SEISMIC AND TSUNAMI HAZARD ASSESSMENT OF COASTAL BUILDINGS IN WEST COAST OF JAPAN

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INTRODUCTION

Coastal cities are exposed to various types of disaster risks, such as tsunamis and storm surges. In particular, a megathrust earthquake has a potential to cause severe damage to cities almost simultaneously in terms of both seismic ground shaking and tsunami damage. However, in the countermeasures against future disasters, seismic and tsunami damage are generally assessed separately, and different source models are assumed for different types of disasters. This study aims to calculate damage probabilities of ground motion and tsunami for buildings in a coastal city under the same earthquake scenarios and to make an intercomparison between these two kinds of hazards.

METHODOLOGY

The target area is the Pacific coast of Japan, and the target earthquake is the Nankai-Tonankai earthquake located in the Nankai Trough. First, a large number of synthetic earthquake source models (i.e., earthquake scenarios) are generated. Then, the damage probabilities to buildings are estimated for each ground motion and tsunami for all generated scenarios. Finally, the characteristics of the damage distribution are compared.

The method of generating the rupture models is based on a stochastic earthquake source model. This model can generate an arbitrary number of heterogeneous slip distributions with similar characteristics to historical earthquakes using wavenumber spectra and random numbers. Nine hundred earthquake scenarios in three magnitude patterns (Mw8.0, 8.5, 9.0) conditioned on the Nankai Trough are generated. A numerical tsunami simulation is conducted for each scenario in terms of tsunami damage. The numerical model is based on the nonlinear shallow water equation. The finest grid spacing is 10 m. The building damage due to a tsunami is estimated using the damage probability function and the simulated inundation depth. Meanwhile, the ground motion prediction equation (GMPE) was used for seismic damage assessment to calculate the peak ground velocity (PGV). As with tsunami damage, damage probability functions and PGVs are used to estimate the damage probabilities of buildings. The building damage function considers the structure type, such as wood and RC.

RESULTS

This paper presents a case study of Osaka City, one of the major cities in Japan. The spatial distribution of building damage probabilities for shaking tends to be spatially discontinuous, largely due to the geological parameters used in the GMPEs. On the other hand, the building damage probability of tsunamis shows a continuous distribution in the coastal area, and the damage probability tends to be larger than that of ground motion if assumed that earthquakes collapse coastal levees. The distribution of combined damage probability is highly biased toward the coastal areas due to tsunami inundation in Osaka City (Figure 1).

The statistically expected number of damaged buildings by the combined probabilities of earthquake and tsunami significantly increases compared to the case where only tsunami damage is considered. This result indicates the importance of considering both ground motion and tsunami damage. While the structure type has a less significant impact on the number of damaged buildings by tsunamis, wooden structures account for a large percentage of damaged buildings by shaking. This is primarily because the damage probability function for ground motion is sensitive to the structure type, and tsunami inundated buildings are very likely to be damaged regardless of their structure types.

CONCLUSIONS

The probabilistic seismic and tsunami hazard assessment is conducted for buildings along the Pacific Coast of Japan. Differences in the characteristics of spatial distribution were observed between tsunami and earthquake damage. In addition, the importance of combined damage assessment is indicated from the individual damage estimation of shaking and tsunami considering building structure type.

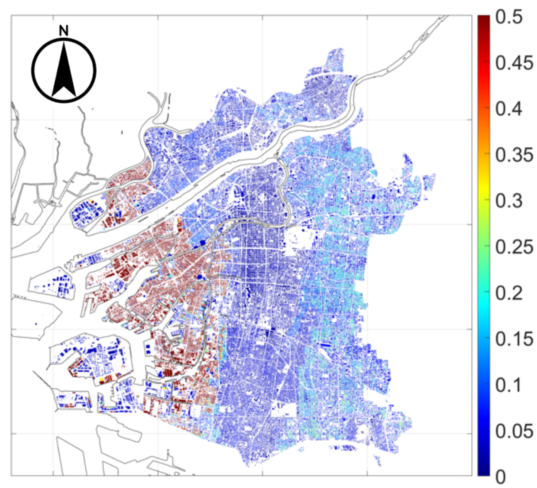

Figure 1 – Spatial distribution of combined tsunami and earthquake damage probability of buildings in Osaka City. Colors represent the 95th percentile values for over 100,000 buildings based on the 300 scenarios in Mw9.0. Black lines represent coastlines.