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Behavior of Reinforced Concrete Beams with effect of Stiffened Plates

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Abstract

This study presents experimental work including an investigation conducted on five simply supported reinforced concrete beams under pure torsion. First beam without strengthening as a control beam. The other four beams were strengthened externally by bolted thin steel plates. For this test the load was applied gradually. The torque was increased gradually up to failure of the beam. The variables were the thickness and height of the steel plate that was externally connected to both sides of the rectangular reinforced concrete beam. The test results for the beams discussed are based on torque-twist behavior. The experimental results show that the attachment of thin steel plates by mechanical means to beams provides a considerable improvement in the torsional behavior of the reinforced concrete beams. Comparable to the reference beam, the maximum increase in the cracking and the ultimate torque of the composite beam was recorded for the reinforced concrete beam that strengthen by steel plate of 150 mm height, 2 mm thickness and 50 mm spacing between shear connectors (B1). The results revealed that the cracking torque, ultimate torque, global stiffness of beam and beam ductility for all composite beams increase with the increase of the plate's thickness, plate's height.

Keywords: Torque; Reinforced Concrete; Steel Plate; Strengthening, Beams.

1. Introduction

The torsion effects were omitted from the design of reinforced concrete structures for many years. In 1958 ACI committee 438 had made recommendations for suitable torsion design requirement [1]. As a result of these efforts, the ACI-318 Building Code [2] was inserting a new form of torsion design criteria at 1971 for the first time.

Before cracking of reinforced concrete members under torsional moment, there was perceivable effect on the stiffness from reinforcement. As the same, an additional strength beyond the plain concrete capacity can be gain from the longitudinal or transverse reinforcement [3].

First cracking torque is commonly increased, when the longitudinal and the transverse steel are combined. According to the value and location of the reinforcement, a considerable increase in strength and a large amount of plastic torque are possible in spite of stiffness reducing after cracking moment [4].

Fang and Shiau [5] presented experimental results of torsional behavior for normal and high strength concrete beams (NSC and HSC, respectively). Different values of reinforcement were used, subjected to pure torsion. The experimental results demonstrated that the high strength concrete beams owned higher cracked stiffness and torsional strength than

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