Urban earthquake simulation using full K computer

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Simulating physical processes in Earth's crust, ground, and buildings are expected to lead to reliable damage estimates for anticipated earthquakes. However, large-scale computation is required to reflect detailed urban information to simulations, and thus empirical methods have long been used in practice. In order to improve reliability of current earthquake disaster estimations, we are developing physics-based urban earthquake simulation methods by effective use of supercomputers.

The challenge of enabling such large scale simulation is in the development of key solver (i.e., unstructured finite-element method). Although this method is important for earthquake simulation as well as applications in the industry (e.g. computer aided design), it is not straight-forward to attain performance on modern supercomputers. By careful algorithmic design considering problem and computer system characteristics, we developed a computing method capable of effectively using K computer at RIKEN Advanced Institute for Computational Science (ranked 7th in Top 500 list of November 2016). In this presentation, I will show earthquake simulation results of 10 km x 9 km area of central Tokyo (covering whole Yamanote Line) with surface ground and 320 thousand buildings, simulated using the full K computer. This simulation corresponds to 1000 times larger problem size compared with the state-of-the-art, which enables reflecting boring data of ground and digital data of buildings to seismic damage estimations.

Since the developed key solver is a general purposed finite-element method, it can be used for other engineering problems or life science problems such as modeling of human bodies based on MRI or CT images. As it was with earthquake simulation, we expect drastic improvement in analysis resolution and target problem area by using our method for these problems. In this presentation, I will show the core technology of the solver with some earthquake engineering application examples, and would like to seek for joint work with audience for application to interdisciplinary topics.