Performance of High Density Concrete with Iron Ores and Alumino Thermit Portion, As A Radioactive Barrier

Prem Singh Rathore
M.Tech. (Structure)
Integral University
Lucknow, India

S.M.A Husain
(Assistant Professor)
Department of Civil Engineering
Integral University
Lucknow, India.

Dr. Sabih Ahmad
(Associate Professor)
Department of Civil Engineering
Integral University
Lucknow, India.

Prof. Syed Aqeel Ahmad
H.O.D
Department of Civil Engineering
Integral University
Lucknow, India.

***Abstract*— High density concrete is widely used in railway, crane counter weight, radiation shielding in nuclear plants or other radiation related application and medical establishment. The aim of this study is to increase the density of concrete and accomplish it by using iron ores, obtain form iron queries as aggregates and thermite portion. The traditional concrete aggregates were replaced by iron ores aggregates in amount of 100% . Physical and mechanical properties (densities C.S., T.S., Freeze- Thaw resistance were determined).**

The aggregates of concrete plays an essential role in modifying concrete properties and physical-mechanical properties of concrete. On its shielding properties; the attenuation measurement will perform by using GAMMA SPECTOMETER SCINTILLATION DETECTOR (of Nal) and finds shielding factors (HVL-half value layer, TVL-tenth value layer) as well as attenuation coefficient (μ).

Keywords—Iron ores, radioactive barrier, concrete shielding, tomography, structurix D.

1. INTRODUCTION

High density concrete consist of concrete with density higher than normal (i.e. 2300 kg/m^3 to 2550 kg/m^3). HDC is used for special purposes such as radiation shielding, counter weights, safe walls safe, roofs and trading cost for space saving.

Concrete is most widely used material for reactor shielding due to its cheapness and satisfactory mechanical properties. The aggregates components of concrete that contains mixture of many heavy metal (like free iron) plays an important role in improving concrete shielding properties. The density of heavy weight concrete is based on the properties of component and the S.G. of aggregates.

High density concrete is a concrete having density in the range of 6000 to 6400 kg/m^3 is also known as heavy weight concrete. Due to better shielding it protect from harmful radiation like X-Rays, γ- Rays, Neutrons.

Concrete with respect to specific gravity higher than 2600 kg/m^3 are called heavy weight concrete and high density aggregates with respect to S.G. higher than 3000 kg/m^3 are called heavy weight aggregates. S.G. is the ratio of the density of substance to the density of reference substance or it is the ratio of mass of substance to the mass of reference substance for the same given volume.

Local Hematite Stone were used as aggregates to produce HDC for application in X and gamma Shielding concrete cubes sample (150*150*150) containing Hematite as a coarse aggregate Prepared by changing mix ratio, w/c ratio and types of fine aggregate The concrete specimen of size
100*100*100 also will form to pass max. radiation through own self with reference to distance(Inverse Square Law).

2. METHODOLOGY

I. Material Used-

(a) **Aggregates:-** High density Concrete (HDC), is achieved by using high-density aggregates usually iron oxides. The most important part of HDC aggregates is that the grading should be constant and that a workable grading limit be agreed on with the supplier. The chemical properties of all high-density aggregates should be evaluated before use in high alkaline environments as found in cement pastes, long term durability such as alkali-aggregate reactivity, Sulphate and Chloride attack and other impurities. The cost of HDC increases with density but not necessary in direct proportion. Aggregates should be selected for their shape free of flat or elongated, maximum density, workability, and cast. The grading of the coarse aggregate should be uniformly graded between 10 mm and 20 mm. as grade 1 and 4.75 mm &10 mm as grade 2.

(b) **Natural Aggregate:-** Different parts of natural high-density aggregates which can be used for high density concrete (HDC) as Iron ores.

(c) **Man-made Aggregate** :- To achieve concrete densities above 6000 Kg/M^3 man-made of synthetic material such as ferrosilin slag, steel or lead shot can be used. Overall HDC are used Barite, Ferrophosphorus, Limonite, Hematite, Ilmenite, Magnetite, Geothite, Steel punching, Steel shots.

1. **Cements:-** if alkali-reactive constituents are present in the aggregates cements with low alkali contents or a suitable not having more that 0.6 & Na_20 may be used with a potentially alkali-reactive aggregate such as lead shot. When lad shot is used high alumina cement (HAC) must be used as it reduces the chemical reactivity of lead in high alkaline condition. Deleterious expansion can be prevented by using alkali-reactive aggregate (Lead shot) and High alkali cements with adding extenders.

(i) Chemical Composition :-

Compounds	**% (by weight)**
CaO	60.720
$Si0_2$	18.680
$A1_20_3$	4.990
MgO	4.560
Lime	4.400
Fe_20_3	3.020
$S0_3$	2.860
Loss of ignition	2.450
K_20	1.680
Na_2Oekv	1.220
Na_20	0.110
Cr	0.004

(ii) Properties :

Compressive strength (MPa):

days	14
days	27
28 days	51
Setting time (min)	200
Fineness (m^2/kg)	330
Bulk density(kg/m^3)	1200

2. **Admixtures:-**Super plasticizers are beneficial in reducing water to minimize bleeding and maintain a cohesive mix that has minimum segregation. Water-reducing admixtures as it will increase concrete density by reducing the amount of water. Water is the material used in HDC with the lowest density. Shrinkage- reducing admixtures as it ensure dense, crack-free concrete used for radiation- shielding concrete. One of the widely used super plasticizers has a Na_20 of about 5% and if added at 1% of cement to the concrete. Lithium based compounds can be used with lead shot to control the alkali reactivity.

Property of Concrete/Aggregate

1. Neutrons shielding property:- Example-Radiation Shielding Concrete.
   The shielding properties of this concrete against is being used to build bunkers, mazes and doors in medical accelerator. The objective was to characterize the material behavior against neutrons, as test alternative mixings including born compounds in an effort to improve neutron shielding efficiency. The original mix which includes a high fraction magnetite, was then modified by adding different proportion of anhydrous borax ($Na_2B_4O_7$).

Properties of High Density Aggregates and Concrete.

Ferrophosphorus- density (kg/m^3)-4080-5290
Steel punchings or shot- density (kg/m^3) - 4650-6090

II. SAMPLE CASTING:-

Mixing, Curing, testing of specimen

The material were placed in the mixer with capacity of 56 dm^3 in the following sequence:-

(1) Material were initially dry mixed for 2 min.
(2) Approximately, 80% of the mixing water was added and there the mixer was started.
(3) After 1.5 min of mixing, the rest of the mixing. water was added to the running mixer in a gradual manner.
(4) All batches were mixed for a total time of 5 min.
(5) In order to prevent fresh concrete from segregation, the mixing duration was kept as low as possible.
(6) All concrete 3 specimens were cast in three layers into 150x150x150 mm cubic steel moulds: each layer consolidated using a vibrating table.
(7) After casting, concrete specimens were covered with plastic membrane to avoid water evaporation and thereafter kept in the laboratory for 24 hrs at ambient temperature.
(8) After demoulding, concrete specimens were submerged into water tank until the time of testing.

Quality Control

Production, Placing, Compaction:- Standard batching procedures can be used for naturally occurring aggregates such as Barytes and Magnetite to allow for the increase in aggregates relative density. It is sometimes necessary to use smaller drum mixers approximately $0.5m^3$ and smaller, for lead shot. Normal batching and handling equipment can be used but great care should be taken not to overload the equipment as HDC is much denser. Batching times will take longer per cubic metre. But individual batch mixing times should be similar to those for standards aggregates.

The slump for high-density aggregates mixtures should normally be between 40 and 75 mm. it is far more susceptible to variations in quality due to improper handling. Concrete should be placed in layers not more that 30 mm thick.

The concrete should be free of segregation and voids. Higher frequencies vibration causes segregation of high-density aggregates by settlement i.e large aggregate migrate to the bottom to the element. The area radius of action of vibrators used in HDC is less effective.

III. SAMPLE TESTING :

Radiographic Evaluation of Concrete –

a) Radiations (γ-rays) characteristic -

Gamma Rays -

1. Wave length (Short) - 0.005 A^0 (Angstroms) to 05 A^0
2. Frequency-more than 1019 Hz.
3. Velocity- V. of light- (3.108 m/s)
4. Penetration - can even pass through 30 cm thick
5. Deflection - Iron no affect electric and magnetic field because of no charge or mass.
6. Energy - high energy EM radiation, energy greater than 100 Kev.

b) Principle of radiographic testing -

It is based on the principle that radiation is observed and scattered as it passed through an object. If there are variations in thickness or density in an object more are less radiation passes through and affects the film exposure flaws shows up on the film.

c) Shielding Property –

Radiations (α, β, γ), β particles can be blocked by sheet of aluminum, γ - rays requires several inches of lead, concrete or steel to be stop.

➢ **Lead Shielding -**

It reduces the intensity of radiation depending on the thickness. This is an experimental reaction with gradually diminishing effect as equal slices of shielding material are added. A quantity knows as halving thickness is used to calculate this, halving thickness of lead is 1 cm. which means the intensity of gamma radiation will reduce by 50% by passing through 1 cm. of lead.

(i) 2.0 cm. thick reduces γ rays to 1/4 of their original intensity (1/2) multiplied by itself 2 times)

(ii) 3.0 cm. of lead reduces γ rays to 1/8 of their original intensity (1/2) multiplied by itself 3 times)

Halving thickness (cm) Density (g/cm3) mass (g/cm2)

Lead	1.0	11.3	12
Steel	2.5	7.86	20
Concrete	6.1	3.33	20

➢ **Concrete Shielding -**

It can be used to shield against both neutrons & rays. It is composed of a mixture of cement (13%), water (7%), aggregates (80%). OPC is referred to as light & has density of about 2.2-2.4 g/cm^3. Heavy concerts have densities ranging from about 3 to 6 g/cm^3. Ferro phosphorus ore aggregate and limonite mixture have been used because of their greater densities and higher water content. The barium sulphate ore aggregate (barite) is also use to form heavy concrete. These concrete contain boron for neutron absorption and hydrogen for neutron attenuation. The barite ore is also a good gamma attenuator.

The thermal neutron absorption properties of concrete can be greatly enhanced by the addition of boron compound. Hydrogen in fixed water (hydrated) from and free water (in the pores) in concrete serves has a good neutron shield. Initially the free water content is about 3% by wt. The water may be lost at ambient temperature by evaporation. To minimize evaporative loss, design criteria limit of ambient temp, is 149°(for photons shield) 71°C (for neutron shield), max internal temperature for photons shield is 171°C and 88°C for neutron shield.

3. RADIOGRAPHIC EXAMINATION & MEASUREMENT :-

❖ **Examination with projector & substance:-**

(i) **Projector Used:- SENTINEL 880 Delta** (other Elite, omega) the patented device body consist of a titanium 'S' tube and cast depleted uranium (DU) shield contained within 300 series stainless steel tube with stainless steel discs welded at each end forming a cylinder shape housing. The discs are recessed to provide protection for the rear mounted outlet part. It radiographic (γ-rays) inspect to materials and structure in the density range of about 2.71 g/cm^3 to 8.53 g/cm^3

(ii) **Specification of projector:- 880 Delta**

➢ Dimension :-

L	= 33.8 cm
W	= 19.1 cm
H	= 22.9 cm
Wt	= 23.6 kg

➢ Activity of Depleted uranium Shield :-
Delta: 5.4 mci (200 mbg)

(iii) **Specification of Radioactive Substance:-**

Isotope	Ir192	Co60
γ Energy Range	206-612kev	1.17-1.33 Mev
Half-life	74 days (0.2301 year)	5.27 years.
Steel work thick	12.63 mm	50-150 mm.
Device source max.	150 ci	65 mci
Capacity	(5.55 TBg)	(2.40 GBg)
Operating temp.	40 ^{0}C to 149 ^{0}C	

❖ **Specimen Tomography:-**It is Application of gamma rays transmission in studies of water vertical ascending infiltration sample of concrete. N.D.T. i.e. ultrasonic pulse velocity, pulse echo, radioactive tests, radar test, acoustic emission but are used to determine the defects of concrete.

In tomography after a number of profile of narrow beam transmission are obtained at different orientations around a sample such measurement total linear attenuation coefficient of γ- rays along the path of the ray. Let if-

Ni – Number of γ-ray photons incident upon sample within specified time interval

N-Corresponding number of photons existing the sample then exp. for. mono energetic γ-ray bean.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 09, September-2020

$$\int \mu^*(x,y)ds = ln\left(\frac{Ni}{N}\right)$$

$\mu^*(x,y)$ – linear attenuation coefficient. at(x,y)

ds- Element distance along the ray.

The linear attenuation. coefficient is directly related to the mass attenuation. coefficient (cm^2/g) through the density (g/cm^3) at material. The attenuation equation for a gamma ray beam passing through the concrete, gives the relation between mass attenuation.

Coefficients-

$$\mu t.Xt.\rho t = \mu c.Xc.\rho c + \mu s.Xs$$

$$\mu t = \left[\frac{1}{1+T}\right](\mu c + \mu sT).$$

❖ **Measurements of radiations – mainly can done by two ways.**

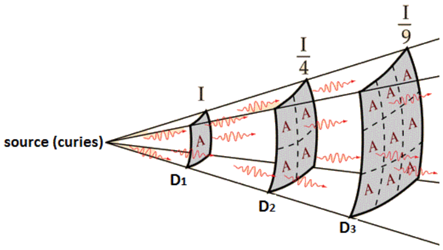
(i) **Inverse Square Law:-** In radiographic inspection, the radiation spreads out as it travels away from the gamma source. Therefore the intensity of radiation follows Newton's Inverse square Law.

This law accounts for the facts that the intensity of radiation becomes weaker as it spreads out from the source since the same about of radiation becomes spread over a large area. The intensity is inversely proportional to the distance from the source.

$$I \propto \frac{1}{D^2}$$

$$Or \frac{I_1}{I_2} = \frac{D_2^2}{D_1^2}$$

i.e. The energy twice as for from the source is spread over four times the area; hence one-fourth the intensity.



I_1 Intensity 1 at D1

I_2 Intensity 2 at D2

D_1 Dis. 1 from source

D_2 Dis. 2 from source

(ii) **Radioactive Exposure of Film:-**In examination to measure exposure of film irradiated, lower energy photons are attenuated preferentially by differing absorber material (black & white emulsion) This property is used in film dosimetry to identify the energy of radiation to which the dosimeter was exposed. The film bodge dosimeter is used for monitoring cumulative radiation dose due to ionizing radiation.

a) Film density Exposure Calculation:-

At E_1 – 10 mm steel plate (for 't' time) pass- get FD_1

At E_2 – 10 mm steel plate (for '2t' time) pass+ Specimen–get FD_2

$$\frac{E_1}{FD_1} = \frac{E_2}{FD_2}$$

where E_1- Exposure 1
E_2- Exposure 2
FD_1- Film density at exposure 1
FD_2- Film density at exposure 2

b) Incident Radiation & time :-

Reciprocity Law-

where C_1- Current 1
C_2- Current 2
T_1- Time 1 at C1
T_2- Time 2 at C2

c) Indication depth:-

$$D = \frac{t.S_D}{S_M}$$

Where, D = Defect depth from the film side of the part

t = Thickness of material
S_D = Shift of defect image on the film.
S_M = Shift of source marker on the film.

4. <u>**Safer, Recommended limits of radiations**</u>

The exposures of individuals should not exceed the limits recommended for the appropriate circumstances.

(i) Public exposure

ICRP (International Commission on Radiological Protection) recommends that the maximum permissible dose for occupational exposure should be 20mSv per year averaged over five years (i.e. 100 mSv in 5 year) with a maximum of 50 mSv in any one year. For public exposure

1 mSv per year averaged over five year is the limit (excluded medical exposure).

(ii) Medical exposure-

(a)	Abdominal Region	10 mSv	for 3 year	(CT-Abdomen & Pelvis)
(b)	Bone	1.5mSv	for 6 months	(spine x-ray)
(c)	Central Nervous system	2.0mSv	for 8 month	(CT-Head)
		6mSv	for 2 year	(CT-Spine)
(d)	Chest	7mSv	for 2 year	(CT-Chest)
		1.5mSv	for 6 months	(CT-Lungs)
		0.1mSv	for 10 days	(Chest x-ray)
(e)	Dental	0.005mSv	for 1 day	(Dental x-ray)
(f)	Heart	12mSv	for 4 year	(CT angi-ography)
		3 mSv	for 1 year	(CT Cardiac)
(g)	Imagine (M/F)	.001mSv	for 3 hours	(Bone Densi-tometry) DEXA
		0.4mSv	for 7 weeks	(Memography)

5. EXPERIMENT TO HIGH DENSITY :-

(i) Casting of Specimen Cubes :- Four concrete Cubes of grade M25 (150x150x150) are casted to check radioactive gamma rays attenuating property for different job thickness (100mm, 150 mm, 300 mm, 600 mm w.r.t. following siew analysis and proportion of ingrediants.

(a) Aggregate siew analysis (for Iron ores)
w.r.t. Specimen block No. 1 & 2.
10 mm - 20 mm → 11.183 Kg.
4.75 mm - 10 mm → 1.892 Kg
0.150 mm - 4.75 mm → 1.833 Kg

(b) Proportion of ingredients (for M25)
w.r.t. specimen block No. 1 & 2
C.A. → 13.075 Kg
F.A. → 6.54 Kg
[1.833 Kg ((I.O.A) + 1.569 Kg (6% Portion) + 3.138 Kg (Coarse Sand)]
C → 6.54 Kg
W/C Ratio → 0.40

(c) Aggregate Analysis (for Iron Ore Aggregate) w.r.t.
Specimen No. 3 & 4 (150x 150x150) and
Specimen No. 5 & 6 (100 x100 x100) 16.103 Kg

20 mm - 25 mm → 2.44 Kg
10 mm - 20 mm → 5.915 Kg
4.75 mm - 10 mm → 7.748 Kg
0.150 mm-4.75 mm → 1.979 Kg

(d) Proportion of Ingredient for M25 w.r.t. specimen No. 3 & 4.
C.A. → 16.103 Kg (I.O.A.)
F.A. → 8 Kg
[1.979 Kg (IOA) + 2.254 Kg (7% Portion) +3.766 Kg (coarse Sand)]
C → 8 Kg
W/C Ratio → 0.42

After demoulding all cube specimen No. 1, 2, 3, 4, 5, & 6 are putted into water tank for water curing up to 28 days for specimen No. 1 2 and 15 days for specimen No. 3, 4, 5 & 6.

ii. Density Performance :-

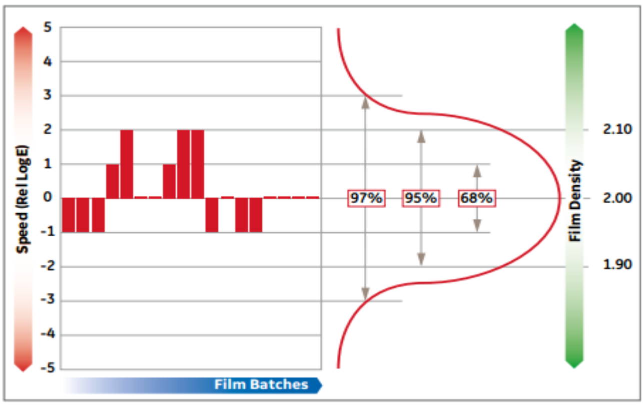
We have achieved weight of all cube specimen w.r.t. completion period of curing 28 days (for specimen No. 1 & 2 and 15 days (for specimen No. 3,4,5 & 6) are as under :-

Specimen detail	Sp. No.	Weight (Kg)	Density (Kg/m^3)
Specimen cube of size 150x150x150m	1	11.1055	3290.52
	2	10.625	3148.12
	3	10.35	3066.67
	4	9.98	2957.04
Specimen cube (size (100mmx100 mmx100mm)	5	2.95 Kg	2950
	6	3.05 Kg	3050

As we know that density reaches beyond 2425 Kg/m^3(area) into Higher density of concrete. So all cube specimen expresses higher density of concrete.

6. EXPERIMENT TO “CONCRETE AS RADIOACTIVE BARRIER”

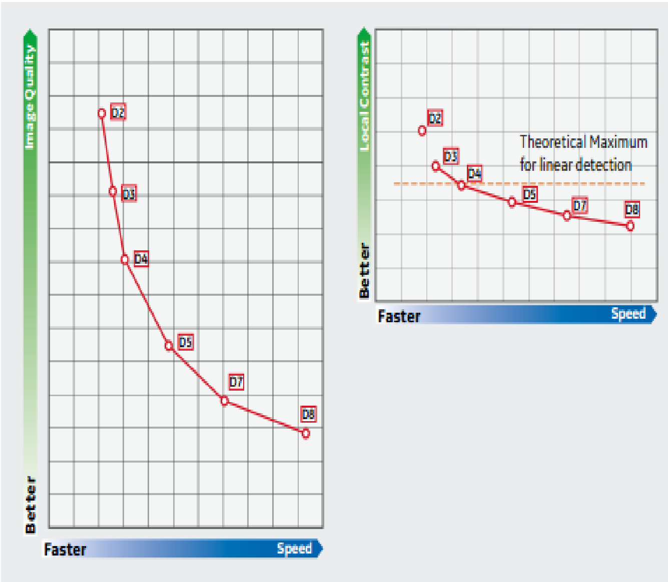
(i) Optimum Image D-Family Quality



International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 09, September-2020

(ii) Technal Specification

(a) Technological Axis of STRUCTURIX D fami-

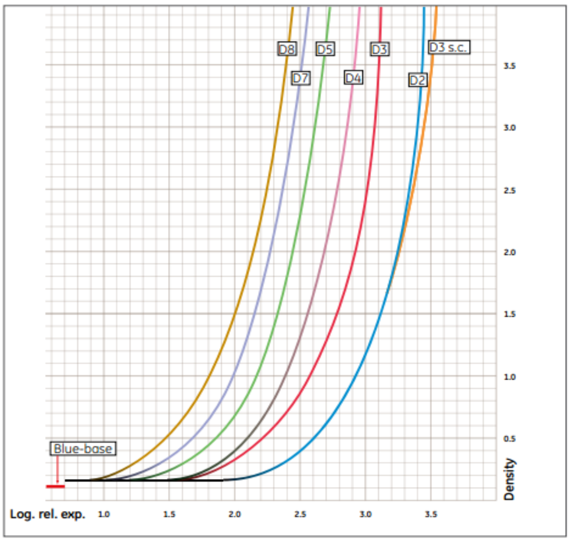


ly→

(b) Characteristics w.r.t. Class of film used

STRUCTURIX D7	
Fine grain film with high contrast and high speed. Designed for direct exposure or with lead screens. For exposure with lead screens, using either X-ray or gamma rays.	• Welding • Castings • Shipbuilding • Aerospace and aircraft industry • Multiple film techniques

(c) Sensitometric Curve & Relative Exposure Factor



Relative Exposure Factors

Type	100kV	200kV	Se75	Ir192	Co 60	Linac/8MeV	Contrast
STX D2	9.0	7.0	6.4	8.0	9.0	9.0	6.0
STX D3 s.c.	9.5	8.0					5.3
STX D3	4.1	4,3	3.6	5.0	5.0	5.1	5.5
STX D4	3.0	2.7	2.4	3.0	3.0	3.1	5.4
STX D5	1.7	1.5	1.4	1.5	1.5	1.5	5.4
STX D7	1.0	1.0	1.0	1.0	1.0	1.0	5.4
STX D8	0.6	0.65	0.6	0.6	0.6	0.6	4.3

(iii) Exposure Theory

(a) Data used in the application :-

S. No.	Radio isotope	Half Life (Days)	RHM	HVT material (cm)		
				Lead	Steel	Concrete
1	Ir, 192	74	0.518	0.24	0.92	2.98
2	Co-60	5.3x35 = 1934.5	1.332	1	1.66	5.2

(b) Current Activity :- It is an exponential function and time and is calculated by expression in equation

$$A = \frac{A_o}{2^{(T/HL)}}$$

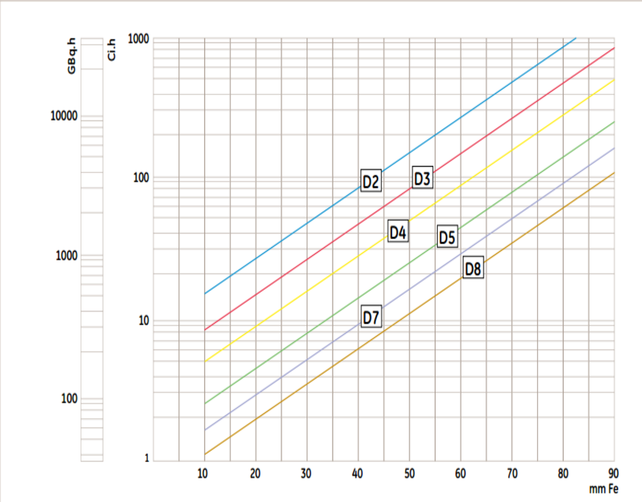
(c) Exposure Time for Radioactive Shot :- Exposure time for radiography shot is commonly evaluated by expression -

$$t = \frac{(F.F.) \times (SFD)^2 \times 2^{(\frac{x}{HVT})}}{(RHM) \times A}$$

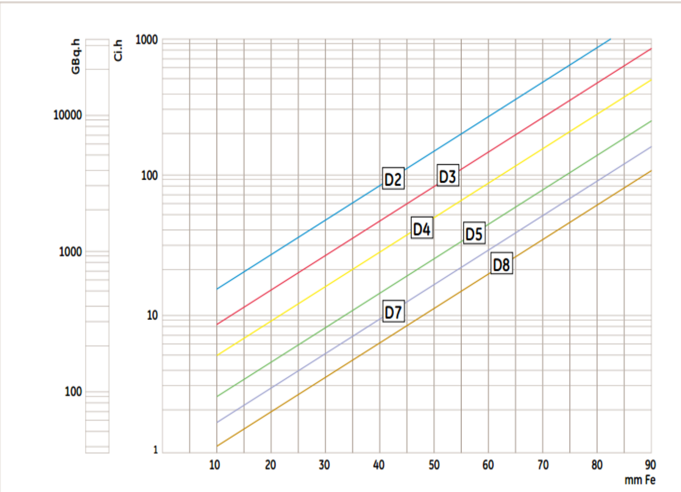
t → time (in minutes)
F.F. → Film Factor
SFD → Source to film distance (cm)
x → Specimen Thickness
RHM → Roentgen per hour per curi at 1 m from given radio-isotope source.
A → Current activity

(d) Exposure Diagram (Ir 192, Co-60)

For Ir 192



For Co-60



7. CONCLUSIVE RESULT OF % ATTENUATION.

A. By Testing Report

i)	B_1 or B_2(15cm) attenuates	54.33%
ii)	B_1 + B_2(30cm) attenuates	67.64%
iii)	B_1 x 3 or B_2 x3 (45cm) attenuates	67.64+13.31= 80.95%
iv)	B_1 x 4 or B_2 x 4 (60 cm) attenuates	80.95+13.31 =94.26%

B. By Beer Lambort Law

i) HVL-

→ Thickness of block which attenuats 100%

$$= \frac{60}{94.26} \times 100 = 63.65\ cm.$$

→ Thickness of block which attenuates 50%

$$= \frac{63.65}{2} = 31.83\ cm.$$

→ HVL= 31.83 cm (for I.O Concrete)

ii) NX→

Fractional radiation intensity passing through different

Job thickness → $Nx = N0.e^{-ux} cm^{-1}$

μ → Linear attenuation coefficient

$$\text{HVL} = \frac{\ln(2)}{\mu} = \frac{0.693}{\mu} = 31.83$$

$$\mu = 0.0218$$

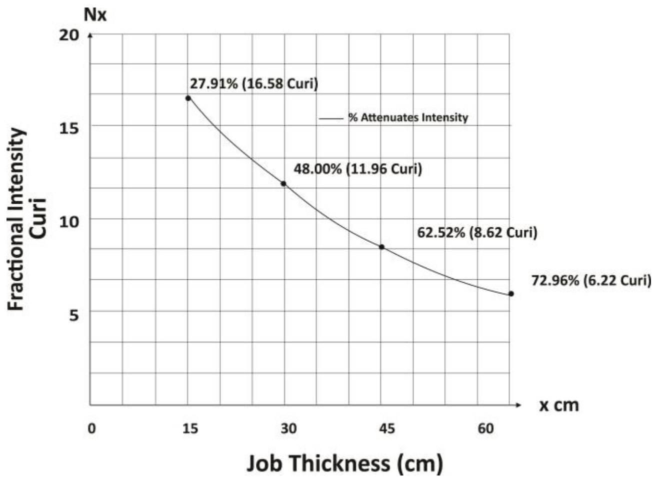
$\rightarrow 23 \times . e^{-(.0218).15} = 16.58\ Curi$ NX (By one block B_1 or B_2)

$\rightarrow 23 \times . e^{-(.0218).30} = 11.96\ Curi$ (By two block B_1 or B_2)

$\rightarrow 23 \times . e^{-(.0218).45} = 8.62\ Curi$ (By three block B_1 or B_2)

$\rightarrow 23 \times . e^{-(.0218).60} = 6.22\ Curi$ (By four block B_1 or B_2)

iii) Graph between fractional Intensity & Thickness of Job



8. TEMPERATURE INFLUENCE

Retention in mass of concrete at elevated concrete Temperature is highly influenced by the type of aggregate Such as mass loss is minimal for both carbonate & siliceous aggregate up to 600^{0}C. and type of aggregate has significant influence on mass loss in concrete beyond 600^{0}C.

As per thermal diffusivity theory thermal. Conductivity (k) of material will be directly proportional to thermal capacity ($\rho.C_p$)

$\propto \frac{k}{\rho.Cp}$	$\propto\rightarrow$	Thermal diffusivity
	$k \rightarrow$	Thermal conductivity
$k = \propto.\rho.Cp$	$\rho.Cp \rightarrow$	Thermal capacity.
	$\rho \rightarrow$	Density of material
$k \propto \rho$	$Cp \rightarrow$	Specific heat of material

As we are using thermit portion (6-7%) in concrete preparation, which is a pyrotechnic composition of metal oxides (FeO, Fe_2O_3, Fe_3O_4) and rich iron ore in form of aggregate and formation of free ferum parts during thermal reaction in thermit portion increases metallic property of concrete blocks. So thermal conductivity going to increase, therefore keeping under 100^{0}C to the block 1 and 3 up to 1 hour gains, slightly increase in their weight. Block 1 gains 11.1065 Kg and Block 3 gains 10.3505 Kg. We achieved 0.008% density by block 1 and 0.004% by block 3 more.

9. CONCLUSIONS-

Based on the present experimental investigation, the following conclusions are drawn.

1. Concrete cube specimen (of M25) B_1 and B_2 of size. 150mmX150mmX150mm. casted with analysis of ingredients. As shown below
   Iron ore Agg → 10mm-20mm → 42.76%
   4.75mm-10mm → 7.24%
   0.150 mm-4.75 → 7.00%
   A.T Portion → 6%
   Coarse Sand → 12%
   Cement → 25%
   W/C Ratio → 0.40
   Achieved own density by B_1 is 3290.52 Kg/M^3 and by B_2 is 3148.12 Kg/m^3 (highly dense concrete).
2. Concrete cube specimen (of M25) B_3, B_4 and B_5, B_6 of size (150mmX150mmX150mm) and 100mmX100mmX100mm. respectively casted with ingredients analysis as per shown as-
   Iron ore Agg → 20mm-25mm → 7.6%
   10mm-20mm → 18.43%
   4.75mm-10mm → 24.13%
   0.150 mm-4.75 → 6.16%
   A.T Portion → 7.02%
   Coarse Sand → 11.73%
   Cement → 24.91%
   W/C Ratio → 0.42
   Achieved own density by B_3=3066.67 Kg/M^3, B_4= 2957.04 Kg/M^3, B_5=2950 Kg/M^3 and B_6=3050 Kg/M^3 (highly dense concrete).
3. As per radiography testing report, for comparative assessment of % attenuation w.r.t normal concrete of grade M_{25} is higher as per following.
   For Block 1 or 2 → 54.33% (Job thickness 150 mm)
   Block 3 or 4 → 35.48% (Job thickness 150mm)
   Block 5 or 6 → 43.82% (Job thickness 100mm)
   (w.r.t normal concrete block of job thickness 150 mm)
4. With reference to Sensitometric Curve, double block of B_1 or B_2 (i.e. cube thickness 300 mm) attenuates γ —rays 67.64% more than normal concrete block of same grade which is 13.31% more than single blocks. Similarly triple blocks of B_1 or B_2 (i.e. Job thickness 450mm) attenuates (67.64+13.31) =80.95% more and Job thickness 60cm (4 nor block of B_1 or B_2) attenuates (80.90+13.31)= 94.26% more.
5. Under comparative study by Beer Lambert Law different job thickness attenuates original intensity of radioactive substance (Co-60 of 23 curi) as per following.
   Job thickness % attenuates γ —ray.
   150 mm → 27.91%
   300mm → 48.00%
   450mm → 62.52%
   600mm → 72.96%
6. Cube specimen no 1 and 3 in coil test (thermal test) of 100^0C up to 1 hour, slightly increases own density similarly 0.008% and 0.004%.

REFERENCES

[1] **Ahmed S. Ouda, 2015**Progress in Nuclear Energy as " Development of high-performance heavy density concrete using diff. agg. for γ —rays shielding" 79 (2015), 48-55
[2] **S.M.J. Mortazavi, 2007**Report on " Economic high-density concrete for shielding by in Iran, J. Radiat. Res. 2007, 5(3):143-146
[3] **Janis Kazjonovs2010**Report on "Designing on High Density concrete by steal treatment waste" 16/20, LV-1048
[4] **P. Ramteja, 2016** Internationa Research Journal of Engineering and Technology (IRJET) on "Basalt agg. as course agg. in High Strength concrete", Vol.03, Issued on Aug. 2016.e-ISSN 2395-0056, p-ISSN2395-0072.
[5] **Harshvardhan C 2016** Asian Research Publishing Network (ARPN) Journal of Engineering & Applied Science on "Study on High Density concrete reinforced with steel fiber at elevated temperature" Vol-2, 19-10-2016., ISSN 1819-6608
[6] **AbithaA.M, 2017**International Journal of Science Technology & Engineering on "Properties of concrete incorporating fly ash & Basalt Fiber", Vol.3, issued 12 June 2017., ISSN 2349-784X
[7] **Siva Kishore, 2015**International Journal of Civil Engineering (SSRG-IJCE) on " Experimental study on. Concrete mixes" Vol-2 issued 04-04-2015, ISSN 2348-8352
[8] **IvetaNovakava 2017**5th International workshop report on concrete spalling due to Fire exposure i.e. "Behaviour of Basalt Fiber reinforced concrete exposed to elevated temperature" issued on 12-13 Oct 2017.
[9] **Md. Tabsheer Ahmed 2013**International Journal of Science and Research (IJSR) on " Experimental study on mechanical properties of Basalt Fiber reinforced concrete" Vol.4 issued 08-08-2015/ISSN 2319-7064.
[10] **FathimaIrineI.A. 2014**International Journal of Innovative Research in Advance Engineering (IJIRAE) on "Strength Aspects of Basalt Fiber Reinforced concrete", Vol.1 issued on 08-09-2014/ISSN 2349-2163.
[11] **Hammadallah Mohammad Al-Baijat2008**Jordan Journal of Civil Engineering on " The use of Basalt Agg. in concrete mixes", Vol.2 01-01-2008.
[12] **RDSOLucknow**, Indian Railways Permanent Way manual (IRPWN) -2019 in context of thermit portion, Based on Research Design & Standard Organization Lucknow.
[13] **M.LAgrawal2008**Modern Track Design text of M.L. Agrawal on laying, maintenance, safety & innovation of 2008.
[14] **D.J. Naus, 2005**A literature Review of " The effect of elevated temperature on concrete material & structure" Prepared for U.S. Nuclear Regulatory Commission ORNL/TM2005/553
[15] **T.ch. Madhavi2016**Journal of Engineering & Applied Science on "Effect of Temperature on concrete" by ARPN, Vol-2 on a may 2016. ISSN 1819-6608
[16] **BARC REPORT EXTERNAL 2013**Bhabha Atomic Research centre (BARC) reprt on the "Application of software for Industrial γ —Radiography" BARC/2013/E/020
[17] **R. Thoraeus 2010** Report on "Iron ore concrete in radiation Protection Published on 14.12.2010, ISSN 0001-6926
[18] **GEIT 2014** Measurement & control of Structurix film system on date 05-2014, GEIT-40007 EN
[19] **J.M. de. OliveriaJr, 2004**, Analysis of concrete material through γ — ray computerized tomography ISSN (P) 0103-9733, ISSN(0) 1678-4448.
[20] **T.E. Northup (1965),** HDC FOR γ —Neutron attenuation ORNL-3704, UC-38, TID-4500 (37thed).
[21] **Thomson Reuters, 2011** (Japan), How much Radiation is dangerous, 360:616.

[22] **Rajeev Shrivastav, 2010** IRFCA Forum, Aluminothermit welding method for rail joint.
[23] **Manual man, 2015** Sentinel 880 Delta source projector report, SKU 880 Delta.
[24] **Jay Norris, 2015,** Technical Rep on Gamma rays.
[25] **Dr. Alan Smale**(Director of Astrophysics Science Division at NASA), 2012, Gama-ray Detectors report.
[26] **Harol S**. Davis, 1958 International concrete Abstract Portal, Vol 54. Issue, 5,965-977
[27] **J. Good Man, 2018,** Essay in Biology on material for high density concrete production, ACI 304R-00,2000 .
[28] **Huizhao, 2013** Journal of Cleaner Production, Utilizing recycled cathode ray tube funnel glass sand river sand replacement in the HDC, 51, 184-190.