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# Experimental Study on Strength and Sustainability of Ferrock-Based M30 Grade Ferrocement

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**Abstract** — Concrete is a building material that is among the most commonly used in building materials but the manufacturing of cement emits high quantity of carbon dioxide that pollutes the environment. In order to minimize this effect, sustainable and alternative material is being devised. Ferrock is also a composite construction material that is produced through the use of steel powder, or waste material used in the steel industry.

As in this project, cement is substituted to some extent at 10% and 20% with steel powder to produce Ferrock. The ready mixture is subjected to research its strengths and performance. The process of ferrock conversion into carbon dioxide occurs during the curing process and the result is a strong and resilient material. It is also useful in minimizing waste in the industry and reducing environmental costs of building.

The overall goal of the research is to assess the usefulness of steel powder partially replacing cement and create a durable construction product that is environmentally friendly and has excellent strength characteristics.

***Key Words:*** *M30 Grade Concrete, Compressive Strength, Steel waste, Flexure strength*

## 1. INTRODUCTION

In the world, concrete is the most used construction material. It contains predominantly cement, fine aggregate, coarse aggregate and water. The production of cement is however a source of great quantity of carbon dioxide ($CO_2$) thereby contributing to pollution in the environment. As such the construction materials should be made green and sustainable.

Ferrock is a new and sustainable construction product produced by means of utilizing steel powder which is another industrial waste received in steel industry. In Ferrock, steel powder takes the place of a given percentage of cement. The process of carbon dioxide absorption by ferrock makes the curing process stronger and tougher.

On this project, Ferrock is ready by substituting cement with 10 and 20 percent steel powder to perform research into its characteristics as a material in terms of strength and durability. The powder of steel can be used in minimizing the industrial waste as well as reducing the environmental effect of the construction materials.

## 2. OBJECTIVE

- To determine the optimal percentage of steel waste (ferrock) that improve or maintain concrete strength within acceptable standards.
- To find properties of various ingredients to determine compressive strength and flexure strength of M30 grade of concrete.

## 3. MATERIAL COLLECTION

**Cement:**

Cement is the main binding material used in concrete. It reacts with water and forms a paste that binds sand and coarse aggregate together. This chemical reaction is called hydration. Cement provides strength, hardness, and durability to concrete.

**Sand (Fine Aggregate):**

Sand is used as a fine aggregate in concrete. It fills the gaps between coarse aggregates and helps in improving the workability of concrete. Sand reduces voids and increases the density and strength of the mix. River sand or manufactured sand (M-sand) is commonly used.

**Coarse Aggregate:**

Coarse aggregate is the main load-bearing material in concrete. It provides bulk volume and strength to the structure. Crushed stones of 10 mm to 20 mm size are generally used as coarse aggregate. It also helps in reducing shrinkage and improving durability.

**Steel Waste:**

The steel waste comes as a result of local metal shops or steel factories. It can normally be found as dust of steel, filings, or tiny particles formed in the sheet of cutting and grinding processes. The steel waste gathered is cleansed, dried and sieved and then used in the Ferrock mixture.

## 4. TESTING

**A. Compressive Strength Procedure:**

- Prepare of sample of concrete mix and cast the cubes, of 15×15×15 cm.
- The concrete filled into the moulds in three layers, each layers gives 25 time blows with the help of tamping rod. After top layer take the surface in smooth finish with the help of float.
- Place the cube sample as it is for 24 hrs. Remove the cubes from the moulds and take it for curing as the curing period after the complete curing period the sample remove from water. Take test after sample dried.

○ Remove all the loose material from sample.

○ Place the cube sample in apparatus. Apply the load slowly.

○ Note the maximum load carried by each sample.

○ Calculate the average compressive strength of concrete.

## 5.Preperation and Testing-

**A. Ferrock Concrete – M30 Grade Concrete:**

For our experiment, we will create three blocks measuring 15 × 15 × 15 cm using ferrock concrete with a grade of M30.

**Table 1. Quantities Required for 12 Blocks of Ferrock Concrete.**

| Sr. No | Material | Quantity | Unit |
|---|---|---|---|
| 1 | Cement | 19 | kg |
| 2 | Sand | 30 | kg |
| 3 | Aggregate | 48 | kg |
| 4 | Water | 8 | Liter |
| 5 | Ferrock | 6 | kg |

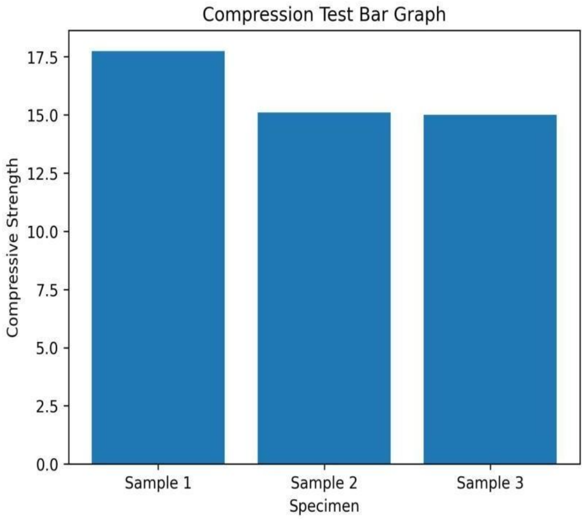
**Table 2. Compressive Strength of Concrete After 7 Days Curing.**

| Sample | Compressive Strength (N/mm²) |
|---|---|
| 1-(10%) | 17.74 N/mm² |
| 2-(10%) | 16.11 N/mm² |
| 3-(10%) | 16.00 N/mm² |
| 4-(20%) | 19.00 N/mm² |
| 5-(20%) | 17.37 N/mm² |
| 6-(20%) | 19.05 N/mm² |

**Observation / Result:**

1. 10% replacement, best performance, safely achieves M30 early strength.
2. 20% replacement, acceptable strength.

**Strength archive after 7 days curing of blocks for shown in below graphs.**




**( Flexural Strength Procedure)-**

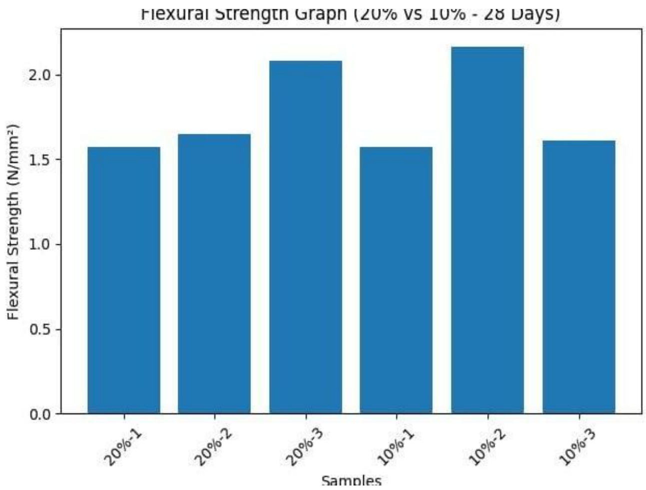
- Take the specimen out of the water and dry the surface.
- Attempt to measure the beam specimen length, width and depth.
- Depending on the specimen being tested, it must be placed in the flexural testing machine with both ends appropriately supported.
- It should be ensured that the load is put at the centre or at two points based on the test method.
- Load should be applied slowly and evenly without any shock.
- Keep adding the load up to the point when the specimen breaks or cracks.
- Record the failure load of the specimen.
- Calculate flexural strength through normal formula.


*Fig - 1: Flexural Strength Testing*

**Table 3. Flexural Strength of Concrete After 7 & 28 Days Curing.**

| Sample | flexural strength (N/mm2) |
|---|---|
| 1-(10%) | 1.57N/mm2 |
| 2-(10%) | 2.16N/mm2 |
| 3-(10%) | 1.61N/mm2 |
| 4-(20%) | 1.57N/mm2 |
| 5-(20%) | 1.65N/mm2 |
| 6-(20%) | 2.08N/mm2 |

**Charts:**




## 6. CONCLUSIONS

Powder was used as a partial substitute for cement in making Ferrock-based concrete. The mixes were created by replacing cement with steel powder at rates of 10% and 20%, and their properties were compared to standard concrete. The experimental results showed that replacing 10% of the cement with steel powder resulted in better strength and performance. However, the 20% replacement led to a slight drop in strength, which was still acceptable.

Using steel powder helps decrease cement use, recycle industrial waste, and reduce environmental pollution. Because of this, Ferrock can be seen as a sustainable and eco-friendly building material for future projects.

## 7. ACKNOWLEDGEMENT

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## 8.CONFLICT OF INTEREST

The authors state that there is no conflict of interest regarding this research titled "Experimental Study on Strength and Sustainability of Ferrock-Based M30 Grade Ferrocement.

(10%, 20%)."

This research was carried out independently as part of an academic project. No financial support, sponsorship, or external funding was received from any company, organization, or individual that could affect the results.

The materials used in this study were gathered and tested without any commercial interest. The experimental results and conclusions in this paper are based solely on laboratory testing and analysis, and they were not influenced by any outside factors.

## 9.Authors biography-

Professor, Mr. K.P Mali Department of Civil Engineering works as a faculty member in the Department of Civil Engineering. He has expertise in concrete technology, construction materials, and structural engineering. He has guided several undergraduate research and capstone projects and has a strong interest in sustainable and eco-friendly construction practices.

Viraj D. Shelake is a student of Civil Engineering. His interests include concrete technology, sustainable construction materials, and environmental engineering. In this project, he actively contributed to mix design, specimen preparation, flexural strength testing, and data analysis for M35 grade concrete with stone crusher dust replacement.

Pranav S. Shinde is a student in Civil Engineering. His academic interests include structural engineering and innovative construction materials. He was involved in collecting materials, casting concrete cubes, the curing process, and laboratory testing during the project work.

Aditya M. Ghogare is a Civil Engineering student with a strong interest in sustainable construction and waste management. In this project, he contributed to experimental work, comparing results for 15%, 25%, and 35% replacement levels, and preparing technical documentation.

Mayuresh A. Jadhav is a student of Civil Engineering. His interests include building materials and construction technology. He participated in laboratory experiments, recording data, analyzing compressive strength results, and preparing reports for the project.

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