MECHANICAL PROPERTIES OF HEAVY WEIGHT CONCRETE USING HEAVY WEIGHT COARSE-AGGREGATE AS HEMATITE (Fe58 HIGH GRADE IRON ORE)

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Abstract

Density concrete is commonly used for radiation shielding of nuclear-reactors and other structures like counter weights, coating of off-shore pipelines. Density concrete or heavy weight concrete is designed by using heavy weight aggregates such as hematite, magnetite, barite etc. The material is called hematite is used in this special concrete.

Integral part of this paper is replacing coarse-aggregate by hematite aggregate partially from 0 to 50% volume at 25% intervals. The concrete mix as per IS-10262-(2009) is used for M25 and M35 grades of concrete and in this only coarse aggregate is replaced with heavy weight hematite coarse aggregate and natural sand is used as fine aggregate and three levels of silica fume at 5%, 10% and 15% are used by weight of cement. All mixes are designed for 100mm slump. Water-cement ratio as per grade of concrete

Keywords: *Density Concrete, Hematite, Heavy Weight Aggregate, Compressive Strength, Silica Fume*

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1. 1INTRODUCTION

The main aim of this paper is to find a suitable local substitute for the high density iron ore. Heavy weight iron-ore is used as the main ingredient of the high density concrete mix for concrete coating of sub-merged marine pipelines which is transportation of petroleum materials like importing crude oil and domestic gas, desired heavyweight concrete is usually used for radiation shielding, counter weights. Radiation shielding is generally used in nuclear power plants to protect against radioactive rays. High density concrete observes neutrons which are accurate construction material which protects from irradiated rays and causing harmful effects to environment and living things, another important aspect is resistant against freeze and thawing cycles and weathering effects. It acts as anti corrosion while used as reinforcing wire-mesh is wrapped and incorporated in the concrete, especially for oil pipe lines.

High density concrete or heavy weight concrete is concrete should have density greater than 2600kg/m3. High density concrete can be made from natural heavy weight aggregates are commonly used having specific gravity ranging from barites (2.5 - 3.5), magnetite (3.5 - 4.0) and hematite (4.0 – 4.5) occasionally. Through previous research we can also be made using iron as a replacement for the portion of either coarse aggregate or fine aggregate, these give even greater densities of 5900kg/m3 for iron.

Heavy weight or high density concrete can be designed in same way as normal weight concretes, but the additional self weight should be taken into account. These can be transported and placed in the same way as normal weight concretes but the additional density means that smaller volumes can be transported and placed.

1.1 Geological Deposits

Hematite deposits in Kurnool district of Andhra Pradesh state are found in the form of associated with rocks of dharwar sediments or purana formations. However low grade iron ore are also known from upper gondwana laterite capping on Deccan traps as per both hematite and magnetite deposits occur in the state. These sedimentary deposits of hematite are found in Kurnool district in veldurti, ramallakota. In this present study hematite of ramallakota is used in concrete.

1.2 Experimental and Field Study

The aim of present work to study the mechanical properties in field of civil engineering works in which hematite is used as coarse aggregate in heavy weight concrete which is used for offshore pipe lines and applicable where ever necessary in field of nuclear research, hospitals, scientific research and radiation shielding etc.

2. MATERIALS AND METHODS OF MIX DESIGN

The key ingredients of concrete used in this study i.e. cement ,fine aggregate, coarse aggregate as well as hematite coarse aggregate of size 20mm and 10mm are tested before use in trial mix of concrete. The relevant tests for material concern as per IS 456: 2000 i.e. Indian standard plain and reinforced concrete code of practice.

2.1 Cement

The cement used in this experimental work is 53 grade ordinary Portland cement. Its properties are tested as per IS 12269 1987 as shown in table 1

Table -1: Properties of cement:

S.no	Description of test	Results
1	Fineness of cement	3.12%
2	Specific gravity of cement	3.11
3	Standard consistency	31%
4	Initial setting time	160min
5	Final setting time	250min
6	28days Compressive strength	65N/mm^2

2.2 Aggregates

Fine aggregate i.e. natural sand from Tungabhadra river is used. Must do tests such as specific gravity, water absorption and sieve analysis, etc. have been done as per Indian Standard. The crushed well graded angular shaped of size 20mm as per IS 383-1970 is used as coarse aggregate.(F.A means fine aggregate and C.A means coarse aggregate) and all the laboratory test of aggregates with respect to material like bulk density, specific gravity, flakiness index, water absorption, crushing test and impact test are conducted

Table -2: Physical properties of F.A and C.A

S no	Properties	River sand (F.A)	C.A
1	Particle shape	Rounded	Angular
2	Particle size	4.75mm	20mm
3	Specific gravity	2.68	2.67
4	Silt content	8.1%	Nil
5	Water absorption	2.45	2.25
6	Fineness modulus	2.81	4.606

Table -3: Sieve analysis of Fine aggregate

S no	Sieve size in mm	Weight retained in gm	% weight retained	Cumulative % weight retained	% passing
1	4.75	25	2.5	0.25	99.75
2	2.36	20	2	2.25	97.75
3	1.18	130	13	15.25	84.75
4	600	570	57	72.25	27.75
5	350	225	22.5	94.75	5.25
6	150	15	1.5	96.25	3.75
7	PAN	15	1.5		100
		1000		281	

Fineness modulus = $\sum$ F/100 =2.81

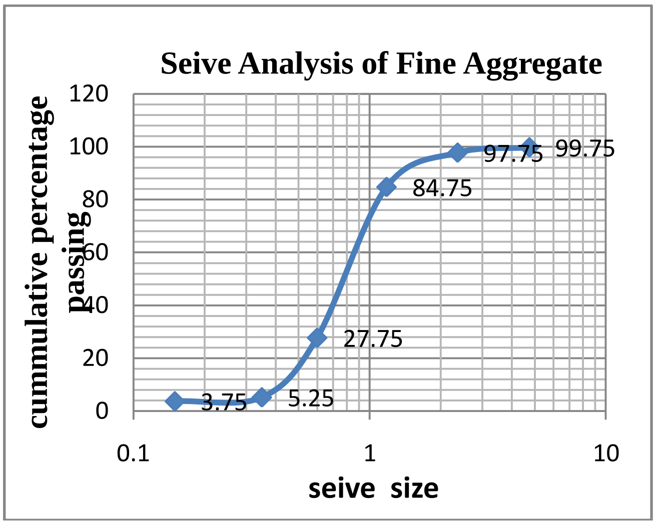

Chart -1: sieve analysis of fine aggregate

Table -4: Sieve analysis of coarse aggregates

Sno	Sieve size in mm	Weight retained	% weight retained	Cumulative % weight retained (f)	% passing (100-f)
1	80	0	0	0	100
2	63	0	0	0	100
3	50	0	0	0	100
4	40	0	0	0	100
5	31.5	30	0.3	0.2	99.8
6	25	1120	11.2	11.5	88.5
7	20	4170	41.7	53.2	46.8
8	12.5	4360	43.6	96.8	3.2
9	10	220	2.2	99	1
10	6.3	90	0.9	99.9	0.1
11	4.75	10	0.1	100	0
				460.6	

Fineness modulus =$\sum$ F/100 =4.606

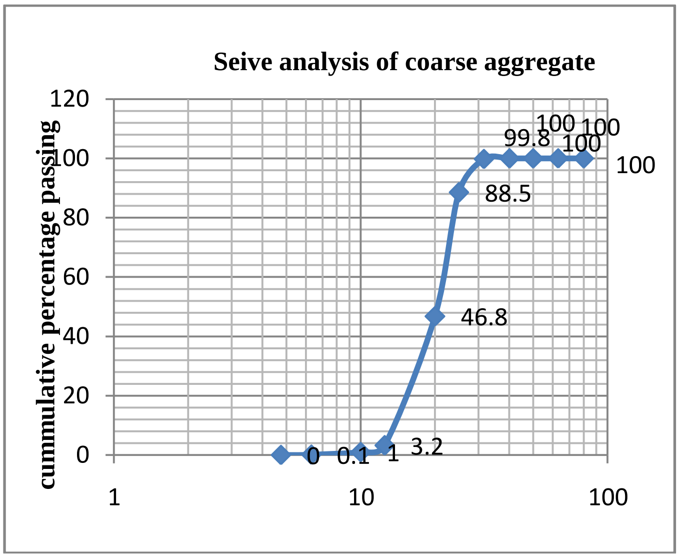

Chart -2: sieve analysis of coarse aggregate

2.3 Water

Portable laboratory tap water was used for concrete mix. In addition water should be Clean and free from oils, acids, leaves, organic matters etc are must taken precautions.

2.4 Hematite Coarse Aggregate

Complete 7samples for knowing the specific gravity of hematite aggregate which was found above 4.0 i.e. my result of sample is specific gravity 4.3. 20mm and 10mm used as coarse aggregate.

Table -5: Physical properties of hematite

S no	Properties	Results
1	specific gravity	4.3
2	Bulk density	2300 kg/m^3
3	Particle shape	ANGULAR
4	Particle size	20mm used*
5	Color	Reddish
6	Water absorption	3%
7	Crushing value	12.55
8	Impact value	12.41

Fig -1: hematite aggregate

Table -6: Chemical composition of normal hematite in weight %

compound	Percentage %
Fe_2o_3	83.16
MnO	0.13
MgO	1.56
TiO_2	0.04
Al_2O_3	0.60
CaO	4.81
SiO_2	4.23
LOI	0.31

3 MIXING, CASTING AND CURING

Mixing was carried out in 100literrs revolving peddle pan mixer. The concrete was cast into steel moulds using a minimal amount of Greece and compacted using a vibrating table. The specimens were demoded after 24 hours and water curing for 28days.

Fig -2: pan mixer

Fig -3: casting of specimens, (cubes, cylinders and beams)

Fig 4: specimen curing tank

4 RESULTS AND DISCUSSION

Fig 5: compressive testing machine of cubes

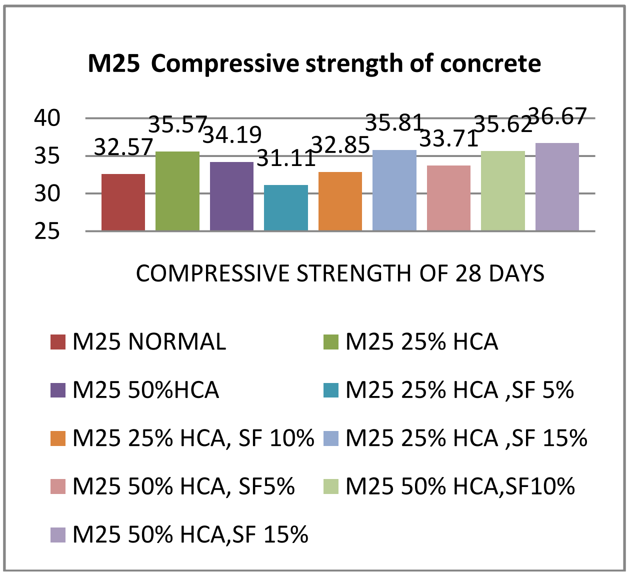

Chart -3: M25 grade of compressive strength of concrete

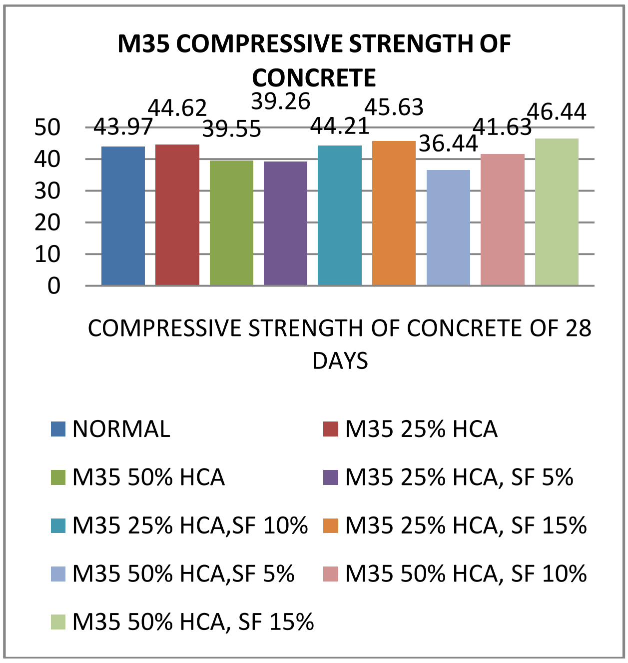

Chart -4: M35 grade of compressive strength of concrete

Fig 6: compressive testing machine, split tensile test for cylinders

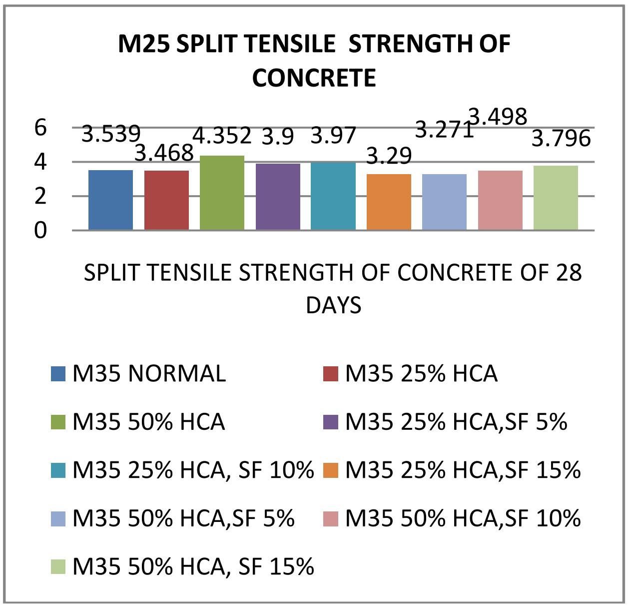

Chart -5: M25 grade of split tensile strength of concrete

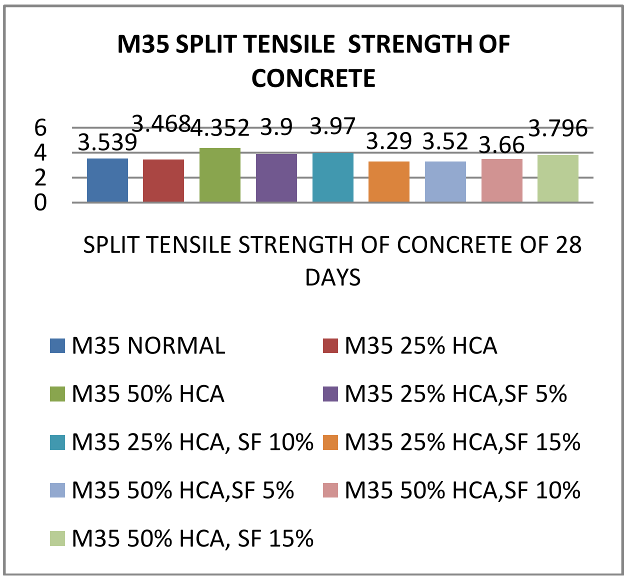

Chart -6: M25 grade of split tensile strength of concrete

Fig 7: universal testing machine for beams

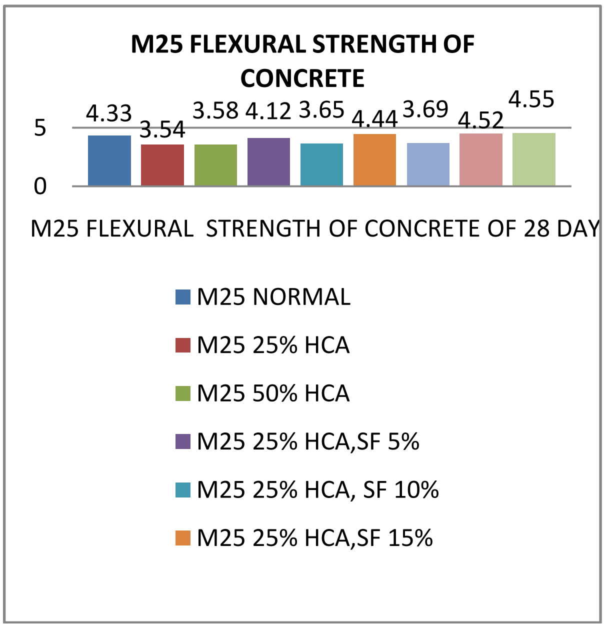

Chart -7: M25 grade of flexural strength of concrete

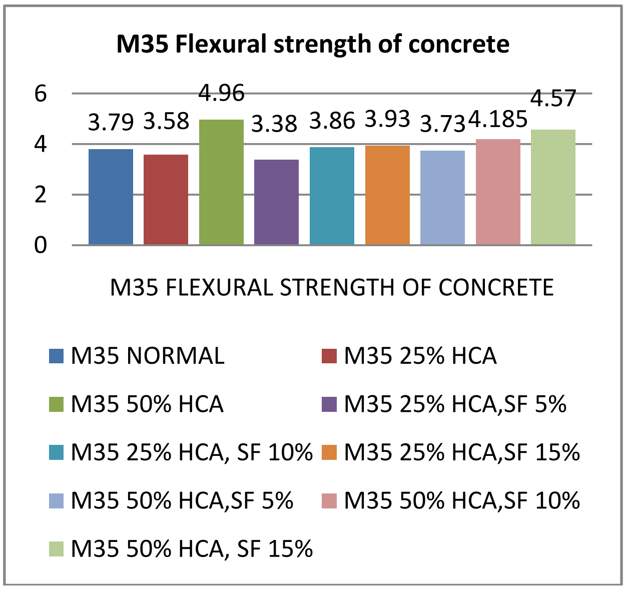

Chart -8: M35 grade of flexural strength of concrete

5 DENSITY OF CONCRETE

The increase in percentage of HCA increases the density of concrete. In other words the density is proportional to percentage of HCA. The details are shown in fig where NA represents the concrete made with conventional material, HB represents sample of concrete prepared with HCA replacing 25% coarse aggregate. And HC represents sample of concrete prepared with HCA replacing 50% coarse aggregate. Thus maximum random density is selected for this chart.

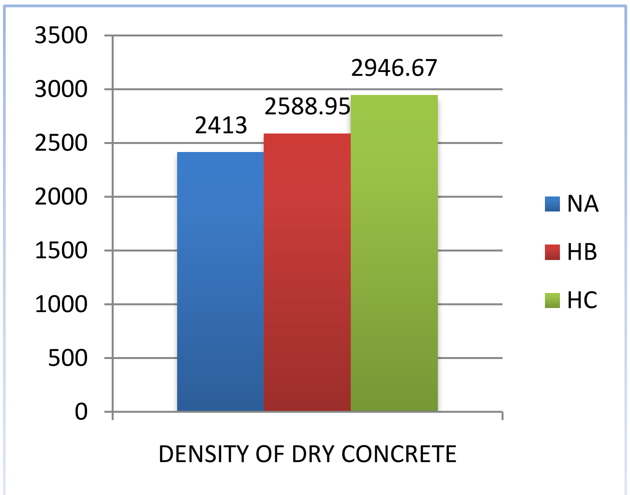

Chart -9: density of dry concrete

6. CONCLUSIONS

The primary objective of this study was to evaluate the use of hematite fe-58 high grade iron ore material in the concrete to make it heavy weight or density material, as partially replacement of coarse aggregate. Based on the results obtained in this study, it may be seen that HCA could be used for making heavy weight concrete, without affecting much the compressive strength, tensile strength, flexural strength of concrete.

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