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Drift based damage functions for reinforced concrete columns

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Abstract

Research has been undertaken to develop damage curves for reinforced concrete column members. A broad range of parameters that influence the damageability of reinforced concrete columns were investigated using finite element program ANSYS v6.1. Damage curves expressed in terms of interstory drift ratio were developed for three levels of ductility from the results of numerical investigations. The levels of ductility were determined based on the axial load level and the transverse reinforcement ratio. These curves are invaluable for estimating damage level of reinforced concrete frame buildings, which are predominantly used throughout the world, especially in developing countries. In addition, many procedures used to evaluate building performance employ acceptance criteria for the components comprising the whole structure so these curves are also recommended for use in the acceptability of reinforced concrete columns of frame structures.

Keywords: Reinforced concrete; Damage curves; Vulnerability; Column; Drift ratio; Damage index

1. Introduction

Every year several destructive earthquakes hit different regions of the world causing loss of huge amounts of economic properties and lives. The high economic loss and death toll prompt research to deal with reducing the seismic risk in the earthquake prone regions. Seismic codes of the countries which are susceptible to damaging earthquakes, are revised or rewritten to enable the satisfactory performance of the structures and thus to reduce loss after a major earthquake. There are still a lot of structures throughout the world, which are highly vulnerable to seismic action. Identifying structures that have high vulnerability is of critical importance for both reliable loss estimation as a result of an expected earthquake and setting priority criteria for strengthening of structures.

Predicting vulnerability of a whole structure is not easy to handle due to lack of proper experimental and observed data. For this reason, the trend has moved towards evaluating the whole structure at the level of its components.

Reinforced concrete frame buildings are amongst the most common construction types in the world. The capacity and behavior of the columns of a reinforced concrete frame structure is an important factor that determines the performance of the whole structure against earthquakes. Thus, predicting the damage level of the columns as a result of an earthquake plays a major role in predicting the seismic vulnerability of a reinforced concrete frame structure. In general, the damage state of a column is determined by computing a damage index, which is usually related to displacement ductility, defined as the ratio of the maximum lateral displacement to the yield displacement, dissipated energy [1], stiffness degradation and deformation of the columns. Deformations characterized by drift ratio or plastic rotation at the member end are widely used by some guidelines given for seismic evaluation of buildings [2,3] and in earthquake vulnerability assessment procedures [4]. The deformation capacity of reinforced concrete columns is affected by various parameters including axial load level, confinement, and concrete strength; this

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