Assessment of Corrosion in Concrete Incorporating Treated Used Foundrysand

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ABSTRACT

Concrete is an essential and widely used construction material. 20–35 percent of the total volume of a concrete mixture is made up of fine particles. Although natural river sand has traditionally been the most widely utilised fine aggregate in concrete manufacturing, its usage has been curtailed in recent years due to its high price and scarcity. The usage of natural sand causes a depletion of natural resources. Crushed granite powder, siliceous stone powder, and other related products are now the focus of several investigations aimed at reducing the stress sand demand for river sand. One such product is used foundry sand (UFS), a high-quality silica sand by-product of the casting of ferrous and nonferrous metals. However, the corrosion performance of concrete made using Used Foundry Sand has only recently been the subject of systematic and detailed study. Specimens of reinforced concrete, each measuring 150 millimetres in height and 50 millimetres in diameter, were constructed with and without the addition of Treated Used Foundry Sand to examine the effects of corrosion on the reinforcement (TUFS). The corrosion rate was increased by placing the cylindrical specimens in a 5 percent NACL solution and applying a direct current density. Corrosion of the rebar was evaluated with the use of the impress current method and half-cell potential testing. At the end of the corrosion phase, all corroded reinforcing bars were removed, cleaned in accordance with the ASTM G1-90 standard, and weighed to ascertain the true extent of mass loss. The microstructure of a control mix and mixes with varying quantities of foundry sand was also studied using XRD techniques. Up to a 30% replacement level, TUFS improved the corrosion resistance properties of steel in concrete. At various points in the tests, either no FoundrySand or 10, 20, 30, or 40% FoundrySand is used as a replacement for the fine aggregate.

1. INTRODUCTION

Quality silica sand, such as foundry sand, has uniform physical qualities. Sand has been used as a moulding material for casting ferrous and nonferrous metals for millennia owing to its thermal conductivity, and this waste is produced as a consequence of this process. Depending on the casting method used and the sector of industry in which the foundry is located, the physical and chemical characteristics of the resulting products will be very different.

Figure.1.Foundry Sand Sample

The industrial sector annually consumes approximately 100 million tonnes of sand, with an estimated 6-10 million tonnes being discarded despite being recyclable. Sand from the vehicle. High-quality, size-specific silica sands are purchased by foundries for use in casting.

2. RELATED WORK

Mortars are primarily constructed of sand, cement, and different additives, and they are used in masonry construction. Joining and sealing concrete masonry units, bonding with steel reinforcement to strengthen masonry structures, and adding aesthetic value are some of its primary uses. About one cubic foot of sand is needed to make one cubic foot of mortar. As the cement paste spreads, it fills the spaces between the sand grains and makes the material more manageable.

Foundry sand as a soil/crop amendment

It is possible to include foundry sand into both finished compost and topsoil. It's ideal for use as topsoil because of its uniformity, consistency, and dark colour. Sinceahighsandcontentisrequiredintopsoil,itisanessentialingredient. When added to compost, foundry sand reduces the formation of clumps and maintains the aeration of the mixture. By increasing the availability of oxygen, this speeds up the breakdown process.

Casting in foundry sands that have been smelted

Sand from a foundry might be utilised in the production of zinc and copper. Foundry sand may be used in lieu of pure sand. When used for smelting zinc and copper, the sand should be sufficiently pure (at least 99.0 percent silica), have a maximum particle size of 2 mm, and have a bulk phenol content of less than 2 mg/kg (ppm). 63 To ensure high-quality zinc and copper, the foundry must demonstrate that the foundry sand meets certain specifications in the smelting plan.

3. MATERIALS

All batches of concrete were formulated using IS mark 43 grade cement (Brand-ACC cement). All of the cement utilised was fresh and smooth. The experiment employed locally-sourced sand that conformed to the standards of grading zone III as specified by the International Standard ISO 383 (1970). All particles bigger than a 2.36 mm sieve were removed by sieving the sand and washing it to get rid of the dust.

Sums up to (Coarse)

Coarse aggregates with maximum diameters of 12.5 mm and 20 mm were used in the present investigation because they were easily available in the study area. Crude aggregates were evaluated using the standards established by IS: 383-1970. Tap water was used for mixing the concrete and drying the samples.

4. CONCRETE MIX DESIGN

Based on IS mix design

For M20 grade of concrete mix design was done by Indian standard method forcontrol specimen
Characteristic compressive strength = 20 N/mm2 Type of cement = OPC 53 grade
Maximum size of aggregate = 20 mm
Degree of workability = 0.9 (compaction factor)
Type of exposure = mild
Specific gravity of cement = 3.125
Specific gravity of fine aggregate = 2.69
Specific gravity of coarse aggregate = 2.72
Sieve analysis:
Fine aggregate –zone 111 (Refer table 4 of IS 383)

Mix proportion for M20 grade concrete

Cement Kg/m^3	Water contentKg/m^3	Fine aggregateKg/m^3	Coarse aggregate Kg/m^3	Water cementratio
394	197	637.5	1150	0.50

Mix proportion ratio

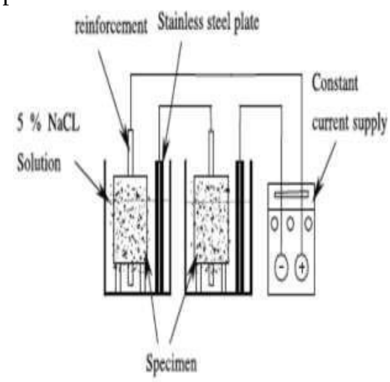
Cement	Fine aggregate	Coarse aggregate	Water cementratio
1	1.6	2.92	0.50

5. ASSESSMENT OF CORROSION

Damage to a material and its qualities may be caused by corrosion, which is a chemical or electrochemical interaction between the substance and its surroundings. Corrosion causes the production of rust, which is two to four times as massive as the original steel but retains none of its excellent mechanical qualities when implanted in concrete. Reducing the cross-sectional area of reinforcing steel due to corrosion causes a decrease in its strength capability.

Leaching lime
Rust discoloration
Extra cover thickness (collection of rust products)
Fractional fractures
Splits on a global scale
Cracking in the concrete overlay

Since reproducing reinforcing corrosion in laboratories takes a long time, several speeded-up test processes have been devised. In order to learn more about the effects of reinforcement corrosion, it is typically required to conduct accelerated corrosion modelling in the lab. amazing modern technology
Measurement of half-cell potential
Using a direct current (DC) source, the impressed current technique (also known as the galvanostatic method) rapidly corrodes steel embedded in concrete.
Setups for inducing reinforcement corrosion by impressed current use a DC power supply, a counter electrode, and an electrolyte. The anode, which consists of the steel bars, is connected to the positive terminal of the DC power source, while the counter electrode is connected to the negative terminal (cathode). Current is impressed from the counter electrode through the concrete and onto the rebar using the electrolyte (normally sodium chloride solution). An example of a lollypop reinforced concrete test specimen and set-up utilised for accelerated corrosion research employing impressed current methods.



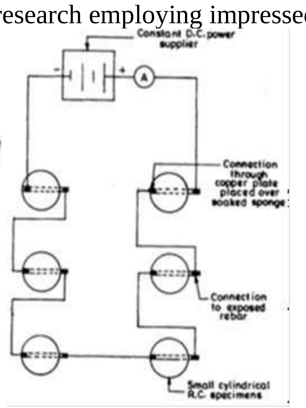


Figure.1. Set-up for impressed current test

Figure.2. Measurement of Mass Loss

$$\text{Mass loss} = \frac{\text{initial weight} - \text{final weight}}{\text{Initial weight}} \times 100$$

Corroded Specimen

Figure.3.Corroded Bars, Cleaning of Bars with Chemical Solution

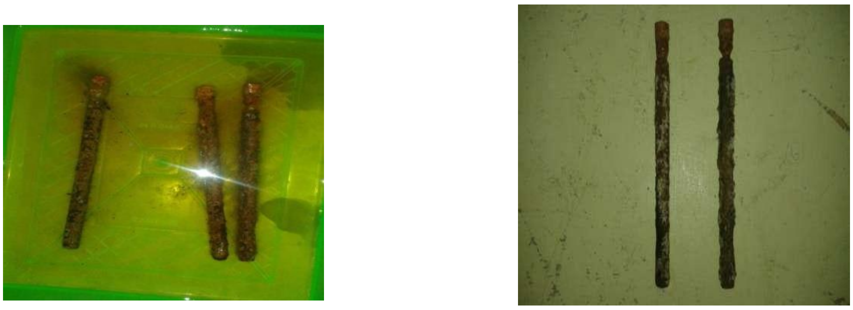


Figure.4.Corrosion

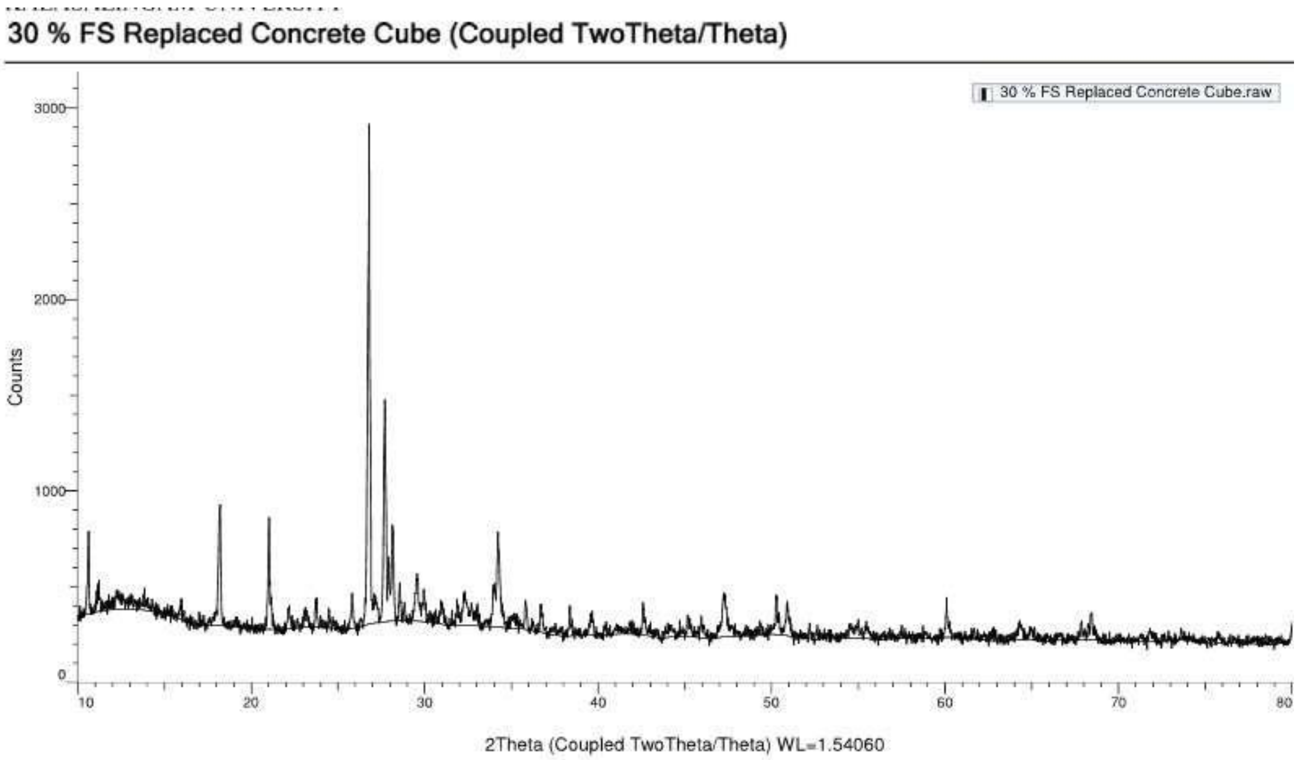
6. RESULTS AND DISCUSSIONS

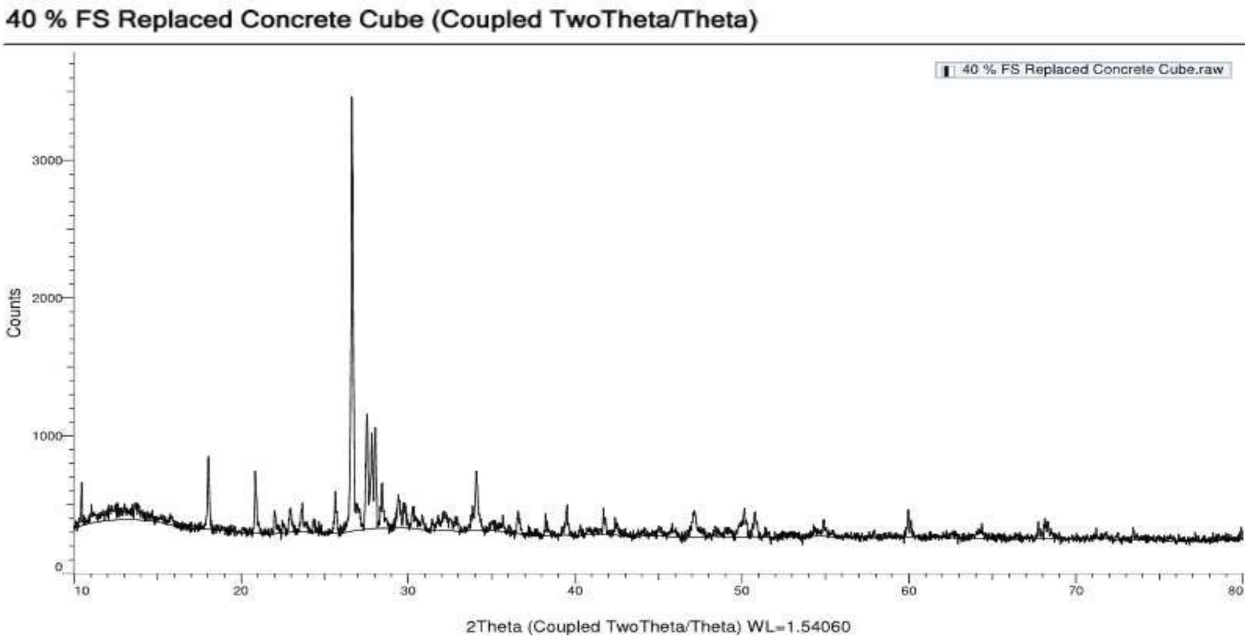
Because of the considerable amount of time needed to simulate reinforcement corrosion in laboratory settings, several accelerated test techniques have been devised. To learn more about reinforcing corrosion and its effects, it is frequently required to conduct laboratory experiments simulating the corrosion process at accelerated speeds. state-of-the-art innovation that is really astounding

Quantifying the potential of half a cell

To rapidly corrode steel embedded in concrete, the impressed current technique (also called the galvanostatic method) requires applying a constant current from a DC source.

For the purpose of inducing reinforcement corrosion by impressed current, a DC power source, a counter electrode, and an electrolyte are often used in experimental settings. In a DC power supply setup, the positive terminal is connected to the steel bars (anode), while the negative terminal is attached to the counter electrode (cathode). The electrolyte facilitates the transfer of current from the counter electrode to the rebar embedded in the concrete (normally sodium chloride solution). Here we see an example of a lollypop-shaped test specimen and setup for accelerated corrosion study using impressed current techniques.





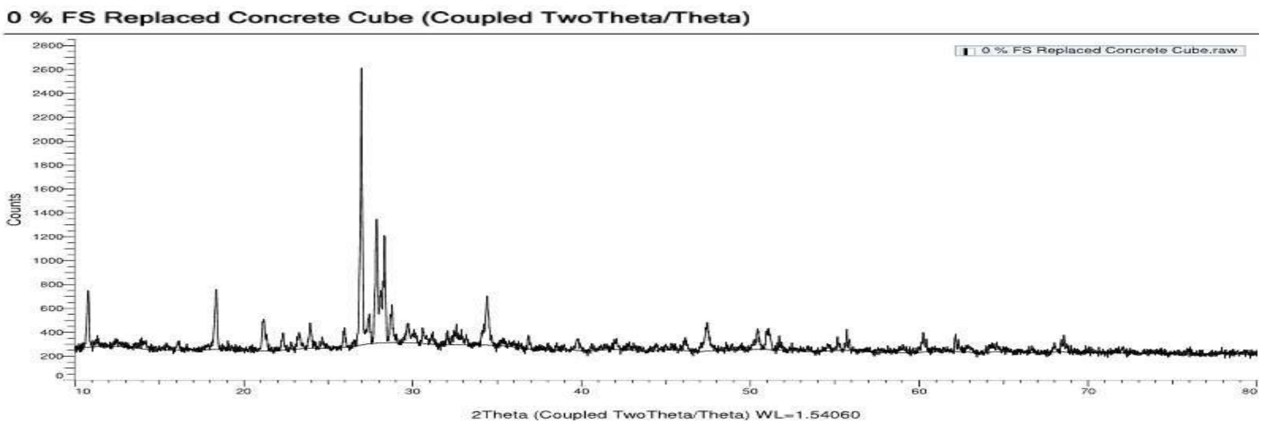


Figure.5. XRD Pattern of 40% Sand Replacement with TUFS

Table.1. Flexural Behaviour Of Beam

LOAD (KN)	DEFLECTION (mm)
0	0.00
4	0.08
8	0.18
12	0.37
16	0.50
20	0.67
24	0.91
28	1.20
32	1.47
36	1.78
40	2.16
44	2.72

Collapse Load = 48.4 KN First Crack @ 14 KN

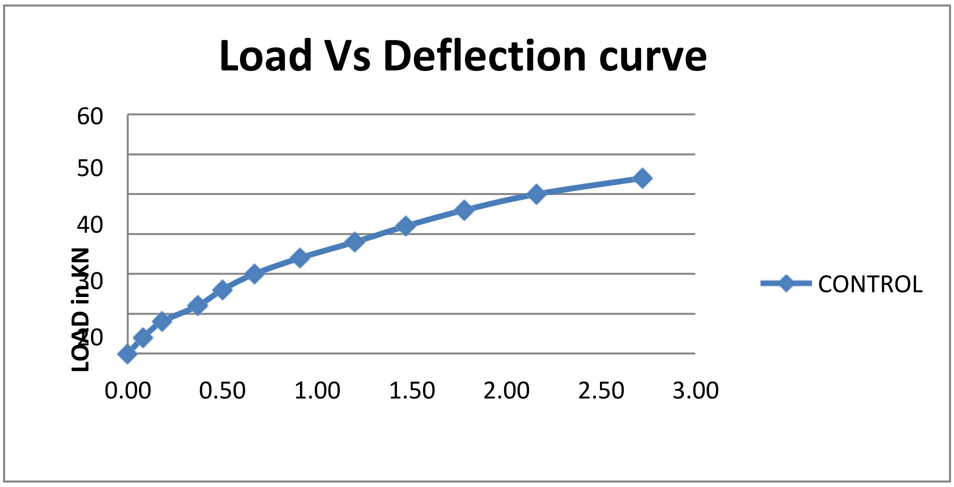


Figure.6. Load Vs Deflection Curve

Table.2.Beam Containing TUFS 30% Replacement

LOAD (KN)	DEFLECTION(mm)
0	**0.00**
4	**0.13**
8	**0.31**
12	**0.50**
16	**0.82**
20	**1.08**
24	**1.36**
28	**1.71**
32	**2.03**
36	**2.54**

40	**4.04**
44	**4.67**
48	**5.50**

Collapse Load = 52.6 KN First Crack @ 12 KN

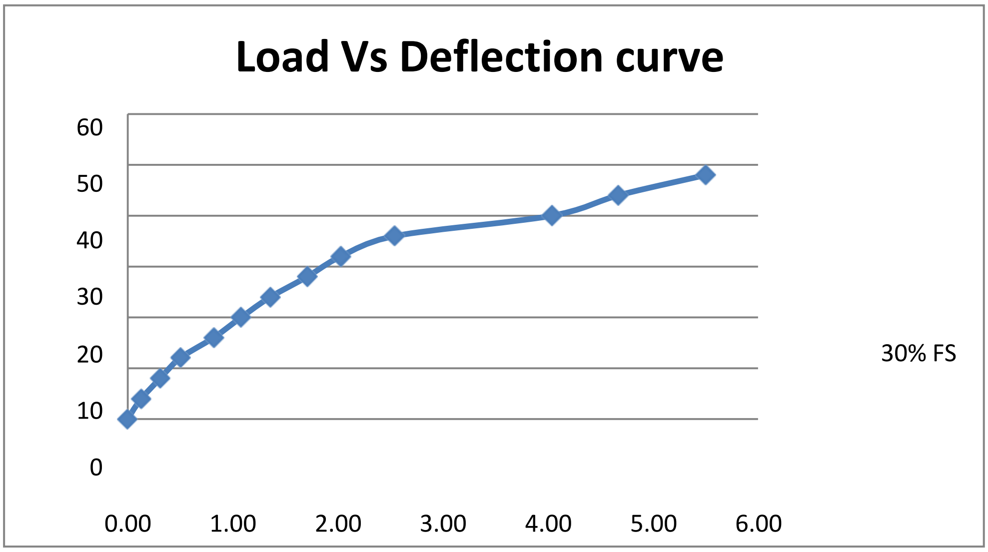


Figure.7. Graphical Representation of Load VS Deflection Curve for 30%FS Beam

7. CONCLUSION

Although natural river sand has traditionally been the most widely utilised fine aggregate in concrete manufacturing, its usage has been curtailed in recent years due to its high price and scarcity. The protection of this natural resource is aided by the substitution of foundry sand for beach sand. To put it another way, the Workability of Concrete made using Replaced Treated Used Foundry Sand is much higher than that of Concrete made with untreated Used Foundry Sand.

Treated Used Foundry Sand has a silica content of 80 percent or more, making it an excellent concrete binding material. In order to test corrosion quickly and accurately, the impressed current method and half-cell potential measurement have been shown to be effective. Up to a 30 percent replacement level, TUFS improved the corrosion resistance of steel in concrete. Corrosion was less severe in TUFS integrated specimens compared to control specimens. The onset of corrosion for the TUFS-enhanced mixture occurs a little sooner than that of the control mixture. Additionally, flexural behaviour is significantly enhanced in TUFS-containing concrete compared to the control mix.

8. REFERENCES

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