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29. *Expectancy of the Maximum Velocity Amplitude of Earthquake Motions at Bed Rock.*

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Some of the results of the recent investigations[1] told us that the damage to structures caused by earthquake motions depends mostly on the velocity amplitude of earthquake motions, so the expectancy of the maximum velocity amplitude of earthquake motions on the surface of ground in Japan has already been obtained by many authors[2].

However, large heavy structures are founded generally on a competent subsurface formation capable of supporting them, so the intensity of earthquake motions at bed rock is still important in the direction of earthquake engineering. Therefore, in this paper, the expectancy of the velocity amplitude of earthquake motions at bed rock in Japan is investigated statistically by using an empirical formula for the velocity amplitude of earthquake motions at bed rock[3] and the table concerning the magnitude as well as the origin of major earthquakes in and near Japan which were accompanied by damage[4].

The location of epicenters as well as the magnitude of earthquakes used here are shown in Fig. 1. The empirical formula used here is as follows:

$$\log_{10} v_0 = 0.61M - \left(1.66 + \frac{3.60}{x}\right)\log_{10} x - \left(0.631 + \frac{1.83}{x}\right), \qquad (1)$$

in which v_0, M and x represent the velocity amplitude of earthquake motions at bed rock in cm/sec, the magnitude of earthquake and hypocentral distance in km, respectively. Besides, Eq. (1) can be available

1) F. NEUMANN, *Proc. II World Conf. Earthq. Engg.*, 1960,
I. MURAMATU, *Sci. Rep. Gifu Univ.*, **3** (1966), 470-481,
K. KANAI, *Bull. Earthq. Res. Inst.*, **45** (1967), 339-343.
2) I. MURAMATU, *loc. cit.*, 1),
H. GOTO & H. KAMEDA, *Memoirs Faculty Engg., Kyoto Univ.*, **29** (1967), 389-419.
3) K. KANAI et al., *Bull. Earthq. Res. Inst.*, **44** (1966), 1276.
4) T. USAMI, *Bull. Earthq. Res. Inst.*, **44** (1966), 1571-1622. (in Japanese)

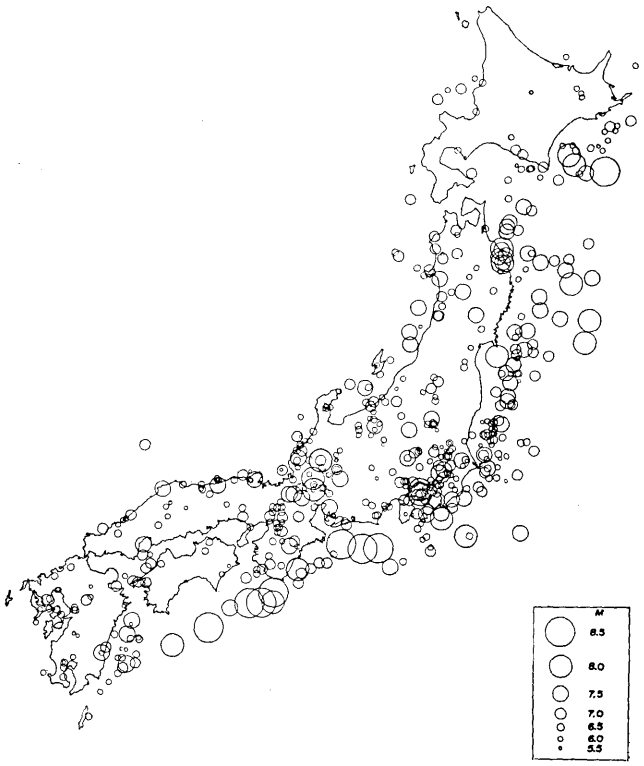

Fig. 1. Distribution of epicenters of major earthquakes in and near Japan. Size of circle corresponds to the magnitude of the earthquake.

for the range of periods from 0.05 sec—0.2 sec to T_m, and T_m is a function of magnitude as follows:

$$\log_{10} T_m = 0.39M - 1.70 . \tag{2}$$

In the practical calculation, the hypocentral depth being assumed at the most frequent value in the table[5], that is, 30 km, and the maximum velocity amplitude at the mesh points of 0.4 degree intervals of longitude and latitude being determined in 507 earthquakes. The expectancy of the maximum velocity amplitude of earthquake motions at bed rock may be obtained by the following formula

$$\frac{y}{Y}\sum_{v}^{\infty} N(v) = 1, \tag{3}$$

5) *loc. cit.*, 4).

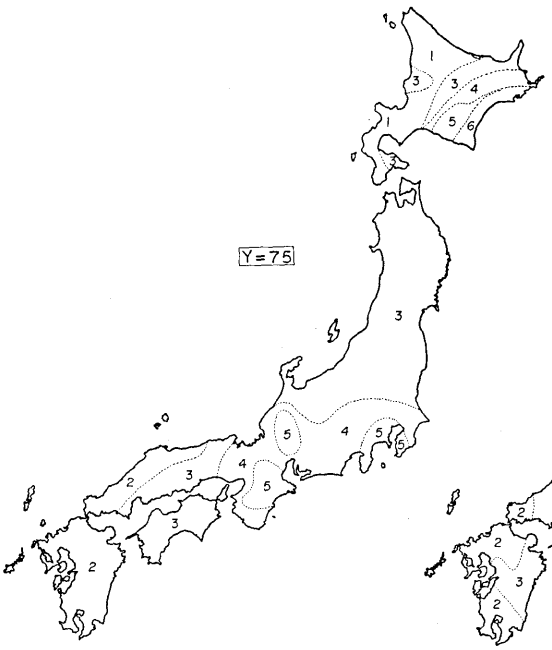

Fig. 2. Expectancy of the maximum velocity amplitude of earthquake motions at bed rock in 75 years.

Fig. 3. Expectancy of the maximum velocity amplitude of earthquake motions at bed rock in 100 years.

in which $\bar{v}$ and $N(v)$ are the expected value of the maximum velocity amplitude during y year and the frequency spectrum of velocity amplitude v, respectively, and Y is the length of the historical time of earthquakes. In the present paper, T are 1290, 1140 and 220 years for south west, northeast and Hokkaido districts, respectively.

The final results for the expectancy of the maximum velocity amplitude of earthquake motions at bed rock in 75, 100 and 200 years are shown in Figs. 2, 3 and 4, respectively. [The maximum velocity amplitude of earthquake motions on the surface of ground may be obtained by multiplying the values represented in Figs. 2-4 by $5/\sqrt{T_G}$, in which, T_G represesents the predominant period of ground in sec.]

In conclusion, many thanks are due to Miss S. Yoshizawa who has assisted us in preparing this paper.

Fig. 4. Expectancy of the maximum velocity amplitude of earthquake motions at bed rock in 200 years.

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29. 基盤における地震動の最高速度振巾の期待値

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基盤における地震動の速度振巾に関する実験式 (1) に日本附近のおもな被害地震のマグニチュードと緯度，経度 0.4° の網目についての震源距離を代入し，統計的な処理をして，最高速度振巾の期待値を求め Figs. 2～4 に示した．なお，震源の深さは，古いものなどわからないものがあるので，資料に出ている深さの頻度のもっとも大きい値の 30 km を一律に使った．
