Simulation of building damage distribution by the 2016 Kumamoto Earthquake by use of limited information on real damage

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1. Introduction

In case of widely spread disaster such as a great earthquake, a disaster information system is under development to gather and estimate the whole damage situation in “real-time” in order to support decision-making for initial corresponding. In a very short time after an earthquake occurs, the system estimates ground motion distribution by each 250m regional mesh by interpolating strong motion records which are gathered by nationwide observation station networks, K-NET and KiK-net etc. Then, it combines the estimated ground motion distribution with prepared fragility functions and exposure data to estimate the number of damaged houses. Moreover, a method to improve the estimated accuracy is being developed, by use of actual damage information on limited areas as “observation” in Bayesian updating protocol. This report deals with numerical examples of the method.

2. Updating framework for estimation error in numbers of damaged houses

The system, at first, generates “immediate estimates” which is based on ground motion distribution and prepared fragilities and exposure data. In the estimation, errors of the parameters of fragilities are modeled as random variables. Then, the parameters of probability distributions are updated by Bayesian protocol by use of actual damage information such as the real numbers of damaged houses in some particular areas.

3. Actual damage information read from aerial photographs

This study uses the numbers of damaged houses in each 250 m mesh as actual damage information. They are read by eyes from the oblique photographs took from a helicopter after occurrence of the Earthquake (Mw 7.3) on April 16th.

In the numerical examples, we use only a part of information; that on some selected meshes, in order to examine how to improve the estimation accuracy even with as small data as possible. The selecting process is as followings: 1. Chose meshes those include twenty or more houses from some districts, where are determined with reference to the estimated ground motion distribution. 2. Divide the chosen meshes into several groups based on geomorphography classification, which is determined for each 250m mesh. 3. Select at random almost same numbers of meshes from each of mesh groups.

4. Results

“Immediate estimate” by inputting ground motion distribution for the Mw 7.3 earthquake into the fragility functions used in damage estimates by Japan Cabinet Office (2012) overestimated the number of damaged houses by around four times of that reported for the whole suffered area. Several cases are examined for different information. The case the presented method works well is that using both information of Mashiki town, which represents most severely damaged areas, and that of Higashi-Ku, Kumamoto City, which represents typically suffered areas. The numbers of damaged houses read from ten meshes of each area can update the estimate to close to the reported numbers. On the other hand, in a case using information of twenty meshes only from Mashiki town the damage is still overestimated, and in a case with twenty meshes only from Higashi-Ku, Kumamoto City, the number is rather underestimated.

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