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# Development of Normal Strength Concrete using Ferrochrome Slag Aggregate as Replacement to Coarse Aggregate

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**Abstract**

Concrete plays a significant role within the development of infrastructure resulting in utilization of enormous amount of concrete. On the opposite facet, price of concrete is attributed to price of its ingredients that is scares and high-priced, this resulting in usage of economically various materials in its production. This demand is drawn the eye of concrete with partial replacement of coarse mixture with ferrochrome scum aggregates. The cubes and cylinders were tested for compressive strength and split durability when a natural process amount of 7days, 14days and 28days respectively and compared to traditional combine concrete. The ferrochrome scum concrete exhibited higher strengths compared to traditional coarse mixture concrete.

Keywords: *Ferrochrome Slag, Concrete, Compressive Strength, Split tensile strength.*

## 1. Introduction

Slags are the unit vital wastes and by-products of metallurgic trade that are treated, recycled and utilization of the varied slags from metallic element and non-ferrous metal production, in addition as waste combustion, and use of salt fluxes in secondary metal production. The metallurgic compound slags have stone-like properties and, thus their major applications area unit in applied science field worldwide. The slags ought to be recycled, changed and processed in an exceedingly correct means, by taking the environmental impact into thought. Ferrochrome scoria may be a by-product from the assembly of ferrochrome, a necessary element in chrome steel. Within the production of refractoriness, there's associate degree possibility of metallurgic trade wastes to be utilized. Slags in production of high carbon ferrochrome area unit sometimes drop. Utilization of drop ferrochrome scoria in refractory castables reduces the value of product and is friendly to the atmosphere. This material is getting used for construction, brick producing and has recently been tried in cement trade and as a base layer material in road pavements.

The most objective of this thesis is to stipulate the appliance of ferrochrome scoria combination in concrete as coarse combination and scrutiny this concrete with the standard concrete.

## 2. Methodology

### 2.1 Methodology Details

The present investigation is to style M25 grade traditional strength concrete. Additional developed mixes are studied each for natural philosophy further more as hardened properties. During this study coarse combination is replaced by ferrochrome scum combination material. Additional it is planned to draw the program for casting range of cubes and cylinders. Combine the combination the combo style planned is as per Indian standards methodology of mix style. The proportion replacement of Ferrochrome scum aggregates chosen within vary from zero to hundred percent at associate degree interval of twenty five.

### 2.2 Experimental Programme

The process consists of testing the essential materials within the laboratory. The look combine is figures out by Indian Standards technique using basic material check results, and then the developed quantitative relation is taken as a combination quantitative relation. For this combine quantitative relation coarse mixture is replaced by ferrochrome scum aggregate (0-100%) at associate in nursing interval of twenty fifth in associate in nursing increasing order. All mixes developed are studied and tested for each contemporary and hardened property. Total ninety specimens were casted and tested for compressive and split strength within the laboratory. The main point of specimen projected to be solid is as shown in table one.

Table 1: Details of cubes and cylinder with various percentage of ferrochrome slag

| Mixes | Ferrochrome replaced by % of coarse aggregates | Cubes | | | Cylinders | | |
|---|---|---|---|---|---|---|---|
| | | 7-days | 14-days | 28-days | 7-days | 14-days | 28-days |
| Control mix | 0 | 3 | 3 | 3 | 3 | 3 | 3 |
| 1 | 25 | 3 | 3 | 3 | 3 | 3 | 3 |
| 2 | 50 | 3 | 3 | 3 | 3 | 3 | 3 |
| 3 | 75 | 3 | 3 | 3 | 3 | 3 | 3 |
| 4 | 100 | 3 | 3 | 3 | 3 | 3 | 3 |
| No. of samples | | 15 | 15 | 15 | 15 | 15 | 15 |

### 2.3 Materials Used

**1.Cement:** In this experimental work, standard Portland Cement (OPC) forty three grade orthodox to IS: 8112 – 1989 is employed. The cement used was Japee cement obtained from the native distributors.

**2. Fine Aggregate:** Locally available river sand belonging to zone II of IS 383-1970 was used for the project work.

**3. Coarse Aggregate:** Quarried and crushed granites stone was used as coarse aggregates. The specific gravity of coarse aggregates of 20mm and downsize was found according to the norms of Indian standards.

**4. 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. Soft waters also produce weaker concrete. Water has two functions in a concrete mix. Firstly, it reacts chemically with the cement to form a cement paste in which the inert aggregates are held in suspension until the cement paste has hardened. Secondly, it serves as a vehicle or lubricant in the mixture of fine aggregates and cement.

**5. Ferrochrome Slag aggregate:** The properties of Ferrochrome Slag aggregate used in the present investigation are reported in Table 2. This was procured fromNinita Enterprises, Bhubaneswar (INDIA).

Table 2: Chemical Composition of Ferrochrome Slag aggregate

| Sl.no | Oxide composition (%) | Ferrochrome Slag Aggregate |
|---|---|---|
| 1 | SiO2 | 59.7 |
| 2 | Fe2O3 | 1.4 |
| 3 | Al2O3 | 7.9 |
| 4 | CaO | 23.2 |
| 5 | Mgo | 5.7 |
| 6 | SO3 | 0.3 |
| 7 | K2O | 0.12 |
| 8 | Na2O | 0.02 |
| 9 | Cl | 0.05 |
| 10 | Loss in ignition | 0.60 |

Table 3: Properties of Conventional Coarse aggregate and Ferrochrome Slag aggregate

| Property | Conventional aggregate | Ferrochrome Slag aggregate |
|---|---|---|
| Maximum nominal size | 20.0 | 20.0 |
| Specific gravity | 2.75 | 3.0 |
| Bulk density, kg/m$^3$ | 1470 | 1480 |
| Water absorption (%) | 0.5 | 0.5 |
| Fineness Modulus | 3.71 | 5.0 |
| Impact Value (%) | 13.5 | 13.0 |

## 3. Results and Discussion

### 3.1 Tests on Fresh Concrete

Mixing of ingredients of concrete is done for the designed mix proportion (M25) grade of concrete mixes by adding Ferrochrome slag aggregate by weight of conventional coarse aggregate with different percentages (25%,50%,75%,100%). Slump cone test, compacting factor test and Vee-bee consistometer test measure the workability of fresh concrete mix. The workability tests are carried out as per IS: 1199-1959, the results are shown in Table 5

Table 4: Results of slump, compaction factor and Vee-bee time test values

| Sl No | Grades of Concrete | Ferrochrome slag replacement in | Slump (mm) | Compaction factor | Vee-Bee degree In seconds |
|---|---|---|---|---|---|
| 1 | M$_{25}$ | 0.0 | 25 | 0.82 | 16 |
| 2 | | 25 | 29 | 0.80 | 15 |
| 3 | | 50 | 30 | 0.78 | 14 |
| 4 | | 75 | 32 | 0.74 | 11 |
| 5 | | 100 | 35 | 0.72 | 8 |

From the table it is observed that both slump and Vee-bee time values decreases and Compaction factor increase as the percentage of Ferrochrome slag aggregate increases.

### 3.2. Tests on Hardened Concrete

This section describes the results of the test programme to establish the mechanical properties of the normal as well Ferrochrome slag aggregate added to the concrete with different percentage to the weight of the Coarse aggregate. Concrete mixes detailed in the preceding section. Mixing of ingredients of concrete is done for the mix proportion for M25 grades of concrete mixes by adding Ferrochrome slag aggregate with different percentages in the range of (0-100%) at an increment of 25%.

**3.2.1 Cube Compressive Strength:** One of the important properties of concrete is its strength in compression. The strength in compression has a definite relationship with all the other properties of concrete i.e. these properties are improved with the improvement in compressive strength. The size of the mould is usually 150x150x150 mm. Concrete cubes are tested for 7,14 and 28days strength as per IS: 516-1959 (Part 5) for testing of concrete cubes. Rate of application of Compressive load is 1.40 KN/cm2/min and is tested in a compression testing machine.

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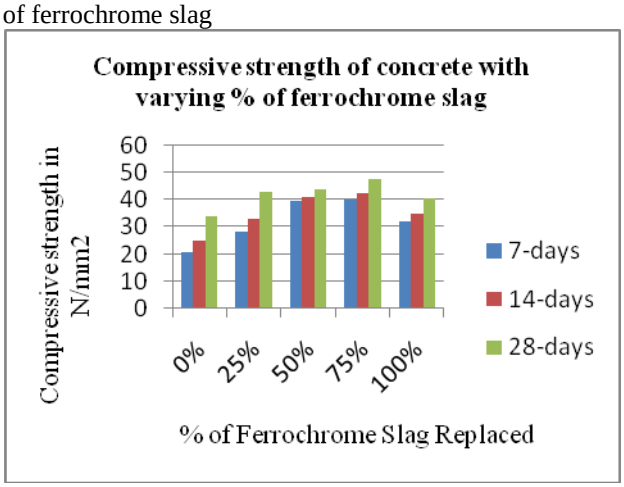
Table 5: Results of cube compressive strength for different curing period

| Sl No | Grade | Replacement of Ferrochrome slag aggregate (%) | Compressive strength (N/mm$^2$) | | |
|---|---|---|---|---|---|
| | | | 7days | 14 days | 28 days |
| 1 | M25 | 0.0 | 20.58 | 25.07 | 34.08 |
| 2 | | 25 | 28.18 | 33.09 | 42.89 |
| 3 | | 50 | 28.18 | 33.09 | 42.89 |
| 4 | | 75 | 40.12 | 42.71 | 47.88 |
| 5 | | 100 | 32.28 | 35.11 | 40.79 |

Chart 1: Compressive strength of concrete with varying % of ferrochrome slag



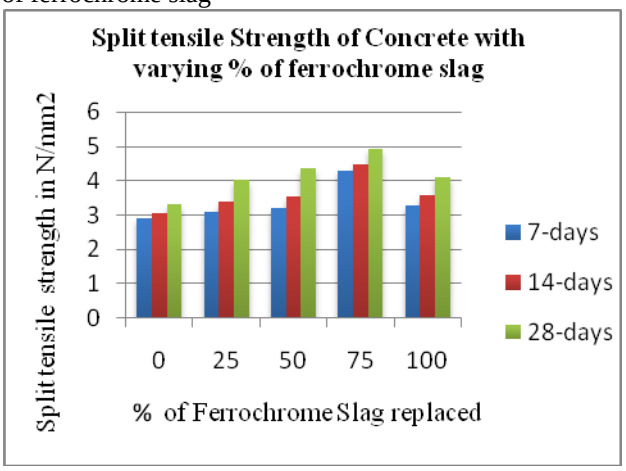

### 3.2.2. Splitting Tensile Strength of Cylinder:

This is additionally referred as, "Brazilian Test". This check was developed in Brazil in 1943. At regarding identical time this was additionally severally developed in Japan. The check is administered by inserting a cylinder specimen horizontally between the loading surfaces of a compression testing machine and also the load is applied till failure of the cylinder, on vertical diameter. The loading condition produces a high compressive stress directly below the two generators to that the load is applied however the larger portion reminiscent of depth is subjected to a homogenous tensile stress acting horizontally. It is calculable that the compressive stress is acting for regarding 1/6 depth and remaining 5/6 depth is subjected to tension. The cacophonous check is straight forward to perform and offers additional uniform results than different tension tests. Strength determined within the cacophonous check is believed to be nearer to verity strength of concrete, than the modulus of rupture. Cacophonus strength provides regarding five to 100% higher price than the direct strength.

Table 6: Results of Cylinder Split Tensile strength for different curing period

| Sl No | Grade | Replacement of Ferrochrome slag aggregate (%) | Split tensile strength (N/mm$^2$) | | |
|---|---|---|---|---|---|
| | | | 7days | 14 days | 28 days |
| 1 | M25 | 0.0 | 2.92 | 3.05 | 3.33 |
| 2 | | 25 | 3.08 | 3.40 | 4.03 |
| 3 | | 50 | 3.19 | 3.56 | 4.36 |
| 4 | | 75 | 4.28 | 4.49 | 4.92 |
| 5 | | 100 | 3.29 | 3.57 | 4.12 |

Chart 2: Split tensile Strength of Concrete with varying % of ferrochrome slag




## 4. Conclusions

The following conclusions are drawn from the experimental investigations carried out on conventional coarse aggregate concrete and ferrochrome aggregate replaced concrete of M25 grade.

1. The basic properties of ferrochrome dross mixture like relatively relative density, Bulk density and impact worth area unit higher than standard coarse mixture that indicates that the standard of fabric is nice and therefore the concrete made victimization the ferrochrome dross can have high Density.
2. The fineness modulus of each the aggregate are nearly same and thus there might not be abundant variation in physical behavior.
3. Compressive strength of concrete will increase with increase of ferrochrome scoria combination up to seventy fifth replacements and reduces slightly at 100 percent replacement, but the values square measure over that of typical concrete
4. Split lastingness of concrete will increase with increase with increase of ferrochrome scoria mixture

up to seventy fifth replacements and reduces slightly at 100 percent replacement, but the values are more than that of typical concrete.

Hence it is concluded that ferrochrome slag aggregate in suitable as an alternative material for conventional coarse aggregate.

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