Development of Fragility Curves for Multi-Span RC Bridges using Generalized Pushover Analysis

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Abstract

Over the past few decades, fragility curves became a powerful tool for the seismic vulnerability assessment of structures. There are several available analytical procedures for calculating fragility curves, using both static and dynamic nonlinear analyses. In this study, a nonlinear static method, based on Generalized Pushover Analysis (GPA), is implemented for the development of analytical fragility curves of reinforced concrete (RC) bridges. The relative accuracy of the GPA algorithm, when applied to a large number of existing bridges, is evaluated through the comparison with the results from Nonlinear Time History Analysis (NTHA). Results indicate that GPA provides a good estimation of the fragility curves with respect to NTHA. The added computational demand of the GPA algorithm in terms of the number of analyses pays off in terms of accuracy while keeping the simplicity of a non-adaptive conventional pushover algorithm, which is desirable in engineering practice.

Keywords: bridges; multi-mode pushover; seismic response; fragility assessment; loss assessment.

1. Introduction

During the past decades, bridge structures have been recognized as one of the most seismically vulnerable components within transportation networks [1, 2]. It is thus necessary to properly assess their seismic performance in order to enhance the reliability of the results coming from seismic risk and earthquake loss models.

Past research has focused on developing methods for the vulnerability assessment of structures [3, 4, 5]; where vulnerability in this context can be defined as the propensity to damage under a given level of earthquake intensity; these methods can be roughly grouped as empirical, analytical and hybrid, depending primarily in their data collection strategy.

Analytical fragility curves are constructed from structural analysis of the system under investigation and there are several approaches for the calculation of the structural response, which differ primarily in terms of type of structural analysis implemented, i.e. linear-elastic, non-linear static and non-linear dynamic. Analytical fragility curves are often preferred over other approaches because they overcome the perceived subjectivity and/or scarce post-earthquake damage data or experimental results that other alternatives require. For what concerns RC bridges in particular, several past studies have employed linear-elastic

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