EFFECT OF FERROCHROME SLAG AS PARTIAL REPLACEMENT OF COARSE AGGREGATE ON STRENGTH AND DURABILITY OF CONCRETE

[1]Vinaya Zapate, [2]Dr. V. A. Patil
Student, Civil Engineering Department, BR Harane College of Engineering, Mumbai[1], Principle, Civil Engineering Department, BR Harane College of Engineering, Mumbai[2]
vinaya.zapate@gmail.com[1], brhcetprincipal@gmail.com[2]

ABSTRACT

Due to the growing population, housing, transportation, the demand of concrete is increasing day by day. The local Ferrochrome slag is one of the alternative materials which can be used as coarse aggregate in concrete. The raw material in the production of Ferrochrome is chromite and iron oxides. Ferrochrome slag is the bi-product of waste generated from the ferrochrome steel plant. The Ferrochrome slag having mechanical and engineering properties suitable for utilization as aggregate material in concrete. In the present study, Ferrochrome Slag is assessed for its suitability to partially replace the coarse aggregate in M25 and M35 Grade concrete. Current study is focused on the effect of Ferrochrome Slag on the properties of concrete such as compressive strength, durability, workability. The result predicted after using ferrochrome slag along with partial concrete shows higher strength and durability compared to traditional coarse concrete.

Keywords: *Ferrochrome Slag, Coarse aggregate, Compressive Strength, Durability, Concrete*

INTRODUCTION

Concrete is a versatile material widely used as principal element for structures and for other applications. The demand on concrete is increasing day by day due to the growing population, housing, transportation, and other amenities. As a result, the demand for concrete making materials also increases leading to the scarcity of naturally available fine and coarse aggregate required for concrete making. Additionally, the speedy development of industrialization contributed to different types of waste bi-products which is environmentally dangerous and creates problem in disposal. Hence, utilization of suitable waste bi-products in construction industries has become an inevitable option in recent days by fulfilling the demands of concrete as well as reduction in impact on environment. The use of industrial waste as aggregates in concrete provides good platform to utilize the waste as alternatives to naturally available. Ferrochrome slag is one of the alternative materials which can be used as both coarse and fine aggregate for replacement of river sand and crushed rock ballast in concrete by altering the physical form. Ferrochrome slag is the bi-product of waste generated from the ferrochrome steel plant. The main components of the slag are SiO_2, MgO, and Al_2O_3. The slag also includes Cr and Fe oxides and calcium oxide. In the present study, Ferrochrome Slag is assessed for its suitability to partially and fully replace the conventional course aggregate in M25 and M35 Grade concrete.

II Material Properties

1)Cement: Cement used in this experimental is Ordinary Portland cement (OPC) of 53-grade cement. The cement for the whole experiment is brought in a single batch and stored properly. The cement properties are determined from experimental investigations and presented in Table 1. The cement is confirming to the IS: 8112-1989.

Table No 1

Sr. No.	Property	Cement
1	Normal Consistency	30.5
2	(a) Initial Setting Time (b) Final Setting Time	117 min 265min
3	Specific Gravity	3.15

2) Fine Aggregate (Natural River sand) River natural sand - well graded passing through 4.75 mm sieve was used in this experimental program. The sand used as per IS 383:1970 specifications.

Table No 2

Sr. No.	Test Parameter	Result
1	Specific Gravity	7.04
2	Water Absorption (%)	0.45
3	Loose Bulk Density (kg/liter)	3.04

3) Coarse aggregate (20 downsize) Coarse aggregate used was crushed basalt is strong and durable aggregate. It is taken from Turbhe Navi Mumbai. The coarse aggregate used as per IS383:1970 specifications, the aggregate is angular in shape. The maximum size of aggregate was limited to 20mm down for 30MPa.

Table No 3

Sr. No.	Test Parameter	Result
1	Specific Gravity	2.87
2	Water Absorption (%)	0.45
3	Loose Bulk Density (kg/liter)	3.04

4)Ferrochrome slag: Water cooled ferrochrome slag is appeared to be dark in colour and is said to have granulated and crystalline texture. Whereas air cooled slag is grey in colour and is said to have a lumpy texture.

Table No 4

Sr. No.	Test Parameter	Result
1	Specific Gravity	2.87
2	Water Absorption (%)	0.45
3	Loose Bulk Density (kg/liter)	3.04

5) Water

Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. In the experimental work, ordinary portable tap water available at laboratory was used for mixing the concrete and curing the concrete specimen.

Table No 5 Chemical Composition of Ferrochrome Slag

Constituent	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	Cr_2O_3
Composition (%) by wt.	30	4	26	2	23	15

Table No 6 Sieve Analysis of Coarse Aggregate and Ferrochrome Slag

Sr. No.	IS Sieve	Cumulative Percentage Weight Retained Coarse Aggregate	Cumulative Percentage Weight Retained FaCr
1	20 mm	100	100
2	16 mm	48.63	55.20
3	12.5 mm	21.106	23.00
4	10 mm	2.216	2.22
5	8 mm	0	1.20
6	6.3 mm	0	0
7	4.75 mm	0	0

III) EXPERIMENTAL INVESTIGATION: The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of required strength, workability as economically as possible is termed the concrete mix design.

Table 5.1 Mix Proportion M25 and M35

M35 GRADE OF CONVENTIONAL CONCRETE MIX PROPORTION		M25 GRADE OF CONVENTIONAL CONCRETE MIX PROPORTION	
Cement	350 kg/m³	Cement	440kg/m³
Water	145 kg/m³	Water	145 kg/m³
Fine aggregate	985 kg/m³	Fine aggregate	948 kg/m³
Coarse aggregate	1354kg/m³	Coarse aggregate	1301 kg/m³
MIX PROPORTION 1:2.8:3.8		MIX PROPORTION 1:2.1:3	

Workability Test -

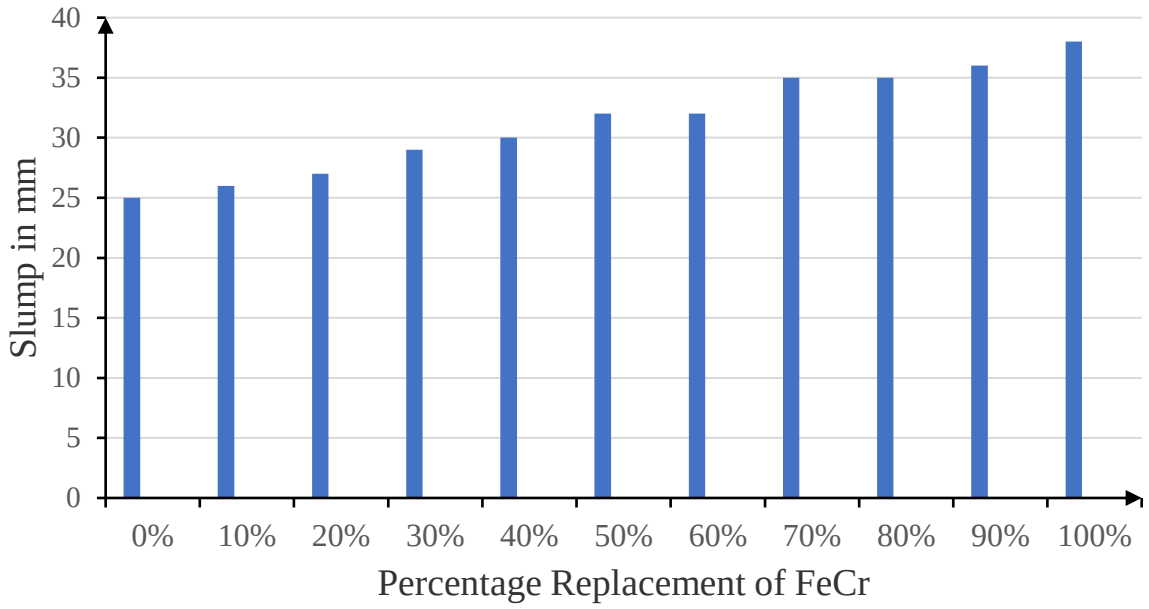

Figure No 1

Workability of Concrete with Percentage Replacement of Ferrochrome Slag(M25 grade concrete)

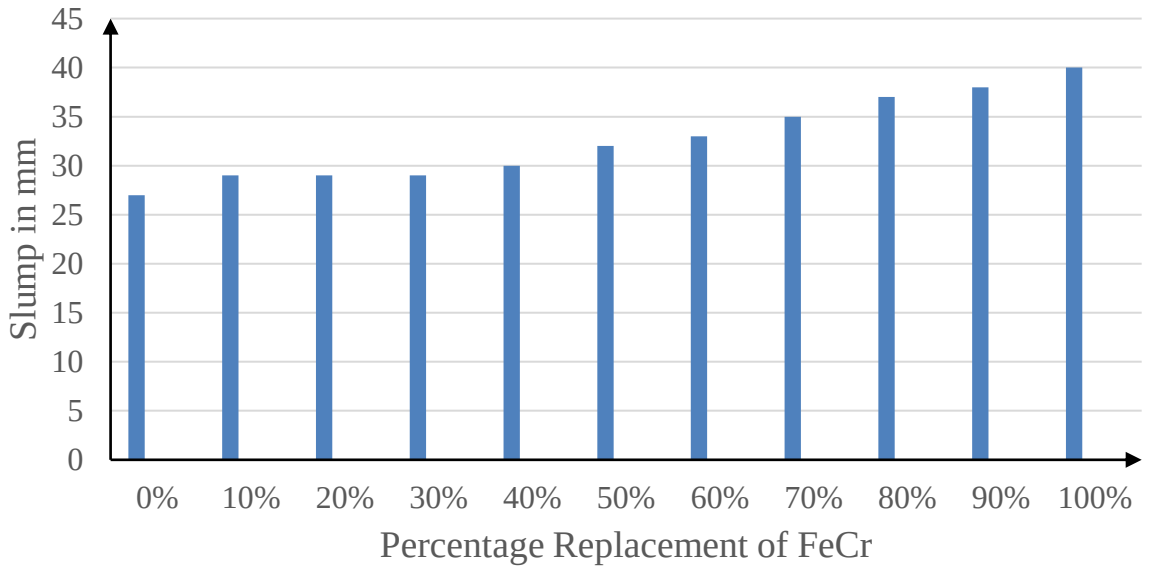

Figure No 2

Workability of Concrete with Percentage Replacement of Ferrochrome Slag (M35 grade concrete)

IV) SUMMARY AND CONCLUSION

1. Ferrochrome slag a waste biproduct generated during the manufacturing of Ferro Chrome alloy.
2. Various materials to be selected and done by experimental investigation programs according to Indian Standards.
3. Verify the material properties and do the mix design as per IS standards .
4. Preparation of sample and tests performed on fresh concrete and measuring the workability of concrete.

CONCLUSION

Based on the experimental investigation conducted on conventional coarse aggregate concrete

1) The basic properties like Specific gravity, impact strength and crushing strength of ferrochrome slag aggregates are higher than conventional coarse aggregate.
2) Ferrochrome slag can be considered as alternativeto conventional coarse aggregate in M25 and M35 grade concrete result of slump value decreases as the percentage of
   Ferrochrome Slag aggregate increases.
3) .The usage of ferrochrome slag as coarse aggregatein concrete reduces the usage of conventional coarse aggregate resulting in reduction of Environmental pollution.

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