*Proceedings of the 3rd Croatian Conference on Earthquake Engineering - 3CroCEE*
*19–22 March 2025, Split, Croatia*

*DOI: https://doi.org/10.5592/CO/3CroCEE.2025.162*

# PHYSICS-BASED SITE-SPECIFIC PSHA FOR SEVERAL URBAN CENTERS IN SOUTHWEST ICELAND

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*Keywords: Physics-based, PSHA, FFCAT, Iceland.*

Seismic risk assessment is crucial for mitigation of strong earthquakes' effects on communities since it offers a comprehensive framework for minimizing damage, casualties, and economic losses. This can be accomplished through designing earthquake-resistant structures, retrofitting the existing buildings, economic resilience, urban planning, and public education. One of the key elements of seismic risk assessment is to estimate the earthquake hazard in the region of interest. The most acceptable way to evaluate the earthquake hazard in a given region is to perform a probabilistic seismic hazard assessment (PSHA). The seismic hazard and risk are highest in southwest Iceland due to the transform faulting near a relatively populated region with all critical infrastructures and lifelines. The South Iceland Seismic Zone (SISZ) is one of the two major transform zones of Iceland where earthquakes take place on an array of short, near vertical, and north-south trending right-lateral strike slip faults, known as the 'bookshelf fault system'. This bookshelf fault system has been shown to be continuous towards the west along the entire Reykjanes Peninsula Oblique Rift (RPOR) [1]. Based on geological and seismological evidence, seismogenic potential is variable in the SISZ-RPOR, with the increasing seismogenic depth from west to east [2,3]. This results in the maximum magnitudes from~5.5 in the westernmost part of the RPOR to~7−7.2 in the easternmost part of the SISZ, which agrees with the seismicity and also historical catalogue in southwest Iceland. Recently, a new physics-based finite-fault system model has been developed for the SISZ-RPOR, calibrated to the steady-state relative plate velocity of transcurrent tectonic motions across the zone [4].

This model, which is constrained by historical and instrumental seismicity, accounts for the variability in inter fault distances guided by fault mapping and relative relocations of seismic swarms. Therefore, the resulting model is completely specified in terms of suites of 3D strike-slip faults along with their corresponding annual slip rates, thus fully capturing the salient characteristics of spatially variable maximum magnitudes and zone-specific magnitude frequency distributions (MFDs). These zone-specific MFDs are entirely compatible with the physical constraints, effectively explain the observed Icelandic catalogues and also avoid the bias introduced by the short duration of earthquake catalogues [5]. This model was further used to simulate a synthetic finite-fault earthquake catalogue (FFCAT) for a long-time interval with random locations across the region [6]. This physics-based approach is in stark contrast to conventional PSHA which relies on simplified seismic source models and simplistic statistics of an earthquake catalogue that for each subzone is effectively incomplete, whereas the finite-fault catalogues fully incorporate the first two key elements of PSHA, the seismic source locations along with their activity rates [7].

In this study, we take advantage of a new physics-based FFCAT and carry out a Monte Carlo PSHA (MC-PSHA) for several major cities and towns in Southwest Iceland. In the MC-PSHA, the ground motion intensity measures of interest are predicted from each finite-fault by several GMMs. However, different ground motions predictions by different GMMs have the largest contributions to the overall epistemic uncertainty. To reduce the epistemic uncertainty, therefore, we use different data-driven GMM-ranking methods to reduce subjectivity in the selection process [8–10]. For inferring the most suitable GMMs, we consider several empirical GMMs developed from local, regional and

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worldwide data. The ranking results favor the Icelandic Bayesian GMMs and thus the logic tree is populated with six Bayesian GMMs with different functional forms for use in PSHA. The PSHA results of this study are shown in terms of hazard curves at different periods. We conclude that this study avoids the use of limited statistics from observed catalogues and is firmly rooted in a physical finite-fault system of Southwest Iceland.

## Acknowledgements

This study is funded by the "seismic hazard and risk for Reykjanes" project from Icelandic Meteorological Office (No. 3721-0-0019), the national energy company of Iceland, Landsvirkjun (No. NÝR-06-2024 and NÝR-28-2024), the Icelandic Road Administration, Vegagerðin (No. 1800-1032).

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