International Journal of Scientific Research and Engineering Development-– Volume 4 Issue 5, Sep- Oct 2021

Available at www.ijsred.com

RESEARCH ARTICLE OPEN ACCESS

Improvising the Strength Properties of Concrete Through Iron Slag

Harshgupta[1], Arun Kumar Mishra[2]

[1]Professor & Head of Civil Engineering Department ,JNCTREWA, Madhya Pradesh 486001,India.

[2]Scholar, Civil Engineering Department, JNCTREWA, Madhya Pradesh 486001,India.

ABSTRACT:

Efficient waste management is a fundamental part of a proper iron industry. In this specific situation, waste methods boards where conceivable and reduce waste in the reuse of materials that may have been wasted in some way or another. Authorities with strong waste practices distinguish reduction, reuse and reuse as important to the board of economic assets. Iron slag, a side-effect obtained from the arrangement of iron during the separation of liquid iron from the debasement in the heater. A viscous fluid consisting of slag is an unpredictable silicate and oxide that sets upon cooling. This investigation mentions partial replacement of iron stags as far as the exact total material is concerned. This test is done to understand the effects of compressive, elastic and flexural strength. It will be helpful for various scientists to find out about this area.

The purpose of this test is to examine the effect of iron slag as half the supply of fine aggregate with 0%, 10%, 20%, 30%, and 40%, which is followed by 7, 14, 28 and M25 of cement. And the M30 is tried for evaluation. The 50day water restore results show that there is great variation in strength for the fine total by iron slag for 7-, 14-, 28- and 50-days water relief.

Keywords: Concrete, Iron slag, Fine Aggregates, Compressive Strength, Flexural Strength and Tensile Strength

1. INTRODUCTION

Aggregates are inactive grainy materials, for instance, sand, rock, or crushed stone that are an eventual outcome to their own advantage and are a crucial fixing in concrete. Aggregate, which contributes 60 to 75 percent of the outright volume of concrete, are isolated into two huge classes - fine and coarse. Fine aggregates generally incorporate standard sand or crushed stone with most noteworthy particles going through a sifter of 4.75mm. Fine Aggregate (regular sand) which has been washed and sieved to dispose of greater particles for instance more than 5 mm. IS determinations arrange the sand into four zones as per its assessment as fine all out of surveying Zone-1 to assessing Zone-4. The four assessing zones show that it becomes better from Zone-1 to Zone-4 powerfully from 90% to 100% of the fine absolute passes 4.75 mm IS sifter and 0 to 15% passes 150 microns IS sifter which depends upon its surveying zone. Iron slag, an incidental effect got from the Iron turn of events, is conveyed by the pattern of division of the fluid Iron from defilements in Iron-creation warmers. A fluid liquid disintegrates got from slag is complicated silicates and oxides that set on cooling. Essentially, all Iron is made in facilitated Iron plants using such the central oxygen measure or in specialty Iron plants (less than typical production lines) using an electric roundabout portion warmer measure. Nowadays open-hearth warmer measure is of no usage. The mark of this examination is to inspect the effect of Iron Slag as midway superseding of Fine Aggregate with 0%, 10%, 20%, 30%, and 40% are pursued M25& M30 assessment of concrete after 7-, 14-, 28-, and 50-days water re-establishing. The result shows that assortment in much strength for Fine complete subbed by Iron slag for 7-, 14-, 28-, and 50-days water re-establishing.

OBJECTIVES

Todeterminetheoptimumquantityof Ironslagasafineaggregatetoenhancethestrengthof concrete by conducting related tests like Compressive strength, Tensile strength and Flexuralstrengthatreplacementlevelof10%,20%,30%and40%.

2. MATERIALSUSED:

2.1. **Cement:**As per IS 8112-1989, ordinary Portland cement of grade 43 is used. The initialsettingtimeofcementis30minutesand3.15isthespecificgravityofcement.

2.2. **FineAggregate:**NaturalRiversandwhichislocallyavailableobtainedfromtheBeeharriver

ofRewaCityisusedasfineaggregates.Naturalsandpassingthrough4.75mmsieveandretainedonthe600-micronsievewiththespecificgravityof2.65wasused.Zone2wasthegradingoftheaggregate.

2.3. **Coarse Aggregate**: Aggregates greater than 4.75mm are considered as Coarseaggregate.Crusted coarse aggregate of 20mm downsize were used with fineness modulus of 4.32 and aspecificgravityof2.84.

2.4. **Iron Slag:**In this experiment the Iron slag collection is done from locally available ironfurnace.NowadaysIronproductsareusedeverywhere.Ironisdurableandstrong.Itisobtainedeitherfromconversionofiron-to-IronslaginaBOF(BasicOxygenFurnace)orbythemeltingofscarptomakeIronintheEAF(ElectricArcFurnace).

2.5. **Water:**AspertheIS:456-2000Specifications,cleanandpotablewaterwasused.

CHARACTERISTICS APPLICATION: Iron slag is used in many fields of constructionindustry where its distinct characteristics can be put to effective use such as road base coursematerial,courseaggregateforconcrete,calciumsilicatefertilizer,blendingmaterialforPortlandcementandsoilimprovement.

3. METHODOLOGY:

Inthisstudy,$M_{25,}$ $M_{30,}$mixpercentageisdesignedasper theguidelinesofIndian StandardrecommendedmethodIS10262:2009.Cementof43gradeisused;alsozone2istakenintoaccountfromIS383(1970).Ironslagissubstitutedby10%,20%,30%and40%.Thecoarseaggregate of size 20mm is designated which is retained on 10mm sieve. Fine aggregate passingthrough4.75mmsieveandretainedon600micronsieveused.

4. EXPERIMENTALTESTSANDRESULTS:

4.1 SLUMPCONETEST:

TostudytheWorkabilityoffreshconcrete,slumpconetestisconducted.ThistestwascarriedoutforM25&M30 gradeofconcrete;theresultsaretabulatedandplottedbelow.

Table1.Slumptest results for M25 and M30 grade of concrete

Sr. No.	% Replacement ofFineAggregate byIronSlag	Slump ValueInMM ForM 25	SlumpValueInMM For M30
1	0%	75	75
2	10%	72	68
3	20%	65	60
4	30%	55	52
5	40%	52	48

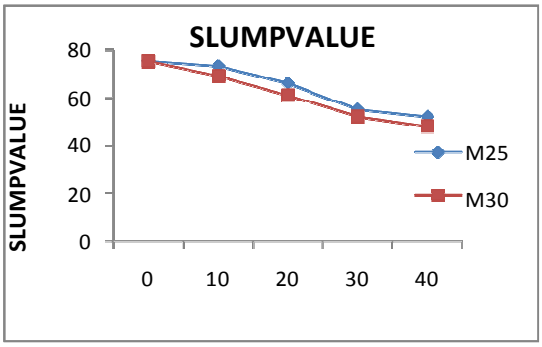


Figure1:Slump Values of M25 and M30 grade of concrete

COMPACTION FACTOR: As per IS: 1199 – 1959, to find the workability of fresh concrete, Compactionfactor testisconducted by using Compacting factor apparatus. For the determination of workability of concrete this test is known for its accuracy. The test results are tabulated and plotted below.

Table2.Compaction factor test results of M25 and M30 grade of concrete

Sr. No.	% Replacementof FineAggregate by IronSlag	Compactionfactor Value inMMfor M 25	Compactionfactor Value inMM for M 30
1.	0%	0.843	0.855
2.	10%	0.848	0.861
3.	20%	0.851	0.868
4.	30%	0.858	0.876
5.	40%	0.861	0.883

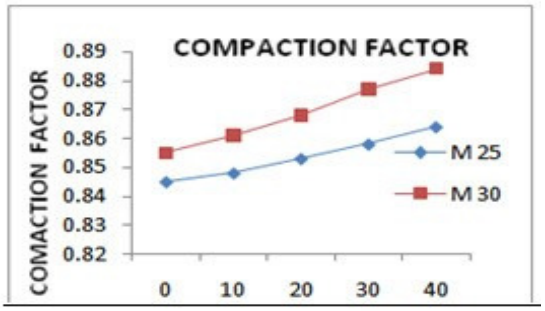


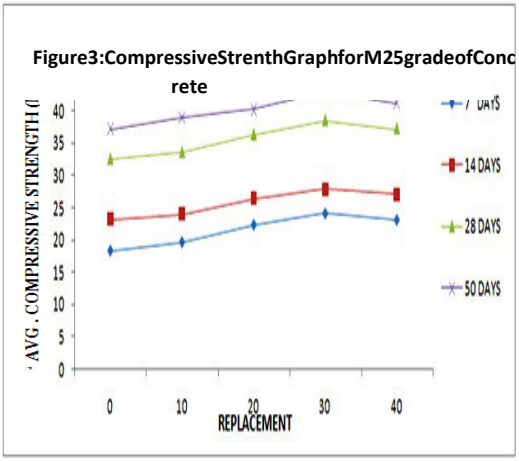
Figure2:Compaction factor graph for M25&M30 grade of concrete

4.2 COMPRESSIVESTRENGTHTEST:

4.2.1 Concrete cubes (150mmx150mm) were casted for 0%, 10%, 20%, 30%, 40%replacement of Iron. Th compressive strength for M25 grade of concrete is tested for 7,14, 28 and 50 days of curing and the results are tabulatedand plotted below.

Table3.Avg.CompressivestrengthtestresultsforM25gradeofconcrete

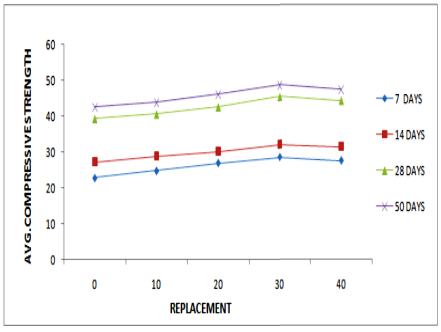
Sr. No.	% ReplacementofFine Aggregate by IronSlag	Average Com-Pressive Strength (N/mm²)	Average Com-pressive Strength (N/mm²)	Average Com-pressive Strength (N/mm²)	Average Com-pressive Strength (N/mm²)
		7DAYS	14 DAYS	28 DAYS	50DAYS
1.	0%	18.30	23.23	32.53	37.19
2.	10%	19.64	24.11	33.58	39.03
3.	20%	22.31	26.44	36.33	40.24
4.	30%	24.07	27.92	38.48	37.22
5.	40%	23.07	27.14	37.22	41.26



4.2.2 Concrete cubes (150mmx150mm) were casted for 0%, 10%, 20%, 30%, 40% Iron slagreplacement. The compressivestrength for M30 gradeof concrete is tested for 7,14, 28and50daysofcuringandtheresultsaretabulated andplottedbelow.

Table4.Avg.CompressivestrengthtestresultsforM30gradeofconcrete

Sr. No.	% Replacement of FineAggregate byIronlSlag	Average Com-pressive Strength (N/mm²)	Averag Com-pressiv Strengt (N/mm²)	Average Com-pressive Strength (N/mm²)	Average Com-pressive Strength (N/mm²)
		7DAYS	14 DAYS	28 DAYS	50 DAYS
1.	0%	22.76	27.19	39.25	42.48
2.	10%	24.69	28.73	40.50	43.85
3.	20%	26.84	30.13	42.50	46.15
4.	30%	28.44	31.98	45.35	44.21
5.	40%	27.49	31.23	44.22	47.25



1. From both of the above graph i.e. M25 and M30, the compressive strength of concrete isincreased gradually from 0% to 20% and achieved a maximum value at a replacement of 30%Ironslaginfineaggregateafterwardsdecreasedfor40%replacementofIronslag.
2. HowevercompressivestrengthofconcreteforthepartialreplacementofFineaggregatewithIronslagof40 %doesnotshowmajordecrementascomparedto30%andcanbeusebycontrolmix.

4.3 SPLITTENSILESTRENGTHTEST:

4.3.1 Concretecylinders(150mmx300mm)werecastedfor0%,10%,20%,30%,40%replacementofIronslag.ThesplittensilestrengthforM25andM30gradeofconcreteistestedfor28daysofcuringandtheresultsaretabulatedandplottedbelow.

Table 5.Avg.Tensile strength test results

Sr. No	% Replacementof FineAggregate by IronSlag	Average TensileStrengthfor M25. ^{2} (N/mm)	Average TensileStrengthfor M30. ^{2} (N/mm)
		28DAYS	28DAYS
1.	0%	2.533	3.376
2.	10%	2.663	3.496
3.	20%	2.75	3.666
4.	30%	2.956	3.906
5	40%	2.866	3.793

forM25andM30gradeof concrete

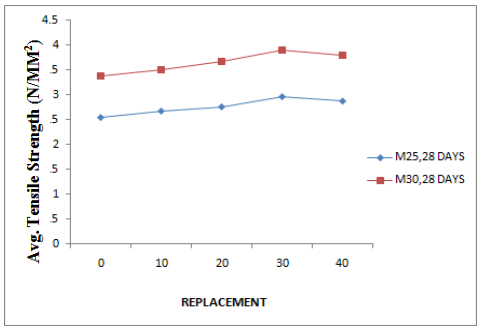


Figure 5: Tensile Strength Graph For M25 & M30 at28Days.

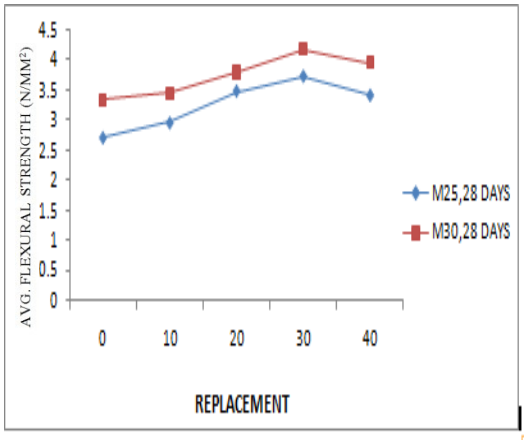
1. From both of the above graph i.e. M25 & M30 grade of concrete, the Split tensile strength ofconcreteisimprovedgraduallyfrom0%to20%andachievedamaximumvalueatareplacementof30%Ironslaginfineaggregateafterwardsdecreasedfor40%replacementofIronslag.
2. HoweverSplittensilestrengthofconcreteforthefractionalreplacementofFineaggregatewithIronslagof 40%doesnotshowmajordecrementascomparedto30%andcanbeusebycontrolmix.

4.4 FLEXURALSTRENGTHTEST:

4.4.1 Concrete beams (500mmx100mmx100mm) were casted for 0%, 10%, 20%, 30%, 40%replacement of Iron slag. The Flexural strength for M25 & M30 grade of concrete istestedfor28daysofcuringandtheresultsaretabulatedandplottedbelow.

Table 6 .Avg. flexural strength test results for M25andM30gradeofconcrete

Sr.No	% Replacement ofFine Aggregateby IronSlag	AverageFlexuralStrengthfor M25.(N/mm ^{2})	AverageFlexuralStrengthfor M30.(N/mm ^{2})
		28DAYS	28DAYS
1.	0%	2.730	3.352
2.	10%	2.972	3.457
3.	20%	3.491	3.801
4.	30%	3.733	4.183
5.	40%	3.422	3.974



1. From the above Graph i.e. M25 & M30 grade of concrete, the Flexural Strength of concrete isincreasedgraduallyfrom0%to20%andattainedamaximumvalueatareplacementof30%Ironslaginfineaggregateafterwardsreducedfor40%replacementofIronslag.
2. HoweverFlexuralstrengthofconcreteforthepartialreplacementofFineaggregatewithIronslagof40%doesnotshowmajordecrementascomparedto30%andcanbeusebycontrolmix.

5. CONCLUSIONS:

Based on profound investigation of experimental outcomes and discussions the following conclusions are made.

1. Comparison and perceptions for the compressive strength, flexural strength and split rigidity of typical concrete and cement with Iron slag as incomplete substitutions, the outcomes show that the strength of the ordinary cement is marginally lower than the Iron slag supplanted concrete.

2. The augmentation in compressive strength is about 31.47% for 7 days relieving 20% for 14 days restoring 18% for 28 days while at 40% a slight decrement of 4.2% was noted for 7 days and 3.4 % for 28 days of restoring when contrasted with 30%.

3. The increment in compressive strength of M 30 grade of cement is about 24.9% for 7 days of restoring 17.5% for 14 days of relieving and 15.5% for 28 days of relieving while at 40% a slight decrement of 3.6% noted for 7 days and 2.5% for 28 days of restoring when contrasted with 30%.

4. The split tensile strength increments with expansion in level of Iron slag up to 30% by weight of the fine aggregate. The addition in split rigidity is about 16.7% for 28 days restoring for M 25 grade of cement and augmentation about 15.6% for 28 days relieving for M 30 grade of cement.

5. The Flexural strength increments with expansion in level of Iron slag up to 30% by weight of the fine aggregate. The addition in flexural strength test is about 36.7% for 28 days relieving for M 25 grade of concrete and 24.7% for 28 days restoring for M 30 grade of cement.

6. From the aftereffects of compressive strength, split elasticity, flexural strength 28 days relieving, 30% substitution of the fine aggregate by Iron slag is the ideal level of substitution of M 25 and M 30 grade of cement.

REFERENCES:

1. BIS:8112-1989:Specificationfor43gradeordinaryPortlandcement:BureauofIndianStandard,NewDelhi.
2. BIS:10262-2009 (Reaffirmed 2004):Guidelines forconcretemixdesign,Bureau

ofIndianStandard,NewDelhi-2004.

3. BIS:456-2007:GuidelinesforPlainandReinforcedConcreteCodeofPractice:BureauofIndianStandard, NewDelhi.
4. M.S.Shetty.(2006)Concretetechnology,S.Chand&Companyltd,RamNagar,NewDelhi.
5. S.Javali,A.R.Chandrashekar,S.R.Naganna,D.S.Manu,P.Hiremath,H.G.Preethiand N. V. Kumar, "Eco-concrete for sustainability: utilizing aluminium dross and iron slag aspartial replacement materials", Clean Technologies and Environmental Policy, vol. 19, no.9,(2017), pp. 2291-2304.

6 B. H. Nagaratnam, M. A. Mannan, M. E. Rahman, A. K. Mirasa, A. Richardson and O.Nabinejad, "Strength and microstructural characteristics of palm oil fuel ash and fly ash asbinaryandternaryblendsinSelf-Compactingconcrete",ConstructionandBuildingMaterials,vol.202,(2019),pp.103- 120.

7 M. Uysal, "The Use of Waste Maroon Marble Powder and Iron Oxide Pigment in theProduction of Coloured Self-Compacting Concrete", Advances in Civil Engineering, vol.2018,(2018), pp. 1-10.

8 A. Khodabakhshian, J. Brito, M. Ghalehnovi and E. A. Shamsabadi, "Mechanical,environmentalandeconomicperformanceofstructuralconcretecontainingsilicafu meandmarble industry waste powder", Construction and Building Materials, vol. 169, (2018), pp237-251.

