Mine Tailings-Based Geopolymers: Durability Properties

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The mining industry produces a considerable amount of stone waste and tailings, posing an environmental danger. It is recyclable by a variety of methods, including the promising geopolymerization method. This literature evaluation indicates knowledge gaps that must be addressed to enhance mine tailings composites for geopolymers.

Mine tailings-

1. Introduction

The tailings are a mineral supply that has been removed from the subsurface of the ground, transported, and unused. Pollutants from food manufacturing and animal feed waste damage valuable agricultural land and natural habitats. The tailings have the potential to serve as an alternate supply for a variety of building and industrial needs. The mining tailings are heterogeneous and include a variety of minerals, aggregates, and chemicals. Geopolymers are mostly solids resulting from the reaction between an aluminosilicate powder and an alkali solution.

Diverse professionals' comprehension of the treatment of tails has significantly increased. It is particularly beneficial to address concerns related with the usage of mine tailings-geopolymer composites, both in terms of mitigating the environmental effect and expanding the resource base of manufactured mineral raw materials. Mine tailings comprise dangerous and poisonous substances associated with waste products or mining operations.

2. Durability properties

Few studies have investigated the long-term durability of composite mine tailings-geopolymer materials. The gold mine tailings-geopolymer was subjected to sulfate and acid solutions as well as high temperatures with the aid of Caballero et al. [1]. In gold mine tailings-geopolymer composites, as compared to a reference cementitious composite, the rate of loss in compressive strength with immersion time in sulfuric and nitric acid solutions is comparable. Similar outcomes have been seen in solutions of magnesium and sodium sulfate, as well as when the solutions are subjected to elevated temperatures. Ahmari and Zhang [2] showed that the plain compressive strength of copper mine tailings-geopolymer composites immersed for 120 days in aqueous solutions with pH values between 4 and 7 decreased by 58–79% compared to reference specimens. According to the experts, the high initial Si/Al ratio and partial geopolymerization of the mine tailings were responsible for this outcome. In contrast, water absorption and weight loss were negligible and had lower values compared to the OPC-based binding agent. Another research conducted by Ahmari and Zhang [3] shown that the addition of cement kiln dust may increase durability and unconfined compressive strength. The positive effect of cement kiln dust was associated with enhanced aluminosilicate dissolution, calcium carbonate formation, and calcium integration into the geopolymer system. Falayi [4] revealed that geopolymers activated with potassium aluminate are more resistant to alternating wetting and drying than geopolymers activated with potassium silicate. After 10 wet and dry cycles, the UCS values decreased in every instance by more than a factor of three [5][6][7][8][9][10]. This makes it difficult to employ these composites in locations with a great deal of wet and dry time, and it also makes it essential to seek for solutions.

The use of tailings to partly or totally replace natural aggregates (gravel or sand) in geopolymer concretes may result in an increase in the water absorption and porosity of the latter [11][12][13][14][15][16]. In turn, this may render these compounds more susceptible to chemical attack, which can reduce their overall durability. Due to a lack of knowledge on these and other aspects of the durability of mine tailings-geopolymer composites, it is necessary to do more study in this subject.

3. Conclusions

The key annotations for this paper review are as follows:According to the study, geopolymers seem to be viable solutions for recovering mine waste and producing sustainable building and construction materials, mine paste backfills, and stabilization materials for hazardous element waste. This technique not only reduces the carbon footprint associated with conventional cementitious materials, but also prevents the significant ecological damage caused by mining waste accumulation. Mine tailings are often constituted of a highly crystalline matrix, which leads to limited contact during geopolymerization and, as a consequence, a product with poor mechanical strength. Incorporating additional materials with enhanced interaction into mine tailings-geopolymer composites may effectively adjust and improve the geopolymer properties. In addition, as the bulk of additives used for this purpose are industrial byproducts, their application has the added advantage of minimizing waste production. In comparison to low-Ca-composing additions, high-Ca-composing materials have a higher positive effect on the geopolymer's overall strength and durability. This is caused by the formation of additional CSH gels, which reinforce the matrix due to their coexistence with NASH, which increases matrix density. Supplemental materials, particularly those containing a great deal of calcium, are often superior for producing geopolymer. The mining tailings minerals are distinguished by their variable chemical reactivity to The interactions of the metal components of the precursors under alkaline circumstances alter the structure and properties of the aluminosilicate framework of the geopolymer. Frequently, the alkaline reactivity of mine tailings is quite low, which is ideal when mine tailings are used to produce geopolymers. There is no categorization scheme for mine tailings based on their chemical composition. Recent research results, such as applying the topological approach to evaluate glass contact, may be used to identify and categorize these materials, hence promoting their use in geopolymerization applications.

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