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Technical Report

# Polymeric composites based on polystyrene and cement dust wastes

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ABSTRACT

Due to the economical and environmental concern, polymer mortar and polymeric composites were prepared by mixing recycled polystyrene waste and cement dust waste as a filler. Virgin polystyrene and portland cement were used for comparison. Cement dust was treated by the reaction with stearic acid to increase the adhesion between the filler and the polymer matrix. The composites were prepared by mixing different concentration of treated and untreated cement dust (30, 50, 70 and 90 wt.%) with either virgin or recycled polystyrene. The suitability of the prepared polymeric composites as building materials in terms of mechanical properties, water absorption and chemical resistance was studied. After 1 week immersion in water, 10% sodium chloride (NaCl) and 10% sodium sulfate ($Na_2SO_4$) solutions, it was found that the chemical resistance and the mechanical properties were enhanced and the water absorption was retarded. The recycled polystyrene composites filled with treated cement dust gave the highest abrasion resistance and the lowest weight loss, also the best compressive and bending strength.



## 1. Introduction

Polymer based building materials have received special attention in many countries all over the world, in building foundation walls, small houses, and shops [1], and as bridge deck overlays [2]. The widely used materials are: polymer composites [3,4], polymer nanocomposites [5], fly ash composites [6], and glass reinforced plastics. High performance new composite cement based materials, among which those containing elastomers, fibers, and other polymer components are the most introduced in the building sector. Reasonable cost, durability under anticipated exposure conditions, adhesion to aggregate, handling properties, and ease of curing are very important considerations in the choice of the resin used. The high cost of the traditional resins used in the preparation of polymeric composites render it relatively expensive, compared to the cement based materials, therefore, limiting the growth of polymeric mortar based products. Recycling of polymers has received a great deal of attention to reduce the cost of resin production; in addition, it is an acceptable convenient solution to some ecological problems [7].

The pollution problem with plastics, among which polystyrene wastes represent a great quantity, imposes urgent solution [8]. Polystyrene offers the combination of strength, lightness and durability. It comes in many shapes and forms. It is also used for insulation in building models and structures, architectural models and in crafts. The majority of polystyrene products are currently not recycled due to a lack of suitable recycling facilities. Furthermore, when it is recycled "it is not a closed loop-polystyrene cups and other packaging materials". Polystyrene is usually recycled into fillers in other plastics, or in other items [9,10] that cannot themselves be recycled and thrown away. It is estimated that only 1% of the produced plastics is recycled worldwide, whereas the remaining majority portion goes to municipal burial sites.

The disposal of municipal solid waste has become an environmental issue of growing concern. Cement dust waste management is a global environmental problem. The production of cement invariably results in the formation of large amounts of waste dust. It is a fine-grained, solid, highly alkaline produced from the pre-heater by-pass systems during the manufacture of portland cement clinker, by using the dry process, and as a result of the presence of some minor volatile constituents in the kiln feed and fuel [11]. Because much of the cement dust is actually unreacted raw material, large amounts of it can and are, recycled back into the production process. Some cement dust is reused directly, while some requires treatment prior to reuse. So, it is important to increase the chemical affinity of the waste cement dust to the polymer chains. Many studies [12,13] have been carried out to enhance the filler affinity to many plastics. Cement dust that is not returned to the production process is typically disposed in land-based disposal units (i.e., landfills, waste piles, or surface impoundments) [14].

Cement dust can be used as stabilizing and solidifying agent in the treatment of soft or wet soils for engineering purposes and for environmental remediation. It has also been used as pozzolan initiator, as a pelletized light weight aggregate material, and as

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