**Seismic Motion Analysis of Furniture Placed in a Reinforced Concrete Building using FEM**


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Japan is one of the countries frequently hit by earthquakes. In Great East-Japan Earthquake occurred in 2011, indoor furniture and interior equipment were severely damaged although there appeared little damages on buildings. Improperly secured furniture, especially on the upper floors of high-rise buildings under seismic excitation, can become dangerous objects for human life. Many tumbled furniture could become fatal obstacles that obstruct people from evacuating. Therefore, it is important to know the overturning behaviors of furniture under seismic excitations, as well as the behaviors and damages of the building itself. From this background, various shake-table tests for such specimen had been carried out, although such tests can be too costly to conduct repeatedly.

To restrain the costs, numerical simulation techniques such as discontinuous element method (DEM) had been often applied to investigate the motion behaviors of furniture. Its calculation cost is very small; however, there are physically uncertain properties that have to be fixed in the models and it is difficult to obtain the deformations and stress distributions of the models. The finite element method (FEM), on the other hand, is an effective means to evaluate the deformations and stress distributions of the models and requires less number of parameters than the DEM. In this research, the behaviors of furniture under seismic excitation are simulated, using the code in which the frictional contact algorithm based on the sophisticated penalty method is introduced to Adaptively Shifted Integration (ASI) - Gauss code [1,2].

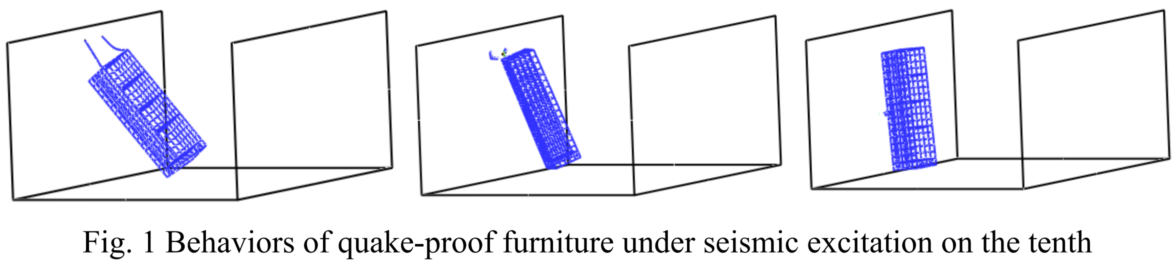

Fig. 1 Behaviors of quake-proof furniture under seismic excitation on the tenth floor of a reinforced concrete building

First, we simulated the behaviors of quake-proof furniture placed on the first floor and the tenth floor of a medium-rise reinforced concrete building subjected under a seismic excitation (Fig. 1). According to the numerical results, large motions appeared in the furniture placed on upper floors and the attached quake-proof equipment were less useful in those cases. Furthermore, the most effective means to suppress the motions was to attach the quake-proof equipment near the centroid position of furniture. Secondly, we conducted a seismic motion analysis of furniture placed on each floor of a medium-rise reinforced concrete building. As a result, the motions of furniture became larger as the location went higher (Fig. 2).

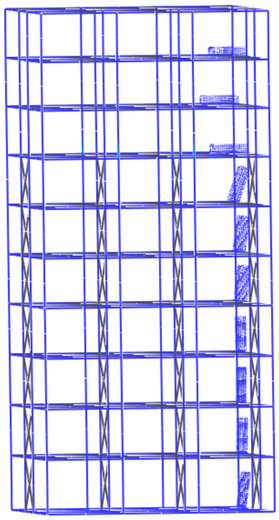

Fig. 2 A seismic motion analysis of furniture placed on each floor of a medium-rise reinforced concrete building

References

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