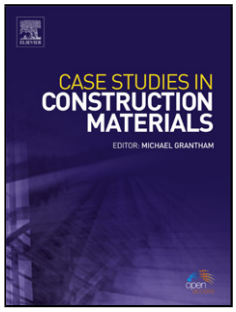

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Experimental Behavior of Full-Scale Exterior Beam-Column Space Joints Retrofitted by Ferrocement Layers under Cyclic Loading

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Abstract

A majority of the traditional reinforced concrete frame buildings, existing across the Middle East, lack adequate confinement in beam-column joints, or in other words, are shear deficient because they were constructed before the introduction of seismic codes for construction. This research studies the experimental behavior of full-scale beam-column space (three-dimensional) joints under displacement-controlled cyclic loading. Eleven joint specimens, included a traditionally reinforced one (without adequate shear reinforcement), a reference one with sufficient shear reinforcement according to ACI 318, and nine specimens retrofitted by ferrocement layers, were experimentally tested to evaluate a retrofit technique for strengthening shear deficient beam column joints. The studied variables were the number of layers, orientation angle of expanded wire mesh per layer, and presence of steel angles in the corners of joint specimen prior to wrapping with ferrocement layers. The experimental results showed that proper shear reinforcement for the test joints, according to ACI 318, enhanced the behavior of the specimen over that of the traditionally reinforced specimens without adequate shear reinforcement. The joints retrofitted by ferrocement layers showed higher ultimate capacity, higher ultimate displacement prior to failure (better ductility), and they did not suffer heavily damage as observed for the traditionally reinforced one. Increasing the number of ferrocement layers for retrofitted specimens led to improving performance for such specimens compared to the traditionally reinforced ones in terms of enhancing the ultimate capacity and ultimate displacement. Specimens retrofitted by ferrocement layers reinforced by expanded wire mesh of 60^{o} orientation angle showed slightly better performance than those of 45^{o} orientation angles. Retrofitting using steel angles in addition to ferrocement layers improves the seismic performance of the specimens, achieves better stability for stiffness degradation, attains higher capacity of the dissipated energy, and reduces the vulnerability of joints to excessive damage. Based on the experimental work in this study, it is recommended to retrofit beam-column joint specimens by two ferrocement layers in addition to steel angles as stiffeners taking the orientation angle of expanded wire mesh into consideration.

Keywords: Retrofitting; beam-column space joints; ferrocement layers; orientation of expanded wire mesh; ultimate capacity; stiffness degradation; cyclic loading; shear deficient; traditionally reinforced buildings

1. Introduction

Most of the reinforced concrete buildings, existing across the Middle East countries such as Egypt, Kingdom of Saudi Arabia, and Turkey are shear deficient because they were constructed before the introduction of seismic codes for construction [1-2]. For example, Joints in typical buildings, constructed before issuing the current Egyptian Code of Practice [3] suffer from lack of adequate steel reinforcement detailing to resist dynamic excitations. In these joints, the confining reinforcement such as column stirrups does not extend in the joint region. The pattern of joint damage in building subjected to the major earthquake in Egypt, October 1992, showed that inadequate shear reinforcement or the

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