Seismic Hazard Maps for Rather-Long Period Ground Motion

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INTRODUCTION

Rather-long period ground motion (RGM) with period of 2-20[s] generated by great earthquakes may threaten serviceability and safety of structures with long natural period and small damping even in far field.

Seismic hazard maps that point out where and how much the RGM predominant are necessary for investigating its effects on the long-period structures such as high-rise buildings, oil tanks, and long-span bridges.

In this study, deterministic and probabilistic seismic hazard maps for RGM are developed using the attenuation relationships for acceleration response spectrum of RGM and the amplification maps to compensate the attenuation relationships for site amplification characteristics (Kataoka *et al.*, 2008).

DATA

Fig. 1 shows the locations of epicenters of 25 earthquakes and 1,775 observation sites of which seismograms are used. The earthquakes include 14 subduction-zone (M_w6.7-8.2) and 11 inland crustal (M_w5.8-6.9) earthquakes.

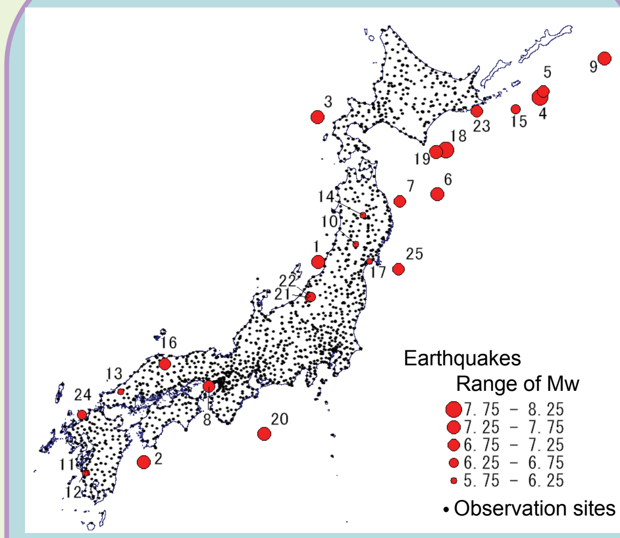


Fig. 1 Epicenters of 25 earthquakes and 1,775 observation sites of which seismograms are used in this study. The size of red circles corresponds to M_w.

ATTENUATION RELATIONSHIP

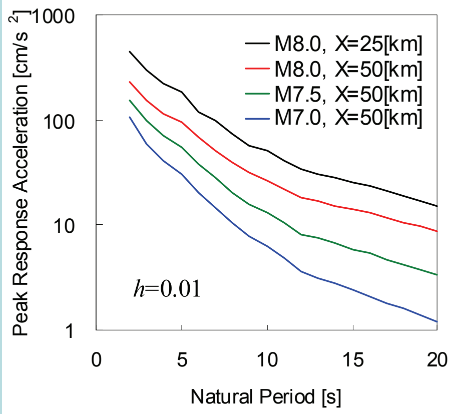
The following attenuation model is used for the regression analysis.

$$\log S_A(T) = a(T)\,M_w - b(T)\,X + c(T) - d(T)\log\left(X + p(T)\cdot 10^{qM_w}\right) + c_j(T)$$

where

S_A : acceleration response spectrum (h = 0.01 or 0.05)
T : natural period [s]
X : source distance [km]
a, b, c, d, p, q : regression coefficients
c_j : correction coefficient for observation site j

Fig. 2 shows examples of $S_A(T)$ calculated from the attenuation relationship.



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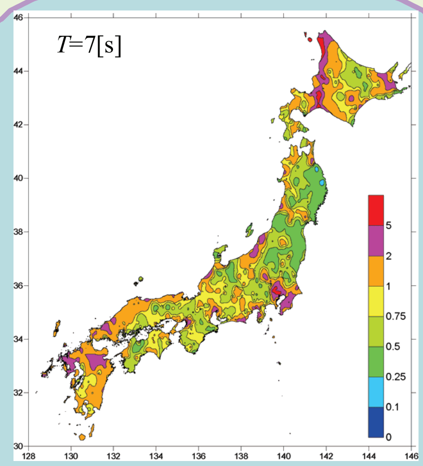

Fig. 3 Amplification map showing distribution of the amplification characteristics of RGM.

AMPLIFICATION MAP

The correction coefficient c_j derived from the regression analysis represents the amplification characteristics of RGM at the site j. Thus, amplification maps can be obtained by spatial interpolation of 10^{c_j} as shown in **Fig. 3**.

We can also draw a predominant period map (**Fig. 4**) taking the period that gives largest amplification at each site. These figures show large amplification and long predominant period in the major plains.

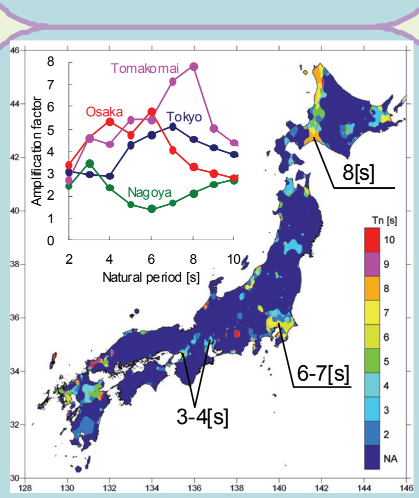

Fig. 4 Predominant period map with amplification factors vs. natural period at four cities.

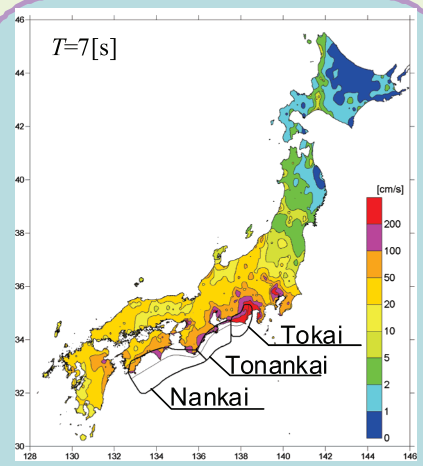

Fig. 5 Application of the attenuation relationship and amplification map to Tokai-Tonankai-Nankai earthquake.

EXAMPLE: A MEGA EARTHQUAKE (Mw8.5)

The attenuation relationship and the amplification map are applied to evaluation of RGM due to the coupled Tokai-Tonankai-Nankai earthquake (M_w8.5).

The result is shown in **Fig. 5** as the distribution of pseudo velocity response spectra (T = 7[s], h = 0.01). We can see the vast area affected by the mega earthquake. Difference of the site amplification characteristics makes the distribution complicated.

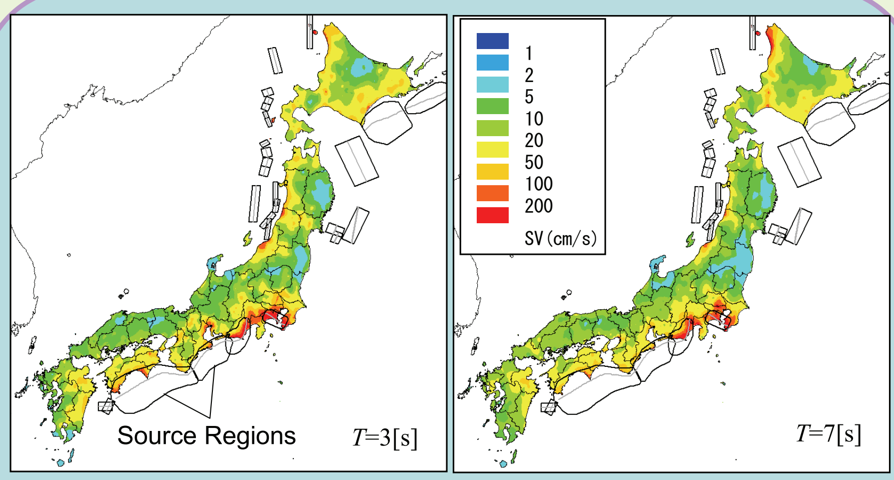

Fig. 6 Deterministic seismic hazard maps for RGM showing pseudo velocity response spectra (T = 3 & 7[s], h = 0.05).

SEISMIC HAZARD MAPS FOR RGM

Figs. 6 & 7 show the deterministic and probabilistic seismic hazard maps for RGM showing pseudo velocity response spectra (T = 3 & 7[s], h = 0.05). Only major subduction-zone earthquakes of which source regions are shown in the figures are taken into account.

The RGM due to Tokai, Tonankai, and Nankai earthquakes predominates in the maps.

As for the Kanto region, the recurrence of the Kanto earthquake predominates in the deterministic map but is overtopped by the Tokai earthquake in the probabilistic map due to the small probability (<5%) of recurrence of the Kanto earthquake in the next 50 years.

These maps and the attenuation relationships can be employed for evaluation of design ground motions for long-period structures.

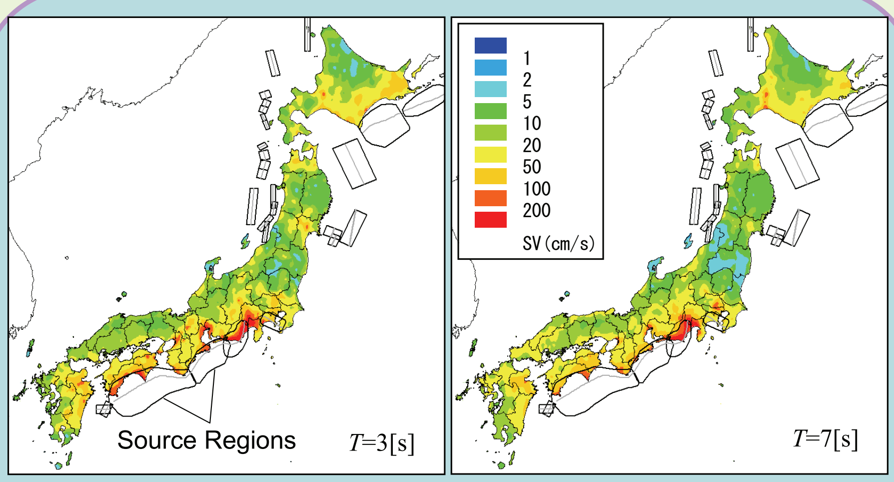

Fig. 7 Probabilistic seismic hazard maps for RGM showing pseudo velocity response spectra (T = 3 & 7[s], h = 0.05) with 10% of exceedance in 50 years.