

# DISPLACEMENT-BASED EARTHQUAKE LOSS ASSESSMENT OF ADOBE BUILDINGS OF PAKISTAN

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The calibration of a nonlinear static displacement-based method is carried out for seismic vulnerability assessment and earthquake loss estimation of adobe buildings in Pakistan. The method makes use of equivalent static single degree of freedom (SDOF) systems, completely defined by secant vibration period, limit state displacement capacity and viscous damping, to assess the seismic vulnerability of structures with due consideration of expected uncertainties in geometrical and mechanical properties of the structures besides the uncertainties in seismic demand. Nonlinear time history analyses (NLTHA) of twenty one case study buildings, with geometric and material uncertainties, are performed in order to derive mechanical model of adobe buildings for global mechanism. Furthermore, available recommendations for other types of masonry are employed to derive the local out-of-plane mechanical model for adobe buildings using static analysis. The mechanical models are used to derive fragility functions for adobe buildings which can be used to predict the socio-economic impacts of earthquakes for future preparedness and risk mitigation in the region. Comparison of the analytical prediction is carried out with the observed vulnerability in 2008 Balochistan earthquake which is found reasonably accurate in estimating the mean damage ratio at the site for the considered earthquake.

*Keywords:* Displacement-based, nonlinear analytical, fragility functions, seismic risk, Balochistan earthquake, mean damage ratio, out-of-plane, adobe, Pakistan.

## 1. Introduction

Adobe buildings are widely used in the underdeveloped parts of Pakistan, e.g. in Balochistan Province about 80 to 100 percent of the total building stock in local districts and 36 percent in whole country. These building systems have shown very poor performance in past earthquakes. However, due to low economic status of the inhabitants and/or old traditions and lack of public awareness, these buildings are still in use in the country. The present paper performed the calibration of a simplified nonlinear static method for seismic vulnerability assessment of adobe buildings for future

applications in regional seismic risk assessment and loss estimation for earthquake preparedness and risk mitigation.

## 2. Displacement-Based Earthquake Loss Assessment of Structures

### 2.1. Nonlinear static SDOF systems for adobe buildings

The SDOF system, called a mechanical model, has nonlinear lateral force-displacement response to assess the seismic performance of structures. The mechanical model simulates the response of the structural system