Modeling of Earthquake Damage Escalation due to Aftershocks - A Case in the 2004 Mid Niigata Pref. Earthquake Sequences -

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The 2004 Mid Niigata, centered Japan, prefecture earthquake (Mj = 6.8) occurred at 17:56 on October 23, 2004 (JST). The maximum JMA seismic intensity 7 (X in MM scale) was recorded in Kawaguchi-cho at main shock, and a sequence of strong aftershocks having seismic intensity 5- or higher (VII to IX in MM) struck mid Niigata district. This sequence of strong aftershocks brought up a new issue of damage escalation. An intensive questionnaire survey on the various seismic effects by main shock and aftershocks in an affected area of Ojiya city was conducted on September 2005. Ojiya city locates next to Kawaguchi-cho with population around 41,000 and households around 12,000. It lies on the limitrophe area of the Echigo Plain and mountainous area. The questionnaire covers wide range of items with seismic intensity, earthquake resistance of dwellings, human behavior, damage to dwellings, human casualties, evacuation, socioeconomic rehabilitation aid and so on. In the questionnaire a special attention was paid on the escalation features of damage to dwellings by main shock and aftershocks.

Damage states in wooden buildings are classified using Damage Index developed by Okada and Takai(1999). Damage to twenty-one percent of wooden dwellings seems to have gotten worse. Aftershocks inflicted further damage on fifty percent of D0 (no damage) wooden dwellings. Two point nine percent of them got reach half collapse (D3) and zero point seven percent of them got reach collapse (D4, D5 and D6). Through cross tabulation analysis, we know that principal parameters of damage escalation about buildings are eight characteristics of building as follows.

Site ground condition, building's stories, age, roof, outer wall, foundation, diagonal braces and condition.

Then primary factors of damage escalation by aftershocks are modeled by quantification theory type II. This theory is for projection of qualitative external criterion from qualitative data. Three cases are analyzed as follows.

1. Explanatory variable : Seismic intensity and age of buildings, Response variable : Damage escalate or not
2. Explanatory variable : Seismic intensity and eight building's characteristics, Response variable : Damage escalate or not
3. Explanatory variable : Seismic intensity and the result of seismic diagnosis, Response variable : Damage escalate or not

The results of each accuracy rate is 1: 61.4%, 2: 64.1% and 3: 60.6%. These findings remained the importance aftershocks from the point of view of disaster prevention.

References

Shigeyuki OKADA and Nobuo TAKAI : CLASSIFICATIONS OF STRUCTURAL TYPES AND DAMAGE PATTERNS OF BUILDINGS FOR EARTHQUAKE FIELD INVESTIGATION, Journal of structural and construction engineering. Transactions of AIJ, No.524, pp. 65-72, 1999.