# Relationships between the length and slip amount of the surface and subsurface faults for predicting of the strong ground motion

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1. Introduction

In the earthquake resistant design of structures in Japan, we adopt two empirical relationships by Matsuda (1975) for estimating the crustal deformations from the information of the length of the surface fault. One is the relationship between the length of the surface fault and the earthquake magnitude, and the other is the relationship between the earthquake magnitude and the slip amount of the surface fault. On the other hand, we adopt a combined empirical relationship between the fault area and the seismic moment by Somerville et al. (1999) and Irikura and Miyake (2001) for estimating the strong ground motions.

This is because we do not think that we always have to relate the slip amount of the surface fault to that of the subsurface fault.

But, the physical relationship should exist between the slip amount of the surface fault and that of the subsurface fault, for the former is the result of the latter. The objectives of this study are to obtain an empirical relationship between the slip amount of the surface fault and that of the subsurface fault and to interpret this relationship analytically by dynamic simulation of the fault rupturing. The dynamic fault model should also radiate the strong ground motions consistent to the existing earthquake records.

2. Empirical relationship between the slip amount of the surface fault and that of the subsurface fault

The relationship between the length and the slip amount of the surface fault by Matsuda (1975) for earthquakes in Japan was found to be quite consistent with the data compiled by Stirling et al. (2002) for earthquakes in the world and with the data of the length and the maximum slip amount of the subsurface fault compiled by Somerville et al. (1999).

3. Empirical relationship between the fault area and the seismic moment

The combined empirical relationship between the fault area and the seismic moment by Somerville et al. (1999) and Irikura and Miyake (2001) was found to be consistent with the data compiled by Stirling et al. (2002).

4. Fault model and constitutive law used in dynamic simulation of fault rupturing

We adopted an asperity model 25 km long and 15 km wide, including an asperity of 3.2 km square (Figure 1). We used the 3D finite difference method by Pitarka et al. (2005), and adopted a slip-weakening law as the constitutive law.

5. Interpretation of the empirical relationship between the slip amount of the surface fault and that of the subsurface fault

Our results indicated that the slip amount of the surface fault was not necessarily the same as that of the subsurface fault and that both the slips were almost the same when the S-wave velocity of the surface soil was about 1 km/s (Figure 2).

6. Interpretation of the empirical relationship between the fault area and the seismic moment

We could tune the relationship between the fault area and the seismic moment by varying the average stress drop, and obtained the relationship consistent with that proposed by Irikura and Miyake (2001) when we applied the average stress drop of 0.7 MPa (Figure 3).

7. Interpretation of the empirical relationship between the short-period level and the seismic moment

We could tune the relationship between the short-period level and the seismic moment by varying the product of the asperity radius and the asperity stress drop, and obtained the relationship consistent with that by Dan et al. (2001) when we applied the product of $4.5*10^{10}$ N/m (Figure 4).

On the other hand, the peak velocities were larger than those of the attenuation formula by Si and Midorikawa (1999).

References

Dan et al. (2001): AIJ, 545, 51-62; Irikura and Miyake (2001): JG, 110, 849-875; Matsuda (1975): Zisin, 28, 269-283; Pitarka et al. (2005): AGU Chapman Conference Maine; Si and Midorikawa (1999): AIJ, 523, 63-70; Somerville et al. (1999): SRL, 70, 59-80; Stirling et al. (2002): BSSA, 92, 812-830.

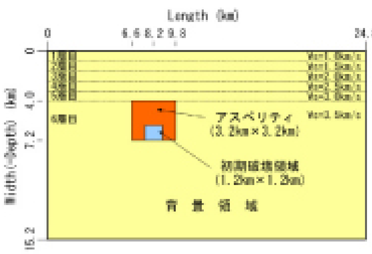


図１ 解析断層モデル

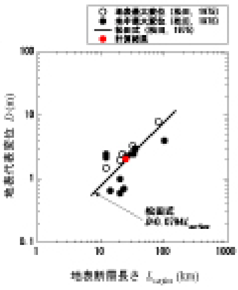


図２ 地表断層長さと地表代表変位の関係

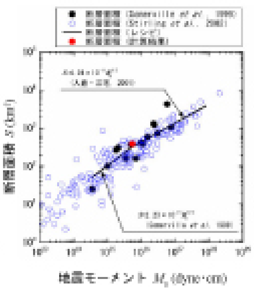


図３ 地震モーメントと断層面積の関係

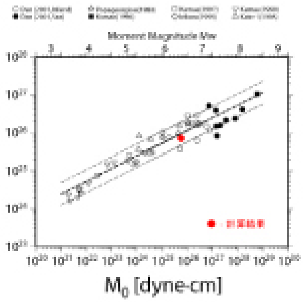


図４ 地震モーメント$M_0$と短周期レベルAとの関係