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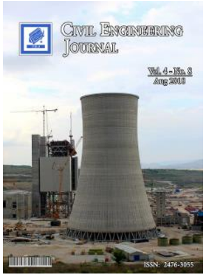

# Monte Carlo Based Seismic Hazard Model for Southern Ghana

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**Abstract**

Seismic hazard assessment involves quantifying the likely ground motion intensities to be expected at a particular site or region. It is a crucial aspect of any seismic hazard mitigation program. The conventional probabilistic seismic hazard assessment is highly reliant on the past seismic activities in a particular region. However, for regions with lower rates of seismicity, where seismological data is scanty, it would seem desirable to use a stochastic modelling (Monte Carlo based) approach. This study presents a Monte Carlo simulation hazard model for Southern Ghana. Six sites are selected in order to determine their expected ground motion intensities (peak ground acceleration and spectral acceleration). Results revealed that Accra and Tema as the highly seismic cities in Southern Ghana, with Ho and Cape Coast having relatively lower seismicities. The expected peak ground acceleration corresponding to a 10% probability of exceedance in 50 years for the proposed seismic hazard model was as high as 0.06 g for the cities considered. However, at the rather extreme 2% probability of exceedance in 50 years, a PGA of 0.5 g can be anticipated. Evidently, the 2% in 50 years uniform hazard spectrum for the highly seismic cities recorded high spectral accelerations, at a natural vibrational period within the ranges of about 0.1-0.3 sec. This indicates that low-rise structures in these cities may be exposed to high seismic risk.

*Keywords:* Seismic Hazard; Monte Carlo Simulation; Uniform Hazard Spectrum; Seismic Hazard Curve; Ghana.

## 1. Introduction

Earthquakes are highly stochastic in nature. From their spatio-temporal occurrence to associated ground motion intensities, there seems to be no reliable form of deterministic model available for adequate characterization. Given their highly uncertain nature, many experts (seismologists, engineers and researchers) have adopted and advocated the use of the probabilistic approach in quantifying the seismic hazard to be expected for a particular region. Once the hazard is quantified, the vulnerability of buildings [1–3], particular older-type reinforced concrete structures can be confidently assessed. Currently, the development of hazard maps has been crucial, and plays a fundamental role in hazard mitigation. Ayele [4] presented a seismic hazard map, which has been implemented in the 3rd generation building code of Ethiopia. Ezzelarab [5], having adopting the probabilistic approach, evaluated the seismic hazard of north-western part of Egypt. Gaspar-Escribano [6] conducted an uncertainty assessment of developed seismic hazard model for Spain. Hassan [7] comprehensively evaluated existing seismic hazard maps of Egypt, to identify short falls such as under-estimated hazard in the event of an earthquake. Usually, one is interested in an optimal mitigation level that minimized the total cost (the summation of the expected loss and mitigation cost), and this is highly dependent on the reliability of the hazard model adopted. When the mitigation level is high, one anticipates a reduction in the expected loss but at the expense of increased construction cost. Ideally, the chosen hazard level should not be too strong (imposing unnecessary cost) or too weak (permitting unwarranted risk). As noted by Rosenblueth [8], there is a need to incorporate societal and economic requirements (how much of its resources to spend in the event of an earthquake) in the setting of seismic

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