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Utilization of Foundry Slag as a Partial Replacement for Fine Aggregate to Attain Sustainability in Construction

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ABSTRACT: Implementation of sustainability in the construction industry should be made mandatory to replenish resources and save it for future generation. Since the resources are finite, it is necessary to think of alternate resources to save the existing resources without affecting the purpose. In the current scenario a lot research on suitable and effective waste product is going on that considerably minimizes the products used in concrete and reduces the construction cost. This paper examines the use of foundry slag which helps in acquiring an eco-friendly and a partial replacement for fine aggregate, so that the construction will be economical and concrete attains high compressive strength. This qualitative research will show the comparison of compressive strengths between normal concrete and concrete mixed with foundry slag for different grades of concrete. The design of the concrete cube is done by manual calculation in accordance to design specification of IS 800:2001 and IS 456:2000. Based on the result it was inferred that foundry slag matches the normal conventional concrete strength as per the standards. Based on the analysis it can be concluded that foundry slag is a viable alternative for fine aggregate to achieve the goal of sustainable construction.

KEYWORDS: Sustainability; conventional; construction industry; resources; foundry slag; fine aggregate; compressive strength.

I. INTRODUCTION

All through the world, concrete is in effect broadly utilized for the development of the greater part of the structures, spans, and so on. Subsequently, it is appropriately marked as the spine to the foundation improvement and an enormous amount of cement is required for it. Foundry sand and slag are side-effect materials produced by metal casting forms at metal foundries. The significant segments in foundry sand are quartz sand (70-80%), dirt (5-15%), added substances (2-5%), and water (up to 4%). The biggest volumes of foundry sand are utilized as 'green sand' (mud reinforced) [2]. Metal casting is a metal framing procedure used to deliver metal parts running from car motor squares and cylinders to plumbing installations to accuracy airplane parts. Replacing river sand partially is being examined to tackle this issue [3]. For the most part, an impact blast furnace works consistently and delivers around 250-300kg of slag per huge amounts of iron created [6]. Foundry sand comprises principally of clean, uniform size, excellent silica sand that is clung to frame moulds for ferrous (iron and steel) and nonferrous (copper, aluminum, metal) metal castings. Even though these sands are spotless before use, once casted they may contain Ferrous (iron and steel). industries represent around 95 percent of foundry sand utilized for castings. The automobile business and its parts providers are the significant generators of foundry sand. The most widely recognized casting process utilized in the foundry business is the sand cast system. Practically all sand cast molds are of the green sand type. Greensand comprises of top-notch silica sand, around 10 percent bentonite dirt (as the fastener), 2 to 5 percent water, and around 5 percent ocean coal (a carbonaceous shape added substance to improve casting finish). The main objective of this study is to design and test M20, M25 & M30 concrete cubes with and without using 10% foundry slag and to compare the results obtained from the above analysis.

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II. Material and Methodology

The procedure to be carried out is shown in the following flow chart.

The flow chart of the methodology proposed is shown in Fig 2.1.

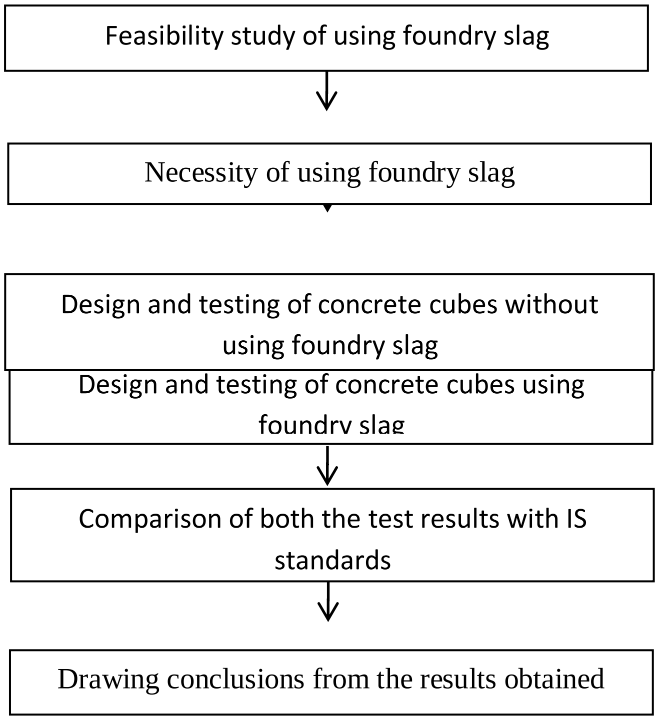

Figure 1. Flow Chart for Methodology

III. Results and Discussion

The slag is commonly used to expel squander in metal purifying; they can likewise fill different needs like temperature control of refining and limiting any re-oxidation of the last fluid metal item before the liquid metal is expelled from the heater and used to make strong metal. The foundry slag samples were collected from metal foundry present in Arasur is situated in Coimbatore district, Tamil Nadu. Concrete cubes of three different grades M20, M25 and M30 were casted using the calculated mix design. For each grade, 4 cubes without replacement and 4 cubes with replacement of 10% of foundry slag were casted. The concrete cubes were tested for compressive tests in universal testing machine which has capacity up to 35 KN for third day, seventh day, fourteenth day and twenty-eighth days.

3.1. Results for Normal Design Mix(Without foundry slag)

Concrete Cube (15×15×15 cm) Compressive Strength

The result for Compressive Strength of Concrete Cube is tabulated in table below.

Table 1. Result for Normal Design Mix

Grade	3rd Day (N/mm^2)	7thDay (N/mm^2)	14th Day (N/mm^2)	28th Day (N/mm^2)
M20	10.2	12.5	17.8	23.1
M25	8.7	12.8	20.6	27.4
M30	11	19.5	26.4	35.8

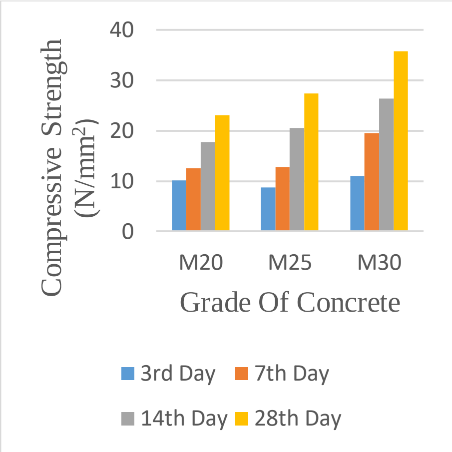

Figure 2. Results for Normal Design Mix

The fig (1) and the table (1) above shows the compressive strength of concrete which varies from10.2 N/mm^2 to 35.8 N/mm^2 for different grades of concrete (M20, M25, M30) for 3rd, 7th, 14th and 28th day of Normal Concrete.

3.2. Results Using Foundry Slag

Concrete Cube (15×15×15 cm) Compressive Strength

The result for Compressive Strength of Concrete Cube using foundry slag is tabulated in table below.

Table 2. Results for Foundry Slag

Grade	3rd Day (N/mm^2)	7th Day (N/mm^2)	14th Day (N/mm^2)	28th Day (N/mm^2)
M20	11.8	15	21.9	22.1
M25	12.2	16.2	23.7	26.2
M30	11.9	23.1	28.2	31.4

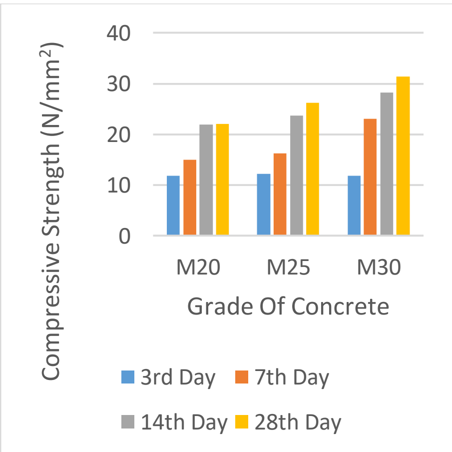

Figure 3. Results for Foundry Slag

The fig (2) and the table (2) above shows the compressive strength of concrete which fluctuates from 11.2 N/mm^2 to 31.4 N/mm^2 for various evaluations of concrete grades (M20, M25, M30) for 3rd, 7th, 14th and 28th day of Concrete using Foundry Slag.

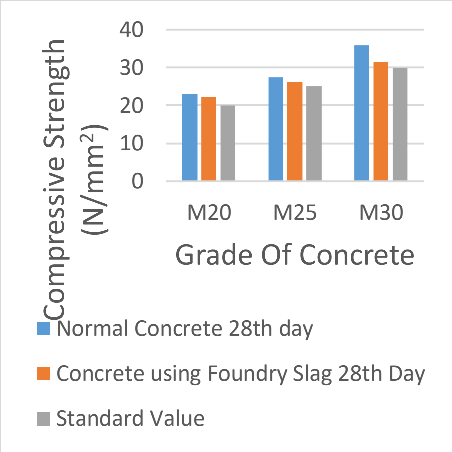

Figure 4. Comparison Between Standard,Normal Concrete and Concrete Using Foundry Slag Compressive Strength

The results obtained were compared. The fig (3) shows comparison between Standard compressive strength (IS 456:2000), Normal concrete and Concrete using Foundry slag. From the results it can be said that Normal concrete and concrete using foundry slag reaches the standard compressive strength for 28th day.

Each grade of concrete cube has achieved its acquired strength according to the IS code IS 456-2000. Further practices can be carried out by varying the percentage of foundry slag and then conducting the tests on concrete.

IV. Conclusion

- Concrete cubes were laid down with and without using foundry slag and their compressive strengths were calculated.
- For both partial replacement and without replacement of foundry slag with fine aggregate the strengths have satisfied the nominal compressive strengths, so we can replace partial fine aggregate with foundry slag.
- Using slag from foundry leads to economic feasibility, and reduce in usage of sand helped save the environment.

Since the use of waterway sand is high in the structure improvement the enthusiasm for the sand is in like manner high in creating nations so instead of sand we can impact usage of foundry slag. It is a disturbing issue for the supportability of the metal throwing industry and nature. So it is significant to discover the answer for use the pre-owned foundry sand and decrease the sand extraction from stream bed .To utilize the eco-friendly by-product to make optimized concrete.

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