Use of Foundry Sand in Conventional Concrete

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Abstract- Generation of waste foundry sand as by-product of metal casting industries causes environmental problems such as infertility of land, unsightness, awful odour etc. because of its improper disposal. Thus, its usage in building material and in other fields is essential for reduction of these environmental problems. This research was carried out to produce a low-cost concrete. An experimental investigation was carried out on a concrete containing waste foundry sand in the range of 0%, 10%, 20%, 30%, 40%, 60%, 80% and 100% by weight for M-25 grade concrete. The concrete containing foundry sand was tested and compared with conventional concrete in terms of workability, compressive strength and acid attack. Cubes were casted and compression test was performed on 3^{rd}, 7^{th} and 28^{th} day for mix of 1:1.01:2.5 at a w/c of 0.4. Through experimental result we conclude that after 20% partial replacement of foundry sand the compressive strength decreases with increase in partial replacement of waste foundry sand. The aim of this research is to know the mechanical properties of concrete after adding optimum quantity of waste Foundry sand in different proportion.

Keywords – Industrial waste, Foundry sand, Mechanical properties, Compressive strength, conventional concrete

I. INTRODUCTION

The foundry sand is normally of a higher quality than the typical bank run or natural sands used in fill construction sites. The sands form the outer shape of the mould cavity. Foundry sand is used for the centuries as a mould casting material because it's high thermal conductivity. The physical and chemical characteristics of foundry sand will depend in great part on the type of casting process and the industry sector from which it originates.

The foundry sand normally rely upon a small amount of bentonite clay to act as the binder material. Two general types of binder systems are used in metal casting depending upon which the foundry sands are classified as: i) clay bonded systems (Green sand) and ii) chemically- bonded systems. Both types of sands are suitable for beneficial use but they have different physical and environmental characteristics. Green sand is the most commonly used recycled foundry sand for beneficial reuse. It is composed of naturally occurring materials which are blended together; high quality silica sand (85-95%), bentonite clay (4-10%) as a binder, a carbonaceous additive (2-10%) to improve the casting surface finish and water (2-5%). It is black in colour, due to carbon content, has a clay content that results in percentage of material that passes a 200 sieve and adheres together due to clay and water.

In the casting process, moulding sands are recycled and reused multiple times. Eventually, however, 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 by-product, new sand is introduced, and the cycle begins again. The old sand replaced is thrown out as waste. This foundry sand consumes a large percentage of local landfill space for each and every year. Worse yet, some of the wastes are land spread on cropland as a disposal technique. Some industries burn their sludge in incinerators, contributing to our serious air pollution problems.

The Waste generated from the industries cause environmental problems. Hence it is most essential to develop profitable building materials from them.

II. LITERATURE SURVEY

2.1 World scenario

The World Scenario There is about 35,000 foundries in the world with annual production of 90 million tonnes. The share of Iron foundries is the maximum i.e. almost 56%, followed by steel with 14% and then the non-ferrous ones with 30%. The growing environmental concern and globalization had led to a closure of some foundries. These countries have been contemplating to shift their business to the low labour cost centres i.e. the developing countries.

COUNTRY	2010		2011		2012		2013	
	M.T.	RANK	M.T.	RANK	M.T.	RANK	M.T.	RANK
CHINA	39.6	1	41.26	1	42.5	1	44.5	1
US	8.24	3	10.01	2	12.82	2	12.25	2
JAPAN	4.76	5	5.47	4	5.34	4	5.54	4
INDIA	9.05	2	9.99	3	9.34	3	9.81	3
GERMANY	4.79	4	5.46	5	5.21	5	5.19	5
BRAZIL	3.24	7	3.34	7	2.86	7	3.07	7
ITALY	1.97	9	2.21	9	1.96	9	1.97	9
FRANCE	1.96	10	2.04	10	1.8	10	1.75	10
KOREA	2.23	8	2.34	8	2.44	8	2.56	8
RUSSIA	4.20	6	4.3	6	4.3	6	4.1	6

M.T.= million tons

TABLE1. Table shows ranks of country and quantities produced by them of foundry sand

2.2 Indian scenario

The foundry industry in India has been growing steadily over the T past several years despite economic slowdown dented its demand from the end user industry i.e. engineering and auto component sectors. The Indian Metal Casting (Foundry Industry) is well established & producing estimated 9.99 Million MT of various grades of castings as per International standards. There are approx 4500 units out of which 85% can be classified as Small Scale units & 10% as Medium & 5% as Large Scale units. Approx 800 units are having International Quality Accreditation. Apart from the registered 4550 units there are several unregistered units, which according to various sources range approximately from 1500 to 5000 units. Several large foundries are modern & globally competitive & are working at nearly full capacity. There are an estimated 5,000 foundries in India producing castings of Grey Iron, Ductile Iron, SG Iron, Malleable Steel, Non-ferrous and Steel totalling approximately 9.9 million metric tons annually. The industry employs 500,000 people and indirectly about 150,000 people. India's share in the global market is approximately 10 per cent of 103.23 million metric tons. India is the second largest producer of foundry-based castings while China is the market leader with 44 per cent (44.5 million metric tons) of the total output.

The foundry produces a wide variety of castings such as manhole covers, pipe and pipe fittings, sanitary items, tube well body, metric weights, automobile components, railway parts, electric motor, fan body etc. 90% of the castings produced are from the SSI sector.

The break-up of production of different varieties of castings is as follows:

Grey Iron-72%

Steel Castings-10%

SG iron-10%

Aluminium castings-8%

III. MATERIAL USED

3.1 Foundry sand: Foundry sand consists primarily of silica sand, coated with a thin film of burnt carbon, residual binder (bentonite, sea coal, resins) and dust. Foundry sand is typically sub angular to round in shape. After being used in the foundry process, a significant number of sand agglomerations form. When these are broken down, the shape of individual sand grains is apparent. Green sands are typically black, or gray. The specific gravity and water absorption of the foundry used has values 1.15 and 31.57% respectively. The foundry sand was conformed to zone III. The foundry sand was procured from Mahesh Casting Works, MIDC, Nagpur.

3.2 Cement: Cement in concrete acts as a binding material that harden after the addition of water. It plays an important role in construction sector. The cement used is of OPC 43 grade (Ambhuja cement). The cement used was fresh and without any lumps.

3.3 Aggregate: Aggregate is a natural deposit of sand and gravel and also gives structure to the concrete. It occupies almost 75% to 80% of volume in concrete and hence shows influence on various properties such as workability, strength, durability and economy of concrete. Aggregate acts as reinforcement and introduce strength to the overall composite material. Aggregate is also used as base material for roads, railroads and under foundation due to its good strength.

3.3.1 Coarse aggregate: The aggregate having size more than 4.75 mm is termed as coarse aggregate. The graded coarse aggregate is described by its nominal size i.e. 40mm, 20mm, 16mm, 12.5mm etc. 80mm size is the maximum size that could be conveniently used for making concrete. In this study coarse aggregate is conformed to IS: 383:1970. Crushed stone aggregate with a maximum particle size of 12.5mm and 20mm was obtained from local quarry & was used as coarse aggregate. The Flakiness and Elongation Index were maintained well below 15%. Obtained specific gravity and water absorption is 2.65 and 0.99% respectively.

3.3.2 Fine Aggregate: Aggregate that pass through a 4.75 mm IS sieve and having not more than 5 percent coarser material are known as fine aggregate. Main function of fine aggregate is to fill the voids in between coarser particles and also helps in producing workability and uniformity in mixture. In this study fine aggregate is conformed to IS: 383:1970 and zone III. Obtained specific gravity and water absorption is 1.27 and 31.57% respectively.

3.4 Water: Water plays an important role as it contributes in chemical reaction with cement. Water is used for mixing as well as for curing purpose also it should be clean and free from salts, acids, alkalis and other harmful materials. Potable water is used for mixing concrete.

IV. EXPERIMENTS AND RESULTS

4.1 Compressive strength test

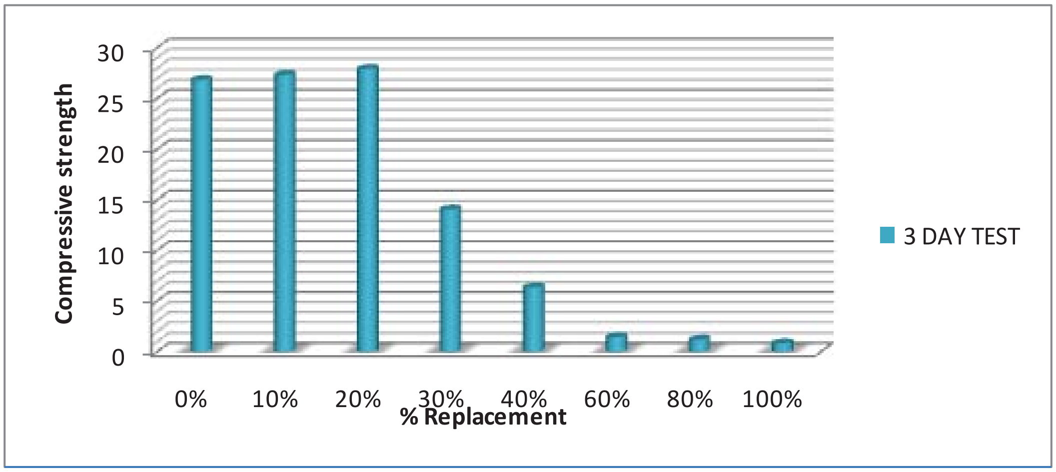
The concrete mixture was prepared by mixing cement, fine aggregate, coarse aggregate, waste foundry sand and water properly. The moulds were cleaned & oiled properly before every pouring. The concrete was filled in the moulds in three layers, each layer being tamped with tamping rod. The specimens were allowed to remain in the steel mould for the first 24 hours at ambient condition and were covered with plastic sheet to prevent moisture loss due to evaporation. After that these were demoulded with care so that no edges were broken and were placed in the curing tank at the ambient temperature for curing. At the end of every curing period, the samples were taken out of curing tank and were tested on compression testing machine of capacity 2000 kN. The load applied on cube was 35 N/mm^2 per minute.

Compressive strength test Results

Table1: Compressive Strength for M25 grade of concrete mix with different % of waste foundry sand

Days	**CC (N/mm^2)**	**10% (N/mm^2)**	**20% (N/mm^2)**	**30% (N/mm^2)**	**40% (N/mm^2)**	**60% (N/mm^2)**	**80% (N/mm^2)**	**100% (N/mm^2)**
3	26.85	27.35	27.95	14.06	6.34	1.45	1.20	0.85
7	28.22	29.74	30.06	16.72	8.61	2.98	1.58	0.98
28	32.58	32.87	33.51	18.21	10.74	5.37	3.22	1.57

Figure- 1:- graph show compressive Strength for 3 days test



The above graph shows that the 3 day strength of the concrete is increasing upto 20% replacement of fine aggregate. The strength of concrete then goes on decreasing from 30% replacement.

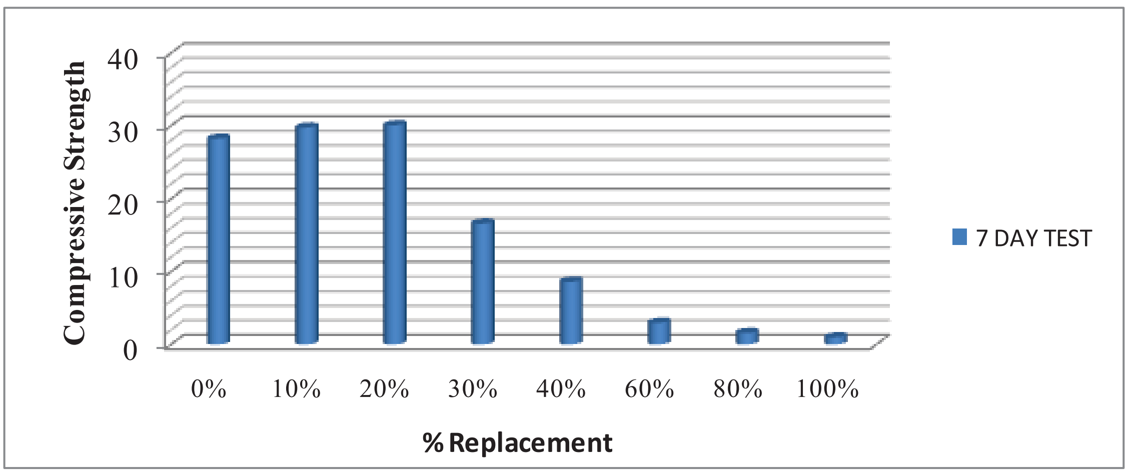


Figure-2: - graph show compressive Strength for 7 days test

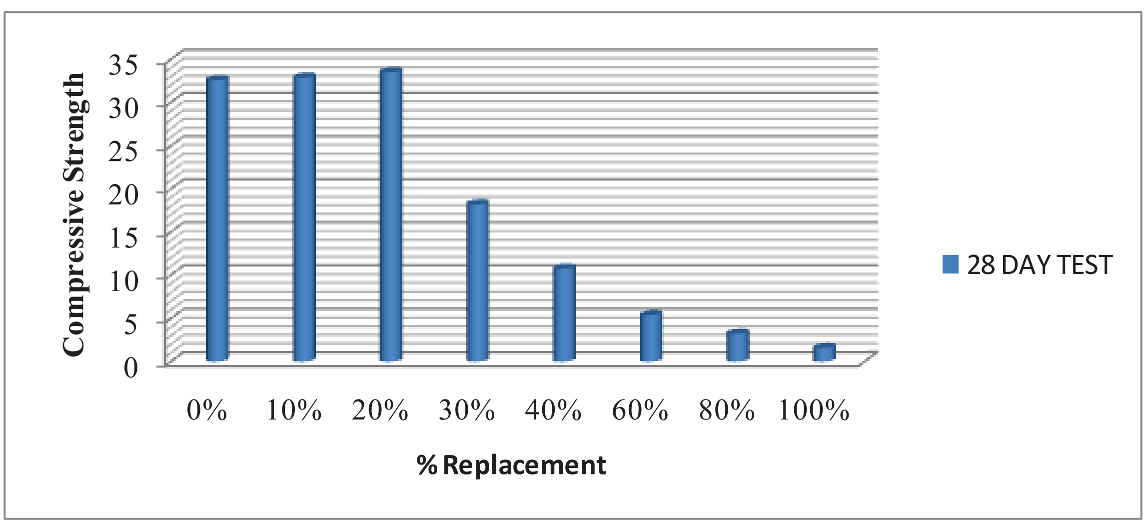


Figure- 3: - graph show compressive Strength for 28 days test

From the above graph, it can be deduced that the 7 day compressive strength of the concrete increases gradually from 0% to 20% replacement of fine aggregate. The strength of the concrete of 20% replacement is 1.84N/mm^2 more than compared to that of conventional concrete. The concrete of replacement of 30% and above give less compressive strength than compared to that of conventional concrete.

The above graph shows that the 28 day compressive strength of 20 % replacement of fine aggregate by waste foundry is found to be 0.93 N/mm^2 more than the conventional concrete. The strength of concrete at 30 % replacement is found to be 46% less than that at 20% replacement.

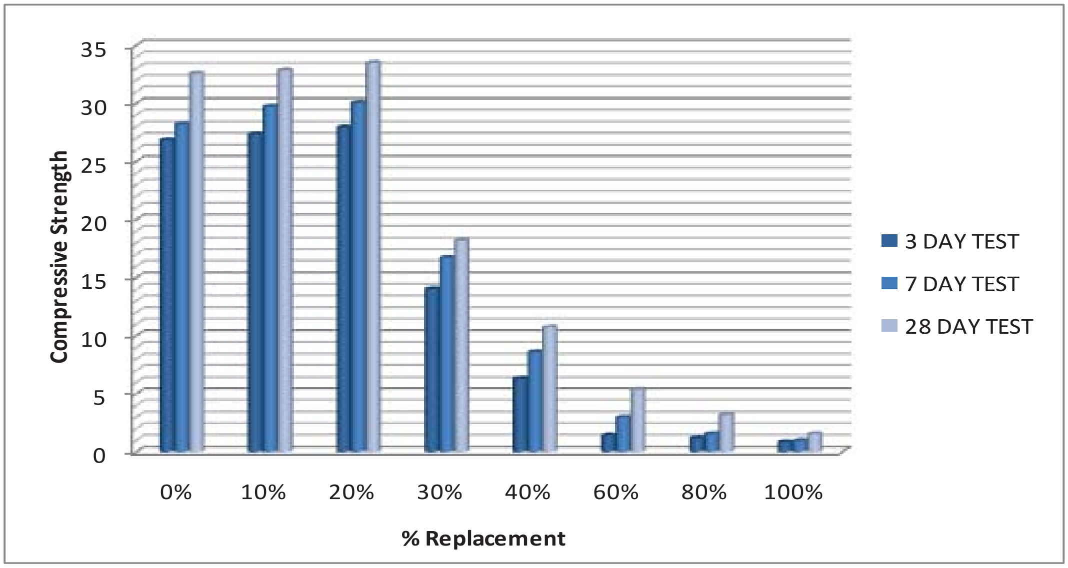


Figure- 4:– graph show compressive strength for 3, 7, 28 days

The above graph shows that the compressive strength of concrete gradually increases with the increase in % of foundry sand only up to 20% replacement and the strength goes on decreasing rapidly after further increase in foundry sand percentage. The initial strength of the concrete for 20% replacement is 1.11 N/mm^2 more compared to that of conventional concrete and 13.89 N/mm^2 more compared to that of the 30% replaced block. The final strength of the 40% replaced sample is 67.6 % less compared to that of 20% replacement. The final strength of the concrete for 30% and above is found to be less than the initial strength of the conventional concrete.

V. CONCLUSION

Based on above study the following observations are made regarding the properties and behavior of concrete on partial replacement of fine aggregate by waste foundry sand:

(1) Compressive strength decreases on increase in percentage of waste foundry sand.

(2) In this study, maximum compressive strength is obtained at 10% and 20% replacement of fine aggregate by waste foundry sand.

(4) Use of waste foundry sand in concrete reduces the production of waste through metal industries i.e. it's an eco-friendly building material.

(5) The problems of disposal and maintenance cost of land filling is reduced.

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