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Deformation Behavior of Reinforced Concrete Two-Way Slabs Strengthened with Different Widths and Configurations of GFRP

Hossein Izadi [a], Hamid Pesaran Behbahani [b*]

[a] *Department of Civil Engineering, Islamic Azad University, Tiran Branch, Isfahan, Iran.*

[b] *Department of Civil Engineering, Islamic Azad University, Khorasgan Branch, Isfahan, Iran.*

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Abstract

In this paper, we conducted a numerical analysis of the deformation behavior of Steel-reinforced concrete (RC) two-way slabs strengthened by glass fiber reinforced polymer (GFRP) with different widths and configurations. A total number of 36 RC slabs of $12 \times 300 \times 300$ cm were used in this numerical study. Also, a column of $30 \times 30\ cm$ was considered in the center of the slab for applying static loading. The bonded GFRP strips had 5, 7.5 and 10 cm width (W) and configured in three models called PM1, PM2, and DM. In PM1 (strip length = 2.4 m) and PM2 (strip length =1.7 m) configurations, the strips were bonded in two directions parallel to the sides of the slab, while in DM configuration (strip length =1.7 m), strips were rotated with 45 degree angle around the central axis that is perpendicular to the surface of the slab. According to the comparison results, we found out that the 5-cm wide strips with PM1 configuration having a parallel space of 0.5 times the strip width ($0.5W$) greatly reduced the deformation of RC two-way slab compared to other strip widths and configurations, while 10 cm strips under all configurations, highly increased the deformation when space between strips varied from $1.5W$ to $2W$.

Keywords: Glass Fiber Reinforced Polymer; Reinforced Concrete Slabs; Finite Element Analysis.

1. Introduction

Since the early 1990s, the use of synthetic Fiber-Reinforced Polymers or Fiber Reinforced plastics (FRP) has become popular for strengthening and repair of reinforced concrete structures. FRP is a composite material made of a polymer matrix reinforced with fibers. FRPs are a category of composite plastics that specifically use fiber materials to mechanically enhance the strength and elasticity of plastics. "FRP offers the engineers an outstanding combination of properties such as low weight, easier site handling, immunity from corrosion, excellent mechanical strength and stiffness, and the ability of formation in long lengths, thus eliminating the need for lap joints"[1]. The fibers are usually glass, carbon, aramid, or basalt, all of which have been used in many studies with seismic recovery practical purposes (e.g. [2, 3]). Among these, glass fibers are the most widely used FRPs in the composite industry. The advantages of this type of fiber can be low cost, high tensile strength, resistance to chemical agents, and good resistance to high temperatures.

Currently, strengthening with FRPs has been applied to structures such as column, beams, walls, slabs. In flexural reinforcement of concrete slabs with FRPs, typically, the FRP strips or plates are pasted to the tensile surface of concrete slabs. This pasting can either cover part of the slab surface [4-6] or cover the whole surface of the slab [4, 6, 7]. For FRP-upgraded members, failure may occur in different modes depending on parameters such as member size, steel reinforcement ratio, FRP properties and dimensions. Sources of FRP debonding include local cracks in a host concrete

* Corresponding author: hamidpesaranbehbahani@gmail.com

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