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RESEARCH ARTICLE

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"EXPERIMENTAL STUDY ON HEAVY WEIGHT CONCRETE BY PARTIAL REPACEMENT OF COARSE AGGREGATE WITH HEMATITE"

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Manuscript Info

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Abstract

Heavy weight concrete or high density concrete is commonly used for radiation shielding either in nuclear power plant or in radiation therapy units. It can also be used as ballast in offshore location such as pipelines. Heavy weight concrete is designed by using heavy weight aggregate such as hematite, magnetite, barite, etc. The rise in construction activity has resulted in an increase in demand for variety of materials. This research into alternative material for used as concrete ingredient that are not inferior to conventional material. The work focuses on the partial replacement of course aggregate with hematite aggregate in a varying percentage of M30 concrete mix. In this work, conventional coarse aggregate is partially replace with hematite aggregate that passes through 20mm IS sieve size. Hematite replaces in a percentage of 25%, 50%, and 75%, and compressive strength are determined.

Introduction:-

Concrete is the composite building material composed of cement, fine aggregates, water and coarse aggregates, with addition of chemical admixtures. The combination of the components causes a chemical reaction known as hydration.

The term concrete aggregates covers a variety of products, but are usually summed up as stone and sand, in coarse and fine grade. Coarse aggregates are defined as any material greater than 4.75mm.

High density concrete observe neutrons which are accurate construction material which protects fromirradiating rays and causing harmful effect to environment and living things, another important aspect is resist against freeze and thawing cycle 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.

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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 additionaldensity means that smaller volumes can be transported as placed.

Introduction on hematite:
Hematite is one of the most abundant minerals on earth's surface and in the shallow crust. It is an iron oxide with a chemical composition of Fe2O3. It is a common rock forming mineral found in sedimentary, metamorphic and igneous rocks at location throughout the world. Hematite has wide variety of other uses, but their economic significance is very small as compared to the importance of iron ore. The mineral is used to produce pigments, preparation for heavy media separation, radiation shielding, ballast and many other products.

Characteristics And Properties:
Hematite is an iron oxide with a chemical composition of Fe_2O_3. Pure hematite has a composition of about 70% iron and 30% oxygen by weight.

Physical Properties Of Hematite	
Chemical Classification	Oxide
Color	Black to steel gray to silver; red to reddish brown to black
Streak	Red to reddish brown
Luster	Metallic, submetallic, earthy
Diaphaneity	Opaque
Cleavage	None
Mohs hardness	5 to 6.5
Specific gravity	5. to 5.3
Chemical composition	Fe_2O_3
Crystal system	Trigonal
Uses	The most important ore of iron. Pigment, heavy media separation, radiation shielding, ballast

Table 1:- Physical properties of hematite.

Literaturereview:-

1. **Effect Of Hematite And Iron Slag Aggregates Replacement On Thermal, Mechanical And Gamma-Radiation Shielding Properties Of Concrete**

In a study conducted by Amr M. Ibrahim where no significant variation between shielding properties of mixes with hematite and and iron slag. Thermal was improved by using hematite aggregates. Using High slag cement improves the mechanical concrete. Specific heat is increased by using iron slag as coarse aggregate replacement.

2. **Material selection and mix design of radiation shielding concrete**

In a study conducted by Mortazavi, et, where the focus was on production of an economic high density concrete for shielding of megavoltage radiotherapy room and nuclear reactors, galena was used as the only heavy- weight aggregate in the mix. In their investigation, two types of concrete mixes were produced. These were the control and galena mixes of w/c of 0.53 and 0.25 respectively. The galena used in this study had a density of 7400 kg/m3 and was obtained from a mine in Firozabad in Iran. It was reported that while the control mix yielded a density of 2350 kg/m3 and 30 MPa, the galena high density concrete had a density of 4800 kg/m3 and 50 MPa. It was reported that the galena concrete gave good shielding properties.

Experimental Program
An experimental study is conducted on Hematite partially mixed with cement concrete. The normal grade of concrete M30 mixed with varying percentage of hematite by replacing course aggregate. Experimental study is carried out to investigate both fresh and hardened concrete properties.

Materials Used
Main constituents of the concrete is cement, fine aggregate, coarse aggregate, Hematite. The materials used in the present program are shown below:

Cement

Locally available Ordinary Portland Cement of 53 grade of ultra-tech brand conforming to ISI standards has been procured, and following tests have been carried out according IS: 8112 – 1989

SR.No.	Physical Property	Test Results of OPC (53 grade)
1.	Initial Setting time	30 min
2.	Final Setting time	600 min
3.	Fineness	6%
4.	Specific Gravity	2.03
5.	Consistency	33%
6.	Soundness	0.5mm

Table 2:- Physical properties of 53 grade OPC.

Fine Aggregate

The locally available natural river sand conforming to grading zone-II IS 383-19100 has been used as Fine aggregate. Following tests have been carried out as per the procedure given in IS 383(1970)

Coarse Aggregate

Machine crushed granite confirming to IS 383-19100[23] consisting 20mm maximum size of aggregates has been obtained from the local quarry. It has been tested for physical and mechanical properties such as specific gravity, sieve analysis and the results have been shown in the Table 4

SR.No.	Properties of aggregates	Test results of Fine aggregates
1.	Loose Density	1235kg/m3
2.	Rooded Density	1325kg/m3

Table 3:- Tests on Coarse Aggregate(CA).

Property	Values obtained
Specific Gravity	2.68
Fineness Modulus	2.7
Grade Zone	2
Water Absorption	0.20

Water

Potable water has been used in this experimental program for mixing and curing.

Mix Design

Mix design is defined as process of selecting suitable ingredients of concrete and determining their relative proportions with the object of producing concrete of certain minimum strength and durability as economic as possible.

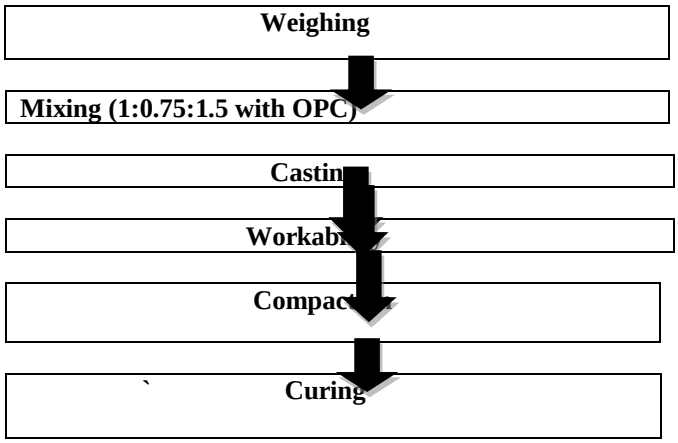
Mix Design Of M30 Grade Concrete

In the present investigation M30 grade of concrete has been considered. The mix of concrete is designed as per the guidelines given in IS 456:2000 and IS 10262-2009, subsequently mixes were prepared with a partial replacement of course aggregate by Hematite of 0%, 25%, 50% & 75%. by weight of aggregate for Cubes and beams.

Preparation Of Test

Concrete cubes specimens of 150 mm x 150 mm x 150 mm size and concrete beam specimens of 150 mm x150 mm x 700 mm size were casted to evaluate the variation in compressive strength and flexural strength respectively. After casting, the concrete specimens were kept in the moulds for 24 hours. The specimens were then demolded and moist cured in a curing tank till the age of 7, 14, 28 days.

SR.No.	Properties of aggregates	Test results of Fine aggregates
1.	Bulk Density	0
2.	Fineness Modulus	2.24
3.	Specific Gravity	2.29



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6. IS Code

IS : 2386 (Part I) – 1963 Particle Size and Shape – Sieve Analysis
IS : 2386 (Part III) – 1963 Bulk Density, Specific Gravity, water Absorption
IS : 2386 (Part IV) – 1963 Impact Value
IS : 12269 – 2013 Soundness by Le' chatelier method, Initial Setting time, Final Setting time , Standard Consistency test
IS : 456 : 2000 Water cement ratio Table no. 5 (Clause 6.1.2) Minimum cement content(Clause 6.1.2) Standard Deviation Table no. 8 (Clause 9.2.4. 2).