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UTILIZING WASTE FOUNDRY SAND FOR THE DEVELOPMENT OF AFFORDABLE CONCRETE REPRESENTS AN EVOLUTIONARY STEP IN CONSTRUCTION

S. K.Waman1,
V.B. Godase 2,
T.V. Bhosale 3,
P. P. Jadhav 4,
Prof. A. V. More 5
1,2,3,4UG Scholar,Department of Civil Engineering,
Adsul Technical Campus, Savitribai Phule Pune University, Ahmednagar, Maharashtra, India.
5UG Guide, Department of Civil Engineering,
Adsul Technical Campus, Savitribai Phule Pune University, Ahmednagar, Maharashtra, India.

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Abstract

The construction sector is currently experiencing massive expansion and is implementing new methods for efficient and comfortable field labor. As a building material, concrete is important to this sector of the economy. Utilizing natural resources to make concrete comes at a considerable—almost prohibitively high—cost. These problems compel us to either replenish natural resources or find alternative solutions. As a byproduct of the metal casting industry, waste foundry sand currently causes a number of environmental problems. Utilizing this garbage as construction material could lessen the strain on the environment. In the metal industry, foundry sand is a premium, uniformly sized silica sand that is used to create molds for casting both ferrous and non-ferrous metals. Metal casting requires sand that is finer than regular sand. Once it is no longer functional, it is taken out of the foundry and disposed of as "waste Foundry Sand." Concrete made with leftover foundry sand substituted partially for fine aggregate is strong, lightweight, and reasonably priced. Cement, water, additives, fine and coarse aggregate, and cement make up concrete. Each of these components strengthens the concrete in some way. Consequently, a partial or percentage replacement of material will have an impact on the various properties of concrete. It is possible to turn environmentally hazardous waste materials into inexpensive, green building materials. In this work, an experimental investigation is conducted to produce inexpensive and ecologically friendly concrete by varying the percentage of fine aggregate with foundry sand.

Keywords: Eco-friendly, waste foundry sand, Compression strength, Water absorption.

I. INTRODUCTION

These days, new methods for efficient and comfortable field labor are being implemented as the construction industry continues to grow dramatically. In this industry, concrete is important because it is a building material. The expense of using natural resources as raw materials for concrete is high and almost unaffordable. These problems compel us to find alternative solutions or restore the environment's resources. The metal casting industry produces waste foundry sand as a byproduct, which currently causes a number of environmental problems. Reducing environmental stress could be achieved by using this waste as building material.

High-quality, uniformly-sized silica sand, known as foundry sand, is essential for creating molds in the metal industry for the casting of both ferrous and non-ferrous metals. In the metal casting process, sand that is finer than regular sand is used. After its useful life ends, it is taken out of the foundry and disposed of as "waste Foundry Sand." Strong, lightweight, and reasonably priced concrete can be produced by partially substituting discarded foundry sand for fine aggregate in the mix.

Coarse aggregate, fine aggregate, cement, additives, and water make up concrete; each of these ingredients gives concrete its strength. Therefore, different concrete properties are affected by the partial or percentage replacement of material. Low-cost, environmentally friendly building materials can be developed by utilizing such waste materials that are harmful to the environment. This study aims to produce low-cost, environmentally friendly concrete by conducting an experimental investigation using different percentages of fine aggregate and foundry sand.

II. LITERATURE REVIEW

Jaychandra ,Shashi Kumar, A. Sanjith J. DG Narayan,(2015),Presented Paper on Strength Behaviour Of Foundry Sand On Modified High Strength Concrete Concluded That: The main component of foundry sand is high-quality, consistently sized silica or lake sand produced by ferrous and nonferrous metal casting moulds. Before casting, the sand will be pure, but after casting, it will have a ferrous content of around 95% of its own volume. The type and quantity of materials used in moulds are determined by the type of metal that will be cast in the mould. However, in most cases, green sand, which accounts for 90% of the materials, is used in significant quantities. It should be mentioned that the effect of concrete including foundry sand is one-of-a-kind, as the foundry sand alters the physical and chemical properties of the concrete, as well as the production process. It might be used more successfully and efficiently for construction rather than landfilling. The presence of foundry sand affects workability and necessitates the addition of extra water to get a homogeneous mix. The addition of foundry sand to concrete improves the hardened qualities of the concrete by 25%.

C.G.Konapure,D.J.Ghanate,(2015),Presented Paper On Effect Of Industrial Waste Foundry Sand As Fine Aggregate On Concrete Concluded that: Massive production waste material from metal companies, which employs foundry sand as a byproduct, now generates a slew of environmental issues. Using these waste products as building materials can assist to reduce environmental stress. Sand is finer than conventional sand and is utilised in the metal casting industry. When burnt sand can no longer be used in metal casting processes, it is taken from the foundry as a waste and disposed of as "waste foundry sand." Waste foundry sand is used as a partial or entire substitution for fine aggregate in concrete, resulting in the creation of cost-effective, light-weight, high-strength concrete. In the research work to explore the various percentages of fine aggregate with used foundry sand, each material in concrete adds its strength or durability of thus, by partial or material that affects the environment can be used for the development of low cost & eco-friendly building material. In order to test the usage of foundry sand as a partial replacement for fine aggregate in concrete, a research study was conducted on a concrete containing foundry sand in the percentages of 0%, 10%, 20%, and 30% by weight for the M20 7 M30 grade of concrete.

Deepak Chaurasiya, KiranKoli, SurajChaudhari, Vardan More, P. C. Satpute, (2016),(9)Presented Paper On Utilization Of Foundry Sand : An Art to Replace Fine Sand With Foundry Sand Concluded That:

For its moulding and casting processes, the foundry industry uses high-quality specific-size silica sand. This is higher-quality sand than what you'd find in a bank or on the beach. Foundries successfully recycle and reuse sand on a regular basis. It is taken from the industry when it can no longer be reused in the foundry and is referred to as waste foundry sand. There is currently relatively little literature on the usage of these byproducts in concrete. One of the most serious problems in the handling of foundry trash is discarded foundry sand.WFS are colourless and contain a high level of fines. The type of metal poured, the casting process, the technology used, the type of furnace (induction, electric arc, and cupola), and the type of finishing process all influence the physical and chemical attributes of WFS (grinding, blast cleaning and coating).

Pranitabhandari, Dr. K. M. tajne,(2016),(10)Presented Paper on Use Of Foundry Sand in Conventional Concrete Concluded that:

A tiny proportion of bentonite clay is usually used as a binder element in foundry sand. In metal casting, two types of binder systems are utilised, depending on the classification of the foundry sands: 1) a clay-bounded system (green sand) 2) a chemically-bounded system Both types of sands have advantageous properties, but they differ in terms of physical and environmental qualities. The most often utilised reclaimed foundry sand for beneficial reuse is green sand. It is made out of natural materials that have been combined together, including high-quality silica sand (85-95%) and bentonite clay (4-10%) as a binder. Carbonaceous addition (2-10%) to increase the completed casting surface and water resistance (2-5 percent). It has a black colour due to carbon content, a clay content that results in a percent of material passing a 200 sieve, and it adheres together due to water.

Jadhav, S. N. Tande, A.C. Dubai,(2017),)Presented Paper On Beneficial Reuse Of Waste Foundry Sand In Concrete Concluded That: Previously discarded industrial byproducts are now being investigated for useful use. Beneficial use can minimise our nation's carbon emissions and virgin material use while also providing economic benefits. It is a key component of a country's stability. Source reduction and waste avoidance come first in the waste management hierarchy, followed by reuse, recycling, energy recovery, and disposal. Today, research is focusing on ways to use industrial or agricultural waste as a source of raw materials for enterprises all over the world. This garbage usage would not only be cost-effective, but it may also result in foreign exchange earnings and pollution reduction.The foundry sector is broad and difficult to understand. The purpose of this study is to look into the effects of using UFS on both mortars and concrete. Conglomerate performance is examined in detail at various w/c ratios. The purpose is to figure out how much wasted foundry sand can be added to admixtures without affecting workability, mechanical performance, or drying shrinkage. The goal of this study was to see how well waste foundry sand as a fine aggregate replacement worked in fresh and cured concrete. After 28 days, a proportionate concrete mix produced a compressive strength of 25 MPa. Other concrete mixes were proportioned to use foundry sand by weight, with foundry sand replacing 25% and 35% of ordinary concrete sand, respectively.

III OBJECTIVES OF INVESTIGATION

- Researching the impact of discarded foundry sand on concrete.

- To investigate the experimental outcomes of substituting normal concrete for waste foundry sand concrete in compression and water absorption tests.

IV. MATERIALS

1. Cement: The term cement is commonly used to refer to powdered materials which develop strong adhesive qualities when combined with water. Cement used in the investigation was 53 Grade Ordinary Portland cement.
2. Fine aggregate: River sand is used as a fine aggregate. Among various characteristics, the most important one for fine aggregate is its grading. Coarser sand may be preferred as finer sand increases the water demand of concrete and very fine sand may not be essential in fine aggregate as it usually has larger content of fine particles in the form of cement and mineral admixtures such as fly ash, silica fume etc. The sand particles should also pack to give minimum void ratio. Properties such as gradation, Specific gravity and water absorption have to be assessed to design a dense fine aggregate mix with optimum cement content and reduced mixing water. The river sand was used as fine aggregate confirming to zone 2.
3. Water: Water is an important ingredient of concrete as it actively participates in the from mix design consideration, it is important to have the compatibility between given cement and chemical mineral admixtures along with the water used for mixing. It is generally stated in the concrete codes and also in the literature that the water chemical reaction with cement. The strength of cement concrete comes mainly from the binding action of the hydrated cement gel. The requirement of water should be reduced to that requires for chemical reaction of an hydrated cement as the excess water would end up in only formation of undesirable voids (and/or capillaries) in the hardened cement paste in concrete. Potable water is used for mixing and curing as per IS 456:2000
4. Waste foundry sand is made up of mostly natural and material. Its properties are similar to the properties of the natural or manufactured sand. Thus it can normally be used as a replacement of sand. Most of the metal industries prefer and casting system. In this system mould made of uniform sized, clean, high silica sand is used. After casting process foundries recycled and reused the sand several times but after some time it is discarded from the foundries known as “waste Foundry Sand”. There are two types of foundry sand such as

   - Green sand
   - Chemically bounded sand

V. METHODOLOGY

Testing Of Concrete: Research Work is divided into 2 parts:

a) Test on fresh concrete state:

1. Slump Flow Test
2. Flow table test (IS: 1199- 1959)

b) Test On Hardened Concrete State

1. Compression test
2. Water Absorption test

VI. Testing Program

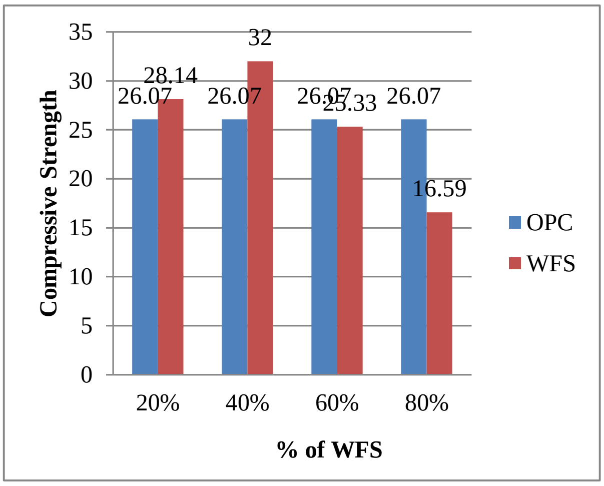
1. Compressive Strength Test (IS 516:1959): For the compressive strength test, cube specimens measuring 150 x 150 x 150 mm were cast for the M25 concrete grade, and the moulds were vibrated using a table vibrator. The specimen's top surface was levelled and completed. The specimens were demoulded after 24 hours and moved to a curing tank, where they were allowed to cure for another 28 days. These cubes were tested on a Universal testing equipment after curing for 3 days, 7 days, and 28 days. It was determined what the failure load was. This is how the compressive strength was estimated.

Compressive strength (MPa) = Failure load / cross sectional area.

Figure 1. Compression testing

Table No. 1: Compression Test of at the End of 28 Days

Sr. No	Notation	Average Load Carried (KN)	Compressive Strength (N/mm^2)
1	OPC	586	26.07
2	WFS 20	633	28.14
3	WFS 40	720	32
4	WFS 60	570	25.33
5	WFS 80	373	16.59



Graph No.1: Comparative Chart of Compressive Strength

2.Water absorption test:BS 1881: Part 122:1983[11].

For 24 hours, the test specimen must be totally immersed in water at room temperature. The specimens should then be withdrawn from the water and allowed to drain for 1 minute before being placed on a wire mesh of 10mm or coarser. ‘ A moist cloth should be used to wipe away any visible water on the specimens. The specimen must be weighed right away, and the weight of each specimen must be recorded in N to the nearest 0.01N. Following saturation, the specimens must be dried in a vented oven at 107 + 7°C for at least 24 hours and until two successive weighings at intervals of 2 hours demonstrate an increase of loss of not more than 0.2 percent of the specimen's previously calculated mass. Each specimen's dry weight must be documented in N to the nearest 0.01 N.

Percent Water Absorption (Percent),

W percent = $\frac{(Ww - Wd)}{Wd} X\ 100$

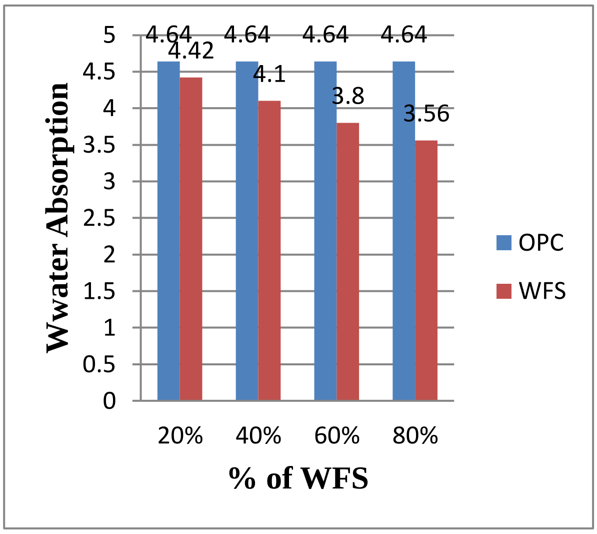
Ww = Weight of wet (saturated) block.

Wd = weight of block after complete drying.

Figure 2. Water absorption test

Table No. 2: Water Absorption Test of at 28 Days

Sr. No	**Notation**	**Water Absorption**
1	OPC	4.64
2	WFS 20	4.42
3	WFS 40	4.10
4	WFS 60	3.80
5	WFS 80	3.56



Graph No.2: Comparative Chart of Water absorption test at the end of 28 days

VII. Conclusions

- It is obvious from the findings of the experimental inquiry that the compressive strength of foundry sand concrete is improving up to a replacement level of 40%, after which it begins to deteriorate. Fine aggregates are finer than foundry sand fractions. It will result in a tightly packed concrete matrix, which will aid in the development of strength. The presence of excess burnt binders, which are mostly carbon compounds, causes a weak bonding between particles in concrete, resulting in a loss in compressive strength.
- It was discovered that the water absorption of concrete containing WFS decreases as the proportion of WFS added increases, and the value increases further.

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