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Effect of Macro Polyolefin Fibers on Bond Strength of Tension Lap Splices in RC Beams

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Abstract: The effect of macro synthetic polyolefin fibers on the bond strength of tension lap splices in reinforced concrete (RC) beams is investigated in this study. The bond between the reinforcement and concrete plays a vital role in the strength of RC beams. The presence of polyolefin fibers in the lap splice zone confines the concrete and enhances the bond strength of the steel bars. The use of synthetic fibers is preferable to steel ones since steel suffers from corrosion over time. Tests were conducted on 12 full-scale beam specimens to determine the effect of fiber volume fraction (V_f), bar diameter (d_b) and concrete cover-to-bar diameter (c/d_b) on the response. Four volume fractions (V_f = 0, 0.5, 1 and 1.5%) of polyolefin fibers and three bar sizes (d_b = 16, 20 and 25 mm) with the corresponding (c/d_b = 2.31, 1.75 and 1.30) were considered to evaluate the bond strength. The test results demonstrated that the polyolefin fibers noticeably enhanced the bond strength and ductility of spliced tension bars. Experimental results were compared with those obtained from two theoretical methods including ACI Committee 318 design provisions. The results showed that the equation proposed by the ACI Committee overestimates the bond strength.

Keywords: lap splices; fiber reinforced concrete; polyolefin fiber; synthetic fiber; bond strength; ductility

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1. Introduction

The structural performance of reinforced concrete structures is dependent on the bond between reinforcing bars and concrete. The bond strength between lap-spliced bars and concrete is dependent on many factors including bar diameter, embedment length, concrete cover, concrete strength, and confinement. Experimental studies have demonstrated that the confinement of the splice regions in RC members can be achieved using two different methods. One method is to provide a certain amount of transverse reinforcement across the splice zone. The alternative method involves using fiber reinforcement during casting in the splice zone. As fiber reinforcement is increasingly used for structural engineering applications, the impact of fibers on the stress transfer between the steel rebar and concrete through bonding must be considered. The most common fibers used in concrete are steel and synthetic fibers due to the importance of their mechanical properties.

Many studies have been conducted on the mechanical, physical and durability properties of fiber-reinforced concrete (FRC). Some experimental and numerical investigations have been carried out to show the effect of steel fibers on bond strength. Harajli and Salloukh [1] carried out an experimental study to investigate the effect of steel fibers on the development/splice strength of reinforcing bars in RC beams. They reported that using steel fibers with 2% volume fraction, the average bond strength increased by about 55%. In 2001, Hamad et al. [2] conducted an experimental study to evaluate the influence of steel fiber on the bond strength and ductility of tension lap splices embedded in high-strength concrete. They found that the steel fiber significantly improved the development/splice strength and the ductility of the bond failure. Harajli [3] presented experimental and analytical studies on the effects of steel fibers on bond capacity and bond stress-slip response