Characteristics and displacement capacity of reinforced concrete walls in damaged buildings during 2010 Chile earthquake

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Abstract

About 2 % of reinforced concrete (RC) buildings taller than nine stories suffered important structural damage during 2010 Chile earthquake. The typical structural configuration of residential buildings is characterized by a large number of RC structural walls which provides high lateral stiffness and strength. The first objective of this paper is to obtain global geometric and design parameters of RC structural walls in damaged buildings and correlate their values with the observed damage. The second objective is to compare the roof displacement capacity with the roof displacement demand in critical walls, and hence, try to explain the observed damage. The wall parameters were obtained from five representative damaged structural wall buildings; these are: wall thickness, aspect ratio, axial load, reinforcement ratios, and the ratio between horizontal reinforcement spacing and the vertical bar diameter. The roof displacement capacity is obtained using a plastic hinge approach, and the ACI 318-08 approach, since both methods are proposed in the current Chilean seismic code. The displacement demand is estimated from ground motions recorded in the vicinity of the buildings. It is found that values of wall parameters correlate well with the observed damage. The structural walls were subjected to relatively high axial loads, and some walls included a large amount of vertical reinforcement to provide the required strength, but had inadequate transverse reinforcement thus compromising ductility. Findings from this research suggest that the plastic hinge approach is inadequate to estimate the roof displacement capacity and lacks correlation with the observed damage. Moreover, the use of the ACI 318-08 approach to estimate the roof displacement capacity is also inadequate, but leads to better predictions of wall displacement capacity. As shown by the results of response history analysis, the failure of walls was triggered by high axial loads rather than flexural deformation.