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# To Check the Strength of Concrete on Partial replacement of Fine Aggregate by Steel Slag

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## ABSTRACT

With increasing population demand for construction industries keeps on increasing and with increased construction rate consumption of naturally available aggregates are increasing. By the passage of time if we do not find any alternative for sustainable development then all the naturally available resources will get exhausted. The steel scrap which is the waste material obtained from the steel manufacturing, casting and forging industries is also a great concern for disposal. This research aims to tackle these two major issues by partially replacing the fine aggregate from concrete by steel scrap and hence check the strength of concrete. The replacement is done step wise by 0%, 20%, 30% and 40% by weight. Water cement ratio is kept constant at 0.51. To check the strength of concrete we caste cubes of size 150mm*150mm*150mm and were tested after 7days and 28 days of curing. The end results are being compared with the 0% replacement to show the variations and obtain the best result. The results shows that the 30% replacement is best fit to obtain some increased strength.

**KEYWORDS:** Aggregates, Sustainable development, Steel scrap, Concrete, W/c ratio.

## INTRODUCTION

Sustainable development is the necessity of the time for smooth and adequate utilization of natural resources. Demand of construction boost the utilization of natural resources so we as an engineer finds the replacement of fine aggregate in construction industry. The steel scrap which is produced in huge amount from the steel industry or reinforcement industry can be the best fit for fine aggregates. This research aims to solve two major problems, firstly it helps in sustainable development by reserving the fine aggregates for future use and making the low-cost concrete and, secondly it solves the serious problem of disposal of steel scrap from the industry which causes various environmental issues.

For the study of steel scrap mixed concrete, we use M25 grade concrete and the steel scrap we used is of Fe415 grade and obtained from SARPANCHFarm Equipment's, Meerut City (U.P.) INDIA. We replace 0%, 20%, 30%, and 40% fine aggregate by steel slag to find the adequate replacement which imparts highest strength. To check the mechanical strength namely compressive strength and tensile strength we caste cubes of size 150mm*150mm*150mm each and after 7 days and 28days of curing we test in compression testing machine. The results obtained were studied with the base value (0% replacement) to check the variation and obtain the desired result. By studying the graphs, we find that till 30% replacement strength keeps increasing and on 40% replacement the strength decreases.

## MATERIALS AND METHODS

### A) Materials:

1) **Cement:**

We used Ordinary Portland Cement (OPC) of grade 43 Confirming to IS8112-1989was purchased from the local market. Various physical tests has been done before using the cement to follow the Indian standard code. Results obtained are satisfactory and are listed in tabular form below.

| Sl. No. | Tests Performed | Results Obtained | Standard values(IS8112-1989) |
|---|---|---|---|
| 1 | Normal Consistency (%) | 32 | 25-30% |
| 2 | Initial setting time (min) | 57 | >=30 mins |
| 3 | Final setting time (min) | 268 | <=600 mins |
| 4 | Fineness % | 3.5 | <10 |
| 5 | Specific gravity | 3.11 | |

2) **Aggregates (Coarse and Fine):**
The Coarse aggregate has been obtained from the local market that are retained on 12.5mm sieve and the fine aggregate is take i.e. Ennore sand.

3) **Steel scrap:**
The steel scrap we used is of Fe415 grade and obtained from SARPANCH Farm Equipment's, Meerut City (U.P.) INDIA. After proper crushing the scrap is made to pass through 4.75mm sieve and is replaced by the fine aggregates.

PURPOSE OF STEEL SCRAP:
* To reduce the wastage of steel scrap and to minimize the problem of dumping of steel scrap produced from industry.
*To reduce the use of natural resources by providing some alternatives.

**B) Mix Design:**
In this research paper, $M_{25}$ mix proportions was designed as per the recommended IS 10262:2009. Four mixes were prepared with different proportions of steel scraps which is replaced by the fine aggregate. Table represents the mix proportions of the various mixes.
Furthermore, M represents the mix with 0% steel scraps, M1 represents the mix with 20% steel scraps, M2 represents the mix with 30% steel scraps and M3 represents the mix with 40% steel scraps.

| Mixes | Cement($kg/m^3$) | Fine aggregate($kg/m^3$) | Coarse aggregate($kg/m^3$) | Steel Scraps($kg/m^3$) |
|---|---|---|---|---|
| M | 532.34 | 794.07 | 1518.02 | 0 |
| M1 | 532.34 | 635.26 | 1518.02 | 158.81 |
| M2 | 532.34 | 555.85 | 1518.02 | 238.22 |
| M3 | 532.34 | 476.44 | 1518.02 | 317.63 |

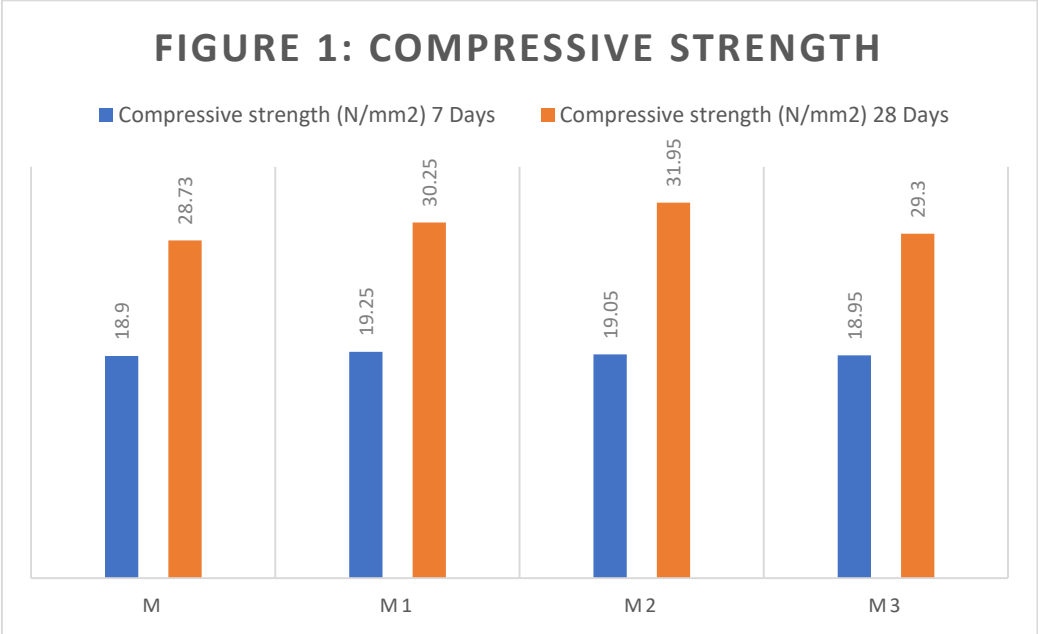
**C) Experimental Programme:**
According to the mix design the concrete is prepared and the fine aggregate is replaced by steel scrap as per the desired percentage (0%, 10%, 20%, 30% & 40%). Cube specimens of size 150mm*150mm*150mm were casted to check the compressive strength in compression testing machine and to determine the split tensile strength using split tensile testing apparatus in compression testing machine. After 7 days and 28 days of curing testing is done accordingly and results are studied in graphical form.

**RESULTS AND DISCUSSIONS**

**1) Compressive Strength:**

Given Table shows the compressive strength test results of various design mixes. From the results we can say that, Mix M2 shows the higher compressive strength when compared with the previous Mix M (without replacement) and Mix M1 after 28 days of curing but in case of 7 days of curing mix M1 shows the greatest compressive strength. However, on further increasing the percentage steel scraps it was noticed that there was reduction in the strength properties. Here, Figure 1 represents the graphical representation of the various mixes.

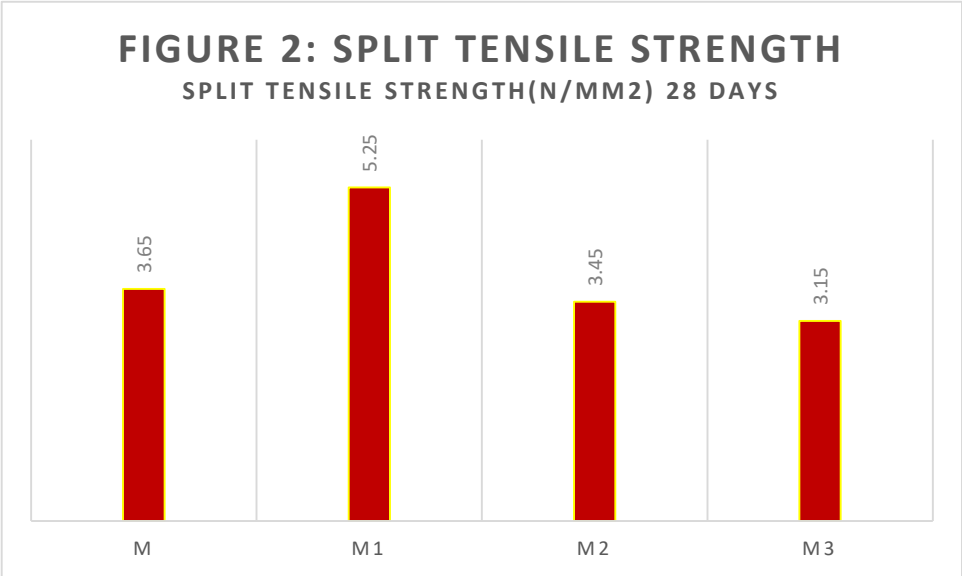
| Table | | |
|---|---|---|
| Mix | Compressive strength (N/mm2) | |
| | 7 Days | 28 Days |
| M | 18.9 | 28.73 |
| M1 | 19.25 | 30.25 |
| M2 | 19.05 | 31.95 |
| M3 | 18.95 | 29.3 |




**2) SplitTensile:**

Given table shows the split tensile strength test results of various design mixes. These results conclude that mix M1 shows the higher split tensile strength from the previous mix M (without replacement). However, on further increasing the percentage of the steel scraps it was noticed that there was decrement in the strength properties. Here, Figure 2 shows the graphical representation of the various mixes.

| Table | |
|---|---|
| Mix | Split Tensile Strength (N/mm2) |
| | 28 Days |
| M | 3.65 |
| M1 | 5.25 |
| M2 | 3.45 |
| M3 | 3.15 |




## CONCLUSION

Basedon the experimental results that has been obtained by replacing fine aggregates with steel scrap following conclusions were drawn:

- Use of steel scrap in concrete reduces the risk of control production waste in factories.
- The maximum compressive strength is obtained by 20% replacement after 7 days of curing and after 28 days of curing the maximum compressive strength is obtained by 30% replacement of fine aggregate by steel scrap.
- It has been found that on further increasing the percentage replacement the compressive strength got reduces further.
- In case of split tensile test we have been found that 20% replacement after 28 days of curing imparts the best strength and on further increasing the steel scrap the strength goes on decreasing.
- The insertion of steel scrap lowers the cost of construction as it is cheaper when compared to normal concrete.
- Hence it can be concluded that the concrete prepared with partial replacement of fine aggregate by steel scrap can be effectively used for sustainable development with enhanced strength and reduced cost.

## REFERENCES

[1] Venkatesan, B., Lijina, V. J., Kannan, V., & Dhevasenaa, P. R. (2021). Partial replacement of fine aggregate by steel slag and coarse aggregate by walnut shell in concrete. Materials Today: Proceedings, 37, 1761-1766.
[2] Anil, M. K., & Pankaj, P. K. (2017). Effect of steel slag as partial replacement of fine aggregate in M35 grade of concrete. Imperial J. Interdiscip. Res.(IJIR), 3(9), 2454-1362.
[3] Bhuvaneswari, N., & Nirmalkumar, K. (2017). Experimental Study on the Mechanical Strength Properties of Steel Slag in Concrete and Weld Slag in Concrete. Ratio, 1, 1-6.
[4]R Dineshkumar, S Suchithra. "Properties of concrete with partial replacement of steel slag with fine aggregate" , 2017 International Conference on Energy, Communication, Data Analytics and Soft Computing (ICECDS), 2017
[5] IS: 8112-1989, “Specification for 43 grade ordinary Portland cement”, Bureau of Indian standards, New Delhi (India)
[6] IS 10262: 2009, “Concrete Mix Proportioning – Guidelines”, Bureau of Indian Standards, New Delhi, India.
[7] IS 456: 2000, “Plain and reinforced concrete – Code of practice”, Bureau of Indian Standards, New Delhi, India.
[8] IS 383:1970, “Coarse and fine aggregate for concrete Specification”, Bureau of Indian Standards, New Delhi, India.
[9] IS 2386: 1963, “Methods of tests for aggregates for concrete”, Bureau of Indian Standards, New Delhi, India.