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Recycling of Polyethylene Waste to Produce Plastic Cement

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Abstract

Disposal of plastic waste in environment is considered to be a big problem due to its very low biodegradability and presence in large quantities. Therefore, finding alternative methods of disposing waste by using friendly methods are becoming a major research issue. In this research, high density polyethylene waste is mixed with Portland cement to investigate the possibility to produce plastic cement, and study the effect of replacing sand by fine polyethylene waste with different percentage on the properties of product. The experiments were done by using the waste of polyethylene packages include bottle and food crates in the range of 10% to 80% by volume as a short reinforcement structure. The results show that there is a possibility to produce plastic cement from polyethylene waste and Portland cement by using 60% and 40%, respectively. In addition, their density was decreased, ductility increased, and the workability improved, which lead to produce lightweight materials.

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1. Introduction

Humans have always produced trash and disposed of it in some way so solid waste management is not a new issue. What has changed are the types and amounts of waste produced, the methods of disposal, and the human values and perceptions of what should be done with it. The applications of plastic materials and their composites are still growing rapidly due to their low cost and ease of manufacture. Therefore, high amount of waste plastic being accumulated which create big challenges for their disposal [1].

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Despite the suitability of plastic for a wide variety of applications, organizations are faced with the growing problem of finding alternative methods for disposing a large volumes of waste packaging. Disposal of plastic waste in environment is considered to be a big problem due to its very low biodegradability and presence in large quantities [1, 2, 3].

One of the environmental issues in the most region of Iraq is the large number of package made from polyethylene materials such as shampoo sachets, carry-bags, nitro packs, milk and water pouches, and vegetable packages etc., which are deposited in domestic waste and landfills [3]. The largest component of the plastic waste is polypropylene, polyethylene terephthalate, and polystyrene [1].

Today sustainability has got top priority in construction industry. Recently plastics were used to prepare the coarse aggregates thereby providing a sustainable option to deal with the plastic waste. Therefore, recycling of plastic waste is an important topic in order to decrease environmental pollution and prevent waste of resources [3, 4].

Recently, plastic waste is one component of municipal solid waste which is becoming a major research issue to study the possibility of disposal the waste in mass concrete especially in self compacting concrete, light weight concrete, and in pavements. It can be used as a component of a composite construction material, as an inorganic filling material, and aggregate of concrete [2, 3, 4].

Recycling of plastic waste in concrete has advantages since it is widely used and has a long service life, which means that the waste is being removed from the waste stream for a long period. Moreover, using of post-consumer plastic waste in concrete will not only be its safe disposal method but may improve the concrete properties like tensile strength, chemical resistance, drying shrinkage and creep on short and long term basis [1].

The scientist has been discovered new types of engineering that include sustainable engineering and green engineering to reduce energy and natural resources consumptions. The goal of green engineering is to minimize adverse impact while simultaneously maximizing benefits to the economy, society, and the environment. It is focusing on the increasing the efficiency of a process to reduce the amount of pollution generated to be as eco-efficiency. This will shift the industrial processes from linear (open loop) system in which the resource and capital investments move through the system to become waste to ecological closed loop systems where wastes become inputs for new processes [5].

Baboo et al, was found that the workability and compressive strength were reduced due to partially replacement of sand by waste plastic flakes in varying percentages by volume to produce waste plastic mix concrete with plasticizer [2]. Rebeiz, has been investigated the strength properties of unreinforced and reinforced polymer concrete using unsaturated polymer resin based on recycle polyethylene terephthalate plastic waste. The result should that there is a possibility to produce a good quality of precast concrete [6]. Choi et al, and Batayench et al, were investigated the effect of waste polyethylene terephthalate bottles aggregate on properties of concrete. The waste plastic reduced the weight of normal concrete and the compressive strength was reduced too [2, 7, 8].

Pezzi et al, found that the addition of polymeric material in fraction less than 10 % in volume inside of cement matrix does not imply a significant variation of the concrete mechanical features [2, 9]. However, Marzouk et al, found that density and compressive strength of concrete decreased when the polyethylene terephthalate aggregate exceeded 50% by volume of sand [2, 10]. Binici H. et al, has been successfully used polyethylene bottles wastes in cement less concrete production and found that the ductility of concrete was improved [11].

Plastic has different properties such as durable and corrosion resistant, good isolation for cold, heat, and sound, saving energy, economical, has a longer life, and light weight [1, 3]. Therefore, in this research, solid-state recycling process is proposed to realize the direct recycling of polyethylene as the green engineering forming technology. Moreover, it will be used to produce plastic cement directly from solid state to improve the mechanical properties and workability of products. High density polyethylene waste is mixed with Portland cement to investigate the possibility to produce plastic cement, and study the effect of replacing sand by fine polyethylene waste with different percentage on the properties of product.

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