EFFECT OF USE OF WASTE FOUNDRY SAND IN CONCRETE

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ABSTRACT

Now-a-days the construction sector is exploring rapidly on a large scale and also involves new technique for rapid and comfort works on the field. Concrete as a building material plays an important role in this sector. The consumption of natural resources as ingredients of concrete cost high as well as it is on verge of extent. These problem force us to recover the natural resources or to find an alternative option to overcome this problem. Presently, the production of waste foundry sand as a byproduct of metal casting industries causes various environmental problem. usage of this waste in building material would help in reduction of stress on environment.

In this study an experimental investigation is carried out by varying % of fine aggregate with used foundry sand to produced low cost and eco-friendly concrete. Waste foundry sand is an industrial waste material and is used for various purposes in India. WFS is used at landfilling sites. It is used for highway sub-base. Several states have allowed full use of foundry sand used and require some type of encapsulation. It is now-a-days used in hot mix asphalt. Foundry sand can be used as a replacement for natural fine aggregate because foundry sand consist of greater than 80 % fine uniform silica sand. The use of foundry sand in Portland cement and Portland cement concrete mixtures is an emerging application area. Several resources are available to end users interested in incorporating foundry sand into construction applications. There are again various trends where the WFS is used but these previously mentioned trends are brought in actual practice and are giving satisfactory results. The utilization of WFS and is also reducing the environmental problems due to WFS. Hence, WFS is proving to be eco-friendly.

Keywords: eco-friendly, waste foundry sand, Compressive strength, split tensile strength.

INTRODUCTION

Now-a-days the construction sector is exploring rapidly on a large scale and also involves new technique for rapid and comfort works on the field. Concrete as a building material plays an important role in this sector. The consumption of natural resources as ingredients of concrete cost high as well as it is on verge of extent. These problem force us to recover the natural resources or to find an alternative option to overcome this problem. Presently, the production of waste foundry sand as a byproduct of metal casting industries causes various environmental problem. usage of this waste in building material would help in reduction of stress on environment.

Metal industries use foundry sand which is uniform sized, high quality silica sand that is bound to form a mould for casting of ferrous and non-ferrous metal. Finer sand than normal sand is used in metal casting process of metal is reused for many times but when it cannot longer have used it is removed from foundry as a waste for disposal known as "waste Foundry Sand". Use of waste foundry sand as a partial replacement by fine aggregate in concrete leads in production of economic, light weight and strength concrete.

Concrete is a material which is composed of coarse aggregate, Fine aggregate, cement, Admixtures and Water these each material in concrete contribute its strength. So, by partial or percentage replacing of material affects different properties of concrete. By using such waste material which harms the environment can be used for the development of low cost and eco-friendly building materials. In this study an experimental investigation is carried out by varying % of fine aggregate with used foundry sand to produced low cost and eco-friendly concrete.

LITERATURE REVIEW

Khattib and ellies(2008),(1)Presented Paper on effect of waste foundry sand as a partial replacement of sand on the strength, ultrasonic pulse velocity and permeability of concrete and concluded that the properties of concrete containing foundry sand as a partial replacement of natural sand. Natural sand and replaced by three types of foundry sand white fine sand and without the addition of clay and coal, the foundry sand and WFS. Thirteen concrete mixture were made to investigate these properties. Replacement % of natural fine and class M with foundry sand was 0%, 25%, 50% and 10%. Based on the test results they concluded that, (a) the concrete made with WFS and white sand showed similar strength of all replacement; (b) strength of concrete was decreased dueto increasing the replacement % of foundry sand.

Dheeraj N. Kumar, Chidananda M. L.,(2013),(2) Presented paper on Utilization of waste foundry sand in rigid pavement structure concluded that the physical and chemical characteristics of waste foundry sand will depend in great part on the type of casting process and the industry sector from which it originates. In modern foundry practice, sand is typically recycled and reused through many production cycles. 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 be recycled into other products in industry. For the grade of concrete considered for the study at 0.42 water-cement ratio M1 i.e. the ratio of 80:20 of conventional sand. Foundry sand has proved to be having optimum ratio which gives maximum compressive strength of all ratios. The compressive strength value of M1 i.e. at 20% replacement level the strength developed for a curing period of 28 days is almost similar to the normal mix i.e.Normal concrete (NC). For the grade of concrete M40 consider for the sudy. Mix the 20% replacement of foundry sand is the optimum level at which split tensile strength is maximum. Mix the 50%replacement of foundry sand M4 gives the least flextural strength.

Dushyant R. Bhimani, JayeshkumarPitroda, Jaydevbhai J. bhavsar, (2013),(3)Presented Paper On study on foundry sand : opportunities for sustainable and economical concrete Concluded that there are about 35000 foundries in the world with annual production of 90 million tonnes. The imputes for foundry sector in india was given by the jute industry in Bengol and the cotton industry in Mumbai in late 19^{th}century.India ranks 2^{nd} in the world based on the number of foundry units present 4550 units. They are concluding that 1m3 M20 grade of concrete consumption of fine aggregate is 538.45 Kg. here in specimen M4 we replace fine aggregate by 162 Kg of foundry sand 1m3 M20 grade of concrete. So we can say that

upto30% foundry sand utilize for economic sustainable development of concrete. Uses of foundry sand in concrete can save the metal industry disposal cast and produced a ,greener , concrete per construction. And innovative supplementary construction material is formed through this study.

PathariyaSaraswati C., RanaJaykrushnaK,ShahPalas A, Mehta Jay G, Patel Ankit N.,(2013),(4),Presented Paper On Application of Waste foundry sand for evaluation of low-cost concrete Concluded that the consumption of natural resources as an ingredients of concrete, cost high as well as it is on verge on extend. These problems force us to recover the natural resources or to find an alternative option to overcome this problem. Presently the production of waste foundry sand as a byproduct of metal casting industries caused various environmental problems. Finer sand than normal sand is used in metal casting process. The burnt sand after the casting process of metal is reuse for many times but when it cannot be longer used it is removed from industry as a waste for disposal known as Waste Foundry Sand. Concrete is a material which is composed of course aggregate, fine aggregate, cement, admixtures, and water these each material in concrete contributes its strength. So, by partial or percentage replacing of material affects different properties of concrete. By using such waste material which harms the environment can be used for the development of low cost eco-friendly building materials. In these study and experimental investigation is carried out by varying percentage of fine aggregatewith used foundry sand to produced low cost and eco-friendly concrete.

Smit M. Kacha, Abhay V. Nakum, ankur C. Bhogayata,(2014,(5)presented Paper On Use Of Used Foundry Sand In Concrete : A State Of Art Review Concluded that the waste generated from the industries causes environmental Problems. Hence the reuse of this waste material can be emphasized. Foundry sand used for the centuries as a moulding casting material because its high thermal conductivity. In the process molding sands are recycled and reused multiple times. Eventually, however, the recycled sand degrades to the point that it can no longer be reused in the casting process. At that point, the old sand is displaced from the cycle as byproduct, new sand is introduced.and the cycle begins again. It concluded that the researcher have their findings with concrete upto 30-40% replacement of fine aggregate with foundry sand in which compressive and tesile strength is increased up to 20% wheres not much change occurs in modulus of elasticity. Very few researcher go up to 100% replacement where strength and durability criteria needed to be studied further effectively in future.

Ravindra N. Patil, Pravin R. Mehetre, Kailash T. Phalak,(2015),(6)Presented paper on Development Of Concrete With Partial Replacement Of Fine Aggregate By Waste Foundry Sand Concluded that the current area of research in the concrete was introducing foundry sand as byproduct of metal. This research was carried out to produced an eco-friendly concrete. This paper demonstrates the possible use of waste foundry sand as a partial replacement by fine aggregate in concrete. It is concluded the compressive strength of concrete increase with increase in percentage of waste foundry sand as compare the regular concrete in both group of concrete. It was maximum for 15% replacement. Split tensile strength increase with increase in percentage of waste foundry sand upto 15% replacement after that it decreases. Among both group concrete results , second group concrete I.e. concrete containing artificial sand and WFS shows more positive results, the problem of disposal and maintenance cost of landfilling is reduced. The results of percentage cost change reducesupto 3.5 for 15% replacement of waste foundry sand. This shows that the concrete produced economical.

OBJECTIVES OF INVESTIGATION

- To study the effect of waste foundry sand on concrete.
- To utilise the waste foundry sand in construction field

to improve the properties of concrete also reduced the problem of disposal of waste foundry sand..

- To study the experimental results of replacement of waste foundry sand concrete with the normal concrete under Compressive and Split Tensile loading.

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

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. Split tensile test

TESTING PROGRAM

Compressive Strength Test (IS 516:1959):

For compressive strength test, cube specimens of dimensions 150 x 150 x 150 mm were cast for M25 grade of concrete & Vibration was given to the moulds using table vibrator. The top surface of the specimen was leveled and finished. After 24 hours the specimens were de-molded and were transferred to curing tank wherein they were allowed to cure for 28 days. After the age $3^{rd,}$, 7^{th} & 28^{th} days curing, these cubes were tested on Universal testing machine. The failure load was noted. The compressive strength was calculated as follows.

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

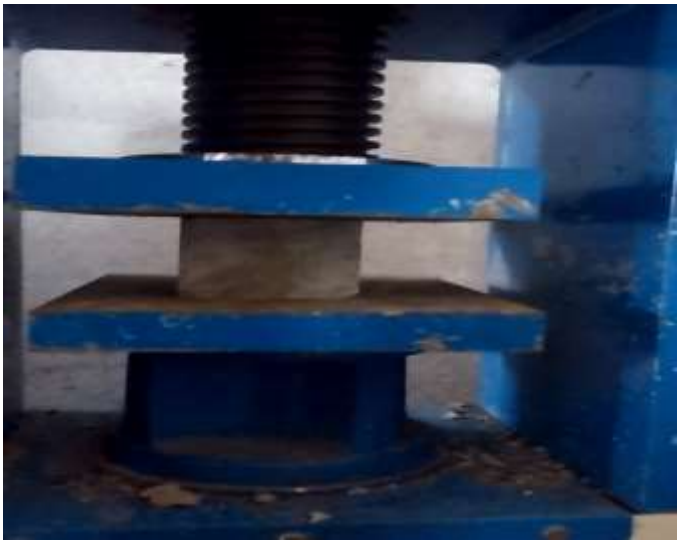
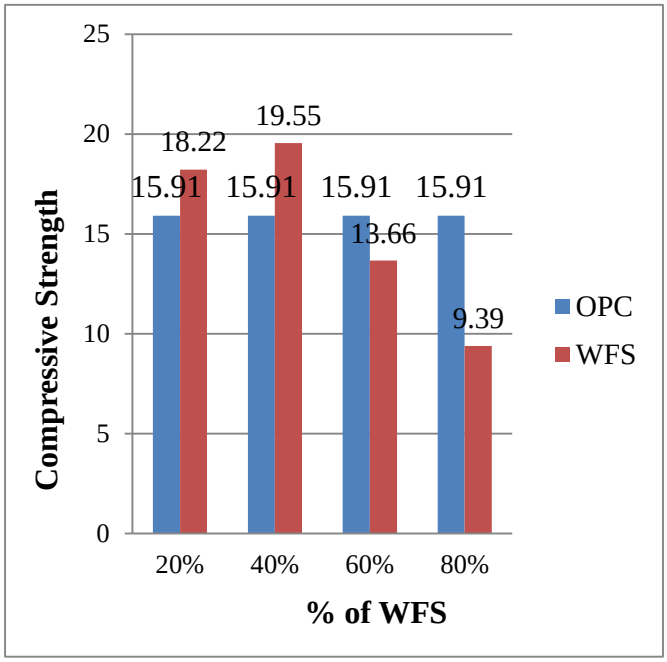


Fig. 1 - Compression Test Setup

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 at the end of 28 days

Split Tensile Test:

The split tensile test is well known indirect test used to determine the tensile strength of concrete. Due to difficulties involved in conducting the direct tension test, a number of indirect methods have been developed to determine the tensile strength of concrete. In these tests, in general a compressive force is applied to a concrete specimen in such a way that the specimen fails due to tensile stresses induced in the specimen.

The tensile strength at which failure occurs is the tensile strength of concrete. In this investigation, the test is carried out on cylinder by splitting along its middle plane parallel to the edges by applying the compressive load to opposite edges. The arrangement for the test is shown in photo with the pattern of failure. The split tensile strength of cylinder is calculated by the following formula,

$$f_t = 2P / \pi LD$$

Where

f_t = Tensile strength, MPa

P = Load at failure, N

L = Length of cylinder, mm

D = Diameter of cylinder, mm

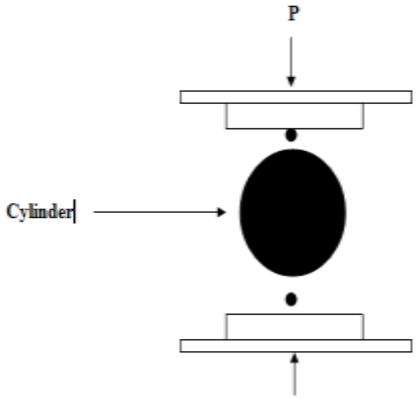
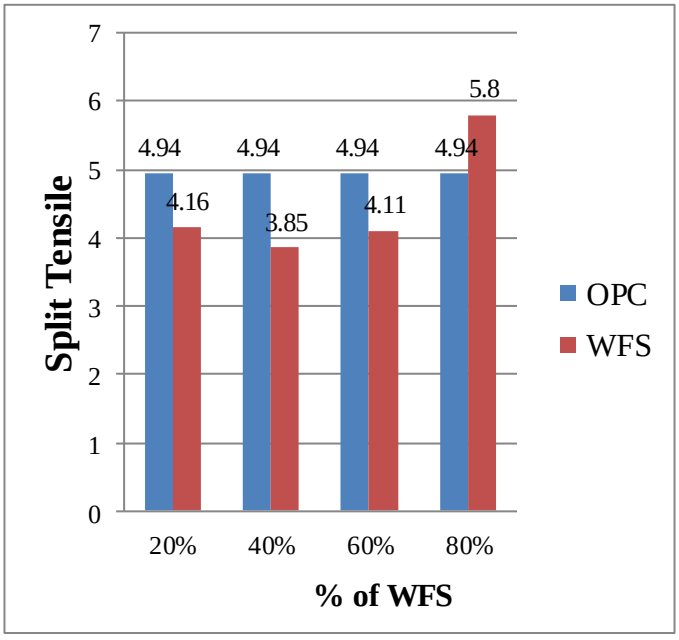


Figure No. 2: Split Tensile Test Setup

Table No. 2:Split Tensile Test of at the End of 28 Days

Sr. No	Notation	Average Load Carried (KN)	Split Tensile Strength (N/ mm^2)
1	OPC	348	4.94
2	WFS 20	294	4.16
3	WFS 40	272	3.85
4	WFS 60	292	4.11
5	WFS 80	433	5.8



Graph No.2: Split Tensile Test at 28 days

CONCLUSIONS

- Use of waste foundry sand in concrete reduces the problem of production waste foundry sand. Moreover it also reduces the issue of disposal and maintenance cost of land filling.
- Based on the results obtained from experimental investigation it is clear that the compressive strength of foundry sand concrete is increasing up to a replacement level of 40% and beyond that there was a decline in strength. The foundry sand fractions are finer than fine aggregates. It will result in a densely packed concrete matrix, which contributes to the strength development.
- During split tensile test it was observed that split tensile strength goes on decreasing with increase in percentage of waste foundry sand. The Strength decreased in the range of 15-20% with the increase in percentage of waste foundry sand.

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