APPLICATION OF WASTE FOUNDRY SAND FOR EVOLUTION OF LOW COST CONCRETE

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ABSTRACT

*Metal foundries use large amounts of the metal casting process. Foundries successfully recycle and reuse the sand many times in a foundry and the remaining sand that is termed as foundry sand is removed from foundry. This study presents the information about the civil engineering applications of foundry sand, which is technically sound and is environmentally safe. Use of foundry sand in various Engineering Applications can solve the problem of disposal of foundry sand and other purposes. Foundry sand consists primarily of silica sand, coated with a thin film of burnt carbon, residual binder (betonies, sea coal, and resins) and dust. Foundry sand can be used in concrete to improve its strength and other durability factors. Foundry Sand can be used as a partial replacement of cement or as a partial replacement of fine aggregates or total replacement of fine aggregate and as supplementary addition to achieve different properties of concrete. This paper demonstrates the use of waste foundry sand as a partial replacement by fine aggregate in concrete. An experimental investigation is carried out on a concrete containing waste foundry sand in the range of 0%, 20%, 30%, 40%, 50% and 60% by weight for M-30 grade concrete(PPC). Material was produced, tested and compared with conventional concrete in terms of workability and strength. These tests were carried out on standard cube of 150*150*150* mm for 7 and 28 days to determine the mechanical properties of concrete. Through experimental result we conclude that the compressive strength increases with increase in partial replacement of waste foundry sand and split tensile strength decreases with increases in percentage of waste foundry sand. So foundry sand can be safely used in concrete for durability and strength purpose.*

Keyword: - *1MPa,2 concrete mixtures,3 foundry 4 eco-friendly,5 pumpable 6 cementations, 7choksey, 8**Slump**,9chassis,10Split ,*

INTRODUCTION

Foundry sand is high quality silica sand with uniform physical characteristics. It is a by-product of ferrous and non-ferrous metal casting industries, where sand has been used for centuries as a molding material because of its thermal conductivity. It is a by-product from the production of both ferrous and non-ferrous metal castings. 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. In modern foundry practice, sand is typically recycled and reused through many production cycles. Industry estimates that approximately 100 million tons of sand is used in production annually of that 6 - 10 million tons are discarded annually and are available to be recycled into other products and in industry. The automotive industries and its parts are the major generators of foundry sand. Foundries purchase high quality size-specific silica sands for use in their molding and casting operations.

The raw 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 mold cavity. These sands normally rely upon a small amount of betonies clay to act as the binder material. Chemical binders are also used to create sand “cores”. Depending upon the geometry of the casting, sands cores are inserted into the mold cavity to form internal passages for the molten metal. Once the

metal has solidified, the casting is separated from the molding and core sands in the shakeout process. In the casting process, molding 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.

1.1 Types of Foundry Sands

Two general types of binder systems are used in metal casting depending upon which the foundry sands are classified as: clay bonded systems (Green sand) and chemically- bonded systems. Both types of sands are suitable for beneficial use but they have different physical and environmental characteristics. Two general types of binder systems are used in metal casting depending upon which the foundry sands are classified as: clay bonded systems (Green sand) and chemically- bonded systems. Both types of sands are suitable for beneficial use but they have different physical and environmental characteristics.

1.2 Material Properties

1 Physical Characteristics of Foundry Sand:-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.

Fig.-1.1 Unprocessed Foundry Sand

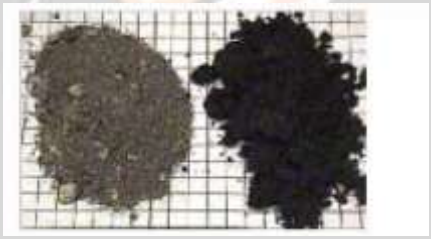

Fig.-1.2 Green Sands from a gray iron Industry

2. Physical Properties

Typical physical properties of spent foundry sand from green sand systems are given in Table-1.1. The grain size distribution of spent foundry sand is very uniform, with approximately 85 to 95 % of the material between 0.6 mm and 0.15 mm (No. 30 and No. 100) sieve sizes. 5 to 12 % of foundry sand can be expected to be smaller than 0.075 mm (No. 200 sieve). The particle shape is typically sub angular to round. Waste foundry sand gradations have been found to be too fine to satisfy some specifications for fine aggregate.

Typical physical properties of spent green foundry sand

Property	Results	Test Methods
Specific Gravity	2.34	ASTM D854
Fineness Modulus	1.8	ASTM C136
Absorption, %	0.45	ASTM C128

Moisture Content, %	0.1-10.1	ASTM D2216
Plastic Limit/Plastic Index	Non-plastic	AASTHO T90/ASTM D4318

Chemical Composition:-Chemical Composition of the foundry sand relates directly to the metal molded at the foundry. This determines the binder that was used, as well as the combustible additives. Typically, there is some variation in the foundry sand chemical composition from foundry to foundry. Sands produced by a single foundry, however, will not likely show significant variation over time. Moreover, blended sands produced by consortia of foundries often produce consistent sands. The chemical composition of the foundry sand can impact its performance. Spent foundry sand consists primarily of silica sand, coated with a thin film of burnt carbon, residual binder (betonies, sea coal, and resins) and dust.

Table-1.2. Chemical Composition of Foundry Sand

Constituent	Value (%)
SiO_2	83.93
Al_2O_3	0.02
Fe_2O_3	0.950
CaO	1.03
MgO	1.77
SO_3	0.057
LOI	2.19

2.1 Mechanical Properties

Typical mechanical properties of spent foundry sand are listed in Table–1.3. Spent foundry sand has good durability characteristics as measured by low Micro-Deval abrasion and magnesium sulphate soundness loss tests. The Micro-Deval abrasion test is an attrition/abrasion test where a sample of the fine aggregate is placed in a stainless steel jar with water and steel bearings and rotated at 100 rpm for 15 minutes. The percent loss has been determined to correlate very well with magnesium sulphate soundness and other physical properties. Recent studies have reported relatively high soundness loss, which is attributed to samples of bound sand loss and not a breakdown of individual sand particles. The angle of shearing resistance (friction angle) of foundry sand has been reported to be in the range of 33 to 40 degrees, which is comparable to that of conventional sands.

Table-1.3. Typical mechanical properties of waste foundry sand

Property	Results	Test Methods
Micro-Devil Abrasion Loss,%	<2	-
Magnesium Sulphate Soundness Loss,%	5-15 6-47	ASTM C88
Friction Angle (deg)	33-40	-
California Bearing Ratio,%	4-20	ASTM D1883

2.2 Foundry Sand Economics

The success of using foundry sand depends upon economics. The bottom line issues are cost, availability of the foundry sand and availability of similar natural aggregates in the region. If these issues can be successfully resolved, the competitiveness of using foundry sand will increase for the foundries and for the end users of the sand. This is true of any recycled material.

3. Foundry Sand Engineering Characteristics

Since foundry sand has nearly all the properties of natural or manufactured sands, it can normally be used as a sand replacement. It can be used directly as a fill material in embankments. It can be used as a sand replacement in hot mix asphalt, flow able fills, and Portland cement concrete. It can also be blended with either coarse or fine aggregates and used as a road base or sub base material.

3.1 Current Management Options

Recycling In typical foundry processes, sand from collapsed molds or cores can be reclaimed and reused. Some new sand and binder is typically added to maintain the quality of the casting and to make up for sand lost during normal operations. Five different foundry classes produce foundry sand. The ferrous foundries (grey iron, ductile iron and steel) produce the most sand and the rest is produced by Aluminum, copper, brass and bronze. The 3,000 foundries in the United States generate 6 million to 10 million tons of foundry sand per year.

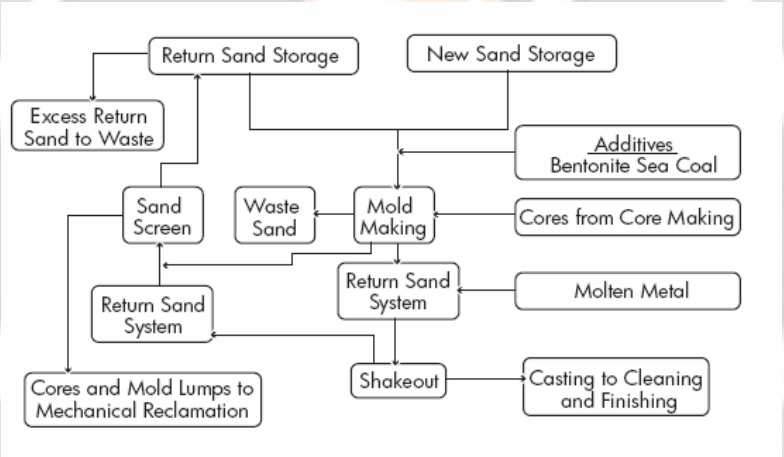

Fig.-1.3 Recycling of Foundry Sand

Market Sources Foundry sand can be obtained directly from foundries. Foundry sand, prior to use, is a uniformly graded material. The spent material, however, often contains metal from the casting and oversized mold and core material containing partially degraded binder. Spent foundry sand may also contain some leach able contaminants, including heavy metals and phenols that are absorbed by the sand during the molding process and casting operations. Phenols are formed through high-temperature thermal decomposition and rearrangement of organic binders during the metal pouring process. Heavy metals are of greater concern in non-ferrous foundry sands generated from nonferrous foundries. Spent foundry sand from brass or bronze foundries, in particular, may contain high concentrations of cadmium, lead, copper, nickel, and zinc.

4. CONCLUSIONS

According to the results of this study, the following conclusions can be drawn.

1. The fresh concrete data shows that addition of foundry waste sands gives low slump mainly due to the presence of very fine binders, therefore use of super plasticizer is essential in order to maintain a good workability.

2. Compressive strength of concrete increased with the increase in sand replacement with different replacement levels of foundry sand. However, at each replacement level of fine aggregate with foundry sand, an increase in strength was observed with the increase in age.
   In this study, maximum compressive strength is obtained at 50% replacement of fine aggregate by waste foundry sand. At 60% replacement it goes on decreasing but still higher than ordinary concrete.
3. Split Tensile Strength also showed an increase with increase in replacement levels of Foundry Sand with fine aggregate. Split Tensile Strength also increased with increase in age.
   Thus, sand replaced with waste foundry sand up to 60% is suitable in the construction works.

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