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Experimental Investigation on Partial Replacement of Fine Aggregate by Foundry Sand

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Abstract - *In current scenario metal foundries are used in large amounts of the metal casting process in industries. Foundries are completely recycled and reuse the sand several times in a foundry and the remaining sand is called as a foundry sand is removed from foundry. This present study involves about the applications of foundry sand in civil engineering. Use of foundry sand in various civil engineering applications can solve the problem of disposal of foundry sand and other purposes. Foundry sand consists of silica sand, coated with a thin film of burnt carbon, residual binder (bentonite, sea coal, resins) and dust. Foundry sand can be used in concrete to improve the strength and durability. Foundry sand can be used as a partial replacement of cement or fine aggregates or total replacement of fine aggregate and as supplementary addition to achieve different properties of concrete. In the present study, effect of foundry sand as fine aggregate replacement on the compressive strength of concrete having mix proportions of M20 & M25 are investigated. Fine aggregates were replaced with 5% of foundry sand. The percentages of replacements were 10, 20, 30, 40 and 50 % by weight of fine aggregate. Tests were performed for compressive strength for all replacement levels of foundry sand at curing period of 28 days. Test results showed that there is some increase in compressive strength after replacing the fine aggregates with certain percentage of foundry sand and also increase the strength and durability in concrete.*

***Key Words*: Fine aggregate, foundry sand, strength, durability, compressive strength**

1. INTRODUCTION

Foundry sand is highly silica sand with uniform characteristics. It is the byproduct of ferrous and non ferrous metal casting industries, where the sand has been used for over a centuries as a molding material. It is a byproduct from the production of ferrous and non-ferrous metal castings. The physical and chemical characteristics will depend on the type of casting process and the industry sector in foundry sand. In modern foundry do, sand is usually recycled and reused through much production process. Industry estimates that roughly 100 million tons of sand is used in production annually of those 6 to 10 million tons and are available to be recycled into other products from industry. Foundries purchase high quality size, specific silica sands for use of molding and casting operations. The raw sand is normally a higher quality than the typical natural sands used to fill construction sites. This sand normally involves a small amount of bentonite clay to be act as a binder material. Chemical binders are also be used to create sand. Depending upon the the casting, sand cores are inserted into the mould to form internal passages from the molten metal. Ones the metal has solidify, the casting is separated from the molding and core sands in the shakeout process. In the casting process, molding sands are recycled and reused several times. Moreover, the recycled sand degrades to the point that it can no longer be reused in the casting process. At that point, the old sand is displaced from the cycle as byproduct, new sand to be introduced, and the cycle process begins again. Sand is used in two different ways in metal castings in molding material, which focus the external shape of internal void spaces in products such as engine blocks. Since natural sand grains does not naturally adhered to each other. So binders must be introduced to cause the sand to bond together and holds its shape.

Table -1: Foundry sand sample chemical oxide composition

3	Value (%)
SiO2	87.91
Al2O3	4.70
Fe2O3	0.94
CaO	0.14
MgO	0.30
SO3	0.09
Na2O	0.19
K2O	0.25
TiO2	0.15
P2O5	0.00
Mn2O3	0.02
SrO	0.03
LOI	5.15 (0.45 to 9.47) 2.1 - 12.1
TOTAL	99.87

2. Materials

2.1 Cement

Ordinary Portland cement of 53 grades is locally available is used in this investigation. The cement is tested as per the code IS: 4031-1988 and it is found to conforming the various specification of IS: 12269-1987 having specific gravity of 3.15.

2.2 Fine Aggregate

The natural river sand is used for this experimental work was locally available and conformed to Zone II as per IS: 383-1970. The sand was sieved through 4.75mm sieve and having specific gravity of 2.67.

2.3 Coarse Aggregate

Coarse aggregates which were locally available having the size of 20mm were used in the experimental program. Testing of coarse aggregate was done to conforming as per IS: 383-1970. The specific gravity of coarse aggregate is 2.75.

2.4 Foundry Sand

The foundry sand was obtained from steel company, erode and testing of sand was done and specific gravity of coarse aggregate is 2.55.

2.5 Water

Portable tap water is used and conforming to standard specified in IS: 456-2000 is used.

2.6 Mix design

The Mix proportion for the ordinary concrete and standard concrete is designed by using IS: 10262-2009.

1 cubic meter of concrete		water cement ratio
M20	1:1.67:3.2	0.5
M25	1:1.47:2.82	0.45

3. Experimental Investigation

The compressive strength, split tensile strength and flexural strength for M25 grade of concrete were investigated. The cube of 150 x 150 x 150mm, cylinder of 150mm dia & 300mm height and prism of 100 x 100 x 500mm were used.

3.1 Compressive Strength Test

Compressive strength test was carried out on the specimens after 28 days of curing by compression testing machine. Totally 30 cubes were casted. The compressive strength is calculated as,

Fck=P/A

Where,

Fck= Compressive strength (N/mm^2)
P = Ultimate load (N)
A = Loaded area(mm^2)

4. Results and discussion

Compressive strength test results after 28 days for M20 grade of concrete are given in table 2. The result shows that the strength gets increases at 30% replacement of foundry sand.

Table -2: Compressive Strength Test Results

S.No	%Replacement	Average Compressive Strength N/mm^2
1.	CC	23.7
2.	10	23.9
3.	20	24.4
4.	30	25.2
5.	40	23.0
6.	50	22.4

There is an increase in strength of concrete up to 30% replacement of fine aggregate by foundry sand .This is illustrated in chart-1.

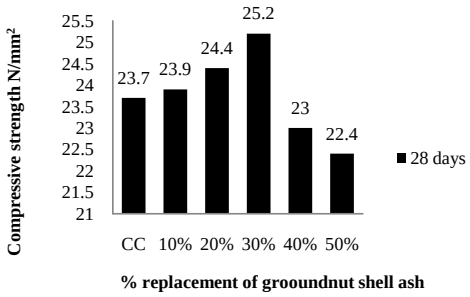


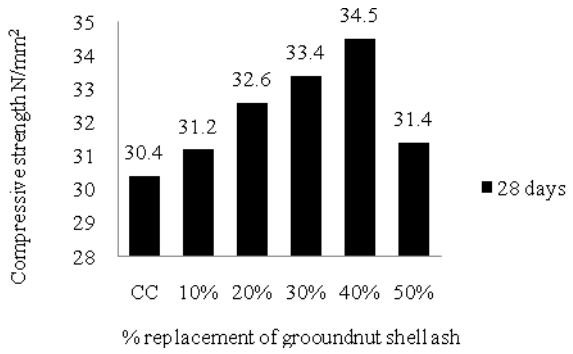
Chart-1: Average Compressive Strength of M20 grade concrete for all replacement

Compressive strength test results after 28 days for M25 grade of concrete are given in table. The result shows that the strength gets increases at 40% replacement of foundry sand.

Table -3 : Compressive Strength Test Results

S.No	%Replacement	Average Compressive Strength N/mm^2
1.	CC	30.4
2.	10	31.2
3.	20	32.6
4.	30	33.4
5.	40	34.5
6.	50	31.4

There is an increase in strength of concrete up to 40% replacement of fine aggregate by foundry sand .This is illustrated in chart-2.



Chart–2: Average Compressive Strength of M25 grade concrete for all replacement

5. Conclusion

Based on experimental study of partial replacement of foundry sand in concrete, the following conclusions are arrived:

- Partial replacement of fine aggregate with foundry sand in concrete proves to give the desired strength in concrete.
- The optimum partial replacement 10, 20, 30, 40, 50% of fine aggregate with foundry sand in concrete, with reference to test results it is suggested that for M20 concrete upto 30% strength increases after that it starts to decline. Similarly for M25 concrete upto 40% strength increases after that it starts to decline.
- Foundry sand can be used to produce quality product at competitive cost.
- Foundry sand can also be used for geotechnical applications such as embankments, site developments fills and road bases.

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