ABSTRACT

Application of Electric Arc Furnace Slag in Shielding X-ray Radiation

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The most common material utilized in the walls of X-ray rooms for shielding is lead and little attention is given to alternatives and more sustainable types of shielding materials. This work examines the viability of using purely electric arc furnace slag as aggregates in concrete for shielding X-ray radiation. As such, the physical, mechanical and radiation shielding characteristics of the electric arc furnace slag aggregates were evaluated. Concrete partitions made with electric arc furnace slag aggregates of thicknesses of 15 cm, 17 cm, 19 cm and 22 cm were prepared and exposed to X-ray energies of 40 kV, 60 kV, 80 kV, 100 kV, 125 kV and 150 kV. The radiation shielding parameters of the concrete partitions were measured and calculated. These parameters are the linear attenuation coefficient, the mass attenuation coefficient, half value thickness and the transmission factor.

The viability of the use of electric arc furnace aggregates in concrete production for the attenuation of X-ray radiation was evaluated by comparing the radiation shielding parameters with that of lead. By analysis, it was found that the concrete partitions with thicknesses of 104.5 mm, 156 mm and 176 mm respectively are able to give the same transmission factor as the lead thickness typically used. At the energy value of 125 kV, there was good correlation between the transmission factors of the different thicknesses of the concrete manufactured with the electric arc furnace slag aggregates and lead. This correlation showed that the radiation was attenuated when concrete made with electric arc furnace slag aggregates is exposed to the different X-ray energy values. The degree of attenuation achieved using electric arc furnace slag aggregates was validated by the formulation of X-ray spectrums at the different energies after interacting with the material. This provides significant insights into the use of slag concrete for designing X-ray shielding partition walls.

Keywords: electric arc furnace slag; aggregates; radiation shield; linear attenuation coefficient; mass attenuation coefficient; half value thickness; transmission factor.