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Application of Foundry Sand In Civil Construction

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ABSTRACT: *This work continues the research on recycling of waste foundry sand in the manufacture of brick. Initially, clay with a major content of soil was used. The obtained specimens showed high porosity due to the combustion of the organic matter present. Moreover, this type of raw material has properties that vary greatly according to the extraction sites. In order to improve quality and achieve uniformity in the properties of the obtained products, samples with commercial clay in similar composition are studied in this work. By recycling of waste foundry sand reduces damping area as well as control the pollution.*

1. INTRODUCTION

A foundry is a manufacturing facility that produces metal castings by pouring molten metal into a preformed mold to yield the resulting hardened cast. The primary metals cast include iron and steel from the ferrous family and aluminium, copper, brass and bronze from the nonferrous family. Foundry sand is high quality silica sand that is a by-product from the production of both ferrous and nonferrous 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. Metal foundries use large amounts of sand as part of the metal casting process. Foundries successfully recycle and reuse the sand many times in a foundry. When sand can no longer be reused in the foundry, it is removed from the foundry and is termed “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.
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”.

There are two basic types of foundry sand available, green sand (often referred to as molding sand) that uses clay as the binder material, and chemically bonded sand that uses polymers to bind the sand grains together. Green sand consists of 85-95% silica, 0-12% clay, 2-10% carbonaceous additives, such as sea coal, and 2-5% water. Green sand is the most commonly used molding media by foundries. The silica sand is the bulk medium that resists high temperatures while the coating of clay binds the sand together. The water adds plasticity.

The carbonaceous additives prevent the “burn-on” or fusing of sand onto the casting surface. Green sands also contain trace chemicals such as MgO, K2O, and TiO2. Chemically bonded sand consists of 93 -99% silica and 1-3% chemical binder. Silica sand is thoroughly mixed with the chemicals; a catalyst initiates the reaction that cures and hardens the mass. There are various chemical binder systems used in the foundry industry. The most common chemical binder systems used are phenol-urethanes, epoxy-resins, fury alcohol, and sodium silicates.

2. PHYSICAL CHARACTERISTICS OF FOUNDRY SAND

I. TYPICAL PARTICLE SIZE AND SHAPE

Foundry sand is typically sub angular & rounded in shape. After being used in the foundry process, a significant number of sand agglomerations . When these are broken down, the shape of the individual sand grains is apparent.

II. GRAIN SIZE ANALYSIS OF FOUNDRY SAND

The grain size distribution of spent foundry sand is very uniform, with approximately 90to 98 percent of the material between 4.75mm and 600micron sieve sizes. Five to 20 percent of foundry sand can be expected to be smaller than 300 micron sieve size. The particle shape is typically sub angular to round. A Waste foundry sand gradation has been found to be too fine to satisfy some specification for fine aggregate.

III. WHAT COLOR IS FOUNDRY SAND?

Green sand is typically black or gray in color. Chemically bonded sand is typically a medium tan or off -white color

IV. SLUMP TEST

Unsupported concrete when it is fresh will flow to the sides and sinking height will to be placed. This vertical settlement is known as slump.

The slump test does not measure the workability of concrete but is very useful in detecting variations in the uniformity of a mix of given nominal proportions. The mould for slump test is frustum of cone placed on a smooth surface with smaller opening at the top and filled with concrete with three layers. Each layer is in tamped 25 times by a slandered 16 mm tamping rod. Immediately after filling the cone it slowly lifted, and the unsupported concrete will now slump hence the name of test is slump test. In order to reduced the influence on slump of the variations in the surfaces frictions the inside of the mold and its bas are moistened at the beginning of every test.

1. For natural sand

For w: c ratio of 0.6 to 0.7 shear slump

2. For 10% foundry sand + 90% sand For w: C ratio of 0.6 to 0.7 shear slump
3. For 30% foundry sand + 70% sand For w: C ratio of 0.7 shear slump.
4. For 60% foundry sand + 40% sand No shear slump

V. COMPACTION FACTOR TEST

There is no generally accepted method of directly measuring in the amount of work necessary to achieve full compaction probably the best test yet available uses the universe approach, the degree of compaction achieved by a standard amount of work is determined.

The degree of compaction, called the compacting factor, is measured by the density ratio i.e. ratio of density actually achieved in the test to the density of the same concrete fully compacted.

The density of concrete in the cylinder is calculated after passing the concrete through the two hoppers, and the density actually achieved by the fully compacted concrete is defined as the compacting factor. The later density can be obtained by actually filling the cylinder with concrete in three layers, each tamped or alternatively calculated from the absolute volumes of the ingredients.

The test is more resistive at the low workability ends of the scale than at high workability. Very dry mixes tend to sticks in one or both hoppers and the material has to be eased gently by polling with still rod. Moreover, it seems that for concrete of very low workability the actual amount of work required for full compaction depends on the weakness of the mix while the compacting factor does not. The compacting factor test provides a good measured of workability.

COMPACTION FACTOR $$\frac{\text{Wt. of partially comp. concrete}}{\text{Wt. of fully comp. concrete}}$$

OBSERVATION TABLE

NATURAL SAND

SR NO	w/c ratio	Wt. of partially comp. concrete (kg)	Wt. of fully comp. concrete (kg)	Compaction factor
1	0.5	16.415	16.515	0.993
2	0.6	18.315	18.325	0.999
3	0.7	18.920	19.050	0.993

10%FOUNDRY SAND +90%NATURAL SAND

SR NO	w/c ratio	Wt. of partially comp. concrete (kg)	Wt. of fully comp. concrete (kg)	Compaction factor
1	0.5	15.780	15.810	0.998
2	0.6	18.460	18.580	0.993
3	0.7	19.545	19.765	0.988

30%FOUNDRY SAND + 70%NATURAL SAND

SR NO	w/c ratio	Wt. of partially comp. concrete (kg)	Wt. of fully comp. concrete (kg)	Compaction factor
1	0.5	15.655	15.720	0.995
2	0.6	16.650	16.700	0.997
3	0.7	19.130	19.200	0.997

60%FOUNDRY SAND + 40%NATURAL SAND

SR NO	w/c ratio	Wt. of partially comp. concrete (kg)	Wt. of fully comp. concrete (kg)	Compaction factor
1	0.5	15.395	15.655	0.983
2	0.6	15.915	16.930	0.940
3	0.7	16.885	17.015	0.992

SIGNIFICANCE AND LIMITATION:

1. When more size of aggregate is larger as compared with mean particle size the drop into bottom container will produce segregation and give unreliable comparison with other mixes of smaller maximum aggregate size.
2. The method of introducing concrete into mold bars no relationship to any of the more common methods of placing and compacting high quality concrete.
3. Compaction factor test establishes the fact that with increases in the size of coarse aggregate the workability will decreases.

3. CHEMICAL PROPERTIES

I. FOUNDRY SAND

Spent foundry sand (chemically bonded sand) consists primarily of silica sand. Following table lists the chemical composition of typical sample of spent foundry sand.

As per our finding the sand has very minute loss on ignition which is around 8.90 % .It indicates that if the foundry sand is used in the construction it also can be used in the regions where the temperatures are high .acid soluble matter in foundry sand has no effect on concrete since its presence is in very negligible amount.

The other contents of the foundry sand are the same as found in the natural sand that is used for the construction purpose such as silica, alumina and ferrous oxide. The presence of lime i.e. calcium oxide increases the binding property of the sand to form mixture.Thus the overall effect of the chemical contents of foundry sand on the concrete is no different than sand.

Loss on ignition	8.90%
Water soluble matter	0.03%
Acid soluble matter	8.50%
Content of SiO2	0.50%
Contents of Al2O3	2.67%
Content of Fe2O3	0.59%
Contents of Cao	2.65%

TABLE NO.1

II. ph value of foundry sand

The ph of foundry sand was determined in the laboratory and was found to be around 13. This defines that the foundry sand is very alkaline in nature. But as the foundry sand replaces the natural sand by means of percentage and not completely hence Ph of foundry sand when it is replaced with the natural sand was determined. Table shows the pH of solution (25% suspension) of the mixture of foundry sand by percentage.

SAMPLE	Ph value
100% foundry sand	13

10 % foundry sand + 90% natural sand	7.65
30 % foundry sand + 70%natural sand	7.85
60% foundry sand + 40% natural sand	8

TABLE NO 2

As the Ph of the solution of foundry sand and the natural sand lies around the natural sand (with 10, 30, 60% replacement of natural sand by foundry sand) Lies around the neutral value . It indicates it's no contribution towards enhancing the corrosion of the steel used in concrete

4. WORK DONE AND SCHEDULE REGARDING CASTING OF CONCRETE

A study investigating the beneficial reuse of foundry sand in cast-iron place concrete and concrete blocks. Several concrete mixes using foundry sand (chemically bounded sand) as a partial replacement for fine aggregate we are developed and tested , concrete block from several mixes we are prepared testing of thesplitting tensile strength. The concrete mixes we are designed using weigh analysis replacement of fine aggregates with foundry sand ranged 10%, 30% 60%, all mixed design used a water cement ratio 0.45.

Concrete blocks were cast manually in laboratory. Design mixes for blocks were developed based on sieve analysis data. Three mixes were developed using 10%, 30% & 60% replacement of fine aggregates with foundry sand. The 7days & 14 days compressive strength of the blocks were then determined. The compressive strength of the block decreased as the percentage of foundry sand is increased. However the mixes containing replacement of 10% produced strength higher than the minimum strength of concrete blocks. The average strength of the percentage of 30% and 60% is sufficient to use in practices.

Also the concrete cylinder was cast manually in the laboratory with the same procedure as concrete blocks. We are determined the tensile strength after curing 7 days and 14 days. The splitting tensile strength of cylinder decreases with respective increasing percentage of foundry sand.

The table shows the actual work done and schedule regarding the casting of concrete blocks and concrete cylinders.

The table shows the strength variations in concrete blocks and concrete cylinder after replacement of natural sand by percentage of foundry sand.

proportion	After 7 days		After 14 days	
	Compressive Strength (N/mm ^{2})	Splitting tensile strength (N/ mm ^{2})	Compressive Strength (N/ mm ^{2})	Splitting tensile strength (N/ mm ^{2})
Blocks with natural sand	**22.37**	**10**	**30.87**	**12.3**
Blocks with 10% foundry sand	**30.37**	**14.61**	**35.33**	**15.87**
Blocks with 30% foundry sand	**25.50**	**13.33**	**34.09**	**14.61**
Blocks with 60% foundry sand	**24.70**	**11.28**	**33.49**	**12.35**

TABLE NO. 03

5.CONCLUSION

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 foundries and for end users of the sand. This is true of any recycled material.

From physical analysis the physical properties are somewhat similar to the natural sand & chemical analysis there is no harmful chemical in it which gives no hazardous to use in concrete

Initially strength increases as the foundry sand replaces sand from 8% to 13% and a drop takes place in same after that as we go on replacing foundry sand by natural sand in more quantity by till 13% to20% and increase takes place as we go from 20% to 40% replacement and slight decreases occurs at 60% replacement. But even than it gives more Splitting tensile strength than the minimum strength of concrete given by natural sand

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