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Gamma Radiation Absorption Characteristics of Concrete with Boron Carbide and Zeolite

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ABSTRACT

Development of nuclear power plant in energy production, protection of radioactive rays from source to surroundings is very important. Our main objective is to reduce the dose rate from source. The sources are emitted various types of nuclear radiation with different energies. These radiations are involving of alpha, beta and gamma radiation. We mainly concentrated in stopping of gamma rays using composite concrete. The materials have the better the potential attenuation effect against gamma rays and high densities are usually used as protective shield concrete. Here we use Boron carbide and Zeolite as an addition in composite concrete.10% Boron carbide and 20% Zeolite added in concrete in the weight of sand.

Keywords: *Boron carbide, Zeolite, Gamma rays, Potential attenuation coefficient, Dose rate.*

I. INTRODUCTION

Radiation is energy in the form of waves or streams of particles. There are many kinds of radiation all around us. When people hear the word radiation, they often think of atomic energy, nuclear power and radioactivity, but radiation has many other forms. Sound and visible light are familiar forms of radiation; other types include ultraviolet radiation, infrared radiation, and radio and television signals. We are exposed to nuclear radiation every day of our lives. Some of this radiation is from natural sources, and some results from human activity. Natural sources include cosmic radiation from space, radiation from lighter, unstable nuclei produced by the bombardment of the atmosphere by cosmic radiation, and radiation from heavy, unstable nuclei produced by the decay of a few long-lived nuclides in the earth's crust. Artificial sources include medical procedures, commercial products that contain radioactive materials, and fallout from nuclear testing. Nuclear radiation can cause biological damage because it is highly energetic. Nuclear technology used in power plants so protection against radioactive rays is important. Radiations are involving of alpha, beta, and neutron and gamma radiation. Dose rate defined as how fast radiation dose being received (R/hour, mR/hour). Physical barriers are placed between the radioactive ionization source and the surroundings for control these radiation. Variety of materials such as lead, iron, graphite, water, polyethylene or concrete is used to reduce radioactive rays. Among these materials Concrete is one of the best and most widely used materials for manufacture of Gamma protection shield. Because there is variety choice of the materials used to build concrete. And also ease to manufacture of concrete with different densities and different combinations. High density concrete protects gamma rays effectively. Materials containing boron and zeolites approximately increases density and protection rate. Heavy

weight concrete is used for radiation shielding for both medical & nuclear purpose. The increased density is improving radiation protection. Compressive strength is the capacity of a material or structure to with stand loads tending to reduce size, as an opposed to tensile strength, which withstand loads tending to elongate. In other words, compressive strength resists compression. Compressive strength is often measured by universal testing machine.

II. Literature survey

1. Yusof Abdullahand et.al [1].describe that, The result shows that the attenuation coefficient of the sample with 20wt% B4C is 0.299cm-1 and the sample without B4C is 0.238cm-1 and hence, concrete/B4C is suitable as a shield for thermal neutron radiation. The results show that the density of concrete was reduced by the addition of boron carbide in concretes.
2. Bulent Buyuk, and et.al [2]. Describe that, the mass attenuation coefficients of the composite materials were calculated. The linear attenuation coefficients of milled titanium diboride reinforced Boron carbide-silicon carbide composites are higher than unmilled reinforced Ones.
3. Sang Y. Lee, Ann and et.al [3]. Describe that, Class 1 includes minerals and rocks with high specific gravities. Class 2 includes minerals and rocks that are particularly effective in absorbing neutrons without producing highly penetrating gamma rays—minerals with substantial boron contents. Class 1 aggregates are Hematite, Limonite, Goethite, Limonite, Magnetite, Barite and Class 2 aggregates are Colemanite, Borocalcite.
4. A.Dyer and K. Y. Mikhail [4]. Describe that, Zeolite/cement composite has the effectiveness of the calcinations and cement containments.
5. Vedat Veli Cay, and et.al [5]. Describe that, Bulk density of bricks with FeCr slag increases, bulk density of bricks with Zeolite decreases.
6. Rajavikraman R. S [6]. Describe that, The use of high-density concrete decreases the required thickness of the concrete barrier.
7. S.J. Stankovic, and et.al [7]. Describe that, the numerical simulations results show that using barite as an aggregate in the concrete is one of the solutions for gamma ray shielding. Thereat, it is shown non-destructive method for determining the gamma radiation absorption characteristics of concrete
8. A. Akkas, and et.al [8]. Describe that, Increase of the boron carbide reinforcing Ratio in the boralyn composites causes higher linear attenuation coefficients. Decrease of the boron carbide particle size causes higher linear and mass gamma attenuation coefficients.

III. Methodology

The starting materials were consisting of M25 concrete

1. Sand, aggregate, Portland cement, Water
2. Sand, aggregate, Portland cement, Water, Boron carbide and Zeolite powders.

They are put into mould and we make Concrete cylinders.

Diameter of mould cavity d =185mm.

Height h =90mm;

Volume V =$\prod r^2 h$;

Volume V =0.002419 m^3

Table I

Composition of normal concrete

s.no	Materials	Calculation	Weight K.G
1.	Cement	1/4×2400×Volume	1.45
2.	Sand	1/4×2400×V	1.45
3.	Aggregate	2/4×2400×V	2.90
4.	Water	W/C=0.45; W=0.45×1.45	0.6525 LTRS

Table II

Composition of new B_4C and Zeolite added concrete

s.no	Materials	Calculation	Weight K.G
1.	Cement	1/4×2400×v	1.45
2.	Zeolite 20% added	Weight of sand×0.2	0.290
3.	Boron carbide 10% added	Weight of sand×0.1	0.145
4.	Sand	(1/4×2400×v)-(Zeolite +Boron carbide)	1.015

After mixing Sand, Aggregate, Water, Cement. And. Sand, Aggregate, Portland cement, Water, Boron carbide and Zeolite with specific portion then poured into mould, the sample was leaved setting within 28 days.

Radiation test measured with Gamma spectrometer. Compression strength measured with Universal testing machine, meanwhile Weight and Density also been calculated.

IV. Result and discussion

4.1. Radiation analysis

The Radiation through each sample was counted for 50,000s using a high-efficiency gamma-ray spectrometer and results was detected by Gamma spectrometry calculated and plotted as graph. These graphs are given below,

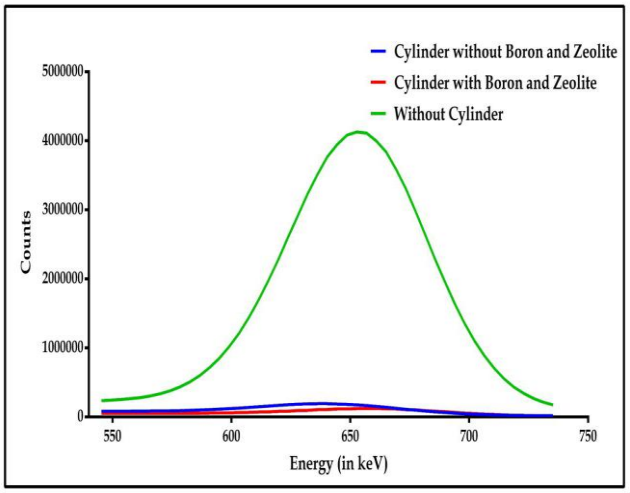

Fig.1 Comparision Between Concretes and Without Concrete Gamma Radiation Absorbtion

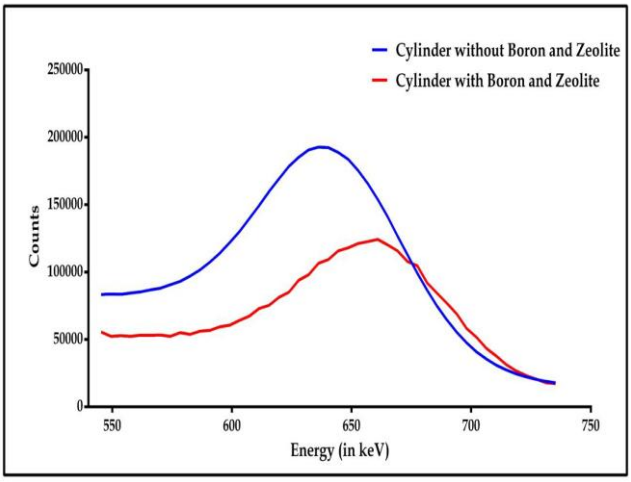

Fig.2 Comparision Between Concretes Gamma Radiation Absorbtion

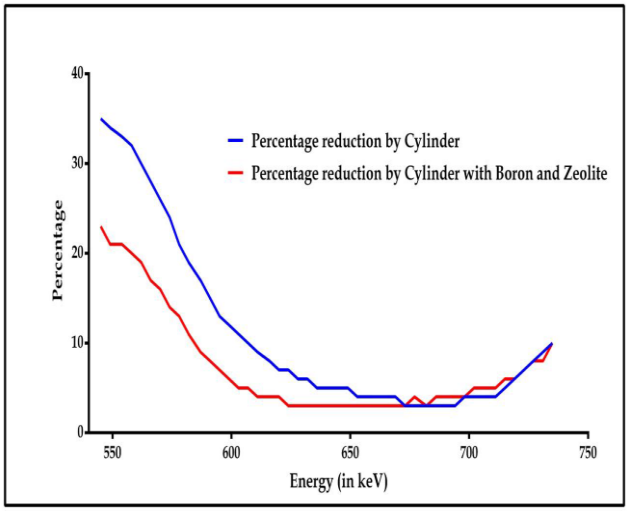

Fig.3 Percentage Reduction of Cesium (137Cs) Gamma Energy by cylinder with and without Boron and Zeolite

The result shows absorption rate of Boron carbide and Zeolite containing concrete higher than Normal concrete. Counts detected always needed to lesser. The graph explains it well.

4.2. Comprssion strength analysis

1.Compressive strength of normal concrete =1075KN.

2.Compressive strength of B_4C and Zeolite concrte =386KN.

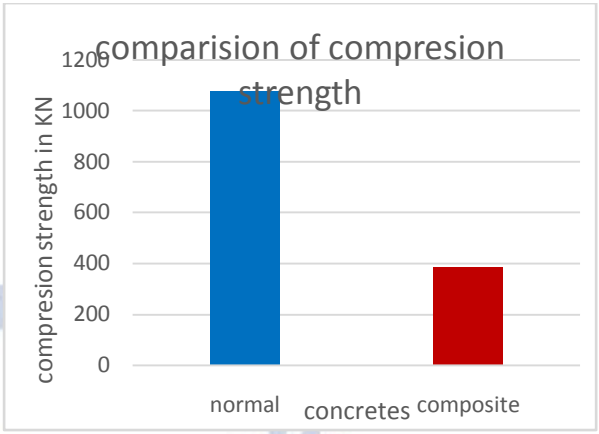

Fig.4 Compression strength

The resut shows normal concrete strength much higher than new composite concrete.

4.3. Weight results

Weight after curing 28 days

1.Normal Concrete =5.761 k.g.

2.Composite Concrete =5.44 k.g.

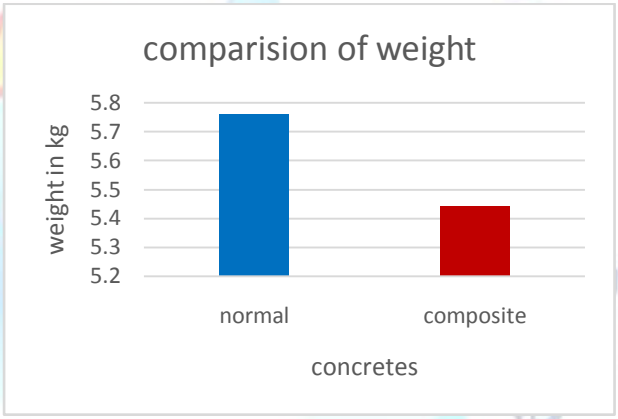

Fig.5 Weight comparision

The weight of composite concrte lesser than normal concrete so lesser weight concrete easy to handle.

4.4. Density of concrete results

1. Density of normal concrete =1610kg/m^3 .

2. Density of composite concrete=1673kg/m^3 .

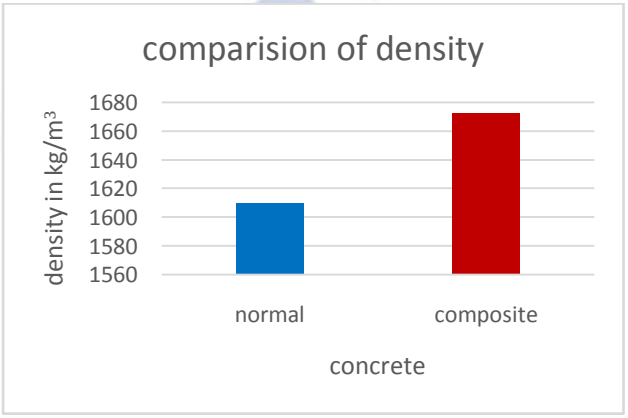

Fig.6 Density comparision

The density of composite concrete higher than the normal concrete. If we use high density concrete than we not need to build high thichkness walls.so less thicker walls are only needed to build with our concrete.

4.5. Summary

Table III
summary table

Parameters Taken	Radiation absorption rate	Density	Compressive strength	Weight decreases
Yousof abdullah et.al	high	low	Low	-
Bulent Buyuk et.al	high	-	-	-
A.Dyer et.al	low	high	-	-
Vedat Veli Cay et.al	-	high	High	-
S.J. stankovic et.al	high	high	-	-
OUR WORK	high	high	Low	high

V. Conclusion

The Results shows Boron carbide and Zeolite containing concrete traps more Gamma rays than normal concrete. Density of Boron carbide and Zeolite containing concrete 1673 kg/m^3 is higher than normal concrete 1610 kg/m^3. Weight of Boron carbide and Zeolite containing concrete 5.44 Kg is lesser than Normal concrete 5.761 Kg. But compressive strength of Boron carbide and Zeolite containing concrete lesser 386 KN lesser than Normal concrete 1075 KN.

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