



Experimental Study on Coarse Aggregate Replaced by Ferro Chrome Slag

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Abstract:

Ferrochrome slag is one of the alternative materials which can be used as coarse aggregate in concrete. Ferrochrome slag is a major solid discarded bi-product got during the manufacturing of ferrochrome alloy. The Ferrochrome slag generated is a stable, dense, crystalline product having tremendous mechanical and engineering properties suitable for utilization as aggregate material in concrete. In the current study, Replacement of ferrochrome slag with conventional coarse aggregate in concrete for (M35 Grade) concrete for every incremental of 25% replacement upto 100% is done. The fresh properties of concrete are determined by means of Slump cone test. The hardened property of concrete is determined by casting cubes for compressive strength, cylinders for split tensile strength for 7days, 14days and 28days curing. The results obtained are compared with conventional coarse aggregate (0% replacement) concrete.

Keywords: Ferrochrome Slag, Coarse Aggregate, Compressive Strength, Split Tensile Strength.

I. INTRODUCTION

In a developing country like India, with fast decrease in the available natural resources which are used for the construction purpose we should search for alternative materials which satisfy the requirements of the materials in use. Construction of infrastructure also increases the demand for production of concrete, which in turn increases the demand and supply of aggregates. Lack of availability of good quality aggregates within reasonable distance brings out the need to identify the sources of new aggregate. The material used for testing need to have the potential to meet the aggregate demands for construction activities. The twin objectives of conservation of natural resources and pollution free environment may be achieved. Recycling the waste concrete was the first initiative step taken to produce a new aggregate concrete. Replacing part of the natural aggregates with alternatives has the benefits of reducing the extraction of aggregates, the amounts of disposed waste materials, and the associated environmental and social impacts. The principal objective of this project is to evaluate the potential use of Ferrochrome Slag aggregate as alternative aggregates in concrete, a major construction product. Construction aggregate, or simply "aggregate", is a broad category of coarse particulate material used in construction, including sand, gravel, crushed stone, slag, recycled concrete and geosynthetic aggregates. Aggregates are the most mined material in the world. Aggregates are a component of composite materials such as concrete and asphalt concrete;

II. MATERIALS

Cement

It is a fine powdered form what called clinker, and adding small amounts of other material. Mahasakthi cement of ordinary Portland cement (OPC) of 53 grade was used which satisfies the requirements of IS: 8112-1989. Various properties of cement such as normal consistency, specific gravity, initial final setting time of cement fineness. The cement properties

are determined from experimental investigations and presented in given Table. The cement is conforming to the IS: 8112-1989.

Table.1. Typical Properties of Cement

S.No.	Properties	Results
1	Specific Gravity	3.15
2	Fineness	2.5%
3	Normal Consistency	30%
4	Initial Setting Time	30 minutes
5	Final Setting Time	600 minutes

Fine aggregate

These are the aggregates which has size less than 4.75mm. In laboratory they are classified as the aggregates which passes through the BIS sieve no.480. In general, natural river sand is used as a fine aggregate. The properties of Fine aggregates determined from experimental investigations and presented in given table. Fine aggregate conforming to IS 383-1970.

Table.2. typical properties of fine aggregates.

S.No.	Property	Results
1	Specific Gravity	2.66
2	Fineness Modulus	2.87
3	Water Absorption	2%
4	Grading	Zone-II

Coarse aggregate

These are the aggregates which has size more than 4.75mm .in laboratory they are separated as the aggregates which are retained on the BIS test sieve no.480.The properties of coarse aggregates determined by using IS: 383-1970.Coarse aggregates properties are determined from experimental investigations and presented in given Table

Table.3. Properties of coarse aggregates.

S.No	Property	Results
1	Maximum nominal size	20 mm
2	Bulk density	1800 kg/m ³
3	Specific gravity	2.72
4	Toughness	10.4%
5	Hardness	9.5%
6	Fineness modulus	6.14
7	Water absorption	2%

Ferro chrome slag

Ferrochrome slag a waste bi-product generated during the manufacturing of Ferrochrome alloy. Ferrochrome alloy is manufactured in a submerged electric arc furnace by physiochemical process at the temperature of 1700oC. Individually the molten liquids of the ferrochromium and slag flow out into dippers. Due to the different specific gravities of metal and slag, separation of the two liquids takes place. The liquefied ferrochrome slag gradually cools down in air forming a stable, dense, crystalline product having tremendous mechanical properties. The main constituents of ferrochrome slag are SiO₂, Al₂O₃ and MgO with minor traces of ferrous/ferric oxides and Clothe properties of Ferro chrome slag aggregates the determined by using IS: 383-1970.the properties shown by a given table

Table.4. Typical properties of ferro chrome slag aggregates.

S.No.	Property	Results
1	Maximum nominal size	20 mm
2	Bulk density	1783 kg/m ³
3	Specific gravity	3
4	Fineness modulus	5
5	Toughness	9.4%
6	Hardness	7.65%
7	Water absorption	1.5%

Water

Water fit for drinking is generally considered fit for making concrete. Water should be free from acids, oils, alkalis vegetables or other organic Impurities. The properties of water can be taken from according to the BIS standards of drinking water. The properties of water can be represented by a given table .

Table.5. Typical properties of water

S.No.	Property	Result
1	Colour	Agreeable
2	pH	6.5-8
3	Total Dissolved Solids	500 mg/l
4	Odour	Aggregable

M35 GRADE RATIO

CEMENT: FINE AGGREGATE: COARSE AGGREGATE

1 : 1.91 : 2.50

WORKABILITY

A. Result and Discussion

The workability of concrete describes the homogeneity and the ease of mixing, handling, placing, compacting and finishing of the concrete (or mortar). Workability or rheology of fresh concrete is the term traditionally been used in concrete technology to embrace all the necessary qualities. The test used is slump test.

Table.6. Slump cone test results

S.No.	Ferro chrome slag replacements in concrete(%)	Slump (mm)s
1	0	25
2	25	28
3	50	30
4	75	32
5	100	34

Tests on hardened concrete

The Testing of Hardened concrete plays a vital role in governing and checking the quality of cement concrete works and helps to determine the performance of the concrete with respect to strength and durability. In this study, for each batch

Compressive Test for Cube 14 days

Control of mix	Compressive strength in N/mm ² at 14 days				
	FCS (0)%	25%	50%	75%	100%
M35	36.05	36.35	36.75	36.85	44.06

Compressive Test for Cube 28days

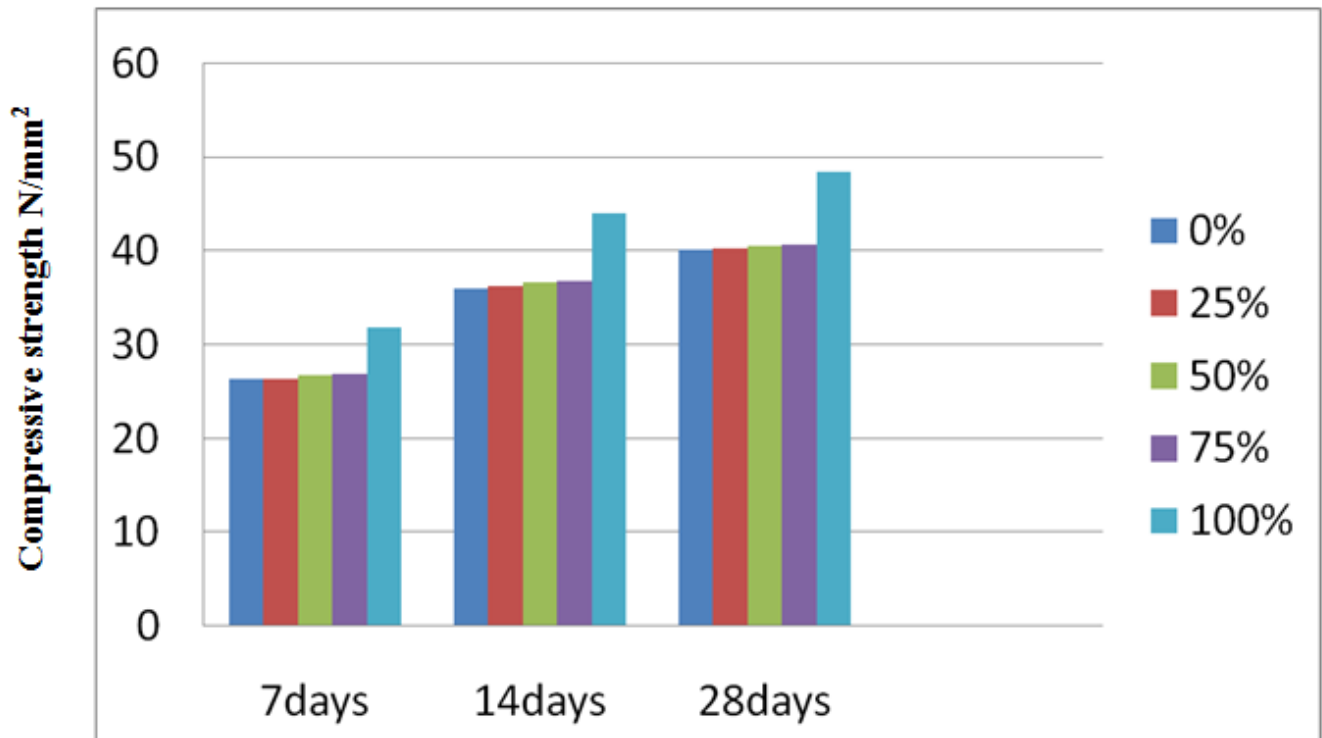
Control of mix	Compressive strength in N/mm ² at 28 days				
	FCS (0)%	25%	50%	75%	100%
M35	40.16	40.25	40.58	40.76	48.47

Of concrete, three cubes of 150mm x 150mm x 150mm sizes are tested for Compressive Strength. Three cylinders of 150mm diameter x 300mm height size are tested for

**Split Tensile Strength: B. Result and Discussion
COMPRESSIVE STRENGTH RESULTS**

After curing period we test the cube specimen at 7 days, 14 days, 28 days various replacements (0%, 25%, 50%, 75%, 100%)

Graph for Compressive Strength Results



Age, Days

Compressive Strength Results

Tensile strength results: After curing period we test Control of mix Split tensile strength in N/mm² at 14 days various replacements (0%, 25%, 50%, 75%, 100%) of Ferro chrome slag to achieve split tensile strength of concrete represented by a table 6.4, 6.5, 6.6, and to achieve the highest split tensile strength of concrete 5.38 N/mm² for 100% replacement of Ferro chrome slag.

Split Tensile Test for Cylinder 14days

Control of mix	Split tensile strength in N/mm ² at 14 days				
	FCS(0)%	25%	50%	75%	100%
M35	3.65	3.69	3.71	3.74	4.4

of Ferro chrome slag to achieve compressive strength of concrete represented by a table 6.1, 6.2, 6.3, and to achieve the highest compressive strength of concrete 48.47 N/mm² for 100% replacement of Ferro chrome slag.

Compressive Test for Cube 7 days

Control of mix	Compressive strength in N/mm ² at 7 days				
	FCS (0)%	25%	50%	75%	100%
M35	26.32	26.41	26.76	26.88	31.83

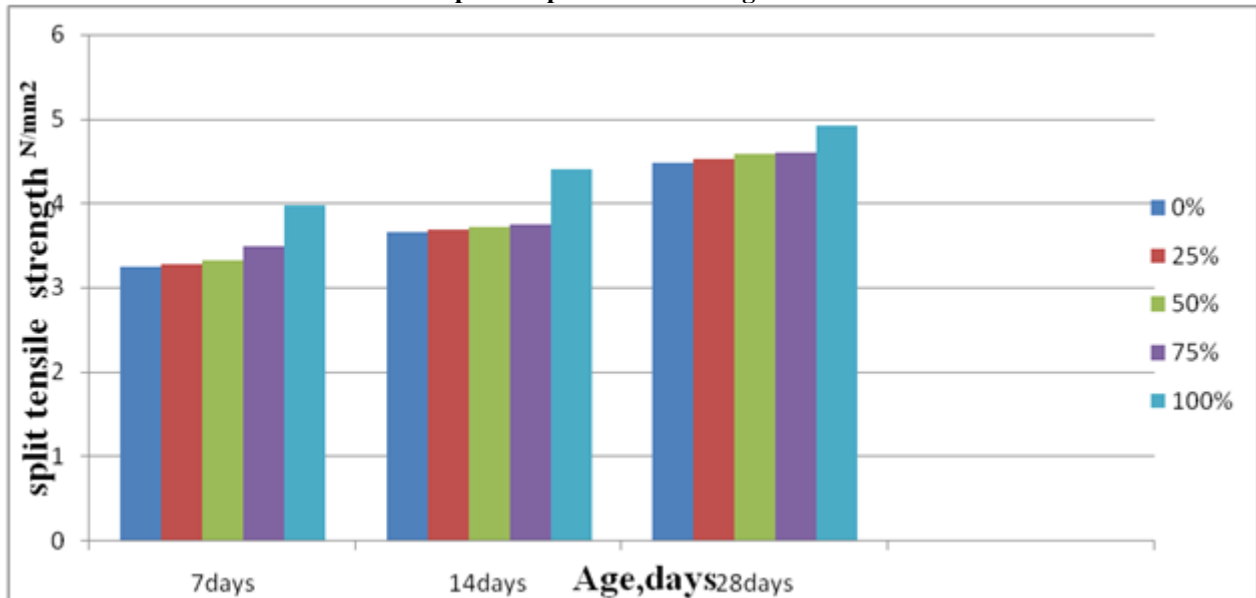
Split Tensile Test for Cylinder 7days

Control of mix	Split tensile strength in N/mm ² at 7 days				
	FCS(0)%	25%	50%	75%	100%
M35	3.24	3.28	3.32	3.48	3.97

Split Tensile Test for Cylinder 28days

Control of mix	Split tensile strength in N/mm ² at 28 days				
	FCS(0)%	25%	50%	75%	100%
M35	4.47	4.52	4.58	4.60	4.92

Graph for Split Tensile Strength Results



III. SUMMARY AND CONCLUSION

Summary

1. Ferrochrome slag a waste bi-product 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.
5. Casting can be done by, moulds, cylinders and kept in Normal curing tank and accelerated curing tank.
6. After curing period various tests performed on hardened Concrete like compressive strength of cubes, split tensile Strength for cylinders. We know the test results and can be Analyzed.

IV. CONCLUSION

Based on the experimental investigation conducted on conventional coarse aggregate concrete and

- 1.The basic properties like Specific gravity, impact strength and crushing strength of ferrochrome slag aggregates are higher than conventional coarse aggregate.
- 2.Workability of M35ferrochrome slag aggregate replaced concrete for M35 Grade, the following conclusions are drawn. grade concrete increased with increase of ferrochrome slag.
- 3.The replacement of conventional coarse aggregate with ferrochrome slag aggregate in concrete up to 100% has resulted in increased strength in compression, split tensile and flexure by conventional curing.
- 4.Ferrochrome slag can be considered as alternative to conventional coarse aggregate in M35 grade concrete mix due to its higher strengths achieved.
- 5.The usage of ferrochrome slag as coarse aggregate in concrete reduces the usage of conventional coarse aggregate resulting in reduction of Environmental pollution.

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