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Utilization of Waste Foundry Sand in Conventional Concrete

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INTRODUCTION

Concrete is one of the most vital and common materials used in the construction field. The current area of research in the concrete was introducing waste foundry sand (WFS) in the ordinary concrete. Waste foundry sand is the by-product of metal casting industries which causes environmental problems because of its improper disposal. An experimental investigation was carried out on concrete containing waste foundry sand (WFS) in the range of 0%, 10%, 20%, 30%, and 40% by weight for M-40 grade concrete. Concrete was produced, tested and compared with conventional concrete in plastic state as well as in harden state for workability, compressive strength & split tensile strength. These tests were carried out on standard cube, cylinder for 7, 28 and 91 days to determine the properties of concrete. Key words: Industrial Waste, Waste Foundry Sand (WFS), Eco friendly, Compressive Strength, Split Tensile Strength and Workability. In the present work an attempt has been made to replace the coarse aggregate by natural sand and waste foundry sand at 10% intervals starting from 0% up to 60% separately and also in place of natural coarse aggregate demolished aggregate is used. In experimental work four sets of specimens were casted having combinations of natural coarse aggregate and natural sand, natural coarse aggregate and waste foundry sand, demolished aggregate and natural sand, demolished aggregate and waste foundry sand.

The recycling of waste materials implies a significant reduction in amounts, destined to disposal by land filling, which enhances the achievement of recycling rates established by law, leads to a reduction in the use of non-renewable resources and produces a positive outcome on the environment. Additionally, in several places, conventional building materials may prove to be too expensive and insufficient to face the worldwide growing need for housing development. Accordingly, the use of waste as alternative material may help to meet the above shortages. The mixing of wastes with inert fractions to produce construction materials should be done to improve functionality rather than merely to dilute wastes. As natural resource raw materials become more costly with ever higher global demand caused by developing nations undergoing economic expansion, the incentive to explore and locate low cost, environmentally beneficial alternative uses of production by-products becomes an ever more near term goal. Recycling involves processing used materials into new products in order to prevent the waste of potentially useful materials, reduce energy usage, reduce air and water pollution by reducing the need for conventional waste disposal, lower greenhouse gas emission as compared to virgin production. Several types of by-products and waste materials are generated. Each of these specific wastes has special effects on the properties of cement-based materials. The utilization of such materials in concrete not only makes it economical but also do help in reducing disposal problems.

SCOPE

The present work concerns the investigation of WFS utilization effect on concretes. The aims are to establish the amount of used foundry sand that can be added in the mixture without too heavy penalizations, principally in terms of workability, mechanical performances (i.e. compressive strength and tensile strength). This research was conducted to investigate the performance of fresh and hardened concrete containing waste foundry sands as a replacement of fine aggregate. A control concrete mix was proportioned to achieve a 7-days and 28-day compressive, tensile and flexural strength of 30 MPa. Other concrete mixes were proportioned to replace 20% and 40% & 60% of regular concrete sand with used foundry sand by weight.

OBJECTIVES

1. To check the suitability of Foundry Sand as an alternative construction material.
2. To investigate the utilization of Foundry Sand as Fine aggregate and influence of it on the strength of concrete made with different replacement levels.
3. To check the effect of Foundry Sand on properties of fresh concrete & hardened concrete.
4. To economize the cost of construction without compromising with the quality.

NEED OF THE PROJECT

The most critical problem we are facing now a day is the deficiency of artificial resources for the construction purpose. The reason behind this is the

ban of on extraction of sand ordered by the government. To solve this problem, we are using the solid waste from industries as a replacement material for fine aggregate i.e. used foundry sand.

LITERATURE REVIEW

1. Bavita Bhardwaj, According to her, several studies have been conducted to investigate the effect of addition of waste foundry sand as partial and complete replacement of regular sand in concrete. It has been found suitable to be used as partial replacement of sand in structural grade concrete. A number of properties have been reviewed in the current paper, the results observed from the various studies depict that replacement of foundry sand to a certain extent enhance the durability as well as strength properties of the concrete but simultaneously decreases the slump value with the increase of replacement level of waste foundry sand.

2. Maria Auxiliadora, Aimed to characterize and analyse the use of a very fine sand, referred here as waste foundry exhaust sand, WFES, from Waste Foundry Sand from the foundry of pieces in the automotive industry in conventional concrete production partially replacing the fine aggregate. The test on the physical properties such as size classification, specific gravity and density were carried out according to the Brazilian standards to obtain the mixture. The chemical characterization of the leachate solution of the waste was assessed to identify the presence of heavy metals. The waste was classified as non-inert and non-hazardous and physically adequate for use in conventional concrete.

3. Thiruvenkitam Manoharan, His investigations were carried out to evaluate the mechanical, durability and microstructural properties of M20 concrete at the age of 7, 28 and 91 day. XRD (X-ray Diffraction), EDX (Energy Dispersive X-ray) and opticalmicroscopic imaging analysis were performed to identify the presence of various compounds and micro cracks in the concrete with WFS. The study shows that, WFS is compatible for the replacement of fine aggregate in concrete. He also stated that, mechanical and durability properties for different grade of concrete can be the future concern.

4. N.Gurumoorthy, This paper presents the results of an experimental investigation carried out to evaluate the micro structural and mechanical properties of concrete mixtures in which fine aggregate (river sand) was partially replaced with TWFS. Test results indicated a marginal increase in the strength properties and good micro structural properties of plain concrete by the inclusion of TWFS as partial replacement of fine aggregate (sand). This will pave the way for making good quality concrete and disposing of the Used Foundry Sand safely without disturbing the environment. Used Foundry Sand (WFS) is the high-quality silica sand by-product from the production of both ferrous and nonferrous metal casting industry. The WFS from ferrous metal casting industry contains more iron content. Inclusion of WFS without proper treatment in concrete will reduce the binding and strength properties. In order to minimize the iron content, the WFS were treated with acid. While treating with acid, the silica in foundry sand has been enriched.

This is called as Treated Used Foundry Sand (TWFS). In Treated Used Foundry Sand, silica content is about 80% when treated with 5% HCl. Mechanical properties of concrete mixtures increase with the increase in the percentage of TWFS content. TWFS concrete mixtures show enhanced mechanical properties (compressive strength, splitting tensile strength and flexural strength) with respect to age for all the percentage of replacement.

5. M Nithya, Properties of concrete containing waste foundry sand for partial replacement of fine aggregate in concrete. Her study demonstrated that the feasibility of waste foundry sand in concrete as a substitute for fine aggregate by evaluating the durability properties of concrete. The durability evaluation in terms of acid resistance and alkalinity has shown relative supremacy over conventional concrete mix. Concrete produce with WFS suffered similar losses in weight and compressive strength as compared to ordinary concrete when subjected to sulphuric acid attack.

METHODOLOGY

Strength is one among the most important properties of concrete since the first consideration in structural design is that the structural members must be capable of carrying the imposed loads.

The mix of concrete used in this study is M30. Concrete mix with 0% waste material is the control mix and water-cement ratio adopted is 0.5 in accordance with the Indian Standards specification IS 10262 - 2009.

A design mix proportions of 1: 1.86: 2.89: 0.5 was investigated for the research. The percentages of replacements are 10%, 20%, 30% and 40% by weight of fine aggregate.

Tests were performed for compressive strength and split tensile strength of concrete for all replacement levels of fine aggregate at different curing period (7 days and 28 days). Besides, the physical and chemical properties of the foundry sand are also studied. Before casting, different tests are carried out on foundry sand, river sand to find out physical properties for further work.

The test includes a water absorption test, specific gravity test, etc. The replacement of fine aggregate is done in three sets by weight. The study will lead to possible innovative utilization of foundry sand in the construction of concrete apart from its present use in a landfill application.

The use of waste foundry sand, it could be feasible, will not only provide for its better utilization but also will help in conserving the precious natural resource of natural sand.

CONCRETE MIX DESIGN OF M30 BY I.S CODE METHOD (IS 10262-2009):

Stipulations for proportioning:

1. Grade designation:	M30
2. Type of cement:	OPC 53 grade conforming to IS 12269
3. Maximum nominal size of aggregate:	20 mm
4. Minimum cement content:	320 kg/m^3
5. Maximum water-cement ratio:	0.55

6. Workability:	100-120 mm (Slump)
7. Exposure condition:	Moderate (For Reinforced Concrete)
8. Degree of supervision:	Very Good.
9. Type of aggregate:	Crushed angular aggregate.
10. Maximum cement content:	450 kg/m^3
11. Chemical admixture type:	None

TESTING & RESULTS

SLUMP CONE TEST

SL.NO	W/C RATIO	FOUNDRY SAND PERCENTAGE %	HEIGHT OF MOULD H1 (mm)	HEIGHT OF SUBSIDED CONCRETE H2 (mm)	SLUMP H1 – H2 (mm)
1	0.5	10	300	215	85
2	0.5	20	300	217	82
3	0.5	30	300	222	78
4	0.5	40	300	240	60

COMPRESSION STRENGTH TEST

Foundry sand percentage %	Ultimate load at 7 days (KN)			Ultimate load at 28 days (KN)		
	Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3
10	460	460	470	700	710	690
20	510	500	510	780	780	770
30	570	580	570	850	860	840
40	390	390	400	610	600	600

SPLIT TENSILE STRENGTH TEST

Foundry sand percentage %	Ultimate load at 7 days (KN)		Ultimate load at 28 days (KN)	
	Trial 1	Trial 2	Trial 1	Trial 2
10	190	200	280	270

20	210	220	300	290
30	230	240	320	330
40	160	170	210	200

RESULTS & CONCLUSION

Based on above project work the following conclusions are made regarding the properties and behavior of concrete on partial replacement of fine aggregate by waste foundry sand.

- It was noticed that workability (slump) of concrete decreases as percentage of foundry sand increases. This may be most likely because of the presence of clayey type fine substances in the WFS, high water absorption, and fineness which are compelling in diminishing fresh concrete fluidity.

- Compressive strength, split tensile strength of concrete specimens increased, with increase in fine aggregate replacement by foundry sand, providing maximum strength at 40 % replacement on 7 and 28 days, and beyond that the strength parameters showed a decline in their respective values.

- Maximum compressive strength is gained at 40% replacement of fine aggregate which is higher than normal concrete strength (M30) by 20.4%.

- The variation in split tensile strength followed the similar trend as observed in compressive strength with a maximum increment by 17.30% and 18.70%.

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