



A Comprehensive Evaluation of Used Foundry Sand in Concrete Applications

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ABSTRACT

The management of solid industrial waste is of big global concern nowadays. The majority of the industries are not interested in the treatment and safe disposal of the industrial waste due to its high cost involvements to reduce the toxic and other chemical contents to a safer level before dumping over to land. In this context the disposal of waste foundry sand is of prime importance due to the big volume produced from the foundries all over the world. Foundry sand which is basically high quality silica sand is disposed of after the initial use for least benefitted land filling usage causing environmental and other ecological impacts. For infra structure developments there needs buildings, bridges, roads and other structures and concrete plays a vital role in these civil construction activities. The mother earth is over exploited for the procurement of construction materials for development works. It is high time to think of alternative materials particularly from the industrial waste products for construction activities for preserving the natural resources to the future generations too. It was inferred that about 20 to 30 percent of replacement of fine aggregate to used foundry sand gave good results in most of the applications. Thus used foundry sand can be economically utilized as a partial or full replacement to fine aggregates for concrete or mortar making and thereby reducing the usage of fresh fine aggregates and to minimize the exploitation of natural resources to a minimum balanced state with reduced ecological impact.

Keywords: Used foundry sand, masonry blocks, workability, compressive strength, water permeability

I. INTRODUCTION

The management of solid industrial waste is of big global concern nowadays. The majority of the industries are not interested in the treatment and safe disposal of the industrial waste due to its high cost involvements to reduce the toxic and other chemical contents to a safer level before dumping over to land. In this context the disposal of used foundry sand is of prime importance due to the big volume produced from the foundries all over the world. The availability of natural sand is diminishing day by day and manufactured sand are widely used for all construction related applications which involves the exploitation of natural rock deposits to an uncontrolled manner. Here used foundry sand can be effectively utilized as a partial or full replacement of natural sand or manufactured sand. Used foundry sand is a byproduct of the metal casting industries generated from the released moulds for casting after several re uses. Foundry sand is basically high quality silica sand.

Depending upon the type of binders used waste foundry sand or used foundry sand can be classified into green sand and chemically bonded sand. In green sand the binder used is bentonite whereas in chemically bonded sand it is mainly of organic system. Due to the chemicals present in the binder the used foundry sand the disposal of used foundry sand in for land filling may cause adverse environmental and ecological impacts. So the used foundry sand should be used for other beneficial applications to reduce its adverse effects.

Foundry industry is declared as a “Red Category Industry” for discharging hazardous substance in the environment. But due to high treatment cost, foundry industries are not much interested to invest on safe disposal of used sand. As per the present disposal practices used foundry sand which is dumped on barren land can not be recovered. The used foundry sand can be efficiently utilized in the production of concrete thereby eliminating the environmental problems associated with it. The other advantage of using used foundry sand in making concrete is of saving of natural resources like river sand which is in threat of depletion as well as the natural rock deposits for the production of manufactured sand to a considerable extent and thereby saving the total construction cost. In this study the usage of used foundry sand for different applications in cement concrete for various purposes is elaborated.

II. USED FOUNDRY SAND FOR APPLICATIONS IN CEMENT CONCRETE

Used foundry sand can be effectively utilised in the production of concretes of different grades and characteristics. A number of researches were conducted on concretes with different grades with different proportions of used foundry sand. Some significant research excerpts are described below.

A. Low Strength Concrete

Several research findings were published on low strength concrete with partial replacement of fine aggregates with used foundry sand. C. G. Konapure and D. J. Ghanate conducted experiment on the effect of industrial waste foundry sand as fine aggregate on M 20 and M 30 grades concrete[1]. The results showed that the compressive strength, flexural strength and split tensile strength increases up to 20% replacement and decreases when the percentage replacement increases further.

Dushyant.R.Bhimani et al. conducted studies on M-20 grade concrete with partial replacement of fine aggregate with used foundry sand[2]. They found that compressive strength increases with percentage increase in used foundry sand. The water absorption in this case is decreasing with the increase in percentages of used foundry sand. A comparative data is shown in Table.1.

Table 1. Comparative Data for M-20 Concrete with Used Foundry Sand

Sl.No.	% of Waste Foundry Sand	28th day Comp.Strength N/mm²	Water Absorption %	Cost Reduction %
1	0	24.00	1.86	0.00
2	10	28.15	1.80	0.67
3	30	32.30	1.52	2.03
4	50	40.89	1.37	3.39

Source: Dushyant.R.Bhimani et al.(2013)

B. Medium Strength Concrete

Used foundry sand can be further utilised for making medium strength concrete. Several researches were conducted in this respect also. Sohail M., Abdul Wahab and Arfath Khan M. conducted study on the mechanical properties of concrete by replacing sand with waste foundry sand [3]. In this investigation they have described M-30 concrete with different percentages of waste foundry sand. Further they concluded that up to 70% addition of waste foundry sand can give sufficient strength properties.

Ravindra N. Patil, Praveen. R. Mehetre and Kailash T. Phalak investigated cement concrete properties incorporating waste foundry sand [4]. In this research they have elaborated the properties of M-30 concrete incorporating waste foundry sand in different proportions. The results showed that compressive strength of concrete increases with increase in percentage of waste foundry sand as compare to normal concrete. It was maximum for 15 % replacement. Split tensile strength increases with increase in percentage of waste foundry sand up to 10 % replacement after that it decreases. Flexural strength was decreased with increase in percentage of used foundry sand. A comparative data of mechanical properties is shown in Table 2.

Table 2. Comparative Data for M-30 Concrete with Used Foundry Sand.

Sl. No.	% of Used Foundry Sand	28 th day Comp.Strength	Split Tensile Strength	Flexural Strength
1	0	30.28N/mm ²	3.30N/mm ²	7.02N/mm ²
2	5	34.40N/mm ²	3.51N/mm ²	6.21N/mm ²
3	10	36.70N/mm ²	3.87N/mm ²	5.40N/mm ²
4	15	39.83N/mm ²	3.77N/mm ²	6.31N/mm ²
5	20	35.98N/mm ²	2.93N/mm ²	6.66N/mm ²

Source: Ravindra N. Patil et al.(2015)

C. High Strength Concrete

High strength concrete can also be prepared with the used foundry sand in partial replacement of fine aggregate. Notable researches were conducted on this area also. Vijayakumar.Y.M and Thejas.H.K conducted study on strength characteristics of normal strength concrete and high strength concrete using used foundry sand as a replacement for fine aggregate [5]. From the study it is inferred that workability of concrete with used foundry sand decreases with increase in percentage of used foundry sand. Compressive strength and split tensile strength increases up to a certain percentage adoption of used foundry sand and then tends to decrease with further dosage of used foundry sand. The results from this research are shown in Table 3.

Table 3. Comparative Data for M-60 Concrete with Used Foundry Sand

Sl. No.	% of Waste Foundry Sand	Slump	28 th day Comp.Strength	SplitTensile Strength
1	0	22 mm	70.74 N/mm ²	4.74 N/mm ²
2	10	18mm	69.76 N/mm ²	4.27 N/mm ²
3	20	20 mm	69.26 N/mm ²	4.91N/mm ²
4	30	16 mm	69.94 N/mm ²	3.90 N/mm ²
5	40	16 mm	68.70 N/mm ²	4.64 N/mm ²
6	50	10 mm	68.00 N/mm ²	3.57 N/mm ²

Source: Vijayakumar.Y.M et al.(2015)

D. High Performance Concrete

High-performance concrete is concrete having desired properties and uniformity that cannot be obtained routinely using only traditional constituents and normal mixing, placing, and curing practices .These concretes have very good workability, high early strength and good mechanical properties.In high performance concrete also the used foundry sand in partial replacement of fine aggregate can be utilized. Several researches were conducted on this area also.Seshadri Sekhar.T and Salim P.M.conducted experimental study on high performance concrete with partial replacement of fine aggregate with used foundry sand [6]. It is found that up to 30% of fine aggregate can be replaced with used foundry sand for the manufacture of high performance concrete.

M.Ranjitham, B.Piranesh and A.Vennila also conducted Experimental Investigation on High Performance Concrete with Partial Replacement of fine aggregate by Foundry Sand with cement by Mineral Admixtures[7].From the test results it is inferred that Foundry sand substitution generally results in favourable outcomes and is highly recommended for all HPC mixes. The results from this research are shown in Table 4.

Table 4. Comparative Data for High Performance Concrete with Used Foundry Sand

Sl. No.	% of Used Foundry Sand	28 th day Comp.Strength	SplitTensile Strength	Flexural Strength
1	0	75.00 N/mm ²	6.015 N/mm ²	6.012 N/mm ²
2	10	75.00 N/mm ²	6.040 N/mm ²	5.990 N/mm ²
3	15	77.00 N/mm ²	6.022 N/mm ²	6.022N/mm ²
4	20	79.00 N/mm ²	6.055 N/mm ²	6.030 N/mm ²

Source: M.Ranjitham et al.(2015)



III. USED FOUNDRY SAND FOR APPLICATIONS IN GEO POLYMER CONCRETE

Used foundry sand can be utilized in the production of geo polymer concrete also. Researches in this field are promising ones for the production of eco friendly concretes. Many research findings are available regarding the usage of used foundry sand in the manufacture of geo polymer concretes. Thaarrini Janardhanan and Venkatasubramani Ramasamy conducted experiments to find out the Properties of Foundry Sand, Ground Granulated Blast Furnace Slag and Bottom Ash Based Geo polymers under Ambient Conditions [8]. From the study it concluded that Geopolymer concrete specimens with lower concentrations of alkaline liquids can be satisfactorily used for structural grade concretes even with lower densities. Geopolymer concrete incorporating Bottom ash and GGBFS using Foundry sand as partial replacement for river sand emerge as a sustainable and eco-friendly building material in the years to come.

Jerusha Susan Joy and Mini Mathew conducted experimental study on geo polymer concrete with partial replacement of fine aggregate with used foundry sand [9]. The test results showed that the workability of the sample decreased with increase in foundry sand content. The mix with 15% replacement of fine aggregate gives maximum strength. A comparative data is shown in Table 5.

Sl. No.	% of Used Foundry Sand	3 day Comp.Strength	7 day Comp.Strength	28 th day Comp.Strength
1	0	18.22 N/mm ²	18.67 N/mm ²	19.11 N/mm ²
2	5	19.11 N/mm ²	19.33 N/mm ²	19.78 N/mm ²
3	10	19.56 N/mm ²	20.22 N/mm ²	20.44 N/mm ²
4	15	20.67 N/mm ²	20.89 N/mm ²	21.33 N/mm ²
5	20	20.00 N/mm ²	20.22 N/mm ²	20.67 N/mm ²
6	25	19.68 N/mm ²	20.00 N/mm ²	20.44 N/mm ²

Source: Jerusha Susan Joy et al.(2015)

IV. USED FOUNDRY SAND FOR COMMERCIAL PRODUCTS

A. Solid Masonry Blocks

Used foundry sand can be effectively utilised for the production solid masonry blocks to a greater extent.

Mahima Ganeshan, Sreevidya.V and Salim .P .M. conducted experiments on the use of waste foundry sand as a replacement for fine aggregate in high strength solid masonry blocks [10]. It is found that incorporation of waste foundry sand increases the strength of blocks and optimum percentage of replacement was found between 20 to 30 %. Also From the test results obtained it is evident that ordinary concrete blocks can be made high strength by using waste foundry sand and thereby it can be used in construction of shear walls, load bearing walls, infill walls etc. It can also be used in earthquake prone areas for higher lateral resistance.

V. CONCLUSION

Use of used foundry sand in concrete increases the strength of concrete. Hence it can be adeptly used in mass production of concrete. If waste foundry sand are used in construction activities near the foundries, it may also help in reducing total cost of construction. Waste foundry sand can be effectively utilised as a partial replacement to fine aggregates in concrete for use in the construction activities of infrastructure developments. Disposal of Foundry sand in structural landfills can hence be minimised thereby reducing the pollution due to seepage in nearby ground water. The use of waste foundry sand in making concrete can not only eliminate the problems of waste management and environmental impacts but also substantially boost up the sustainable developmental activities by way of reducing the consumption of natural resources with lesser energy requirements. In the present arena used foundry sand is only beneficially used as a replacement of fine aggregate in concrete and related products. Still wider horizons are open for research for finding out other applications. For achieving this a collective effort from the researchers, academia, and industrialists for resorting and promoting to alternative building materials particularly from the industrial wastes for sustainable development that meets the needs of the present without compromising the ability of future generations to meet their needs.

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