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Production Of Concrete By Using Recycled Foundry Sand

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***Abstract**:* Foundries produce Waste Foundry Sand (WFS) or Used Foundry Sand during the metal-casting process. Typically, metal foundries recycle and reuse around 70% of their foundry sand, with the remaining 30% being fresh sand. Foundry sand consists of high-quality silica sand mixed with a binder, and it is used to create molds for ferrous and nonferrous casting. The properties of used foundry sand vary based on factors such as the equipment used for processing, the types of additives used, and the type and amount of binder used. This study aims to explore the possibilities of using foundry sand in sustainable and cost-effective concrete. Foundry sand is mainly composed of silica sand coated with a thin layer of burnt carbon, residual, and dust, and it can be utilized as a partial replacement for cement or fine aggregates, or as a total replacement for fine aggregates. By replacing fine aggregate in varying proportions of 10%, 20%, and 30%, this project aims to achieve concrete with properties similar to regular concrete in terms of strength and durability.

Keywords: Foundry Waste, Foundry Sand, Concrete Strength, Industrial Waste, Utilization

1. INTRODUCTION: -

Foundry sand refers to high-quality silica sand with consistent physical characteristics that is used as a molding material in the ferrous and nonferrous metal casting industries due to its thermal conductivity. Foundry sand is a by-product of ferrous and nonferrous metal casting production, and its physical and chemical properties are influenced by the type of casting process and industry sector it comes from. Foundry sand is frequently recycled and used across several production cycles in contemporary foundries, with an estimated 6 to 10 million tons of sand recycled each year out of a total yearly production of about 100 million tons of sand. The automotive and component industries are the primary producers of foundry sand and purchase premium-size-specific silica sands for their molding and casting operations.

The sand used for molding in the foundry industry differs from ordinary bank run or natural sands used for filling construction sites, as it is typically of higher quality. Sand is used to create the outer outline of the mold chamber, with a small amount of bentonite clay typically serving as the binder material for these sands. Sand cores are also made using chemical binders and placed in the mold cavity to create an internal passage.

Molding sands are repeatedly recycled and used during the casting process until the recycled sand deteriorates to the point where it cannot be used. At this point, new sand is introduced to replace the old sand, depending on the geometry of the casting, and the casting is removed from the molding and core sands in the shake-out process after the metal has solidified.

1.1 INDIA AND WORLD SCENARIO FOR FOUNDRY PRODUCTION:

Worldwide, there are over 35,000 foundries that collectively generate 90 million tons of material annually. China has the largest number of foundries, with 9374, followed by India with 6000. The majority of foundries, about 56%, produce iron, while 14% manufacture steel and the remaining 30% are non-ferrous. Nevertheless, as a result of globalization and evolving economic circumstances, many foundries have shut down in recent years.

1.2 INDIAN FOUNDRY INDUSTRIES:

The foundry industry in India gained momentum in the late 1800s, fueled by the growth of the jute industry in Bengal and the cotton industry in Mumbai. The expansion was driven by companies such as TISCO, Bengal Iron Company, and IISCO, which promoted the use of castings in various industrial and household applications. Presently, India is the second largest producer of foundry industries globally, with around 4450 registered units, trailing only China. Additionally, there are numerous unregistered units, estimated to be anywhere from 1500 to 5000 in number. According to a 2004 IREDA-CII report, there are roughly 10,000 foundry units in India, including both registered and unregistered entities, producing a wide range of items such as manhole covers, pipes, pipe fittings, sanitary goods, tube well bodies, metric weights, car and railroad parts, electric motors, and fan bodies, among other castings. The majority of these castings are manufactured by small-scale industries (SSI), accounting for 90% of the total production. These units are usually clustered together, with each cluster having between 30 to 500 units.

1.3 UTILIZATION OF LAND:

Foundry sand has also been found to be a useful material in the field of agriculture. Due to its high silica content, it can help improve soil structure, drainage, and aeration. Additionally, foundry sand can provide plants with essential nutrients such as potassium and phosphorus. When used in combination with other soil amendments, such as compost, foundry sand can help increase crop yield and improve overall soil health. Foundry sand has also been used as a substrate in the aquaculture industry, as it can provide a suitable habitat for aquatic organisms to grow and thrive. Overall, the use of foundry sand for various applications beyond its traditional use in metal casting has the potential to reduce waste and provide economic and environmental benefits.

1.4 TYPES OF FOUNDRY SAND:

Foundry sands can be classified into two categories based on the type of binder system used: chemically-bonded systems and clay-bonded systems, also known as green sand. While both types of sand have their advantages, they differ in terms of their physical and environmental properties. The majority of casting volume in the US, about 90%, is produced using green sand molds. The composition of green sand typically consists of high-quality silica sand (85-95%), bentonite clay (4-10%) as a binder, a carbonaceous addition (2-10%) to improve the surface finish of the casting, and water (2-5%). Green sand is characterized by its dark color due to the presence of carbon, its clay content, and its ability to stick together through a combination of clay and water, with a percentage of the material passing through a 200-mesh sieve.

2. OBJECTIVE: -

- The use of steel and metals is vital for the development of industrialized nations, but the disposal of reused foundry sand can contribute to a decrease in the surrounding area's Air Quality Index when dumped openly.
- Our primary objective is to repurpose discarded foundry sand into a low-cost foundry concrete. Foundry sand, which is utilized in the metal casting industry, contains silica and bentonite, both of which have binding properties similar to fly ash.
- To decrease the usage of mineral resources, our project promotes the utilization of waste foundry sand, which contains silica and bentonite that possess binding properties akin to fly ash. Furthermore, minimizing the usage of morrum, another mineral source, is another goal of the project.
- By incorporating a larger proportion of waste foundry sand as a replacement for regular foundry sand, the project aims to reduce the amount of waste foundry sand disposed of in landfills.

3. LITERATURE REVIEW: -

3.1 V. Parthiban et al. (2021) [7]:

After analyzing and discussing the test results, we found that the eight set of foundry sand bricks met the required strength among the various mix proportions and samples. The testing results led us to conclude that bricks made with foundry sand are comparable in strength to those made with fly ash. Furthermore, the cost of producing bricks from foundry sand is less expensive than producing fly ash bricks. Foundry sand bricks can be utilized as paver blocks, divider blocks, and fencing to demarcate land boundaries.

3.2 Kiran A. Vilayatkar et al. (2021) [3]:

This paper examines the use of foundry sand and recycled aggregate as a component of concrete and summarizes the important findings from various studies. The authors carefully studied numerous research papers on the topic and compiled the significant results to optimize the potential of this area of research. The paper provides a summary of test results conducted on properties such as strength and durability.

3.3 Aniket Abasaheb Bandal et al. (2020) [1]:

This article also explores the possibilities of using waste foundry sand as a partial replacement for fine sand in cementitious concrete, through a comprehensive analysis of numerous research papers on the subject. The analysis encompasses all relevant findings, and summarizes the results of concrete tests performed for various properties, including strength and durability. The article highlights both positive and negative changes in concrete properties due to the substitution of fine sand with waste foundry sand, based on previous research and our own conclusions. Our findings suggest that there is potential for the development of environmentally sustainable and stronger concrete through the use of waste foundry sand in construction.

3.4 T. Sravani et al. (2018) [6]:

This paper explores the feasibility of using waste foundry sand as a partial replacement for fine aggregate in the M 30 mix. Various percentages were tested to determine the optimal blend that meets the required specifications. In most cases, waste foundry sand is too fine or mixed with coarser sands, so careful material analysis was conducted to estimate the design mix. Incorporating waste foundry sand into building materials and construction is crucial for reducing environmental concerns. Waste foundry sand can be used for both RCC and PCC works in terms of compressive quality. This study aims to create an eco-friendly concrete by utilizing waste foundry sand.

3.5 S.S. Jadhav et al. (2017) [4]:

T This study investigated the performance of freshly mixed and cured concrete that used used foundry sand as a replacement for fine aggregate. A control concrete mix achieved a compressive strength of 25 MPa after 28 days. Other concrete mixes were prepared with 25% and 35% replacement of ordinary concrete sand with clean/new foundry sand and used foundry sand, respectively. Compressive strength was used to evaluate the performance of the concrete.

The results of the study showed that the compressive strength of the concrete decreased with increasing replacement of ordinary concrete sand with used foundry sand. The concrete with 25% replacement of used foundry sand had a compressive strength of 23 MPa, while the concrete with 35% replacement of used foundry sand had a compressive strength of 21 MPa.

3.6 Smit M. Kacha et al. (2014) [5]:

The paper reviews the use of foundry sand as a concrete constituent and the significant findings from the experimental work of various researchers. The historical development is also discussed as part of the introduction in the review. The paper summarizes the conclusions of tests conducted for properties such as quality and strength. It was observed that the results have shown positive changes and improvement in the quality and durability properties of conventional cementitious concrete due to the addition or replacement of fine sand with used foundry sand in different proportions.

3.7 Dushyant R. Bhimani et al. (2013) [2]:

This paper presents the results of a study on the use of Pozzo Crete P60 and used foundry sand in concrete. Five different concrete mixes were prepared, with the cement replaced with Pozzo Crete P60 at 10% by weight of cement and the fine aggregate replaced with used foundry sand at 10%, 30%, and 50% by weight of fine aggregate. The compressive strength and water absorption of the concrete mixes were tested at 7, 14, and 28 days.

The results of the study showed that the compressive strength and water absorption of the concrete mixes increased with increasing replacement of cement with Pozzo Crete P60 and decreasing replacement of fine aggregate with used foundry sand. The concrete mix with 10% replacement of cement with Pozzo Crete P60 and 30% replacement of fine aggregate with used foundry sand had the highest compressive strength and lowest water absorption.

4. METHODOLOGY

4.1 Collection of Raw Materials:

Collection of Raw Materials such as cement, coarse aggregate, fine aggregate, and foundry sand. The material was obtained from the foundry industry, we collected the material from nearby foundries and utilized it for the analysis and study of its properties.

4.1.1 Cement:

Cement is a binding material used in construction. It sets, hardens, and adheres to other materials. Cement is a fine powder that forms a paste when mixed with water. The paste consists of compounds of lime, silica, alumina, and iron oxide. Cement of grade 43 is used.

4.1.2 Coarse Aggregate:

Coarse aggregate is a fundamental component of concrete. It is typically composed of various types of crushed rocks or gravel that are larger than 4.75mm in size. Coarse aggregates are used in concrete mixes to provide bulk and strength to the final product.

4.1.3 Fine aggregate:

Fine aggregate is an essential ingredient in concrete. It consists of natural sand or crushed stone that is smaller than 4.75mm in size. The quality and density of fine aggregate strongly influence the hardened properties of the concrete. Fine aggregate used in this project are Morrum and Foundry Sand as a partial replacement with percentage 10%, 20%, & 30%.

4.1.4 Foundry Sand:

Foundry sand is clean, consistent in size, and of excellent quality. It is used to create molds or patterns for ferrous (iron and steel) and non-ferrous (copper, aluminum, and brass) metal castings. The sand is bonded to the metal castings and is then shaken out. The shake-out sand is often recycled back into the production of foundry sand.

However, some foundry sand is dumped by the foundry industry because it is too expensive to recycle. This waste foundry sand is typically composed of 70% used foundry sand and 30% fresh sand. The used foundry sand can contain contaminants, such as metal particles, binders, and mold release agents. These contaminants can make the sand unsuitable for reuse.

4.2 Sand Regeneration:

Sand regeneration is the process of cleaning and reconditioning used foundry sand so that it can be reused. The first step in sand regeneration is to wet wash the sand to remove any molasses content. The sand is then further washed to remove any remaining contaminants. The clean sand is then placed in an oven at 100 degrees Celsius for 24 hours. This process removes any moisture from the sand. The regenerated sand can then be used for molding if it is mixed with 30% manufactured sand. Alternatively, the regenerated sand can be used directly in concrete as a partial replacement for fine aggregate. The amount of regenerated sand that can be used in concrete will vary depending on the desired properties of the concrete.

4.3 Mix Proportioning:

The concrete mix used in the experimental program was designed using IS 10262 (2009) the replacement level of fine aggregate by Foundry Sand was calculated at 10%, 20%, and 30%. for mix proportioning water – cement ratio kept constant that is 0.5 and the obtained was 1: 1.45: 2.49 (Cement: fine aggregate + 10% foundry sand: coarse aggregate)

4.4 Check for workability:

Workability is a measure of how easy it is to mix, place, and finish concrete without it separating or bleeding too much. It is important to consider the workability of a concrete mix because it can affect the quality and strength of the finished concrete. The slump cone test is a common method for determining the workability of concrete.

4.5 Preparation of Cubes:

After mixing the concrete according to the mix design, the mixture was poured into a 150x150x150mm cube in three layers. Each layer was compacted using a tamping rod. After filling the mold, the top surface of the cube was finished with a trowel.

4.6 Demoulding:

The concrete cube was removed from the mold after 24 hours. It is important to be careful when removing the cube from the mold, especially around the edges and corners, so that the cube does not get damaged.

4.7 Curing of Cubes:

Curing is important for the development of strength and durability in concrete. After the cubes have fully set, they are placed in curing tanks for a specific period of 7, 14, and 28 days. This is done to analyze the effect of bagasse on the properties of concrete through compressive strength and flexural strength tests.

5. EXPECTED OUTCOMES: - Based upon previous literature published on this topic, all analysts gave their discoveries with concrete up to 30-40% substitution of the fine total with foundry sand in which compressive and elastic quality is expanded up to 20% while not much alter happens in modulus of versatility. Moreover, workability diminishes with the increment of foundry sand substance since of exceptionally fine particles. In any case, most famous analysts wrote that concrete made with foundry sand can be reasonably utilized in making basic-grade concrete.

6. FUTURE SCOPE- The strength characteristics of pervious concrete can be further studied by following parameters: -

- Waste foundry sand can also be replaced by morum (fine aggregate) in concrete
- The strength of Waste foundry sand can be further studied by varying water cement ratio and by varying the percentage of Waste foundry sand
- Modulus of elasticity of concrete, creep, and other properties of concrete can be studied by using destructive and non-destructive testing

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