Studying the FRP-Concrete Bond Behavior of Normal and Light-Weight Concrete Using FEM

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Abstract

The main objective of the present study is to investigate the behavior of FRP-concrete bond of two types of concrete (normal and light weight concrete) using different concrete properties. For this purpose, a model of single shear test was selected and modeled using ANSYS program to study the FRP-concrete bond. The modeling was represented in two ways: with epoxy material (epoxy model) and without epoxy material (full bond model). These two models were formulated and used in the analysis process. Different models of two types of concrete (normal and light weight concrete) were analyzed in order to study bond behavior. In general, the full bond model gave results of more good agreement with the available experimental results than the epoxy model. The average difference between the experimental and analytical failure load was 5.35% and 10.32% for the full bond and epoxy model, respectively. It was found that the increasing in compressive strength of concrete leads to increasing in the bond capacity and the greater concrete compressive strength the better utility of the CFRP sheet. As the compressive strength was increased from 20 to 40MPa, the bond strength of normal concrete and light weight concrete models increased by about 81% and 106%, respectively.

Keywords: FRP, Bond, Bond capacity, Single Shear Test.

1. Introduction

FRP (fiber reinforced polymers) are composite comprise fibers of high tensile strength within a polymer matrix. The FRP material is generally consisting of carbon, aramid, or glass fibers in a polymeric matrix (e.g., thermosetting resin) [1]. Over the last decennium there has been important growth in the use of FRP composite materials as construction materials in structural engineering. The light weight of these materials and their formability of FRP reinforcement make them easier to install. These materials are noncorrosive, nonmagnetic, and generally resistant to chemicals so they are an excellent option for many applications as external reinforcement and repairing structures (columns, beams, slabs, walls, chimney and tunnels). The use of external FRP reinforcement may be generally classified as flexural strengthening, improving the confinement and ductility of compression members, and shear strengthening [2]. There are three common types of FRP materials; carbon, glass and aramid fibers. The carbon fiber reinforced polymer (CFRP) is the most type that used for strengthening and repairing structural elements [3].

The most important issue in the field of strengthening reinforced structures with FRP plates or sheets is the proper design against debonding failure (loss of composite action between concrete and FRP). There are various debonding failure modes such as cover separation, plate and interfacial debonding, intermediate flexural crack induced interfacial debonding, and critical diagonal crack induced interfacial debonding [4]. Therefore, the behavior of the interface between FRP and concrete support is one of the main elements controlling debonding failures in RC structures strengthened with FRP sheets or plates, Fig. 1 shows some typical debonding failures.