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A Review Study on Utilization of Waste Foundry Sand

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Abstract - *This paper reviews the Utilization of waste foundry sand in Civil Engineering field. It comprises the important findings from the experimental works of many researchers. Due to over dependence on non-renewable energy material is becoming an imminence and therefore it is necessary to look for the possibility of recycling. Generation of waste foundry sand as by-product of metal casting industries causes environmental problems due to its inappropriate disposal so it can be used as a partial replacement of the fine aggregate with the foundry sand in concrete. It was observed that about 20-30% of replacement of fine aggregate to waste foundry sand gave good result for all practical purpose. Foundry sand can be used in concrete to improve its strength and other durability factors. It presents the information about the opportunities for sustainable and economical concrete. Foundry sand can also be utilized in the sub-bases fill for airport runway, land fill, embankment/structure fill, hot mix Asphalt, traction control etc.,*

Key Words: Waste foundry sand, partial Replacement, Compressive strength, concrete mix, land fill, casting industry.

1.INTRODUCTION

Foundry sand is basically high quality silica sand which is a by-product of both ferrous and non-ferrous metal casting industries. The primary metals cast include iron and steel from the ferrous family and aluminium, copper, brass and bronze form the nonferrous family. The physical and chemical characteristics of foundry sand mainly depend on the type of casting process and the industries from which it is originated. Industries use large amounts of sand as part of the metal casting process, which can be recycle and reuse the sand many times in a foundry but when these sand can no longer be reused in the foundry, it is removed from the foundry and it termed as "foundry sand". Foundry sand production is nearly 6 to 10 million tons annually. Like many waste products, foundry sand has beneficial applications to other industries.

There are basically two types of foundry sand available, chemically bonded sand and Green sand. Green sand also known as the moulding sand that uses clay as the binding material, and chemically bonded sand that uses polymers to bind the sand grains together. Green sand is the most commonly used by foundries. Green sand consists of silica (85-95%), bentonite clay (4-10%), carbonaceous additives (2-10%), and (2-5%) water. It is basically black in colour, due to carbon content. High content of silica sand resists high temperatures while the coating of clay binds the sand together. Chemically bonded sands are used both in core making where high strengths are necessary to withstand the heat of molten metal, and in mould making. Most chemical binder systems consist of an organic binder that is activated by a catalyst although some systems use inorganic binders.

As we all know now days the construction sector is exploring rapidly on a large scale and also involves new techniques for rapid and comfort works on the field. Concrete which is the main building material plays an important role in this sector. Natural resources are main ingredient of concrete which are expensive as well as on the verge of extent. So it is very important to find an alternative option. Foundry sand can be use as an alternative by replacing fine aggregate. Quarrying of aggregates leads to disturbed surface area etc., but the aggregates form industrial wastes are not only adding extra aggregate sources to the natural and artificial aggregate but also prevent environmental pollution.

3. LITERATURE REVIEW

Many authors have reported the use of used foundry sand in various civil engineering applications.

Bakis investigated the use of waste foundry sand (WFS) in asphalt concrete. Asphalt concrete mixtures were pre-pared with 0%, 4%, 7%, 10%, 14%, 17%, and 20% replacement of fine-aggregate with WFS. Grain size of the WFS ranged between 0.8 and30 mm. Tests were performed for the measurements of flow value sand Marshall Stability. The results showed that (i) replacement of10% aggregates with waste foundry sand was found to be most suitable for asphalt concrete mixtures; and (ii) waste foundry sand did not significantly affect the environment around the deposition. [1]

Eknath investigated the comparative study of the properties of fresh & hardened concrete containing ferrous & non-ferrous foundry waste sand replaced with four (0%, 10%, 20% and 30%) percentage by weight of fine aggregate & tests were performed for M20 grade concrete. Result showed that (i) addition of both foundry sand gives low slump mainly due to the presence of very fine binders; (ii) Compressive strength at 7 days of both ferrous & nonferrous mixtures increases and maximum increase was observed with 20% WFS of both types of sand, at 28 days 30% addition of ferrous WFS & 10% addition of nonferrous WFS gives same strength as ordinary concrete and goes on decreasing for higher percentages of replacement; (iii) Split tensile strength gives maximum values with 20% WFS for both types of sand; (iv) water absorption is minimum with 20% ferrous WFS & with 10% nonferrous WFS. They also reported that both ferrous & nonferrous WFS can be suitably used in making structural grade concrete. [2]

Fiore and Zanetti studied the foundry sand reuse and recycling. They investigated the foundry sand of varying sizes. On the grounds of the gathered results, they concluded that residues may be divided in three categories according to the particle-size dimensions: below 0.1 mm, between 0.1 and 0.6 mm, and above0.6 mm. The fraction above 0.6 mm, mainly made of metallic iron, may be reused in the furnaces. The fraction between 0.1 and0.6 mm may be reused in cores production, after a regeneration treatment. The fraction between 0.1 mm and 0.025 mm may be recycled as raw material for the concrete industry, and the below0.025 mm fraction may be reused in green moulding operations. An economic evaluation of the proposed reuse and recycling solutions was performed. [3]

Gurpreet Singh and Rafat Siddique performed experimental investigations to evaluate the strength and durability properties of concrete mixtures, in which natural sand was partial replaced with (WFS). Test results obtained shown that, (a) Concrete mixtures made with WFS exhibited higher compressive strength than control concrete. From the results, it was found that 28 day compressive strength increased by 8.25%, 12.25%, 17% and 13.45% for mixtures M-2 (5%WFS), M-3 (10% WFS), M-4 (15% WFS) and M-5 (20% WFS) respectively than control mixture M-1 (0% WFS). Comparative study of compressive strength at 28 and 91 days indicate that % increase in compressive strength decreases with the increase in WFS content at 91 days in comparison to 28 days, it was decreased by 7% to 1.98%. (b) Splitting tensile strength of concrete mixtures increased with the increase in WFS content. Splitting tensile strength of control mixture M-1 (0% WFS) was 4.23 MPa at 28 days. It was increased by 3.55%, 8.27%, 10.40% and 6.38% of M-2 (5% WFS), M-3 (10% WFS), M-4 (15% WFS) and M-5 (20%

WFS) respectively. Higher value of splitting tensile strength was observed at 15% WFS. [4]

Khatib investigated **s**ome mechanical and fresh properties of concrete containing waste foundry sand (WFS). With reference to the properties investigated, they reported that (a) there is systematic loss in workability as the foundry sand content increases which was found by observing the percentage decrease in slump with increase in WFS. (b) All the mixes (with and without WFS) show an increase in strength with curing time. (c) The compressive strength of concrete also decreases with increasing amounts of WFS. This decrease is systematic. (d) The control mix shows the least water absorbed and generally the water absorption increases as the WFS in the concrete increases. (f) The shrinkage increases as the WFS in the concrete increases and this increase systematic. [5]

Naik studied the utilization of Class F fly ash, coal combustion bottom ash, and used-foundry sand for the manufacture of bricks, blocks, and paving stones. They replaced sand with either bottom ash or used-foundry sand by 25% and 35%. Replacement rates, by mass, for Portland cement with fly ash were 25% and 35% for bricks and blocks, and 15% and 25% for paving stones. The results of this investigation showed that (i) partial replacement of cement with FA consistently improved the strength and durability of concrete masonry units; (ii) and up to 25% of sand in blocks could be replaced with either BA or UFS in cold regions, and up to 35% of sand in bricks and blocks could be replaced with either BA or UFS for use where frost action is not a concern. [6]

Reddi reported that compressive strength of stabilized foundry sands decreases as the replacement For each of the replacement levels, compressive strengths were obtained after 3, 7, 14, 28, & 56 days in order to evaluate the difference due to curing time. The clay bonded foundry sand reduced the strength of the stabilized mixes more than the resin- bonded foundry sands. A similar observation is made in context of fly ash stabilization. The drastic reduction in strength with an increase in clay bonded foundry sand replacement is apparent in the cases of both fly ash & cement. Cement – stabilized mixes acquired their strength considerably slower than fly ash stabilized mixes. After 7 days of curing the cement-stabilized RBS reached only 30% of peak strength whereas its fly ash counterpart achieved 80% of its peak strength. [7]

Tikalsky reported that CLSM mixtures containing only Portland cements had compressive strength that exceeded the upper limit of acceptable compressive strength range i.e. 700 KPa. This was found for all four sands i.e. three from casting facilities and one from a commercial aggregate producer. The cement was ASTM C 150 type ½ cement and the fly ash was an ASTM C 618 class F fly ash. Text mixtures were prepared in accordance with mixing recommendations developed by ACI committee 229.Mixtures were prepared in a 0.06 m3 constant speed shear mixer. Three specimens from each CLSM mixture were tested at 3,7,14 & 28 days. A neoprene capping system was used to transfer load evenly to test specimen loading was applied to 75×150 mm cylindrical specimens at a uniform strain rate until failure using a strain controlled testing machine.
All the mixtures containing fly ash maintained a compressive strength below upper limit and one CLSM mixture did not reach the lower limit. The data supports the concept that by-product foundry sand can be successfully used in CLSM. The foundry sand assists in keeping the strength from exceeding the upper compressive strength limit. [8]

3. CONCLUSION

This investigation results the following conclusion.

1. By increasing the content of foundry sand compressive strength of concrete mixture increases.

2. It is founded that use of foundry sand could be very conventionally used in making good quality concrete and construction materials
3. Increase in the compressive strength was achieved when the replacement of foundry sand is between 10-20%.
4. Decrease in compressive strength shown when 30% replacement done.
5. The used foundry sand can be innovative Construction Material but cautious decisions are to be taken by engineers.
6. Disposal problem of waste and Environmental effect can be reduced through this.
7. Earthquake resistant buildings can't be made by the use of foundry sand.

4. DISCUSSIONS

In this review paper we studied the waste foundry sand as the replacement of fine aggregate in concrete mixture in different proportion (10%, 20%, 30%) respectively after which we compare the compressive strength of concrete having different foundry sand proportion. These foundry sand can also be used as an embankment of roads, yards, backfilling of retaining wall, landfill, traction, etc.,

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