ES Earth Simulator News
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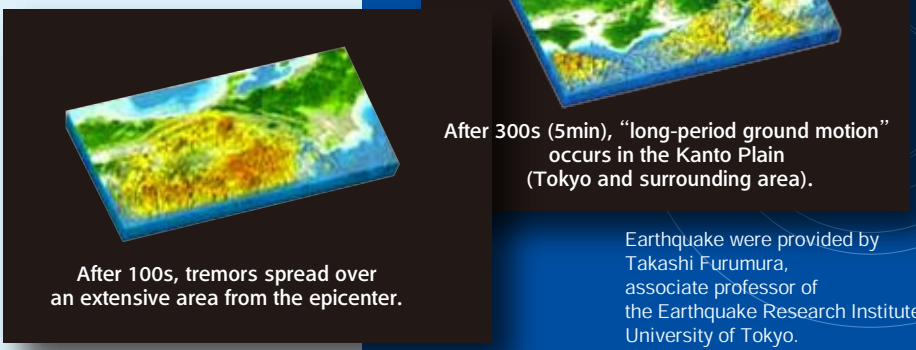
From Simulation Predicting Long-Period Ground Motion to Significant Resonance in Super-High Rise Buildings

In May 2006, the Furumura Group at the Earthquake Research Institute, University of Tokyo succeeded in restoring the seismograph record of the Tonankai Earthquake (M8.1) of 1944. This work confirmed that, although the seismic intensity of the earthquake was 4-5 in Tokyo and Yokohama, slow tremors with a period of approximately 8 seconds continued for more than 30minutes. Using the Earth Simulator, the same group has also predicted the occurrence of long-period tremors with a scale more than 4 times that in 1944 in the event of a future Tokai-Tonankai Earth-quake.This is a phenomenon called "long-period ground motion," in which the tremors generated by a giant earthquake pass through a plain with soft sedimentary layers,collide with a sedimentary hard rocks, and are reflected in a reiterated process which continues for several minutes to several tens of minutes. Although these tremors do not have a serious impact on medium- to low-rise structures, including wood-frame houses, recent research has found that they can cause severe damage in super-high-rise buildings, which did not exist in the past. Why are only super-high-rise buildings damaged? Physical objects have a period, called the "eigen period," at which that object oscillates most easily. Looking at the following list of eigen periods, the eigen period of super-high-rise buildings (defined as structures with a height of more than 60m) is 2-6 seconds. Because this is close to the period in long-period ground motion, buildings with this eigen period display significant resonance with long-period ground motion during an earthquake.

Images of simulations predicting the occurrence of "long-period ground motion" during Tokai- Tonankai



After 100s, tremors spread over an extensive area from the epicenter.

After 300s (5min), "long-period ground motion" occurs in the Kanto Plain (Tokyo and surrounding area).

Earthquake were provided by Takashi Furumura, associate professor of the Earthquake Research Institute, University of Tokyo.

What occurs when long-period ground motion causes significant resonance? The results can be seen in the Tokachi-oki Earthquake. In the Tokachi-oki Earthquake (M8.0) in 2003, long-period ground motion with a period of 7s occurred at Tomakomai City,which is located approximately 250km from the epicenter on a plain with soft sedimentary layers. cause oil tanks on the coast resonated with this ground motion, and the significant resonance continued for several minutes, the roofs of the tanks were damaged, resulting in a serious fire. Initially, the management responsibility of the oil company was questioned, but a subsequent investigation found that the damage had been caused by long-period ground motion.

Structure	(Second)
Wood-frame house	0.1-0.3
Medium- and low-rise building (≤20m)	0.2-1
High-rise building (21-60m)	<2
Super-high-rise building (>60m)	2-6
Large-scale oil tank	<15
Long/large bridge	～ 25

In the Tokyo metropolitan area, more than 70 super-high-rise buildings have been constructed between 2003 and the present in an unprecedented skyscraper construction boom accompanying urban renewal projects. However, the "Joint Recommendations for Improvement of Seismic Resistance against Long-Period Ground Motion" (prepared over a 2-year period by the Earthquake Engineering Committee, Japan Society of Civil Engineers and the Architectural Institute of Japan), which was published on November 20, 2006,warned that urgent measures for "long-period ground motion" are necessary in all existing super-high-rise buildings based on the long-period ground motion predicted by simulations.

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