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STRENGTH BEHAVIOUR OF IRON FILLING SINCONCRETE BY PARTIAL REPLACEMENT OF SAND

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ABSTRACT

The utilizing of iron fillings in concrete as a partial replacement of sand is attaining enormous significance nowadays, mostly because of improvement in strength of concrete and environmental benefits. The aim of study is to assess the possibility of applying iron waste in different percentage (20%,25%,30%,35%) as fine aggregate replacement of sand to increase the strength of concrete. For this purpose, the mix proportion was designed as M20 (1:1.5:3) for giving the compressive strength. To achieve the goal of study, laboratory experiments, compressive strength and split tensile strength were conducted to determine the influence of iron filling sand the strength of concrete. As the result,

Higher content of iron fillings particle replaced in concrete increases workability of concrete. Using iron fillings with 35% of replacement of fine aggregate gives the higher strength than normal concrete mix. Addition of iron fillings in concrete increases the strength characteristics of concrete.

Keywords:- Iron waste, Fresh concrete test and Hardened concrete test, Iron filings; sand; strength properties;concrete

CHAPTER 1

INTRODUCTION

1.1 GENERAL

Concrete is the most widely used man–made construction material in world and is second to water as the most utilized substance on the planet. A major portion of this concrete volume is occupied by coarse and fine aggregate. The demand for aggregate is enormous in liberalization, privatization and globalization, and in the construction of important infrastructure projects like expressways, airports, Nuclear plants etc., The increased extraction of coarse and fine aggregate from the natural resources is required to meet this high demand.

The increasing use of natural fine aggregate creates an ecological imbalance. Thus, partial replacement of fine aggregate is vital in construction industries. Aggregates are the most important constituents in the concrete mix that help in reducing shrinkage and impart economy to concrete production. Most of the aggregate used are naturally occurring aggregates. Basics of cement, fly ash, pozzolana and physical and chemical properties of cement have been studied to precede the project easily. The test methods available to find out physical and chemical properties of fly ash based Portland pozzolana cement have been studied. To identify the importance of this blended cement, comparison of physical and chemical properties of fly ash based Portland pozzolana cement with normal ordinary Portland cement is proposed. From that it can be easily identified the importance this locally manufactured special fly ash based Portland pozzolana cement in many applications in the construction industry.

1.2 IRON FILLINGS

The iron filings used for this research was sourced from workshops in Ibadan environs, Ibadan, Nigeria. Iron filings are very small pieces of iron that look like a light powder. The iron filings has water absorption of 1.5%, coefficientofcurvatureof0.98andcoefficientof uniformity of 2.21, hence, it is a poorly graded. Filings are mostly a byproduct of the grinding, filing, or milling of finished iron products, so their history largely tracks the development of iron. For the most part, they have been a waste product.

Iron filings have some utility as a component in primitive gunpowder. In such a fine powdered form, iron can burn, due to its increased surface area.

The primary utility of iron filings is in the study and teaching of magnetism and electromagnetic fields. The substance makes impressive demonstrations when sprinkled on a white card placed on top of a permanent magnet, such as a bar magnet. The filings can be found in toys that allow one to draw with a magnetic pen. By sprinkling fine iron on a magnetic stripe card, itis possible to see the magnetic encoding on the stripe. A semi-viscous fluid in which iron filings are suspended, may be poured onto the exposed platter of a hard drive, so that the patterns of bits on the platter are revealed by the alignment of the iron filings.

They are very often used in science demonstrations to show the direction of a magnetic field. Since iron is a ferromagnetic material, a magnetic field induces each particle to become a tiny bar magnet. The south pole of each particle then attracts the north poles of its neighbors, and this process repeated over a wide area creates chains of filings parallel to the direction of them a genetic field. Iron Filings are used in many places, including schools where they test the reaction of the filings to magnets.

1.3 OBJECTIVES

1. To Understand the various application involved in iron fillings
2. To perform laboratory test that are related to compressive and tensile by use of iron fillings in concrete.
3. To improve strength characteristics of concrete with iron fillings.

1.4 IMPORTANTTERMINOLOGIES CEMENT

Cement is a binder substance that set sand harden sand can bind other materials together

FINEAGGEGATES

Fine aggregates in building and construction material used for mixing with cement, bitumen or other adhesives to form concrete or mortar.

COARSEAGGREGATES

Coarseaggregatesareparticlesgenerallygreaterthan4.75mm.The nominal size of coarse aggregates is 20mm

CHAPTER 2

LITERATURE REVIEW

Prof. Festus Adeyemi Olutoge, Prof. Michael Attah On ugba and Prof. AmanaOcholi

An experimental study was carried out to investigate the strength properties of concrete produced with iron filings as partial replacement for sand. Concrete specimens (cubes, cylinders and prisms) were cast and tested for compressive, split-tensile and flexural strengths at 0% (control mix), 10%, 20% and 30% replacement of sand by weight with iron filings after curing in water for 28 days. The results obtained showed that the compressive strength of concrete increased for the 10% and 20% replacement levels of sand with iron filingsby3.5%and13.5%respectivelywhiletherewas adecreaseof8% for the 30% replacement level. The split-tensile strength of concrete for the 10% and 20% replacement levels increased by 12.7% and 1% respectively and decreased marginally by 1.7% for the 30% replacement level when compared to the control mix. The flexural strength of concrete increased by 11.1% and 4.8% for the 10% and 20% replacement levels respectively while it decreased marginally by 1.6% for the 30% replacement level as compared to the control mix. An optimumof10%and20% replacement by weight of sand (fine aggregates) with iron filings in concrete mix is recommended for concrete production depending on the desirable property required in the concrete.

Mr.Zainab Z. Ismail *, Mr.Enas A. AL-Hashmi One of the major environmental issues in Iraq is the large quantity of waste iron resulting from the industrial sector which is deposited in domestic waste and in landfills. A series of 109 experiments and 586 tests were carried out in this study to examine the feasibility of reusing this waste iron in concrete. Overall, 130 kg of wasteironwerereusedtopartiallyreplacesandat10%,15%, and20%inatotal of 1703 kg concrete mixtures. The tests performed to evaluate waste-iron concrete quality included slump, fresh density, dry density, compressive strength, and flexural strength tests: 115 cubes of concrete were molded for the compressive strength and dry density tests, and 87 prisms were cast for the flexural strength tests. This work applied 3, 7, 14, and 28 days curing ages for the concrete mixes. The results confirm that reuse of solid waste material offers an approach to solving the pollution problems that arise from an accumulation of waste in a production site; in the meantime modified properties are added to the concrete

Chetan Khajuria A.P and Rafat Siddique S.P(June 2014) The environment problems are very common in India due to generation of industrial byproducts. Due to industrialization enormous byproducts are produced and to utilize these by-products is the main challenge faced in India. Iron slag is one of the industrial by-products from the iron and steel making industries. In this paper, the compressive strength of the iron slag concrete was studied. The results confirm that the use of iron slag overcome the pollution problems in the environment. The results shows that the iron slag added to the concrete had greater strength than the plain concrete

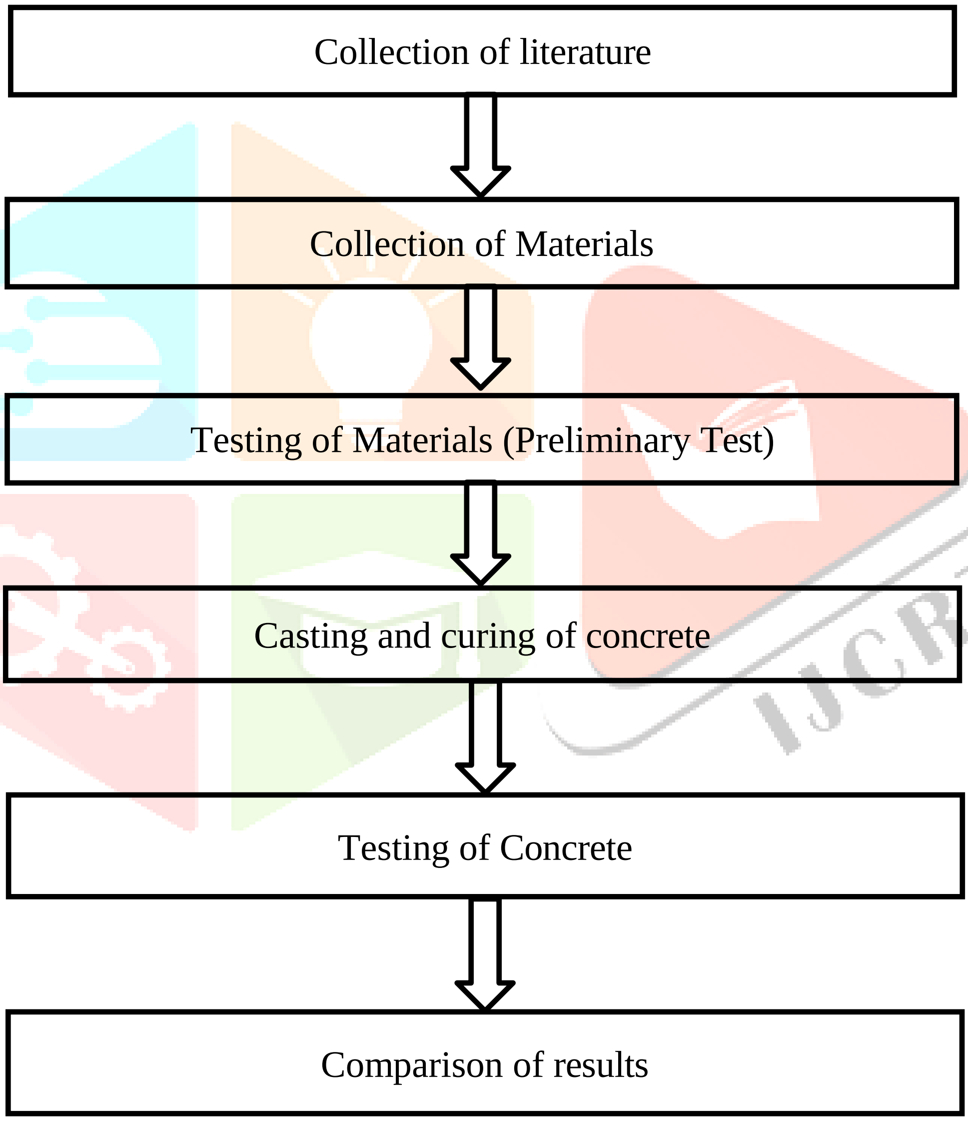
Shivam Tiwari, Anubhav Rai, Y.K. Bajpai(Dec-2017) Iron ore tailing (IOT) is a waste generated from iron ore industry. Millions of tons of IOT are produced every year in India and disposal of the same is a huge problem as it cause to environmental pollution. In other hand availability of sand is continuously depleted. Hence, partially or fully replacements of fine aggregate by the other compatible material are being researched in view of conserving the ecological balance. In this work, the effects of partial replacement of sand by iron ore tailing on the compressive strength of concrete are experimentally studied. In the present work iron tailing were used as partial replacement to fine aggregates at levels of 0%, 5%, 10%,15% and 20% and the basic material

properties, strength parameters are studied. Experimental investigation was done using M25 mix and tests were carried out as per recommended procedures by relevant codes. The mix proportions used for concrete are 1: 1.484: 2.698.

Shehdeh Ghannam, Husam Najm and Rosa Vascone (2 June 2016) Granite Powder (GP) and Iron Powder (IP) are industrial byproducts generated from the granite polishing and milling industry in powder form respectively. These byproducts are left largely unused and are hazardous materials to human health because they are airborne and can be easily inhaled. An experimental investigation has been carried out to explore the possibility of using the granite powder and iron powder as a partial replacement of sand in concrete. Twenty cubes and ten beams of concrete with GP and twenty cubes and ten beams of concrete with IP were prepared and tested. The percentages of GP and IP added to replace sand were 5%, 10%, 15%, and 20% of the sand by weight. It was observed that substitution of 10% of sand by weight with granite powder in concrete was the most effective in increasing the compressive and flexural strength compared to other ratios. The test resulted showed that for10% ratio of GP in concrete, the increase in the compressive strength was about 30% compared to normal concrete. Similar results were also observed for the flexure. It was also observed that substitution of up to 20% of sand by weight with iron powder in concrete resulted in an increase in compressive and flexural strength of the concrete.

CHAPTER 3

MATERIAL AND METHODOLOGYSEQUENCEOFWORK



3.1 PRELIMINARY TEST FOR MATERIAL

3.1.1 TEST ON CEMENT it is most important ingredient in concrete. One of the important ingredients for the selection of cement is its ability to produce improved micro structure in concrete Conventional concrete; the effect characteristic of cement on water demand is more noticeable.

Some of the important factors which play a vital role in the section of cement are compressive strength of various ages, fineness, heat of hydration, alkali content, tri calcium aluminate (C3A) content, in calcium silicate (C3S) content, di calcium silicate content (C2S) etc. Different brands of cement have been found to possess different strength development characteristics and archaeological behavior due to the variations single suppliers, Portland pozzolona cement (PPC) conforming to IS 1489 part2 was in the compound compositions and fineness. Hence it was decided to use cement from used for the present experimental investigation. The cement was tested as per the Indian standard 4031-1988.

FIGURE3.2.1CEMENT

3.1.1.1 SPECIFIC GRAVITY OF CEMENT

Specific gravity is defined as the ratio between the weights of a given volume of cement and weight of an equal volume of kerosene. Specific gravity of ordinary Portland cements normally various between 3.10-3.15

$$\text{Specific gravity} = \frac{\text{Weight of solid material excluding pores}}{\text{Weight of an equal volume of gas free distilled water}}$$

$$\text{Specific gravity} = \frac{w2-w1}{(w2-w1)-(w3-w4)}$$

Specific gravity of cement=3.1

3.1.1.2 FINENESS TEST ON CEMENT

Fineness of cement is relative measure of particle size. The fineness of cement has an important bearing on the rate of hydration and hence on the rate of gain of strength and also on the rate of evaluation of heat. Finer cement offers a greater surface area for hydration and hence the faster and greater the development of strength. Maximum number of particles in a sample of cement should have as less than 90micron.Thesmallestparticlesmayhaveasize 1.5micron.Anaveragesizeofcementparticlesmaybetakenas10micron.

The fineness value of the cement is not exceeding 10% far ordinary Portland cement. **Fineness value of cement =4%**

3.1.1.3 STANDARD CONSISTENCY TEST ON CEMENT

Standard consistency of cement is the consistency which will permit the vicat plunger to a depth of 5.-7 mm from the bottom of a vicat mould when cement pasted is tested. About 400g of cement is taken and trial water cement ratio of31% is added to make a cement paste. The paste is put in the mould and the vicat plunger is allowed to penetrate in to the cement paste. The reading is noted.

TABLE3.2.1.3 STANDARD CONSISTENCY TEST ON CEMENT

S.NO	Weight of cement(g)	Volume of water(ml)	netration from bottom(mm)	% of water
1	400	100	25	25
2	400	105	19	26
3	400	106	10	26.5
4	400	109	7	27

Standard consistency of cement= 31%

TABLE3.2.1 PROPERTIES OF CEMENT

S.NO.	PROPERTY	RESULT	PERMISSIBLE LIMIT
1	Specific gravity	3.1	3.1-3.15(conforming to IS4031-1998part1)
2	Normal consistency	31%	5-7mm(conforming toIS4031-1998part4)
3	Fineness of cement (by90 micron sieve)	4%	Notexceed10%(conforming toIS4031-1998part3)

3.1.2 TEST ON FINE AGGREGATES

FIGURE3.2.2FINE AGGREGATE

3.1.2.1 SPECIFIC GRAVITY OF FINE AGGREGATES

$$\text{Specific gravity} = \frac{\text{Weight of solid material excluding pores}}{\text{Weight of an equal volume of gas free distilled water}}$$

$$\text{Specific gravity} = \frac{w2 - w1}{(w2 - w1) - (w3 - w4)}$$

Specific gravity of fine aggregates=2.6

TABLE3.2.2 PROPERTIES OF FINEA GGREGATES

S.No	PROPERTY	RESULT	PERMISSIBLELIMIT
1	Specific gravity	2.6	2.5-3.0conformingtoIS 2386part 3)

3.1.3 TEST ON COARSE AGGREGATES

FIGURE3.2.3 COARSE AGGREGATE

3.1.3.1 SPECIFIC GRAVITY OF COARSE AGGREGATE

$$\text{Specific gravity} = \frac{\text{Weight of solid material excluding pores}}{\text{Weight of an equal volume of gas free distilled water}}$$

$$= \frac{(W2-W1)}{(W2-W1)-(W3-W4)}$$

Specific gravity of coarse aggregate=2.68

3.1.3.2 ABRASION TEST

Abrasion test is carried out to find the hardness property of aggregate and also find out percentage wear due to relative rubbing action between the aggregate and steel balls used as abrasion charge by using Los Angel’s abrasion machine.

$$\text{Abrasion value} = \frac{(w1-w2)}{w1} X100$$

Weight of sample (W1) =3000 g Weight of sample after abrasion(W2)=2307g

Abrasion value=23.1%

3.1.3.3 IMPACT TEST

Impacttestiscarriedouttoevaluatetheresistancetoimpactofaggregates. Aggregates to be used for wearing course, the impact value shouldn’texceed35 percent. The impact value is measured as percentage of aggregate passing sieve (w1) to the total weight of the sample (w2).

$$\text{Impact value} = \frac{w1}{w2} X100$$

Weightofaggregatepassing2.36 mm sieve(w1)=127g Total weight of sample (w2) =500 g

Impact value=25.4%

3.1.3.4 WATER ABSORPTION TEST

The water absorption test is to determine the amount of water absorbed under specified conditions by measuring the increase in weight of an oven dry sample when immersed in water for 24 hours. It is the different between the apparent and bulk specific gravities is nothing but the water permeable voids of the aggregate.

$$\text{Water absorption} = \frac{(w2-w1)}{w1} X100$$

TABLE 3.2.3.4 WATER ABSORPTION TEST

S.NO	OBSERVATION	TRAIL
1	Weight of dry specimen(w1)	200g
2	Weight of wet specimen(w2)	201.1g
3	Water absorption in %	0.55

TABLE3.2.3 PROPERTIES OF COARSE AGGREGATES

S.NO	PROPERTY	RESULT
1	Specific gravity	2.68
2	Abrasion value	23.1%
3	Impact value	25.4%
4	Water absorption	0.55%

3.1.4 WATER

Water is an important ingredient of cement of concrete as it actively participant in the chemical reaction with cement to form the hydration product, calcium-silicate hydrate (C-S-H) gel, the strength of cement concrete depends mainly from the binding action of the hydrated cement gel. Higher water-binder (w/b) ratio decreases the strength, durability, water-tightness and other related properties of concrete. The quality of water added should be the minimum requirement for chemical reaction of hydrate cement. The strength of cement paste is inversely proportional to the dilution of the paste. Hence, it is essential to use as little paste as possible, consistent with the requirement of workability and chemical combination with cement.

From CC mix design consideration, it is important to have the compatibility between the given cement and the chemical and mine ralad mixture along with the water used for mixing. The water used for making concreteshouldbefreefromundesirablesaltthatmayreactwithcementand

admixture and reduce their efficiency. Silts and suspended particles are undesirable as they interfere with setting hardening and bond characteristic.

Algae in mixing water may cause marked reduction in strength of concrete either by combining with cement to reduce the bond or by causing large amount air entrainment in concrete. Water conforming to the requirement of BIS: 456-2000 is found to be suitable for marking CC. It is generally stated that water fit for drinking is fit for making concrete. For this present investigation, water supplied to Trichy city from Cauvery River was used for making CC and curing.

3.1.5 IRON FILLINGS

The iron filings used for this research was sourced from workshops in Ibadan environs, Ibadan, Nigeria. The iron filings has water absorption of 1.5%, coefficientofcurvatureof0.98andcoefficientof uniformityof2.21, hence, it is a poorly graded. A sample of the iron filings used for this study is shown in Fig.

1.The gradation of iron filings, as well as its physical and chemical properties

$$\text{Specific gravity} = \frac{\text{Weight of solid material excluding pores}}{\text{Weight of an equal volume of gas free distilled water}}$$

$$\text{Specific gravity} = \frac{w2 - w1}{(w4 - w1) - (w3 - w2)}$$

Specific gravity of iron fillings=3.12

FIG.NO.3.2.5 IRON FILLINGS

3.2 MIX DESIGN

ThemixproportionofM20gradeconcretewasdesignedbasedonthe recommendation of IS 10262-2009 for the following stipulation.

Grade designation -M20

Type of cement -OPC43 Size of coarse aggregates - 20mm Water – cement ratio - 0.5 Degree of quality control - Good

Type of aggregates -Crushed angular Minimum cement content - 250kg/m^3

Exposure condition -Mild(IS456;Table5)

Workability -100mm(slump)

DATA OF MATERIAL

Cement used -OPC43

Specific gravity of cement - 3.1 Specific gravity of fine aggregates - 2.86

Specific gravity of coarse aggregates - 2.95 Aggregates zone -Zone2

Solution

Target mean strength for mix design; Fck= Fck+ ts

Fck=Fck+1.65s

=20+ 1.65(4)

=26.6 N/mm^2

i. Selection of water cement ratio

Fromthetable5IS456, maximum water-cement ratio=0.5 Take, water-cement ratio = 0.5

ii. Selection of water content

iii. Watercontent100mmslump=186 + $\frac{6}{100}$

x 186

=197 litter

iv. Selection of cement content

Water cement ratio=0.5

Cement content =394kg/m^3>250$kg/$m^3

Hence ok.

v. Proportion of volume of coarse aggregates and Fine aggregates

Volume of coarse aggregates=0.62(FromIS10262-2009,Table 3)

Volume of fine aggregates =1−0.62 =0.38m

vi. Mix calculation

Volume of concrete	$=1m^3$
Volume of cement	$=0.13m^3$
Volume of water	$=0.197m^3$
Volume of all in aggregates	$=0.673m^3$
Mass of coarse aggregates	$=1240\ kg/m^3$
Mass of fine aggregates	$=620.5kg/m^3$

RATIO FOR M20 MIX CC = 1: 1.5: 3.1

Mix contains part of cement, 1.5 parts of fine aggregates and 3.1 parts of coarse aggregates for M20 grade. The identification of mix proportion and the quality of material used are tabulated as follows:

3.3 PREPARATION OF TEST SPECIMENS

3.3.1 PREPARATION OF MORTAR CUBES

The mould used for preparation of cubes is of dimension 150 mm x 150 mm x 150 mm. This is the standard mould size specified for cement mortar cubes. The moulds were first properly greased and oiled so as to make the surface smooth so that removal of the cubes is easy after the setting process.

Mortar was added to the mould such that the mould is filled up to the top and compacted in a mortar cube manually. This vibration was done for a period

Of almost two minutes. Then these cubes were kept at a temperature of 27° C+2°Cinmoistconditionfor24hours.

After the drying the cubes were removed from the mould and they were kept for curing in a curing tank. It was kept in mind that the cubes does not break while removal from the mould. If some damage happens to the cubes they have to be discarded and new cubes have to be casted.

3.3.2 MIXING

Mixing of ingredient is done in pan mixer of capacity 40 liters. The cementitious material is thoroughly blended and them the aggregate is added and mixed followed by gradual addition of water and mixing. Wet mixing is done until a mixture of uniform color and consistency are achieved which is then ready for casting. Before casting the specimen, workability of the mixes was found by compaction factor test.

FIGURE3.4.2MIXINGPROCESS

3.3.3 PREPARATION OF SPECIMEN

The cast iron mould is cleaned of dust particles with mineral oil on all sides before concrete is poured in to the mould. The mould is and applied placed on a level platform. The well mixed concrete is filled into the mould and kept on vibration table. Excess concrete was removed with towel and top surface is finished level and smooth as per IS 516-1969.

PLAN FOR PHASE-2:

STEP1-CASTINGANDCURING STEP

STEP2-TESTING

STEP3-ANALYSISOFRESULT

CHAPTER 4 CONCLUSION

1.There is a possibility for the replacement of sand (fine aggregate) with iron filings in the production of concrete.

2. The use of iron filings in concrete production would lead to improved environmental waste management and profitable utilization of industrial wastes.

3. Iron filings can be used for production of heavyweight concrete.

4. Compared to the control mix, the compressive strength of concrete increased for the 10% and 20% replacement levels of sand with iron filings by 3.5% and 13.5% respectively while there was a decrease of 8% for the 30% replacement level.

5. The split-tensile strength of concrete for the 10% and 20% replacement levels increased by 12.7% and 1% respectively and decreased marginally by 1.7% for the 30% replacement level when compared to the control mix.

6. The flexural strength of concrete increased by 11.1% and 4.8% for the 10% and 20% replacement levels respectively while it decreased marginally by 1.6% for the 30% replacement level as compared to the control mix.

7. Thus, an optimum of 10% and 20% replacement by weight of sand (fine aggregates) with iron filings in concrete

8. Higher content of iron fillings particle replaced in concrete increases workability of concrete.

9. Using iron fillings with 35% of replacement of fine aggregate gives the higher strength than normal concrete mix.

10. Addition of iron fillings in concrete increases the strength characteristics of concrete R

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