Modelling of wooden houses in Furukawa district based on damage states during 2011 Tohoku Earthquake

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In case that building structures are subjected to a strong earthquake, both the strength of the building structure and the ground property greatly affect their damage level. Even if the buildings are closely located in a small area, it is possible that the difference of the velocity structure of subsurface layers divide their damage states significantly. Numerical simulation can be a powerful tool to give an explanation for spatial differences of actual damage in such a local site, however, it often becomes a task to introduce appropriate numerical models; it requires not only to set appropriate structural parameters of buildings but to estimate ground properties over the targeted area. Particularly with respect to ground properties like velocity structures, available information over a targeted area is limited in most cases.
Furukawa district, Miyagi, Japan, was subjected to the 2011 off the Pacific coast of Tohoku earthquake (the 2011 Tohoku earthquake) and then some of wooden houses in particular areas were severely damaged. Goto et al. (2012) established a temporal network of seismometers (Furukawa Seismometer Network, FuSeN) in the area, that is very high density networks using more than 30 accelerometers with a spatial interval of about 100 m. By analyzing the earthquake records and ambient vibration records observed by the FuSeN, Goto et al. (2016) proposed a model of local velocity structure in Furukawa district.
Using the velocity structures proposed by Goto et al. (2016), we estimated earthquake motions at each location in Furukawa district and calculated seismic responses of the wooden houses during the 2011 Tohoku earthquake. As both the detailed structures and the exact age at the time of the wooden houses were unclear, we modeled the story stiffness by shear springs and set three types of mass and stiffness model according to Building Standards Act of 1959, 1981 and 2000. Accelerations on the ground surface at each location, which were used as input earthquake motions, were calculated from both linear and nonlinear analyses to discuss the influence of soil nonlinearity on the spatial distribution of seismic damage. From the analytical results for each calculation case, this study examined the possible structure types of wooden houses and settings of analytical conditions that can explain the damage states over the area.

Keywords: damage analysis, Tohoku earthquake, wooden house

