Textile Reinforced Ceramic Composites for Structural Infill Slab Applications

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Summary

This paper reports on a proof-of-concept study to develop an innovative structural infill slab system using textile reinforced ceramic composites. A magnesium-phosphate binder is used in combination with various aggregates and the resulting composites are produced and tested. Several mixes were optimized based on criteria including unit cost, density, strength and workability. The mechanical properties of the resulting composites were determined. Using candidate ceramic composites and flexible fiberglass reinforcing fabrics, structural panels were produced and evaluated for strength and stiffness. Panel configurations represented full-depth precast structural elements as well as partial-depth precast panels suitable for use as a stay-in-place formwork solution. The structural panels achieved the desired strength and stiffness prior to flexural cracking and considerable deformation capacity in the post-cracked region. However, the results indicate the need to alter the fabric reinforcement properties to achieve the required post-cracking strength.

Key words: Ceramic composite, Textile reinforcement, Infill slabs, Compression, Flexure

1. Introduction

Steel reinforced concrete is typically used for structural infill slab applications. Design and construction of infill structural slabs for civil infrastructure upgrades can be complex due to the interaction of material properties, installation techniques and the overall structural response.

Traditional concrete materials have several disadvantages including high permeability, slow curing and rate of strength gain, undesirable shrinkage and high self-weight. In addition, the Portland cement used for making concrete has high environmental impacts during production. In recent years, phosphate cements have gained attention as an alternative to Portland cements and can be used to produce so-called chemically bonded phosphate ceramics (CBPC) [1-3]. A CBPC is typically formed through chemical reaction of an acid (e.g. phosphoric acid) and a metal oxide base (e.g. magnesium oxide). CBPC can also incorporate Fly Ash (FA) at high loading [1]. FA is a by product from coal-fired thermal power stations and thus a CBPC with FA can result in substantially lower environmental impact and energy consumption during production than Portland cement binders. CBPC with sand aggregates can produce a sand concrete (SC) with high early strength and good durability. Light weight concrete is commonly made using Lightweight Expanded Clay Aggregate (LECA) [4,5] and it is proposed in this research that CBPC binder combined with LECA will result in a viable light weight concrete (LC).

Reinforcement for flexural tension forces in slab-type elements can be provided by glassfiber textile reinforcement. The use of textile reinforcement has advantages compared to conventional steel reinforcement. Glassfiber textiles can match almost any geometric shape, have excellent resistance to corrosion, are light weight, and offer easier handling and rapid placement to speed the overall construction process. The use of textile reinforcement in Portland cement based concrete has been investigated by prior researchers [6-8] but no work has examined use with CBPC concretes.

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