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FE Modeling of CFRP-Retrofitted RC Frames with Masonry Infill Walls

Mohamed A. Sakr [a], Saher R. El-khoriby[b], Ayman A. Seleemah[b], Essam A. Darwish[c*]

[a] *Assoc. Prof., Departement of Structural Engineering, Tanta Univeristy, Egypt.*

[b] *Prof. of Strcutural Engineering, Departement of Structural Engineering, Tanta Univerist, Egypt.*

[c] *Assistant lecturer, Departement of Structural Engineering, Tanta Univeristy, Egypt.*

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Abstract

A number of numerical and experimental studies have been reported in recent literature to investigate the effects of infill walls on the seismic response of RC infilled frames. Many experimental studies used CFRP sheets as an external bracing system for retrofitting the infilled RC frames. It has been found that the common mode of failure of such retrofitted frames is the debonding of the CFRP-concrete adhesive material. In the current study, the behaviour of CFRP retrofitted infilled RC frames was investigated with a finite element micro model. In that model, a four-node shell element was used for modeling the concrete, infill panel and CFRP sheets. The interaction between concrete frame and infill panel was modelled using contact surfaces to allow the occurrence of separation and prevent penetration. Nonlinearities of the concrete, infill panel, steel and CFRP sheets were considered. To allow the occurrence of debonding mode of failure, the adhesive layer was modelled using cohesive surface-to-surface interaction model, which assumes that the failure of cohesive bond is characterized by progressive degradation of the cohesive stiffness, which is driven by a damage process based on the fracture energy. The proposed model was verified using experimental results from the literature. Results indicated that the cohesive model could capture the debonding mode of failure which has been observed experimentally. The validated micro model was used to investigate the effects of the strip end area, the anchor location and partial bonding of the CFRP sheet to the infill panel surface on the behaviour of infilled frames. The results of parametric study showed that, to get the highest efficiency of the CFRP retrofitted infilled frame, bonding about 25% only of the diagonal length from each end is sufficient to get the same behaviour of the totally bonded sheet.

Keywords: Infilled RC frames, CFRP Retrofitted, Finite Element Model, Debonding.

1. Introduction

Retrofitting of constructions vulnerable to lateral loads is a current problem of great political and social relevance. Many existing buildings are subjected to seismic action. Most of these buildings have ordinary non-ductile RC elements, beams and columns, infilled with brick walls (infilled RC frames). Many experimental works have been conducted to investigate the seismic behavior of partially infilled frames, infilled frames with opening, and retrofitted and unretrofitted infilled frames. Therefore, they represent conclusive scientific evidence for the possibility of using the infill walls as lateral load structural elements.

Hashemi and Mosalam [1] and Al-Chaar [2] investigated experimentally the behavior of infilled RC frames subjected to lateral loads. The results indicated that, the infilled RC frames exhibit significantly higher ultimate strength, residual strength, and initial stiffness than the bare frames. Furthermore, the number of bays appears to be influential with respect to the peak and residual capacity, the failure mode, and the shear stress distribution.

* Corresponding author: essam.darwish@f-eng.tanta.edu.eg