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Strength and Durability Characteristics of Foundry Sand as a Partial Replacement of Fine Aggregate in Self- Compacting Concrete

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Abstract- *Increasing rate of urbanization and industrialization has lead to over exploitation of natural resources such as river sand and gravels, which is giving rise to sustainability issues. It has now become imperative to look for alternatives of constituent materials of concrete. Waste foundry sand, a by-product of ferrous and non-ferrous metal casting industries is one such promising material, which can be used as an alternative to natural sand in concrete Foundry sand is high quality silica sand that is a by-product from the production of both ferrous and non-ferrous metal casting industries. It is used for the centuries as a moulding casting material because of its high thermal conductivity. For various foundry operations, raw sand is used and several binders and additives are added into it to enhance its properties. The WFS is collected at Hindustan Foundries near Nava India, Coimbatore. The sand, which is used for experiment, is no longer being useful for the foundry industries. The objective of this experiment is to find the chemical properties of foundry sand and to find the optimum replacement of foundry sand as a fine aggregate in the following ratios of 10%, 20%, 30%, 40% and 50%. Also super plasticizer is added for self-compaction. Finally, the strength characteristics of concrete casted in foundry sand are being found. The study focuses on providing strength as equal as conventional concrete. Experiment leads to the study of strength parameters in the form of beam. Experiment further leads to the research of chemical and binding properties of concrete.*

I. Introduction

Substitution of alternative materials in concrete has been found to improve both the mechanical and durability properties, and this practice can lead to the sustainable concrete development. Waste foundry sand (WFS) is one such promising material, which needs to be studied extensively as substitute of fine aggregates in concrete. It is a by-product from the ferrous and non-ferrous metal casting industries with ferrous foundries producing the most sand. It is characteristically sub-angular to round in shape and has high thermal conductivity, which makes it suitable for moulding, casting operations. Moulding sands are recycled and reused multiple times during casting process. In due course, the recycled sand degrades to the state that it can no longer be reused in the casting process. Then, the old sand is dismissed as by-product, and new sand is introduced into the cycle.

II. OBJECTIVE AND STUDY

To find the chemical properties of foundry sand. To find the optimum dosage for replacement of foundry sand as a fine aggregate in the following ratios of 10%, 20%, 30%, 40% and 50%. To find the strength characteristics of Self Compacting concrete such as Compressive Strength, Split Tensile Strength in above mentioned proportions. To study the flexural behaviour of RC Beam made with optimum proportion of Foundry sand in SCC.

III. LITERATURE REVIEW

Bavita Bhardwaj and Pardeep Kumar (2017) found that the need of use of waste foundry sand (WFS) in concrete. Material properties of WFS. WFS shows enhanced mechanical performance of concrete. Durability of concrete enhanced with incorporation of WFS up to an optimum level.

Gurpreet Singh and Rafat Siddique (2011) added that the partial replacement of sand with WFS (up to 15%) increases the strength properties (compressive strength, splitting tensile strength and modulus of elasticity) of concrete. Maximum increase in compressive strength, splitting tensile strength and modulus of elasticity of concrete was observed with 15% WFS, both at 28 and 91 days. Inclusion of WFS increases the USPV values and

decreased the chloride ion penetration in concrete, which indicates that concrete has become denser and impermeable. WFS can be suitably used in making structural grade concrete

G. Ganesh Prabhu, Jung Hwan Hyun, Yun Yong Kim (2014) stated that the Foundry sand (FS) reused as a substitute material for fine aggregate in concrete. The physical and chemical characterization of the FS was studied. FS substituted in five different substitution rates (10%, 20%, 30%, 40% and 50%). Destructive and non-destructive tests were performed on all concrete mixtures. 20% Substitution is established as an optimum proportion of FS in concrete making.

N. Gurumoorthy, K. Arunachalam (2016) said to minimize the iron content; the Used Foundry Sand (UFS) was treated with acid. By treating, silica in sand enriched is called as Treated Used Foundry Sand (TUFS). To assess properties of concrete; fine aggregate was partially replaced with TUFS.

Rafat Siddique, El-Hadj Kadri (2011) - With 0% Foundry Sand (FS), as the metakaolin (MK) content increased from 5% to 15%, flow decreased up to 6.5%, 17.2%, and 27.6% at the age of 7, 28, and 56 days of testing. This implies that as MK content increased, reduction in surface permeability occurred, which further ensures better surface Durability. With 20% FS, as the MK content increased from 5% to 15%, there was reduction in sorptivity till 10% MK, but at 15%. MK an increase in sorptivity was observed.

IV. METHODOLOGY

The methodology of the project is carried from the Objective and Scope followed by Analysing the chemical properties of Foundry Sand, Calculating the Mix design for M 30. Casting concrete cubes and cylinders in the ratio of 10%, 20%, 30%, 40% and 50% as a replacement of Fine Aggregate and super plasticizer. Finding the Strength Characteristics of cubes and cylinders respectively. Finding the optimum ratio and casting a beam to find the flexure urability of the concrete is studied

V. PROPERTIES

Table 1 : Properties of Sand

	m-sand	Foundry sand
Specific gravity	2.59	2.63
Density(Kg/m3)	1510	1784
Water Absorption (%)	2.2	5

The particle shape is typically sub angular to round and it does not meet the gradation requirements for fine aggregates as per ASTM C33. Hence, only partial replacement with coarser sand is recommended to meet the standard specifications of fine aggregate.

Table 2 : Chemical Properties of Foundry Sand

CHEMICAL COMPOSITION OF FOUNDRY SAND	
Constituents	**Composition**
SiO_2	87.91
Al_2O_3	4.70
Fe_2O_3	0.94
CaO	0.14
MgO	0.30
SO_3	0.09
TiO_2	0.15
K_2O	0.25
Na_2O	0.19
LOI	5.15

VI. MIX DESIGN

The characteristic compressive strength of the concrete is designed for 30 N/mm2

Table 3 : SG of Materials

Materials used	**Type**	**Specific Gravity**
Cement	PPC-43	3.15
F.A	m-sand	2.59
C.A (size)	10-12.5 mm	2.66
Replacement material	Foundry sand	2.63
Super Plasticizer	SP Conplast 430	1.14

INITIAL MIX PROPORTIONS

Cement	**F.A**	**C.A**	**Water**	**Super plasticer**
504.75	908.72	802	175	5.75

The fine Aggregate is replaced with the foundry sand with the following percentages as 10%, 20%, 30%, and 40%

Table 4 : FA & FS Replacement %

.Fine Aggregate (%)	Replacement Sand (Foundry Sand %)
100	0
90	10
80	20
70	30
60	40

VII. RESULTS AND DISCUSSIONS

Cube Compressive Strength at 28th day

Type of Mix	Trial 1	Trial 2	Trial 3	Average
Control (100%)	31.25	33.15	29.05	31.15
Mix 1 (10%)	26.35	25.52	25.25	25.71
Mix 2 (20%)	30.05	31.36	32.58	31.33
Mix 3 (30%)	28.51	28.03	26.65	27.73
Mix 4 (40%)	22.48	23.41	21.60	22.50

SPLIT TENSILE STRENGTH OF CYLINDER AT 28TH DAY

Type of Mix	Trial 1	Trial 2	Trial 3	Average
Control (100%)	3.8	3.15	3.2	3.38
Mix 1 (10%)	2.55	2.64	2.30	2.50
Mix 2 (20%)	3.11	3.14	3.48	3.24
Mix 3 (30%)	2.80	2.65	2.94	2.80
Mix 4 (40%)	2.12	2.50	2.05	2.22

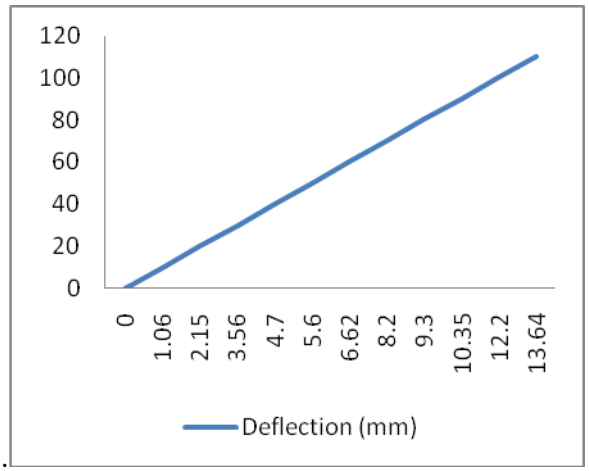
FLEXURE STRENGTH OF THE BEAM

Control Beam	
Load (KN)	**Centre Deflection (mm)**
0	0
10	1.65
20	2.96
30(IC)	**3.78**
40	4.58
50	6.90
60	8.56
70	9.43
80	10.06
90	10.63
100	11.54
102(UL)	**12.58**

IC - Initial Crack

UL - Ultimate Load

Optimum (20%)	
Load (KN)	**Centre Deflection (mm)**
0	0
10	1.06
20	2.15
30	3.56
40(IC)	**4.70**
50	5.60
60	6.62
70	8.20
80	9.30
90	10.35
100	12.20
110(UL)	**13.64**



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