

Assessment Using Copulas of Simultaneous Damage to Multiple Buildings Due to Tsunamis

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Abstract : If risk management of the assets owned by companies, risk assessment of real estate portfolio, and risk identification of the entire region are to be implemented, it is necessary to consider simultaneous damage to multiple buildings. In this research, the Sagami Trough earthquake tsunami that could have a significant effect on the Japanese capital region is focused on, and a method is proposed for simultaneous damage assessment using copulas that can take into consideration the correlation of tsunami depths and building damage between two sites. First, the tsunami inundation depths at two sites were simulated by using a nonlinear long-wave equation. The tsunamis were simulated by varying the slip amount (five cases) and the depths (five cases) for each of 10 sources of the Sagami Trough. For each source, the frequency distributions of the tsunami inundation depth were evaluated by using the response surface method. Then, Monte-Carlo simulation was conducted, and frequency distributions of tsunami inundation depth were evaluated at the target sites for all sources of the Sagami Trough. These are marginal distributions. Kendall's tau for the tsunami inundation simulation at two sites was 0.83. Based on this value, the Gaussian copula, t-copula, Clayton copula, and Gumbel copula ($n = 10,000$) were generated. Then, the simultaneous distributions of the damage rate were evaluated using the marginal distributions and the copulas. For the correlation of the tsunami inundation depth at the two sites, the expected value hardly changed compared with the case of no correlation, but the damage rate of the ninety-ninth percentile value was approximately 2%, and the maximum value was approximately 6% when using the Gumbel copula.

Keywords : copulas, Monte-Carlo simulation, probabilistic risk assessment, tsunamis

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