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FRP Composite Strengthening of Concrete Slabs

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Summary

Fiber reinforced polymer matrix composite materials show significant potential for use in the rehabilitation of aging and/or deteriorating concrete civil infrastructure components. This paper describes results of a focussed test program on the use of prefabricated carbon/epoxy strips used for the external strengthening of concrete slabs. Tests are conducted at full scale level and emphasise aspects of strengthening and repair. The tailoring of strip capacity (modulus) is also addressed and it is shown that optimisation of materials form and performance can result in cost-effective structural functionality.

Keywords: Strengthening; Slabs; Fiber-reinforced-composites; Carbon; Debonding; Concrete.

1. Introduction

In the past steel plates have been used for the external strengthening of damaged/deteriorated slabs, or in cases where an increase in load capacity for an existing structures is required. Although clearly feasible the method has its disadvantages in that the steel plates are heavy, require substantial equipment to place and connect (adhesive bonding with end bolting or anchoring), have problems related to length restrictions and field joining, are difficult to erect in cases where clearance is limited, and are susceptible to corrosion. In comparison, fiber reinforced polymer matrix composite plates provide ease of installation, high stiffness-to-weight and strength-to-weight ratios, light weight, and do not corrode. Although these materials have been extensively used in the field through demonstration projects, research on structural response and the development of design guidelines has been almost restricted to their use for the flexural strengthening of beams. However, a review of a large number of field demonstrations shows that a significant number of these have been related to the use of composite material for the rehabilitation of slabs wherein the response and geometrical configuration is substantially different from that of a beam.

Previous studies on the use of externally bonded composite strips for the strengthening of scaled slabs [1,2] have indicated that failure was almost always through debonding at about 50% of the actual material capacity. Debonding was generally initiated in the midspan region as a tension failure of the concrete cover between the steel reinforcing bars and the adhesive with the final failure path being through the composite itself. Materials related reasons for this response were given in [1], and a number of issues were raised related to effects of materials and geometrical conditions on failure initiation and resulting performance of the strengthened slabs. This paper focuses on investigation of some of these issues through a series of full-scale tests in which reinforcement detailing, composite strip geometry and properties, and condition of the slab prior to application of the composite serve as variables.

