Strengthening of plain concrete beams using Strain Hardening Geopolymer Composites (SHGC) layers

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Abstract

In this paper the application of novel, environmentally friendly, Strain Hardening Geopolymer Composites (SHGC) for the structural upgrade of existing concrete elements has been examined. The binder of these cement-free materials (SHGC) is different from that used in conventional cement based systems. Ternary geopolymer binder is used instead of Portland cement, which is activated by a low concentration and content of alkaline liquids (Potassium Silicate). The addition of two types of fibres (steel and PVA) has been examined in order to provide enhanced ductility and energy absorption characteristics. These novel materials have been used for the strengthening of concrete prisms. SHGC layers have been applied to conventional concrete elements and composite prisms with 100 mm breadth and depth and 500 mm span length and have been tested through flexural tests. The experimental results indicate that the addition of SHGC layers to existing concrete elements can considerably improve the flexural response of normal concrete. The proposed technique can lead to significantly higher flexural loading carrying capacity, while at the same time the ductility can be considerably improved, especially by the addition of PVA fibres which can also provide strain hardening properties.

Keywords: Geopolymer, SHGC, PVA fibres, steel fibres, fly ash and slag.

1 Introduction

Improvement of the structural performance of many existing infrastructure elements is an urgent need worldwide, especially in earthquake prone areas. Several techniques have been proposed for the strengthening of existing structures using conventional materials (e.g. Reinforced Concrete), Fibre Reinforced Polymers (FRPs) and, recently, Ultra High Performance Fibre Reinforced Concrete (UHPFRC). These techniques have been proven to be relatively efficient but, as the need for sustainable development is becoming increasingly important, the application of new environmentally friendly materials for strengthening applications is becoming an area of growing interest.

Cement-based materials are characterised by an overall brittle behaviour with relatively low tensile strength and ductility [1]. One of the most widely used techniques for the enhancement of ductility,

https://doi.org/10.2749/vancouver.2017.2715
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