Abstract

This dissertation deals with the analytical and experimental investigation of the behavior of a reinforced concrete wall specimen, examined in cyclic loading. At the beginning, two wall specimens are being tested in its initial form until they exhibit some kind of damage, under constant axial force and the simultaneous loading of gradually increasing horizontal cyclic imposed displacement. After that, the two specimens are being retrofitted using FRPs (Fiber Reinforced Polymer) and new experimental tests are carried out in the same way as before. Moreover, a series of tests is conducted in order to examine the bond strength in the concrete – FRP interface.

Each of the two wall specimens has a height of 2.00 m and rectangular cross-section of 20x50 (cm). The longitudinal reinforcement comprises of eight bars of smooth, soft steel. The bars' diameter is 6.00 mm and the steel's mechanical characteristics are known. The same type of steel is used for the transverse reinforcement, in the form of rectangular hoops at 10.00 cm spacing. The reinforcing details of the specimens are such as to provide ductile behavior to the wall, as it is defined by the modern concrete and earthquake resistant structure design codes. A heavily reinforced rectangular foundation is formed at the base of each wall.

The behavior of the wall is analytically investigated by the calculation of its strength at critical regions using the interaction curves M – N and the moment – curvature diagram for various loads. The shear strength is evaluated according to the current Greek Code of Concrete Structures. Finally, there is a brief presentation of the wall's deformation modes (deformation patterns), which compose the total displacement response of the wall.

Each specimen is placed vertically on the steel reaction frame located in the Laboratory of Mechanics. The foundation is anchored in such a way as to produce fully fixed support at the base of the wall. As already mentioned, a gradually increasing horizontal cyclic displacement is imposed at a height of 1.42 m. At the same time, a constant vertical axial force is applied at the top of the wall. The horizontal and vertical loading are imposed using one horizontal and one vertical piston, which are properly attached to the steel reaction frame and are electronically controlled. Each piston has a Load Cell attached to it in order to measure the applied loads. The displacements of the wall are measured in fourteen selected locations, using the appropriate instrumentation (LVDTs). All instruments (Load Cells, LVDTs) are connected to a computer, in which the measured data are stored during the experimental procedure.

At the beginning, the two wall specimens are experimentally tested in its initial form, in such a way as to exhibit important but repairable damages. After that, they are being retrofitted using FRPs. The retrofit pattern is applied in respect to the type of damage of each specimen. In order to prevent the sliding of the FRP on the concrete surface (due to loss of bond) two retrofit practices are applied. One of them is successive, whereas the other is insufficient.

The issue of the bond strength in the concrete – FRP interface is examined in particular in a separate chapter of this dissertation. The bond strength is experimentally measured using a specific experimental application. The tests come to the conclusion that the bond strength can be increased by imposing a compressive force perpendicular (transverse) to the surface of the FRP. The corresponding strength curve τ – σ (shear bond stress – transverse stress) is calculated. The experimental results are compared with those of other researchers and with the instruction for structures retrofit using FRPs.