Strength And Durability Studies on Usage of Scrap Material Aggregate In Concrete

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Abstract- *Aggregate is one of the main ingredients in producing concrete. It is 75% of the concrete. The strength of the concrete produced is dependent on the properties of aggregates used. There is huge demand for this material. Hence need for an alternative coarse aggregate arises. The scope of project was to investigate the possibility of using sponge iron scrap material as an alternative material to coarse aggregate in structural concrete. Experimental investigation was carried out on compressive strength and durability related tests such as acid resistance test and Permeability. Tests were conducted by replacing the coarse aggregates in concrete mixes by sponge iron scrap material. From the experimental investigation it was found that sponge iron scrap material can be used as an alternative for coarse aggregate in concrete. However further investigations have to be made to study long term effects.*

Keywords- Sponge iron scraps material, Compressive strength, Acid resistance test and Permeability tests

I. INTRODUCTION

Cement concrete is the most extensively used construction material in the world and is the second to water as the most heavily consumed substance with about six billion tonnes produced every year. It has emerged as the dominant construction material for the infrastructure needs of the 21st century. The challenge for civil engineers in the future is to design the project using high performance materials within reasonable cost and lower impact on environment. Large quantities of waste materials are produced from the manufacturing industry, service industry and municipal solid waste incinerators. The waste materials are gaining attention to use the materials as a substitute to natural getting them utilized in cement, concrete, and other construction materials, it helps in reducing the cost of cement and concrete manufacturing, but also has numerous indirect benefits such as reduction in land-fill cost, saving in energy, and protecting the environment from possible pollution effects.

Concrete is a composite material composed of gravels or crushed stones (coarse aggregate), sand (fine aggregate) and hydrated cement (binder). It has been in use for over a century in all construction works. A variety of new materials in the field of concrete technology have been developed during the recent past with the ongoing demand of construction industries to meet the functional, strength, economical and durability requirements.

II. EXPERIMENTAL PROGRAMME

In the present experimental program, standard cubes of size (150x150x150mm) conforming to IS: 10086-1982 were cast and tested for compressive strength , standard cubes of size (100x100x100mm) were cast and tested for acid attack resistance.

1 MATERIALS

The materials used in this experimental study were cement, fine aggregate, coarse aggregate, water.

1.1 CEMENT

Ordinary Portland cement (Ultra tech cement) of 53 grade confirming to IS: 12269-1987 was used. Physical Properties of Ordinary Portland Cement are given in table 3.4.

1.2 AGGREGATE

The size, shape and gradation of the aggregate play an important role in achieving a proper Concrete. The flaky and elongated particles will lead to blocking problems in confined zones. The sizes of aggregates will depend upon the size of rebar spacing. The coarse aggregate chosen for Concrete was typically angular in shape, well graded, and smaller than maximum size suited for conventional concrete.

1.2.1 Fine Aggregate

The locally available river sand was used as fine aggregate in the present investigation. The sand was free from clayey matter, salt and organic impurities. The sand was tested for various properties like specific gravity, bulk density etc., and in accordance with IS 2386-1963. The fine aggregate was conforming to standard specifications. The details of test results are given in Table.

1.2.2 Coarse Aggregate

Coarse Aggregate used is scrap material obtained during manufacturing process of reinforcement steel from iron ore, while processing raw ore to sponge iron .The physical properties of coarse aggregate were investigated in accordance with IS 2386 -1963. The details of test results are given in Table.

Crushed stone coarse aggregate of angular in shape obtained from local crushing plant was used in the present study. The physical properties of coarse aggregate were investigated and the details of test results are given in table.

III. CONCRETE MIX DESIGN

M15 grade concrete cubes were casted using the following proportions by weight.

Material requirement for M15 grade concrete

Cement	Fine Aggregate	Coarse Aggregate	Water
240 kg/m^3	480 kg/m^3	960 kg/m^3	144 kg/m^3

Using the properties of cement aggregate concrete mix of M20 grade was designed as per IS10262-2009 the mix design procedure and calculations are presented in Appendix A the following proportions by weight were obtained.

Table 2: Material requirement for M20 grade concret

Cement	Fine Aggregate	Coarse Aggregate	Water
320 kg/m^3	694 kg/m^3	1156 kg/m^3	192 kg/m^3

IV. PREPARATION OF TEST SPECIMENS

1 Mixing

Mixing of ingredients is done in a pan mixer. The cementitious materials are thoroughly blended and then the aggregate is added and mixed followed by gradual addition of water. Before casting specimens, workability of the mixes was found by slump test.

2 Casting of Specimens

The cast iron moulds are cleaned of dust particles and applied with mineral oil on all sides before concrete is poured in the moulds. The moulds are of size 150mm x 150mm and 100mm x 100mm for cubes. The well mixed concrete is filled in to the moulds by vibration with vibrator. Excess concrete was removed with trowel and top surface is finished level and smooth.

3 Curing of Specimens

The specimens are left in the moulds undisturbed at room temperature for about 24 hours after casting. The specimens are then removed from the moulds and immediately transferred to the curing pond containing clean and fresh water.

4 Testing of Specimens

A time schedule for testing of specimens is maintained to ensure their proper testing on the due date and time. The cast specimens are tested as per standard procedures, immediately after they are removed from curing pond and wiped off the surface water. The test results are tabulated carefully.

5 Testing Arrangement

The specimens are removed from the curing pond just before testing on the specified due date and time and cleaned to wipe off the surface water. The cube specimen is placed on the lower plate of the compressive testing machine such that the load is applied centrally on the faces other than top and bottom faces of Casting. The top plate is brought in contact with the specimen by rotating the handle the oil pressure valve is closed and the machine is switched on a uniform rate of loading is maintained. The maximum load at failure at which the specimen breaks and pointer starts falling back is noted. The test is repeated for the three specimens and the average value is taken as mean strength. Compressive strength is taken as load applied on the specimen divided by the area of the load bearing surface of specimen.

V. TESTING PROGRAMME

Compressive strength of concrete can be defined as maximum resistance of concrete to axial loading. The specimens used for compression test were cubes of size 150x 150x150 mm size. Compressive strength was determined for 7 and 28 days respectively. The test was conducted in the laboratory on the compression testing machine of 3000 KN capacity and the reading at the time of failure of specimen was taken.

VI. OBSERVATIONS AND DISCUSSION OF TEST RESULTS

1 Aggregate Crushing Value

The aggregate is placed in a cylindrical mould and a load of 40 ton is applied through a plunger. The material crushed to finer than 2.36 mm is separated and expressed as a percentage of the original weight taken in the mould. The results are tabulated in Table 4.1.

Table 4.1: Aggregate Crushing Value Test

Sample No.	Weight of Aggregate (W1) gms	Weight of aggregate passing through 2.36 mm sieve after crushing (W2) gms	Aggregate Crushing Value =(W2/W1)x100
1	2809	875	31.15
2	2785	859	30.84

Aggregate crushing value is restricted to 30 percent for concrete used for roads and pavements and 45% for other structures as per IS 283-1970, Hence Sponge iron material can be Used as Aggregate in concrete works other than roads and pavements

2 Aggregate Impact Value

The test done by a sample of standard aggregate kept in a mould is subjected to fifteen blows of a metal hammer of weight 14 Kgs falling from a height of 38 cms. The quantity of finer material (passing through 2.36 mm resulting from pounding will indicate the toughness of the sample of aggregate. The ratio of the weight of the fines (finer than 2.36 mm size) formed, to the weight of the total sample taken is expressed as a percentage. The results are tabulated in Table 4.2.

Table 4.2: Aggregate Impact Value Test

Sample No.	Weight of Aggregate (W1) gms	Weight of aggregate passing through 2.36 mm sieve after Load applied (W2) gms	Aggregate Impact Value =(W2/W1)x100
1	338	107	31.65
2	341	102	29.91

Aggregate Impact is restricted to 30 percent for concrete used for roads and pavements and 45% for other structures as per IS 283-1970, Hence Sponge iron material can be Used as Aggregate in concrete works other than roads and pavements.

3 Bulk Density

Table 4.3: Bulk density of material

SAMPLE No.	WEIGHT OF AGGREGATE		VOLUME OF CONTAINER (ml)	BULK DENSITY (kg/m³)	
	LOOSE AGGREGATE (gms)	COMPACTED AGGREGATE (gms)		LOOSE	COMPACTED
I	4093	4403	2975	1376	1480
II	3994	4353	2975	1342.5	1463.2

Bulk density of sponge iron scrap material is similar to conventional crushedgranite coarse aggregates.

4 Specific Gravity

Specific gravity of aggregates is made use of in design calculations of concrete mixes. With the specific gravity of each constituent known, its weight can be converted into solid volume and hence a theoretical yield of concrete per unit volume can be calculated. Specific gravity of aggregate is also required in calculating the compacting factor in connection with the workability measurements. The results are tabulated in Table 4.4.

Table 4.4: Specific Gravity of Sponge Iron Scrap Material

SAMPLE No.	Specific gravity
1	2.65
2	2.63

5 Water Absorption

Water absorption of aggregate will affect the water/cement ratio and hence the workability of concrete. The water absorption of aggregate is determined by measuring the increase in weight of an oven dry sample when immersed in water for 24 hours. The ratio of the increase in weight to the weight of the dry sample expressed as percentage is known as absorption of aggregate. The results are tabulated in Table 4.5.

Table 4.5: Water Absorption of Sponge Iron Scrap Material.

SAMPLE No.	Water absorption (%)
1	6.24
2	6.04

Water absorption of conventional crushed granite coarse aggregates is 0.8 %. Water absorption of sponge iron scrap material is 6.14% which is higher than conventional aggregates. Hence necessary corrections has made in mixed designs

VII. CONCLUSIONS

- Crushing and impact values of Sponge iron scrap material have found to be satisfactory as per is IS: 383-1970
- Specific gravity and bulk density of Sponge iron scrap material are similar to that of conventional crushed granite stone.
- Water absorption of Sponge iron scrap material is found to be higher than conventional crushed granite stone aggregate. Hence necessary corrections have to be carried out in mix design.
- Sponge iron scrap material is innocuous in nature, which indicates no alkali aggregate reaction.
- Compressive strength of M15 grade concrete using sponge iron scrap material as coarse aggregate is 8.2% higher than that of conventional crushed granite stone concrete.
- Compressive strength of Design mix of M20 grade concrete using sponge iron scrap material as coarse aggregate is 1.5% higher than that of conventional crushed granite stone concrete.

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