

Reinforcement of cement mortar with recycled polyethylene waste for construction applications

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Abstract

This current research work combines both experimental and theoretical study of the impact of cement mortar reinforced with recycled polyethylene waste for applications in the construction industry. The work explores incorporating low density polyethylene (LDPE) waste into cement mortar to improve its fracture toughness and flexural strength with balanced compressive strength. Different volume fractions (0, 5, 10, 15, 20, 30, and 40%) of the powdered LDPE were mixed with cement and the density, compressive strength, flexural strength, and the fracture toughness were observed under different testing conditions. All specimens were tested after curing of 7, 14, and 28 days. The results show that there was ~6% increase in the fracture toughness at 5 vol. %, ~7% increase at 10 vol. %, and 24% increases at 20 vol. % of LDPE. Also, it was observed that the weight and compressive strength decreased with increasing volume fraction up to 40 vol. % of LDPE waste. The results for the survival/failure probability show that the PE-mortar composites with PE volume percentages up to 20 vol. % had the highest survival probability. The composite with this volume percentage can withstand crack up to 6 mm, with a survival probability of 0.6.

Keywords

Polyethylene, survival/failure probability, brittle fracture modelling, mechanical testing, crack opening tip displacement

Introduction

Globally, the collapse of buildings and structures in the construction and building industries poses major challenges and threats to the health and wellbeing of human beings. Major damages have been reported due to the collapse of buildings. This has resulted in expansive loss of huge investments in housing and properties,¹ with many people losing their lives. Building collapses could result in several factors such as the quality and strength of cement used, the mixing ratios of cement, sand/aggregate and water used as well the usage of sub-standard building materials and equipment.^{2,3}

Cement is a global material that is very expensive and is often used as a binder for the construction of modern buildings across the world. This binder is not environmental friendly and therefore, there is the need to reduce the amount of this polluting cement with materials that can be recycled. Recently, a couple of

works have been carried out to reduce the quantity of industrial cement with several natural and artificial waste materials^{4–13} for composite processing in building applications. These recycled materials including polyethylene⁵ and natural straws⁹ in cement have shown to possess excellent compressive strengths,

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