are the basic materials required for the construction industry. This certainly incited a constant and extending enthusiasm of natural materials used for their production. Parallel to the necessity for the utilization of the natural resources builds up a creating stress for guaranteeing the earth and a need to spare natural resources, for such as aggregate, by using elective materials that are either reused or discarded as a waste.

### FIBRES

Fibre is a natural or synthetic substance that is significantly longer than it is wide. Fibres are often used in the manufacture of other materials. The strongest engineering materials often incorporate fibres, for example carbon fibre and ultra-high-molecular-weight

polyethylene. Synthetic fibres can often be produced very cheaply and in large amounts compared to natural fibres, but for clothing natural fibres can give some benefits, such as comfort, over their synthetic counterparts.

### TYPES OF FIBRES

There are two types of fibres

1. Natural Fibres
2. Man Made Fibres

**Natural Fibres-** Natural fibres develop or occur in the fibre shape, and include those produced by plants, animals, and geological processes. They can be classified according to their origin:

Vegetable fibres are generally based on arrangements of cellulose, often with lignin: examples include cotton, hemp, jute, flax, ramie, sisal, biogases, and banana. Plant fibres are employed in the manufacture of paper and textile (cloth), and dietary fibre is an important component of human nutrition.

Wood fibre, distinguished from vegetable fibre, is from tree sources. Forms include ground wood, lacedbark, thermo mechanical pulp (TMP), and bleached or unbleached Kraft or sulphite pulps. Kraft and sulfite (also called sulphite) refer to the type of pulping process used to remove the lignin bonding the

original wood structure, thus freeing the fibres for use in paper and engineered wood products such as fibre board.

ii) **Man Made Fibres-** Man-made or chemical fibers are fibers whose chemical composition, structure, and properties are significantly modified during the manufacturing process. Man-made fibers consist of regenerated fibers and synthetic fibers.

a) **Synthetic fibers-** Synthetic come entirely from synthetic materials such as petrochemicals, unlike those man-made fibers derived from such natural substances as cellulose or protein. Fiber classification in reinforced plastics falls into two classes: (i) short fibers, also known as discontinuous fibers, with a general aspect ratio (defined as the ratio of fiber length to diameter) between 20 and 60, and (ii) long fibers, also known as continuous fibers; the general aspect ratio is between 200 and 500.

b) **Metallic fibers-** Metallic fibers can be drawn from ductile metals such as copper, gold or silver and extruded or deposited from more brittle ones, such as nickel, aluminium or iron. See also Stainless steel fibers.

c) **Carbon fiber-** Carbon fibers are often based on oxidized and via pyrolysis carbonized polymers like PAN, but the end product is almost pure carbon.

#### APPLICATION OF STEEL FIBRES

The most common uses for stainless steel fibers is in the field of the electrical and textiles industry such as anti-radiation cloth, thermal resistant fabric, and anti-static brushes.

Many people also use stainless steel fibers in weaving. Increasingly common today are stainless steel fibers in clothing, including radiation protection for pregnant women. Stainless steel yarns are woven, braided, and knit into many industrial fabrics.

For additional variety, stainless steel yarns are twisted with other fibers such as wool, nylon, cotton, and synthetic blends to produce yarns which add novelty effects to the end cloth. Stainless steel and other metal fibers are used in communication lines.

#### MANUFACTURED SAND (M-SAND)

Manufactured sand (M-Sand) is a substitute of river sand for concrete construction. Manufactured sand is produced from hard granite stone by crushing.

The crushed sand is of cubical shape with grounded edges, washed and graded to as a construction material. The size of manufactured sand (M-Sand) is less than 4.75mm.



M-Sand

## II. OBJECTIVE OF STUDY

This study was conducted to achieve the following objectives-

1. To determine the Workability of concrete with and without Steel fibres and M-sand in different proportion.
2. To determine the Compressive Strength of concrete with and without Steel fibres and M-sand in different proportions.
3. To determine the Flexural Strength of concrete with and without Steel fibres and M- sand in different proportions.
4. To determine the Split Tensile Strength of concrete with and without Steel fibres and M-sand in different proportions.

## III.LITERATURE REVIEW

### Origin of Geopolymer Concrete

1.Kiran. M. Mane, et.al, (2024) has worked on The strength and workability of concrete with manufactured sand. The main part of work has to study the effect of percentage replacement of manufactured sand by natural sand as 0%, 20%, 40%, 60%, 80% and 100% respectively on workability of concrete and the strength characteristics such as compressive strength, shear strength, of concrete was carried out. It has M30 grade concrete with 0.45 water cement ratio.

2. Stephan Assie, et.al, (2024) has Estimates of self-compacting concrete potential durability. IN most of the projects the self-compacting concrete has been used. the rebar has been affected by the corrosion. This project deals about the self-compacting concrete and reference with vibrator concrete according to the French recommendations. To Regardless of a higher Water/Cement proportion (however an equal Water/Binder proportion), SCC has a compressive quality to the VC. SCC and VC has aggressive agents (for example, carbon dioxide and ammonium nitrate) and introduced proportional energy of response.

3.Mounir M. Kamal,et.al, (2023) has worked on the “mechanical properties of self- compacted concrete mix”. The Self Compacting Concrete has increase Quality, durability, Strength. The Paper deals about the contents of Steel fiber and polypropylene fiber in the SCC. The experimental work with Fresh concrete and hardened concrete has been done. The fiber percentage used as 0.75% and 1% percentage has been carried. By addition of fibers it will reduce the bleeding. They several cracks causes the failure in flexure and impact the fibers failed in a ductile manner.

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ductile-  
manne.

| Property             | IS Code (IS:8112-1989) | Result    |
|----------------------|------------------------|-----------|
| Specific gravity     | 3.15                   | 3.15      |
| Consistency          | 30 - 45                | 35        |
| Initial setting time | 30 Minute              | 45 Minute |
| Final setting time   | 600 Minute             | 80 Minute |

5. Santosh Kumar karri, et.al, (2022) Studied on the quality and solidness properties of concrete with replacing the cement with GGBS. The GGBS is replaced with 30%, 40% and 50%.this paper focused on M 20 and M 40 grade of concrete. The following test where conducted on cubes, cylinder and prism, the compressive quality, split rigidity and flexural quality respectively. The study on durability with the H2so4 acid and HCl acid where directed. The following conclusion were made with increase in GGBS replacement the workability increases. At 40% replacement concrete attains maximum strength in compressive quality, split ductile and flexural quality.

6. Shaik Akhil Mastan. et. al. (2022) has examined out that experimental investigation on partial replacement of sand with foundry sand. The principle point of this exploration is to ponder the use of waste ceramic tiles as a fractional replacement of coarse aggregate (20mm) and 10% fly fiery remains as a supplanted of cement in concrete. For every one of the materials physical properties might be done and mechanical properties, for example, compressive strength and split elasticity of concrete were inspected and contrasted and typical concrete. M30 review of concrete was intended to set up the customary blend. The 3D shapes and chambers are resolved at 7 years old and 28 days.

7. M. Sekar (2022) has examined that partial replacement of coarse aggregate by waste ceramic tile in concrete. In this investigation, an endeavour has been made to discover the appropriateness of ceramic coarse aggregate as a conceivable substitute for customary aggregate in concrete. The concrete examples were thrown with blend 1:1.65:2.82 and 1:1.56:2.82. M-sand aggregate 15%, 30%, 45% incomplete replacement, the strength of concrete.

**PRINCIPAL OF CONCRETE MIX DESIGN**

Proportioning of a concrete mix contains choosing the relative measures of materials to be utilized in progress of concrete for a committed limit. The path toward picking degrees of these materials is called "Concrete Mix Design" and should not be misconstrued with the fundamental arrangement. Proportioning may be established on particular data got by realistic experience and examinations of test eventual outcomes of various fixings or an observational data. The method of mix arrangement

incorporates the possibility of properties and costs of fixings. Essentials of putting and finishing the new concrete and properties of hardened concrete, for instance, quality, sturdiness, and volumetric security et cetera. The principal goals of the concrete mix arrangement would in this way have the capacity to be started as the production of concret

**SELECTION OF INGREDIENTS**

**CEMENT**

Ordinary Portland Cement of Grade 53 is utilized, which adjusting IS 12269 Cement might be recommended as a material with adhesive and cohesive properties which make it fit for bonding material sections into a minimal entirety. The most ordinarily utilized cement in development today is Portland cement and thus Ordinary Portland Cement of 53 grades has been chosen for the examination. It is dry, fine and free of bumps.

**AGGREGATES**

Natural aggregates utilized as a part of the fabricate of concrete clearing squares should meet the necessities for aggregates for concrete given in IS 383 Aggregates from normal sources – Aggregates for concrete. Slag aggregates may likewise be utilized on the off chance that they can be appeared to be physically and artificially stable. Squander materials, or materials not popular, are frequently looked for after as these are by and large generally modest.

**SIZE OF AGGREGATES**

The maximum nominal size suggested of aggregate is 20 mm. In any case, the most extreme size for the most part utilized is 20 mm, littler sizes (4,75 mm) might be utilized to suit conditions or may specifically choose to acquire a specific surface. Byand large, the utilization of coarse particles brings about funds in cover gave the blend is legitimately proportioned.

**COARSE AGGREGATES**

The aggregates which stayed on 4.75mm IS Sieve is called coarse aggregates, coarse aggregate is uncrushed rock or stone which comes about because of the characteristic breaking down of rocks, squashed rock or stone when it comes about because of smashing of rock or hard stone. A coarse aggregate which is utilized as a part of the concrete solid shape is affirmed by IS 383.

**FINE AGGREGATES**

Aggregate which goes from 4.75 mm sifter and contains just so substantially coarser material as allowed, fine aggregate is normal sand which is coming about because of the characteristic crumbling of shake and which has been saved by streams or chilly offices, it is additionally pounded stone sand which is created by pulverizing hard stone, it is likewise smashed rock sand which delivered by squashing regular rock.

**STEEL FIBRE**

Stainless steel fibres are manufactured fibres composed of stainless steel. Composition may include carbon (C), silicon (Si), manganese (Mn), phosphorus (P), sulphur (S), and other elements. The most common uses for stainless steel fibres is in the field of the electrical and textiles industry such as anti-radiation cloth,

thermal resistant fabric, and anti-static brushes. Many people also use stainless steel fibres in weaving. Increasingly common today are stainless steel fibres in clothing, including radiation protection for pregnant women. Stainless steel yarns are woven, braided, and knit into many industrial fabrics

**TEST ON FRESH CONCRETE**

**WORKABILITY OF CONCRETE**

Workability is considered to be that property of plastic concrete which indicates its ability to be mixed, handled, transported and most importantly, placed with a minimum loss of homogeneity. More precisely, it defines that it can be fully compacted with minimum energy input. There should be no sign of any segregation or bleeding in a workable concrete. The workability of all the mixes of concrete used in this work was controlled by conducting slump test,

**RESULTS AND DISCUSSIONS**

**TEST RESULTS AND DISCUSSIONS**

**CEMENT TESTING**

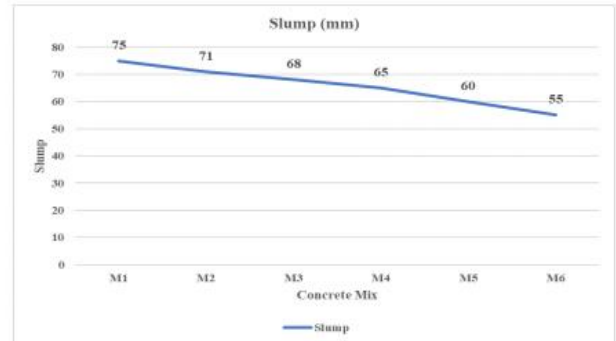
The reason for this test is to decide the level of water required for planning cement paste for different tests. The essential point is to discover the water content required to create a cement paste of standard consistency as determined to be: 4031 (Part 4) – 1988. The guideline is that standard consistency of cement is that consistency at which the Vicat plunger enters to a point 5-7 mm from the base of Vicat shape.

**Consistency Test**

| Mix | Steel Fibre % | 28 days | Average Value |
|-----|---------------|---------|---------------|
| 1   | 1.00%         | 50.73   | 50.99         |
|     |               | 51.21   |               |
|     |               | 51.04   |               |

**WORKABILITY OF CONCRETE**

In this part, different test results on concrete are presented and analyzed. This includes workability of concrete contain ceramic waste crushed tile aggregate blended mortar which is assessed by the compressive strength of concrete with M20 grade.



| S No | Mix | Slump (mm) |
|------|-----|------------|
| 1    | M1  | 75         |
| 2    | M2  | 71         |
| 3    | M3  | 68         |
| 4    | M4  | 65         |
| 5    | M5  | 60         |
| 6    | M6  | 55         |



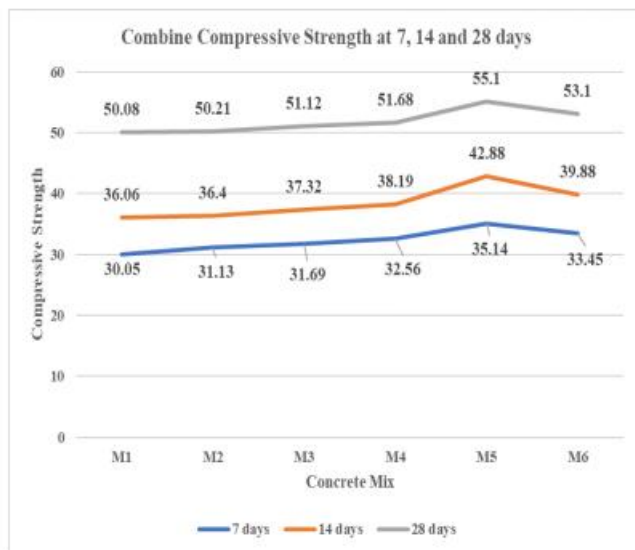
Workability values for different concrete mix M-20

| Trial Mix | Wt. of Cement (gm.) | Penetration (mm) | % of Water | Average % |
|-----------|---------------------|------------------|------------|-----------|
| BM-1      | 300                 | 8                | 35%        | 38%       |
| BM-2      | 300                 | 9                | 40%        |           |
| BM-3      | 300                 | 7                | 38%        |           |

| Trial Mix | Wt. of Cement (gm.) | Penetration (mm) | % of Water | Average % |
|-----------|---------------------|------------------|------------|-----------|
| BM-1      | 300                 | 8                | 35%        | 38%       |
| BM-2      | 300                 | 9                | 40%        |           |
| BM-3      | 300                 | 7                | 38%        |           |

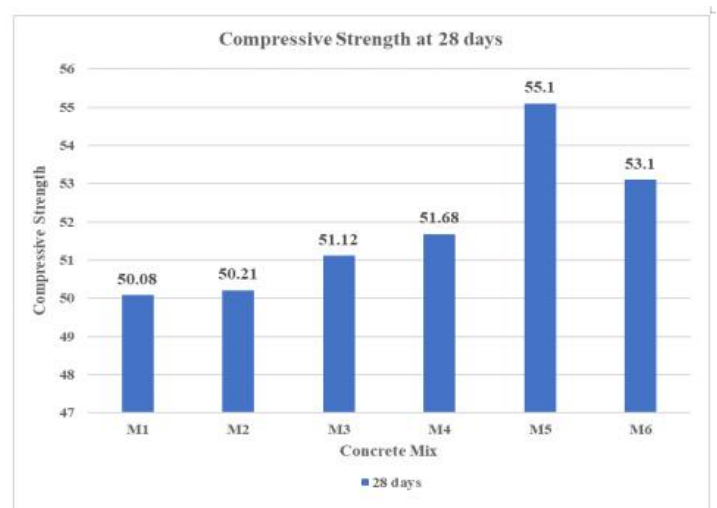
**COMPRESSIVE STRENGTH TEST**

The results of the compressive strength tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section. The compressive strength test was conducted at curing ages of 7, 14, and 28, days. The compressive strength test results of all the mixes at different curing ages are shown in below table. Variation of compressive strength of all the mixes cured at 7, 14, and 28, days



percentage of steel fibre is 1 percent, when we increase it, strength were decreases.

The results of this experimental work establishes that river sand can be partially replaced with manufactured sand and with the addition of Steel fibers does not have any adverse impact on the mechanical characteristics of the concrete. We also observed M-sand, its 10% economical as compare with natural sand



**1. CONCLUSION**

- Concrete produced by replacing natural sand by manufactured sand with addition of 1% of Steel fibres imparts higher compressive, flexural and split tensile strengths due to sharp edges and better interlocking of M-sand particles and good bonding with other materials.
- Workability of concrete decreases as proportion of Steel Fibre and M-Sand are increases.
- The compressive strength of 70% replaced manufactured sand concrete with 1% of Steel Fibres are 10.08% more than reference mix (0% replaced mix).
- The split tensile strength of 70% replaced manufactured sand concrete with 1% of Steel Fibres are 44.82% more than reference mix (0% replaced mix).
- The flexural strength of 70% replaced manufactured sand concrete with 1% of Steel Fibres are 51.58% more than reference mix (0% replaced mix). With the increase in w/c ratio strength of concrete decreases.

**REFERENCES**

- Santosh Kumar Karri1, G.V.Rama Rao, P.Markandeya Raju, Strength and Durability Studies on GGBS Concrete-SSRG .International Journal of Civil Engineering (SSRG-IJCE) – volume 2 Issue 10 October 2015.
- Manoj Kadiwall1, Girish Hombal, Experimental Study on Strength Characteristics of Concrete by Replacement of Cement and Fine Aggregate by GGBS and Sand - IJSART - Volume 2 Issue 8 –AUGUST 2016.
- Dr. T Suresh Babu, M Anveshkumar, An experimental investigation on the properties of concrete containing manufactured sand & GGBS-International Journal of Applied Research 2016; 2(1): 362-369.
- J.Parvesh, Concrete Added with Manufactured Sand, Coconut Shell, Steel and Sisal Fibres- International Journal of Latest Trends in Engineering and Technology (IJLTET).
- Likhil L. Raut1, D. B. Kulkarni, Torsional Strengthening of

under Reinforced Concrete Beams using Crimped steel fiber-IJRET: International Journal of Research in Engineering and Technology.

6.Mohammd Moyunddin, Varnitha MS, Sathish , To Study the partial Replacement of Cement by GGBS and Natural sand by Manufactured sand in concrete using different dosages of admixture.

7.Pazhani.K., Jeyaraj.R —Study on durability of high performance concrete with industrial wastes| ATI - Applied Technologies & InnovationsVolume 2 August 2010.

8.Kumar Shantveerayya, Vikas Nikkam, An Experimental Study on the Properties of Glass Fibre Reinforced and Ground Granulated Blast Furnace Slag Concrete- SSRG International Journal of Civil Engineering (SSRG-IJCE) – volume 3 Issue 3– March 2016.

9.Vinayak Awasare, Prof. M. V. Nagendra, Analysis of Strength Characteristics of GGBS concrete- , International Journal of Advanced Engineering Technology E- ISSN 0976-3945.

10.Aruna d “Studies on usage potential of broken tiles as part replacement to coarse aggregates in concretes” ijret: international journal of research in engineering and technology eissn: 2319-1163 | pissn: 2321-7308.