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Application of rock wool waste in cement-based composites

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ABSTRACT

This study investigates the properties of cement-based composites with addition of various rock wool wastes. The rock wool wastes are an insulating material. This study used rock wool waste with a cylindrical size distribution ranging from 17 to 250 μm, 30% of which is less than 150 μm. Rock wool waste can be used as a suitable substitute for coarse and fine aggregates, saving on the cost of natural aggregates and minimizing the environmental impact of solid waste disposal. In addition, because the composition of rock wool waste is similar to other pozzolan materials such as fly ash, ground granulated blast-furnace slag (GGBS), and silica fume, it can be considered as a supplementary cementitious material. Experimental results show that partially replacing natural aggregates with rock wool wastes improves the compressive strength, splitting tensile strength, abrasion resistance, absorption, resistance to potential alkali reactivity, resistivity, and chloride-ion penetration of cement-based composites. These improved properties are the result of the dense structure achieved by the filling effect of pozzolanic product. Pozzolanic strength activity index (PSAI) results and scanning electron microscope (SEM) observations confirm these findings. Therefore, rock wool wastes can act as either a cementitious material or inert filler in cement-based composites, depending on the particle size. The critical size appears to be 75 μm.

1. Introduction

Rock wool is an inorganic fibrous substance produced by steam blasting and cooling molten glass. Rock wool is frequently used for acoustic insulation, fire protection, cement reinforcement, pipe insulation, and even as synthetic soil for growing plants [1]. Taiwan generates more than 100 million tons of rock wool wastes annually [2]. This rock wool waste is loose and bulky, and requires a large space to be stockpiled or landfilled. Traditional landfill or stockpile methods are not environment-friendly solutions, and it is very difficult for these disposal processes to meet Environmental Protection Agency regulations [3,4]. Like other industry by-products, rock wool wastes can be reused and recycled to avoid environmental problems resulting from improper solid waste disposal. Therefore, reusing non-disposable rock wool waste is an important research topic.

Rock wool wastes are usually briquetted and reprocessed [5]. However, this treatment has proven to be uneconomical. Since an acceptable solution is difficult to obtain, rock wool wastes should be used as a composite or substitute of cement-based composites. Many efforts have been made to use industrial by-products, such as fly ash, silica fume, and ground granulated blast-furnace slag (GGBS), in civil constructions for many years [6–12]. Moreover, these industrial by-products usually have a fine particle size and thus are not easily recyclable. A potential application of industrial by-products in concrete is partial replacement for aggregates or cementitious materials, depending on the chemical composition and grain size of the by-product. Using these recycled materials as a substitute for natural raw materials may help preserve natural resources.

To solve the disposal problem of rock wool waste, recycling it in the concrete industry may be the most feasible application. The specific treatment method proposed in this study is suitable from both the technological and economical point of views. This research primarily focuses on evaluating the mechanical and durability properties of cement-based composites containing rock wool wastes. Rock wool wastes can be used as coarse aggregates, fine aggregates, cementitious materials, or ultra fine fillers in concrete, depending on their chemical composition and particle size. Therefore, this study conducts a series of laboratory tests on concrete containing various amounts of rock wool wastes. The pozzolanic strength activity index, compressive strength, splitting tensile strength, abrasion resistance, resistivity, absorption and chloride-ion penetration of the tested concrete are also reported.

2. Experimental program

2.1. Materials

Rock wool wastes obtained from thermal insulation materials were crushed and ground. Table 1 lists the chemical composition of rock wool wastes. Rock wool wastes have a higher CaO content

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