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Study the Possibilities of using Waste Foundry Sand in Concrete as a Fine Aggregate

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ABSTRACT

Now a day the worldwide consumption of sand as a fine aggregate in concrete production is very high. Developing countries have encountered some strain in the supply of natural sand in order to meet the increasing need of the infrastructural development in recent year, to overcome the stress and demand of river sand, researchers and practitioners in the construction industry have identified some alternative. One of them is foundry sand, it is a high quality silica and with uniform physical characteristics and by-product of ferrous and non-ferrous metal casting industry. It is provided that foundry sand used as fine aggregate will enhance the strength of concrete to a greater extend. The foundry industry in Nagpur produces waste foundry sand that ends up in landfill sites. The utilization of waste foundry sand will benefit the industry, as raw material and energy are conserved, while costs of disposal are lowered. In this study, the physical, chemical and mechanical properties of three waste foundry sand from Nagpur were analyzed. The samples were investigated with a view to determine their conformity with applicable engineering criteria when used as a replacement, to various extents, of the fine aggregate. The main properties investigated included physical properties (sp. Gravity, fineness modulus, unit weight, absorption, moisture content, clay lumps and friable particle, material finer than 75mm.) and the chemical properties X-ray fluorescence (XRF), X- ray diffraction (XRD). However, the chemical test result showed the composition of these sands to be comparable with results from other investigations, from IS 383 : 2016 and suitable for use as a fine aggregate replacement in concrete.

Keywords: Chemical Properties, Physical Properties, Waste Foundry Sand (WFS), Concrete, Construction Material, Waste Recycling

I. INTRODUCTION

A foundry produces metal casting by pouring molten metal into a performed mould to end the resulting harden cast. The metal cast include iron steel from the ferrous family and Aluminium, copper, brass and bronze from non-ferrous family. WFS is high quality silica sand with uniform physical characteristics. It is a by by- products of ferrous and nonferrous metal casting industry Where sand has been used for centuries as a molding material because of its thermal conductivity. Foundries successfully recycle and reuse the send many times. When the sand can no longer be reused in the foundry it is removed from the foundry and this term as WFS.[4]

Classification of foundry sand depends upon the type of binder system used in metal casting. Two types of binder systems are generally, used and on the basis of that foundry sands are categorised as: clay-bonded sand (Green Sand) and chemically bonded sand. The most common casting process used in foundry

industry is the sand cast system. Virtually all sand cast mould for ferrous castings are of the Green Sand type. Clay- bonded (Green) Sand is composed of naturally occurring materials, which and blended together such as 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%). It is black in colour due to carbon content.[1], [3]

Green Sand is the most commonly used moulding media by foundries. Silica sand is the bulk medium that resists high temperatures while the casting 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 sand also contains trace Chemicals such as Mgo, K2O and Tio2.

Chemically bonded sand is used both in core making where high strength is necessary to withstand the heat of molten metal, and in mould making. These systems involve the use of one or more organic binders in conjunction with catalysts and different hardening or setting procedures. Chemically bonded sand consists of 93-99% silica and 1- 3% chemical binder. Chemically bonded Sands are generally light in color and in texture than clay-bonded sand.[8]

The foundry industry estimates that approximately 100 million tonnes of sand is used in production annually of that 6-10 million tonnes are discarded annually and are available to recycle into other products and are used in The Other industries. The automotive industries and its parts are the major generator of foundry sand. (about 95 % of estimated used foundry sand).[6]

II. METHODS AND MATERIAL

1) A. Materials

Waste foundry sand (WFS) consist of primarily of uniformly sized high quality silica sand or lake sand that is bonded to form molds for ferrous and non-ferrous metal casting. It is a by by-products of ferrous and nonferrous metal casting industry Where sand has been used for centuries as a molding material because of its thermal conductivity. Foundries successfully recycle and reuse the send many times. When the sand can no longer be reused in the foundry it is removed from the foundry and this term as WFS. [4]

In the casting process molding sands are recycled and reused multiple times. Eventually however the recycled sand degrades to the joint that it can no longer be reused in the casting process when it is not possible to further reuse in the foundry it is removed from the foundry and termed as WFS.

WFS samples were collected from three foundry sites in Nagpur. These comprised two clay-bonded systems (green sand) which were collected from the Jaiswal Neco Industry, Ekta Casting Industry and Shree Steel Industry (respectively referred to as samples WFS01, WFS02 and WFS03). The samples collected had a mass of approximately 10 kg each.

2) A.a. Methods

The methods used for evaluation of physical and chemical properties of WFS are discussed in this section.

A.a.i Physical Properties

Seven methods for the evaluation of physical properties were used as follows:

1. Mmoisture Content: The moisture content of soil in an important parameter affecting its behavior. Moisture content is a ratio expressed as a percentage of the weight of water in a given soil solid particles under the specified testing

condition.

2. Specific Gravity : The specific gravity of a soil is the ratio of weight in air of weight in air of a given volume of soil particle at a stated temperature to the weight of an equal volume of distilled water under the same condition.
3. Fineness modulus : Fineness modulus of sand is an index number which represents the mean size of the particles in sand. It is calculated by performing sieve analysis with standard sieves. The cumulative percentage retained on each sieve is added and subtracted by 100 gives the value of fineness modulus.
4. Clay lump test : Clay lump is a traditional form of construction, using earth with a high clay content, straw, animal dung, chalk/flint etc.
5. Water absorption : This test is a rapid procedure for field determining the percentage of free or surface. moisture in sand, and for determining the percentage of water absorption for sand of less than saturated surface dry condition.
6. Unit weight : Unit weight for a soil is a property of a soil which is used to solve the problems related to the earthwork. Unit weight is also known by the name specific weight.
7. Material finer than 75micron : Thistest method covers determination of the amount of material finer than 75micron.

A.a.ii. Chemical properties

Two methods for the evaluation of chemical properties were used as follows:

1.X-ray Fluorescence (XRF) : XRF is a non-destructive analytical technique used to determine the elemental composition of materials. XRF analyzers determine the chemistry of a sample by measuring the fluorescent X- ray emitted from a sample when it is excited by a primary X-ray source. Each of the elements present in a sample produces a set of characteristic fluorescent X- rays that is unique for that specific element. XRF analyzers are available in handheld models designed to provide instant elemental analysis for immediate feedback in the field, or in lab-based systems designed to provide qualitative and quantitative analysis for process and quality control. Both types of XRF equipment are used in applications as diverse as cement manufacturing, metallurgy, mining, petroleum, polymers, paints and chemicals, forensics investigations, and environmental analysis.

2. X-ray diffraction (XRD) : XRD is a versatile and nondestructive analytical technique that reveals detailed structural and chemical information about the crystallography of materials. XRD looks at a crystalline material's characteristic X-ray scattering, or diffraction pattern, which reveals the material's atomic structure. Qualitative analysis is possible by comparing the XRD pattern of an unknown material with a library of known patterns. XRD's many applications include:

3.

1. Identification of single or multiple phases in an unknown sample
2. Quantification of known phases of a mixture
3. Amorphous content evaluation
4. Crystallography – solving crystal structure
5. Non ambient analysis – crystal structure changes with temperature, pressure or gas phase
6. Surface and thin film analysis
7. Texture analysis

III. RESULT AND DISCUSSION

Expected Outcome

- From the different literature review, we found that waste foundry sand can be effectively used in concrete as a fine aggregate up to a different certain percentage with different mix grade of concrete.
- Waste foundry sand can be effectively replace as a fine aggregate upto 15-20%.
- With waste foundry sand we can use the fly ash, coal bottom ash or admixture in concrete to

improve its properties of concrete.

- But the researchers found that the properties of waste foundry sand is varying on the basis of metal custard, because foundry sand is used for both ferrous and nonferrous materials. Due to these its chemical properties are varying and it directly affects on the concrete.
- Also we see some limitations of using foundry sand. Foundry sand is black in color, in some concrete this may cause the finished concrete to have a grayish/black tint, which may not be desirable. Foundry sand reduced workability of concrete.
- Hence, before using it in the concrete it is to be checked the feasibility by physical, chemical and Mechanical properties of waste foundry sand from different industries. There are some process to improve the properties of foundry sand use in concrete.

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