ASSESSING SEISMIC PERFORMANCE OF MID-RISE BUILDINGS USING FRAGILITY CURVE

By

Ahmed Mohamed Ali Mohamed Ali Naiel

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Structural Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Key Words:
Structure analysis, Seismic analysis, non-linear analysis, time history analysis, Reinforced concrete structures, Earthquake resistant structure, Resilience, seismic effect, concrete, reliability, fragility, mid-rise.

Summary:

In conventional design approaches, structural safety is assessed by utilizing the damage that could occur to main components, such as columns and shear walls, and consequently, their failure that may lead to progressive (or partial) collapse of structures under extreme dynamic loads. Even when extreme conditions are taken into account, structural safety is not probabilistically assessed and controlled, thus uncertainties in loads and system capacity are neglected. In this thesis, the behavior of mid-rise reinforced concrete (RC) buildings, which are designed in accordance with the Egyptian standards, are assessed analytically under the action of seismic loads. In addition, resilience evaluation for such buildings under the action of seismic loads is determined. As such, non-linear time-history analyses (NLTHA), in addition to pushover analyses, were carried out on nine RC frames with reinforcement ratios used in columns varying from 1% to 3% and a number of stories varying from six to ten floors. In addition, fragility curves are developed in order to illustrate the probability of exceeding structural damage due to earthquakes as a function of ground motion indices. The lateral response of previously

mentioned nine RC frames are evaluated by utilizing more than five hundred NLTHA considering ten different earthquake records with six peak ground acceleration in addition to the Egyptian response spectrum analysis. The output of this research includes roof drift and base shear histories, which are converted to damage in beams and columns in accordance with FEMA-356 guidelines. Based on statistics and probability distribution functions for obtained results, fragility curves are then developed, which may be used as an effective tool for planning and implementing retrofit schemes, modifications to codified seismic provisions, seismic mitigation strategies, and for insurance-related applications. Fragility curves showed that reinforcement ratio of 2% in columns is the optimal reinforcement ratio and it is recommended to utilize for columns designed to withstand lateral loads.

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