アフガニスタンにおける地震のリスクと構造物の振動特性評価に関する基礎的な研究

Form 3

Abstract

Title: A fundamental study on the seismic risk in Afghanistan and vibration characteristics of structures

Earthquakes threaten life and infrastructure in Afghanistan in addition to the numerous human-made disasters. The problem that needs to be addressed for the future in Afghanistan region is the shortcomings that result the intermediate-magnitude deep and small size shallow earthquakes cause considerably impact. The primary goals of this work are to assess the seismic hazard and seismic vulnerability of common-type buildings in Afghanistan. The energy for earthquakes in Afghanistan is mainly released from two regional earthquake sources: namely, the Eurasia-Indian global plate boundary movements in the SE and Hindu Kush and Pamir in the NE.

To analyze the earthquake hazard, a homogenized earthquake catalogue is developed. It includes earthquakes of a broader area bounded by $27.0 \leq \text{Latitude} \leq 39.5$, $58.5 \leq \text{Longitude} \leq 75.0$, and $M \geq 4.0$. The earthquake recurrence parameters derived from the homogenized earthquake catalogues are used to analyze the seismic hazard. PGA for Kabul city corresponding to 2% and 10% PE in 50 years are 32%g and 19%g, respectively. Maximum spectral acceleration in Kabul city at 2% and 10% PE in 50 years are 82%g and 42%g corresponding to 0.2-second, respectively.

Unavailability of reports or studies about the damage of buildings in past earthquakes of Afghanistan is another serious problem in the path of understanding their collapse mechanisms. The construction methods in Afghanistan, Pakistan, Turkey and in Nepal are studied. Photo-elasticity tests are conducted on masonry buildings, frames and frame structures with various structural systems. The structural members plinth/foundation beam (B), Columns (C), and ceiling slab (S), and partition walls (W) of reinforced concrete buildings in Afghanistan are constructed in three different models classified by the construction order of these elements; namely, model 1 BCSW, model 2 BCWS and model 3 BWCS. Photo-elasticity tests and FEM simulations are conducted to evaluate the response of these models. The model 3 provides better response as the structural members and wall start to react as a single resisting system whereas in model 1 and model 2, the walls start to react when the column and slab undergo certain amount of deformation. The masonry buildings provide better response to earthquakes when continuous beams are constructed below and on top of the windows/openings.

Last but not the least, structural integrity of some common type structures is evaluated using their natural frequency and vibration characteristics. Four different vibration methods; namely, free vibration, forced vibration, micro-tremor device and Fourier Amplitude are used. In most of the case, particularly for the slender structures it is seen that all these methods give very close results. This implies that the free vibration and sandbag drop test are easy and cheap methods and most appropriate, particularly for the areas and countries where lack of advance experimental devices are scarce, and the budget limitations are major problems to conduct quality researches.

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