# Relationships between the length and slip amount of the surface and subsurface faults for the strong motion prediction (Part 3)

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For estimating the crustal deformations from the length of the active fault, we often adopt two empirical relationships by Matsuda (1975). 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 surface slip. On the other hand, for estimating strong ground motions, we often adopt an empirical relationship between the subsurface fault area and the seismic moment by Somerville et al. (1999) for smaller scenario earthquakes and that by Irikura and Miyake (2001) for larger scenario earthquakes.

In the previous study (Irie et al., 2007), we constructed the dynamic fault model for connecting the empirical relationships of the surface fault and that of the subsurface fault, because we thought that the physical relationship should exist between them. In this study, for much longer fault systems, we tried to construct the dynamic fault models that were consistent with the empirical relationships of the surface fault and that of the subsurface fault.

As a unit fault model, we adopted the fault model 25 km long by Irie et al. (2007). And, we examined three megafault models consisting of two unit models, three unit models, and four unit models (Fig. 1). In each megafault model, we finally obtained the value of the combined area of the asperities and the dynamic stress drop of the asperities, that were consistent with the three empirical relationships between the fault length and the surface slip by Matsuda (1975), between the fault area and the seismic moment by Irikura and Miyake (2001), and between the seismic moment and the short period level by Dan et al. (2001). Here, we carried out the dynamic rupture simulation by the 3D finite difference method developed by Pitarka et al. (2005).

The estimated parameters of the dynamic megafault models and the results of the dynamic rupture simulation were summarized in Table 1. The longer the length of the fault becomes, the larger the ratio of the area of the combined asperities to the entire area of the fault becomes. Also the dynamic stress drops of the asperities becomes smaller.

On the other hand, the peak velocities of ground motions from dynamic fault models were a little larger than the attenuation relationship by Si and Midorikawa (1999). This is because that the dynamic stress drop of the background was set as 0 MPa. Hence we should examine the amount of the dynamic stress drop of the background to reduce the dynamic stress drop of the asperities.

From the results based on the dynamic fault models in our study, we estimated the area where the amount of the average slip was twice that of the fault area. That area was defined as the asperity based on the final slip distributions in the fault area by Somerville et al. (1999). The accounted area for the average slip was assumed to be in the seismogenic layer at the depth of 4-15 km. The results showed that the ratio of the area of the combined asperities to the entire area became smaller as the length of the fault became larger. Especially, the area of the combined asperities in the longest model was 0 km$^2$. This is because the distribution of the final slip became smooth as the asperity area of the dynamic fault model became larger with its area. But, it was not observed in the megafault earthquakes of the 1999 Kocaeli, Turkey, earthquake or the 2002 Denali, Alaska, earthquake. Hence, we should add some plasto-elastic structures (Fujii and Matsu'ura, 2000), that were not considered in the dynamic models of this study, at the bottom and the ends of the fault.

References

Dan et al. (2001): AIJ, 545, 51-62; Irie et al. (2007): SSJ, B32-04; 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; Fujii and Matsu'ura (2000): PAG, 157, 2283-2302.

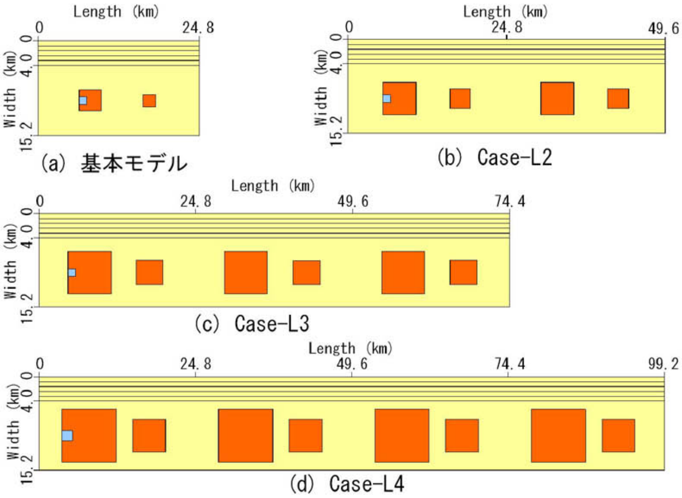

図１　解析断層モデル

表１　断層モデル諸元と解析結果

| 設定値 | | | | 解析結果 | | | | |
|---|---|---|---|---|---|---|---|---|
| ケース名 | 断層長さ(km) | 断層面積に対するｱｽﾍﾟﾘﾃｨ面積の割合 | ｱｽﾍﾟﾘﾃｨの動的応力降下量（MPa） | 最大地表変位（m） | 地震ﾓｰﾒﾝﾄ(Nm) | 短周期ﾚﾍﾞﾙ（Nm/s2） | 断層の平均すべり量（m） | 断層面積に対する平均すべり量2倍領域面積の割合 |
| 基本ﾓﾃﾞﾙ | 24.8 | 3.7% | 32 | 2.00 | 8.00E+18 | 1.07E+19 | 0.79 | 22.3% |
| Case-L2 | 49.6 | 9.9% | 22 | 3.97 | 3.24E+19 | 1.69E+19 | 1.59 | 14.0% |
| Case-L3 | 74.4 | 16.9% | 18 | 6.09 | 6.99E+19 | 2.20E+19 | 2.28 | 2.3% |
| Case-L4 | 99.2 | 26.8% | 15 | 7.88 | 1.22E+20 | 2.65E+19 | 2.97 | 0.0% |