SEISMIC ASSESSMENT and REHABILITATION of A HISTORICAL UNREINFORCED MASONRY (URM) BUILDING IN ISTANBUL

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SUMMARY

The earthquake vulnerability of a historical building in Istanbul, which is a four-story unreinforced clay brick masonry (URM) structure built in 1869, is evaluated and a conceptual design solution for seismic rehabilitation/strengthening of the building is proposed. The local strength characteristics of the brick walls are assessed based on the Schmidt hammer testing Dynamic properties of the building (fundamental vibration periods) are checked with ambient vibration tests. The building is modeled and analyzed as a three-dimensional assembly of finite elements using SAP2000 v11 (Static and Dynamic Finite Element Analysis of Structures) software package. The dynamic analysis procedure of FEMA 356 (Pre-standard and Commentary for the Seismic Rehabilitation of Buildings, ACEL, 2000) is followed for the detailed seismic assessment of the building. In order to improve earthquake resistance of the building, reinforced cement jacketing of the main load-carrying walls and application of fiber reinforced polymer (FRP) bands in the secondary walls are proposed.

1) EARTHQUAKE HAZARD ASSESSMENT

Deterministic seismic hazard assessment was conducted to determine the spatial distribution of the design basis earthquake ground motion for the site that would result from a deterministic (scenario) earthquake. The design ground motion was assessed at the so-called farfield output of the reference soil media, which is the engineering bedrock of NEHRP BC boundary soil class with an average shear wave propagation velocity of 750 m/s. This reference soil media correspond to the upper layers of the so-called Turkish Formation consisting of claystone, sandstone and siltstone. This zone essentially be assumed to be soft rock with an average shear wave propagation velocity of 760 m/s. For the Mw=7.5 earthquake, the spectral acceleration at the fundamental periods is required for the dynamic analysis. Spectral acceleration, Sa [m/s^2], is utilized. Similar values of fundamental free vibration periods are found from the ambient vibration tests and computer analysis. The similar values of fundamental free vibration periods were identified from the power spectral densities (in Vsec). The fundamental structural vibration frequencies could be identified; tests and subsequent data analysis following fundamental frequencies of vibration could be identified.

2) AMBIENT VIBRATION TESTS

Ambient vibration tests were carried out in the building with four Kinemetrics SS-1 1-D seismometers. The seismometers were distributed among the four stories of the building. The results of the ambient vibration tests are presented in Figure 2. On the basis of ambient vibration tests and subsequent data analysis following fundamental frequencies of vibration could be identified.

3) MATERIAL TESTING

Schmidt hammer tests were carried out at seven locations in the basement of the building (Figure 4) and the average rebound number is found as 35.4. On the basis of the values given in the literature following compressive strengths can be determined: tests and subsequent data analysis following fundamental frequencies of vibration could be identified.

4) REHABILITATION / STRENGTHENING OF INDIVIDUAL WALLS

The walls to be retrofitted are shown on the floor plans in Figure 6. The wall marked with red color will be strengthened by fiber reinforced cement jacketing and use of FRP reinforcement. The wall marked with yellow color will be strengthened by fiber cement jacketing and use of FRP reinforcement. The wall marked with orange color will be strengthened by fiber cement jacketing and use of FRP reinforcement. The wall marked with blue color will be strengthened by fiber cement jacketing and use of FRP reinforcement. The wall marked with green color will be strengthened by fiber cement jacketing and use of FRP reinforcement. The wall marked with purple color will be strengthened by fiber cement jacketing and use of FRP reinforcement. The wall marked with black color will be strengthened by fiber cement jacketing and use of FRP reinforcement. The wall marked with white color will be strengthened by fiber cement jacketing and use of FRP reinforcement.

5) CONCLUSIONS

The results of the seismic hazard assessment of a historical URM building carried out and strengthened techniques are proposed to improve in earthquake resistance. In order to obtain dynamic response of the building, 5% damped elastic response spectrum that results from deterministic seismic hazard assessment considering the maximum credible earthquake-MCE scenario event at the site of building is utilized. Similar values of fundamental free vibration periods are found from the ambient vibration tests and computer analysis. The strength characteristics of the unreinforced masonry (URM) walls are determined by Schmidt hammer testing. The seismic performance of the building is assessed based on the demand-to-capacity ratios of the individual walls. Reinforced cement jacketing for the main load-carrying walls and application of FRP strip bands to the secondary walls are proposed.