"Mechanical Properties of Concrete Incorparating used Waste Foundry Sand"

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Abstract

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 engg. applications can solve the problem of disposal of foundry sand and other purposes. In the present study, effect of foundry sand as fine aggregate replacement on the compressive strength, split tensile strength and modulus of elasticity of concrete having mix proportions of 1:1.45:2.20:1.103 was investigated. Fine aggregates were replaced with three percentages of foundry sand. The percentages of replacements were 10, 20 and 30 % by weight of fine aggregate. Tests were performed for compressive strength, split tensile strength and modulus of elasticity for all replacement levels of foundry sand at different curing periods (7-days & 28-days).Test results showed that there is some increase in compressive strength, split tensile strength and modulus of elasticity after replacing the fine aggregates with certain percentage of foundry sand so foundry sand can be safely used in concrete for durability and strength purposes.

KEY WORDS: Foundry sand, Compressive strength

I.INTRODUCTION

1.1 General

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 modernfoundry practice, sand is typically recycled and reused through many production cycles. Industry estimates that approximately 100 million tons of sand are 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 silicasands for use in their molding and casting operations. Although there are other casting methods used, including die casting and permanent mold casting, sand casting is by far most prevalent mold casting technique. Sand is used in two different ways in metal castings as a molding material, which focuses the external shape of the cast part and as cores that form internal void spaces in products such as engine blocks.

1.2 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 characteristicsGreen sand molds are used to produce about 90% of casting volume in the U.S. Green sand 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%). Green sand is the most commonly used recycled foundry sand for beneficial reuse. It is black in color, 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.

1.3 Material Properties

1.3.1 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.

Green sands are typically black, or gray, not green chemically bonded sand is typically a medium tan or off-white color Figs.1.1 & 1.2 shows the unprocessed foundry sand and green sand respectively.

Fig.-1.2 Green Sands from a gray iron Industry

1.3.2 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 percent of the material between 0.6 mm and 0.15 mm (No. 30 and No. 100) sieve sizes. Five to 12 percent 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.

II. LITERATURE REVIEW

Naik et al., 2006 reported that compressive strength increased with age. To determine the compressive strength, 150mm × 300mm diameter cylinders were made for each flow able slurry mixtures. The compressive strength for all slurry mixtures with and without foundry sand varied from 0.17 to 0.4 MPa at the age of 7 days. The compressive strength values ranged from 0.27 to 0.55MPa for the fly ash F1 mixtures and 0.3 to 0.6 to MPa for the fly ash F2 mixtures at 28 days. Compressive strength increased with an increasing amount of foundry sand up to certain limit, and then decreased.

Tikalsky et al., 2000 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 producerThe cement was ASTM C 150 type 1/2 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 m^3 constant speed shear mixer. Three specimens from each CLSM were tested in 3,7,14,28 days.

Naik et al., 2003 performed an investigation to develop technology for manufacturing cast-concrete products using Class F fly ash, coal-combustion bottom ash, and used foundry sand. A total of 18 mixture proportions with and without the by-products was developed for manufacture of bricks, blocks, and paving stones. Tests for compressive strength were performed acc. to ASTM C140 for which 3-6 specimens were tested for each brick or paving stone mixture at 5, 28, 56, 91 & 288 days. Three compression specimens were tested for each block mixture at 7, 14, 28, & 91 days.

3.1 Object of testing

The main objective of testing was to know the behavior of concrete with replacement of ordinary sand with foundry sand at room temperature.The main parameters studied were compressive strength, split tensile strength, modulus of elasticity. The materials used for casting concrete samples along with tested results are described.

3.2 Scope of the study

The scope of the study is to establish to achieve the objectives and this study will be mainly concentrated on experimental works. Experiments regarding compression strength and split tensile strength on the partial replacement steel waste and wood waste in concrete will be carried out in order to study the behavior of concrete. All testing methods and procedure are specified according to Indian Standards

3.2.1Super plasticizer

Conplast – SP 430, a concrete super plasticizer based on SulphonatedNapthalene Polymer was used as a water-reducing admixture and ton improve the workability of concrete containing foundry sand. Conplast - SP 430 has been specially formulated to give high water reductions up to 25% without loss of workability or to produce high quality concrete of reduced permeability. Conplast - SP 430 is non-toxic.

Super plasticizer complies with IS: 9103: 1999, ASTM C – 494 Type F, BS 5057 part Ш. The dosage of super plasticizer varied from 0.5% to 2% by weight of cement in plain concrete, concrete incorporating foundry sand.

3.2.2 Batching, Mixing and Casting of Specimens

A careful procedure was adopted in the batching, mixing and casting operations. The coarse aggregates and fine aggregates were weighed first with an accuracy of 0.5 grams. The concrete mixture was prepared by hand mixing on a watertight platform. PPC having 43 grades was used in casting. Three proportions of fine aggregates are replaced with foundry sand and thoroughly mixed. After that coarse aggregates are added to it. Super plasticizer as per requirement was added to required quantity of water separately in different containers. Then water was added carefully so that no water was lost during mixing. Six clean and oiled moulds for each category were then placed on the vibrating table respectively for the cubical samples for compression strength testing and twelve cylindrical moulds for split tensile and modulus of elasticity testing were filled in three layers.

IV.RESULTS AND DISCUSSION

4.1 Compressive Strength

In this research the values of compressive strength for different replacement levels of foundry sand contents (0%, 10%, 20% and 30%) at the end of different curing periods (7- days,28days) which show the variation of compressive strength with fine aggregate replacements at different curing ages respectively.

It shows that compressive strength increases with the increase in foundry sand. The compressive strength increases by 4.2%, 5.2%, & 9.8% when compared to ordinary mix without foundry sand at 7-days

Table 4.1: Compressive Strength (MPa) of Concrete with Foundry Sand

Foundry Sand Content, %	Designation	Compressive Strength, MPa	
		7 days	28 days
0	M-1	18.5	28.5
10	M-2	19	29.7
20	M-3	19.5	30
30	M-4	20.8	32

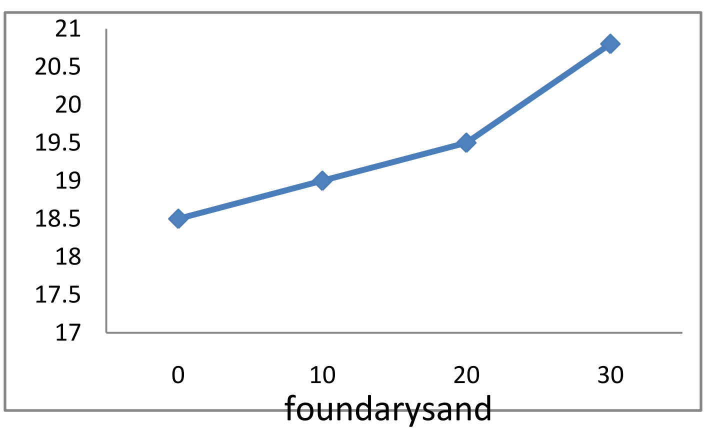

Fig 4.1 Compressive strength vs. replacement of foundry sand at 7-days

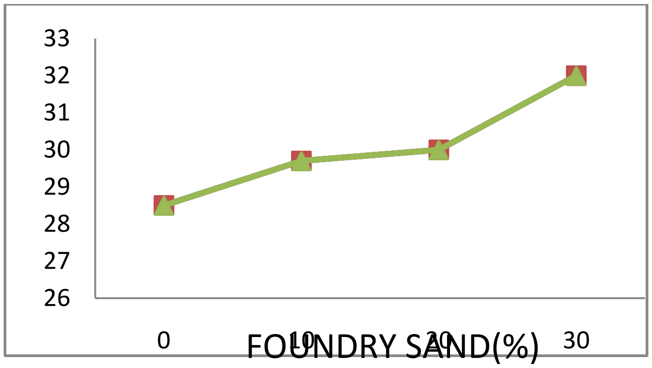

Fig4.2Compressive strength vs. Replacement of foundry sand at 28 days

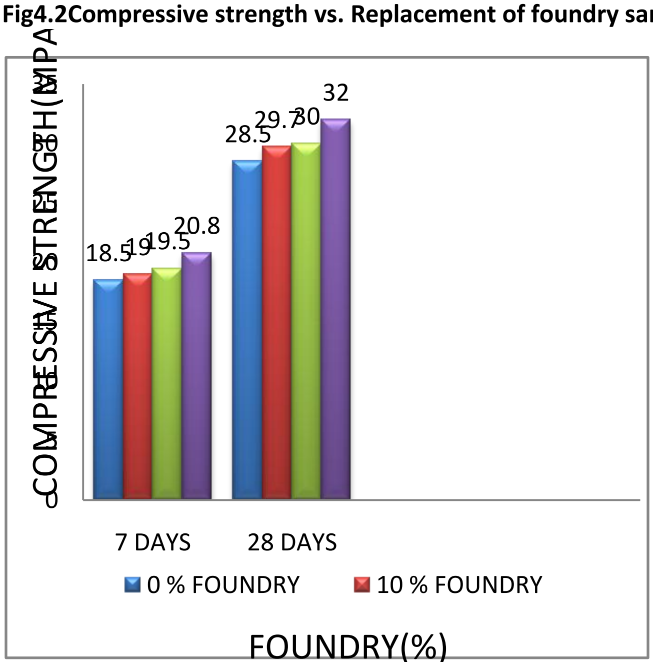

Fig 4.3 Compressive strength vs. Age at various replacement levels of foundry sand

V. CONCLUSIONS

The following conclusions are drawn from this study:

1. 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.

2. The compressive strength increased by 4.2%, 5.2%, & 9.8% when compared to ordinary mix without foundry sand at 7-days.

3.At 7- days ,control mix M-1 with (0% replacement level of foundry sand) achieved compressive strength of 18.5Mpa.

4. At 7- days, control mix M-2 with (10% replacement level of foundry sand) achieved compressive strength of 19Mpa.

5. At 7- days, control mix M-3 with (20% replacement level of foundry sand) achieved compressive strength of

19.5Mpa.

6. At 7- days, control mix M-4 with (30% replacement level of foundry sand) achieved compressive strength of 20.8Mpa.

7. Compressive strength at 28 days increased by 1.0 %, 5.18 %, & 14.3% compared to ordinary mix.

8. At 28- days, control mix M-1 with (0% replacement level of foundry sand) achieved compressive strength of 28.5Mpa.

9. At 28- days, control mix M-2 with (10% replacement level of foundry sand) achieved compressive strength of 29.7Mpa

10. At 28- days, control mix M-3 with (20% replacement level of foundry sand) achieved compressive strength of 30Mpa.

11. At 28- days, control mix M-4 with (30% replacement level of foundry sand) achieved compressive strength of32Mpa.

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