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Development of high- performance heavy density concrete using different aggregates for gamma-ray shielding

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Abstract. This study aimed to investigate the suitability of some concrete components for producing "high- performance heavy density concrete" using different types of aggregates that could enhances the shielding efficiency against γ- rays. 15 mixes were prepared using barite, magnetite, goethite and serpentine aggregates along with 10% silica fume, 20% fly ash and 30% blast furnace slag to total OPC content for each mix. The mixes were subjected to compressive strength at 7, 28 and 90 days. In some mixes, compressive strengths were also tested up to 90 days upon replacing sand with the fine portions of magnetite, barite and goethite. The mixes containing magnetite along with 10% SF reaches the highest compressive strength exceeding over M60 requirement by 14% after 28 days. Whereas, the compressive strength of concrete containing barite was very close to M60 and exceeds upon continuing for 90 days. Also, the compressive strength of high-performance concrete incorporating magnetite fine aggregate was significantly higher than that containing sand by 23%. On the other hand, concrete made with magnetite fine aggregate had higher physico-mechanical properties than that containing barite and goethite. High-performance concrete incorporating magnetite fine aggregate enhances the shielding efficiency against γ -rays.

Keywords: heavyweight aggregates; high- performance concrete; linear attenuation coefficient (μ); half-value layer (HVL); tenth- value layer (TVL)

1. Introduction

Concrete is by far the most widely used material for reactor shielding due to its cheapness and satisfactory mechanical properties. It is usually a mixture of hydrogen and other light nuclei and nuclei of fairly high atomic number Ikraiam *et al*. (2009). The aggregate component of concrete that contains a mixture of many heavy elements plays an important role in improving concrete shielding properties and therefore has good shielding properties for the attenuation of photons and neutrons El-Sayed (2002) and Akkurt *et al*. (2012). The density of heavyweight concrete is based on the specific gravity of the aggregate and the properties of the other components of concrete. Concretes with specific gravities higher than 2600 kg/m^3 are called heavyweight concrete and aggregates with specific gravities higher than 3000 kg/m^3 are called heavyweight aggregate according to TS EN 206-1 (2002).

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