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Review Article

A comprehensive overview about recycling rubber as fine aggregate replacement in traditional cementitious materials

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Abstract

Currently, the need to incorporate recycled materials such as rubber in building products is becoming more important than ever before. The use of waste rubber in mortar/concrete mixtures creates landfill avoidance and decreases the depletion of virgin raw materials. Waste rubber can be used as a part of fine aggregate, coarse aggregate or both aggregates. It can be used as an additive to Portland cement (PC). This paper presents an overview of the previous researches carried out on the use of waste rubber as partially or fully natural fine aggregate replacement in traditional mortar/concrete mixtures based on PC. The effects of rubber sand on workability, setting time, bleeding, density, strength, impact energy, impact load, toughness, ductility, shrinkage, abrasion resistance, freeze/thaw resistance, fire resistance, thermal insulation, carbonation resistance, corrosion resistance, water absorption, porosity, chloride ion penetration, resistance to aggressive environmental, energy absorption, sound absorption, electrical resistance and cracking resistance of rubberised mortar/concrete were reviewed.

Keywords: Waste rubber; Fine aggregate; Fresh properties; Mechanical strength; Durability

Contents

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1. Introduction

As known, waste generation in the EU was estimated to stand at over 1.43 billion tonnes per year and was increasing at rates comparable to those of economic growth (Martínez et al., 2013). Consequently, waste reduction and recycling are very important elements in a waste management framework because they help to conserve natural resources and reduce the demand for valuable landfill space. Waste rubber is one of the significant wastes which has been a major concern in the world. Data that were collected from the literature has shown that in 2005, over 10 billion tyres are discarded worldwide every year (Alamo-NoleLuis et al., 2011). According to Colom et al. (2007), it was estimated that around 1 billion tyres are withdrawn from use each year. It was estimated that 1000 million tyres reach the end of their useful life every year. By the year 2030, the number can reach up to 1200 million tyres representing almost 5000 million tyres (including stock piled) to be discarded on a regular basis (Pacheco-Torgal et al., 2012). In the United States, for example, there were 2–3 billion tyres deposited in landfills per year (Humphrey, 1995) and 275 million scrap tyres stockpiled across the country, with an increase of 290 million tyres generated per year (Batayneh et al., 2008). It was estimated that one car tyre per person was discarded each year in the developed world and hence 1 billion waste tyres were disposed globally each year (Martínez et al., 2013). It was estimated that approximately 4 billion of waste tyres were in landfills and stockpiles worldwide (Business Council for Sustainable Development, 2011).

The US Environmental Protection Agency reported that 290 million scrap tyres were generated in 2003. Of the 290 million, 45 million of these scrap tyres were used to make automotive and truck tyre re-treads. In Europe every year, 355 million tyres are produced in 90 plants, representing 24% of world production (Presti, 2013). In addition the EU has millions of used tyres that have been illegally dumped or stockpiled. The inadequate disposal of tyres may, in some cases, pose a potential threat to human health (fire risk, haven for rodents or other pests such as mosquitoes) and increase environmental risks. Most countries, in Europe and worldwide, have relied on land filling to dispose of used tyres but the limited space and their potential for reuse has led to many countries imposing a ban on this practice. The current estimate for these historic stockpiles throughout the EU stands at 5.5 million tonnes (1.73 times the 2009 annual used tyres arising) and the estimated annual cost for the management of ELTs is estimated at € 600 million (Presti, 2013).

In UK, approximately 37 million tyres were used annually in 2002. This number continues to grow (Martin, 2001). In Thailand, the record of the year 2000 alone indicated a consumption of approximately 250,000 metric tonnes of rubber products. About 38% of this (94,000 metric tonnes) were vehicle tyres. These numbers keep on increas-