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Retraction: Type Radiation Resisting High Density Concrete - A General Review (*IOP Conf. Ser.: Mater. Sci. Eng.* **1145 012034)**

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[1] Cabanac G, Labbé C and Magazinov A 2021 arXiv:[2107.06751v1](#)

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Type Radiation Resisting High Density Concrete - A General Review

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Abstract. Exposure to very high levels of radiation, can cause acute health effects such as skin burns and acute radiation syndrome ("radiation sickness"). It can also result in long-term health effects such as cancer and cardiovascular disease. The Intensity of the radiation which a body receives is inversely proportional to the Thickness or density of the shielding material. Concrete is already an effective Shielding material but if its density is increased, it can be even more effective. Thus, producing high density concrete provides good resistant towards radiation. High density concrete is widely used in nuclear Powerplants and reactors to provide shielding against harmful radiations Emitting from the process of nuclear fission. It can be widely used in hospitals Where radioactive materials are used for medicinal purposes such as radiation Therapy, x ray imaging etc

Key words: Radiation, High Performance Concrete, Baryte, Galena, Gamma Radiation.

1. Introduction

By employing barite as a material in the high-density concrete offers good shielding against radiation, also it provides control to drying shrinkage said in study [1]. Percentage decrease in compressive and tensile strengths were 7.46% and 3.7%, respectively, for a water-cement ratio of 0.45. No profound effect has been absorbed on replacing barite to fine aggregate. Galena concrete shows significantly higher strength than ordinary concrete said in study [2]. The advances in the use of radiation in medicine include both diagnostic and Therapeutic areas. Iodine-131, for example, is used as a diagnostic tracer and had been developed for Use as therapeutic medicine [3]. Radiology, in particular, has witnessed great developments in latest equipments of medicine and practices being commonplace in this region.

2. Literature Review

The paper by Izaz Ahmad, Khan Shahzada, Muhammad Imran Ahmad, Fayaz Khan, Yasir Irfan, Badrashi, Sajjad Wail Khan, Noor Muhammad and Habib Ahmad suggests using barytes as fine aggregates. Being a heavy mineral with specific gravity from 3.5 to 4.5, and also being abundantly available in different parts of Pakistan, barytes are suggested for use. Radiation shielding ability of baryte concrete is studied experimentally for being employed in optimization of thickness of radiation



therapy bunkers. The mechanical properties of the concrete were also studied with water cement ratio 0.30 to 0.45. The potential of radiation shielding of high-density concrete is observed by testing the concrete with a radiation source that is Cobalt 60. The results suggest that using barytes as fine aggregates increases the shielding ability of the concrete. But a minimal reduction in the strength of compression is noticed because of the replacement of fine aggregates with barytes [4].

This article suggests to employ galena to improve the shielding of radiation. Galena is an important ore of lead. Two types of concrete mixes were produced, one being a normal concrete and the other is galena concrete. In the galena concrete, the fine aggregate is entirely replaced with galena. 1300 grams of galena is used to produce 1800 grams of galena concrete. The density of the galena concrete is 4800 kg/cubic meters. To measure the shielding of gamma radiation, the water cement ratio is kept as 0.25. The samples are subjected to gamma radiation beam radiated from a therapy unit of Theratron Cobalt 60. The measured thickness of concrete samples made with galena were much lesser than that of normal concrete. This also has significantly more compressive strength of 500 kg per cubic centimetres compared to normal concrete [5]

This article speaks the concerns over aged power stations in the country. It says that cement pastes and aggregates behave differently over a certain period of time. Due to prolonged exposure of radiation, their behaviour changes, cement paste contracts in certain conditions. This leads to reduced volume of concrete and eventually cracks. This reduced volume is not counterbalanced fully by expansion because of the heat of radiation. The reduction in volume of cement paste can be attributed to evaporation of water molecules due to exposure of gamma rays. But there is an expansion in aggregates because of the defects in the structures of crystal due to collisions of neutrons. This odd reduction in volume can be said as the main reason on damage occurred in cementitious materials due to exposure of radiation. The author also recommends further researches aimed on the damage occurred in concrete due to radiation exposure [6].

The article, after extensive trial and errors, has prepared various concrete samples of 15 types with barytes, magnetite, goethite and serpentine by adding 10 percentage of fume of silica, 20m percentage of fly ash and GGBS of 30 percentage to the OPC. The author determines the strength of compression of hard concrete after twenty-eight and ninety days. He uses different types of aggregates i.e., baryte, magnetite, goethite and serpentine. Fine aggregate was washed sand. In certain mixes of concrete, crushed coarse aggregates replaced the sand in order to increase the density. The cement content and sand to aggregates ratios were adjusted and the samples were made. The results portrayed, barytes as coarse aggregates has more specific gravity compared to serpentine, magnetite and goethite. It also shows that the water absorption capacity of goethite is more than barytes, magnetite and serpentine [7].

The barite shielding board, developed by him has a sandwich construction with two outside covering layers and an internal layer for radiation protection. These boards are constructed as precast members. These precast members are constructed in modules for easy installation. Baryte mixed with concrete and water serves the purpose of shielding and is present in the middle layer of the board. The density of the fibre concrete board is calculated as 1.34 kg/cubic meter and it has a thickness of 0.5 centimetres. The cement concentration in the concrete accounts for about 35% density. Barite in its purest form of BaSO_4 of about 90 to 91.2% is used for the purpose of shielding. It has a density of 4.2 tons per cubic meter. The barite shielding boards are characterized as BSB 002, BSB 003 and BSB 005. Each with protective layer thickness of 15, 25, 37 mm respectively. The attenuation properties of three BSBs are found out using TUV NORD. X rays are passed on the BSBs using Xray tubes with 100kv, 140kv, 200 kv, 250 kv, 300 kv voltages and gamma rays are subjected using a cobalt 60 source. The impact of radiation is measured with and without the boards. The results show that for Xray radiations of energies around 100 kv, barite shielding boards BSB 002 can replace 2 mm thick lead plates. Similarly, BSB 003 can replace 3 mm lead plates and BSB 005 can replace 5 mm lead

plates. Also, these shielding plates are superior to 3,5,7 mm lead plates when it comes to gamma ray shielding from CO-60 gamma ray source [8]

In this experiment, high density concretes are designed such that the parameters of absorption are determined for various radiations by employing Monte Carlo Simulation program GEANT4 code. For the sample production, different types of materials are used such as: wolframite [(20Fe,80Mn) WO₄], chromite (FeCr₂O₄), barite (BaSO₄), titanium oxide (TiO₂), hematite (Fe₂O₃), limonite (FeO (OH) nH₂O), aluminium oxide (Al₂O₃) materials. Calcium Aluminate Cement (CAC) is used for resistance of great temperatures. New concrete samples of five different types are produced and strength parameters are tested. The tests are made at 1000°C and greater resistance with high temperature is observed. The measurements of neutron radiation are made using 4.5 MeV energy 241Am-Be fast neutron source. It is observed that the new heavyweight concretes had the better absorption capacity. The measurement of gamma radiation is carried out at different energies of 160KeV, 276KeV, 302KeV, 356KeV, and 383 keV with 133Ba point radiation source. The author suggests that the newly developed concrete is worth to be employed to shield radiation [9]. In this article, two concretes were made, one a normal concrete mixture and the other with magnetite as aggregate. The properties are tested at ambient temperatures and heat exposure. The tests for compressive strength and split tensile strength are made. For each test, the temperature is raised at 1°C/min in the range of 300, 450, 600 and 800°C. For ensuring even temperature in the specimen, the temperature is maintained at the required level for 1 hour before cooling. In order to determine the weight loss of tested samples, the mass of the specimen was measured before and after heating. It is suggested that by employing magnetite aggregate, the negative impact of high temperatures on the properties of concretes can be reduced [10].

This article suggests to use galena and tourmaline as aggregates. For effective shielding of radiation in radiotherapy rooms and nuclear reactors, high density concrete is widely used. In the previous years, some concretes made with galena are used for shielding of gamma radiation. The article aims in the production of high-density concrete against photon and neutron radiation using galena and tourmaline. intensity of gamma photons is measured using a cobalt 60 based ionization chamber on a therapy unit of Theratron 60Co. An Am-Be source is used for measuring the characteristics of neutron shielding. The transport computer code of MCNP4C radiation is used to study various thicknesses of shields and the intensity of radiation. The concrete samples are 4.0- 4.2 g/cm³ in density. The strength of compression in the concrete is calculated as 326 - 560 kg/cm². The HVL of the concrete samples is 2.72 cm for Cobalt 60 gamma rays. This is lesser than ordinary concrete (6.0 cm). The HVL for photons derived from MC is 2.77 cm with the same energy. This is in a good agreement with the data obtained from experiment. The concrete has greater neutron shielding of up to 10 mes compared to the reference concrete. Hence this concrete is effective in shielding of radiation.

In this article, they use baryte for shielding of harmful radiations. Mixed blocks of barite-concrete are tested for their radiation shielding properties, especially with proton and neutron radiations. Cobalt 60 and 137Cs isotopes are used as gamma radiation sources; 241AmBe is used as the source of neutron. A tube of BF₃ is used for detection. The radiation intensity is measured and coefficients of attenuation are calculated. The barite mixture samples are analysed by using X-ray. it is found out that though barytes increases the concrete's radiation shielding property, it comes with the cost of slight reduction of compressive strength. In this article, the author prepares 15 different types of heavyweight concretes including ordinary concrete, barytes included concrete and concrete with mixture of them in different rates and investigates their behaviour against gamma rays. The concretes are produced in five series, each series having five types of concrete. In concrete series A, the whole aggregates are normal aggregates. If the series is called B, the whole aggregates are barytes. In the series AB, the coarse aggregates are barytes and fine aggregates are normal. If the coarse aggregates are normal and fine aggregates are barytes, this is referred as BA. When half the aggregates are normal, half of the aggregates are barytes, this is referred as K. In each series, there are five samples on the basis of water

cement ratio. The samples are cylindrical samples of dimensions 15*20 cms. Tests for ultrasound velocity, unit weight, Schmidt hardness, compressive strength were carried out. It is found that the strength of compression of B type concrete is low compared to A type concrete. It is suggested that a wc ratio of 0.51 is suitable for heavyweight concrete. The concrete at wc ratio 0.43 gives the highest compressive strength.

3. Conclusion

Thus from all these studies , we conclude that ,if the density of the concrete increases ,it becomes effective in shielding different types of radiations. The overall density of the concrete is increased by using aggregates with high densities.

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