I-584 STUDY OF FRACTURE OF AN EARTHQUAKE FAULT USING THE MDEM

Mahesh Raj RIMAL	Grad. Student	Univ. of Tokyo
Kimiro MEGURO	Researcher	Univ. of Tokyo
Motohiko HAKUNO	Professor	Univ. of Tokyo
Hiromichi HIGASHIHARA	Asso. Professor	Univ. of Tokyo

Introduction

The relevant parameters that govern the dynamic rupture of an earthquake fault are likely to be heterogeneous at all scales and hence it is very difficult to model an earthquake source realistically. Numerical experiments using a computer allow us to simulate some of the fundamental processes of rupturing of an earthquake fault and discuss observational results. In seismology, the terms *barrier* and *asperity* are often used to describe heterogeneity. A *barrier* is the location where a rupture is slowed down or brought to rest. Sometimes the dislocation reinitiates at the far side of the *barrier*. A *barrier* in the Das-Aki[1] model may be broken initially or after conditions are developed for its breakage. The inherent heterogeneity of the fault region being very difficult to model, we use the **M**odified **D**istinct **E**lement **M**ethod (**MDEM**)[3,4] with lognormally distributed element radius to simulate rupture of an earthquake fault. The distribution of the pore springs gives the anisotropy of a medium naturally. One strong point of the MDEM is that the progressive development of cracks inside a medium can be obtained automatically.

Description of the Model

Figure 1(a) shows a numerical model obtained after packing 1800 elements with a lognormal distribution of the element radius and as a result of application of compressive all-round pressure to simulate the prestrained crust. Figure 1(b) shows the initial pore spring distribution and Figure 1(c) shows the initial distribution of normal compressive forces acting between the elements. The top and bottom sides of the model are subjected to constant rate shear displacement in the direction of the arrows as shown in Figure 1 (a) with the boundaries deflecting under displacement proportional restoring force. The fault region is 5 m in thickness and 240 m in length.

Simulation Results

By a constant rate shear displacement of the upper and lower boundaries, strain accumulates in the medium, and after sometime, cracks start to develop in the normal (tension) and the tangential (shear) directions. The relationship between the dilatation and the friction force and the development of the cracks are simulated as shown in Figure 2 and Figure 3 respectively. As can be seen from Figure 2, the volume (area) first decreases and then increases (dilatation) when the friction force is almost constant. This is an observation in the field of rock mechanics as well.

Summary

By constructing a simple model of an earthquake fault, we simulated the development of cracks, the dilatation and the friction force relationship and the shear band by the use of the MDEM. The MDEM is a powerful tool to simulate some of the complicated phenomena in seismology, dynamic fracture of concrete structures[3], debris flow and rock avalanche for which other numerical methods are not suitable.

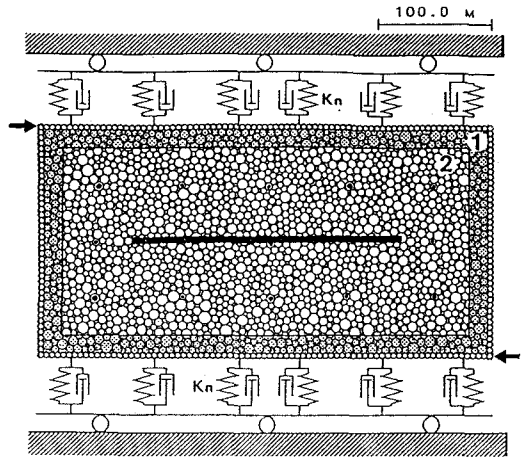
References

1) Das, S. and Aki, K. : Fault Plane with Barriers: A Versatile Earthquake Model, J. Geophysical Res., Vol. 82, No. 36, 1977.

2) Kasahara, K. : Earthquake Mechanics, Cambridge Univ. Press.

3) Meguro, K. and Hakuno, M. : Fracture Analyses of Concrete Structures by the Modified Distinct Element Method, Structural Eng./ Earthquake Eng., Vol.6, No.2, 283s-294s, October 1989.

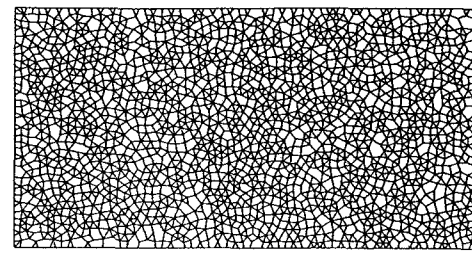
4) Meguro, K. and Hakuno, M. : Fracture Analysis of Seismic Fault by the Modified Distinct Element Method, Japan Earthquake Engineering Symposium, 1990.



(a)

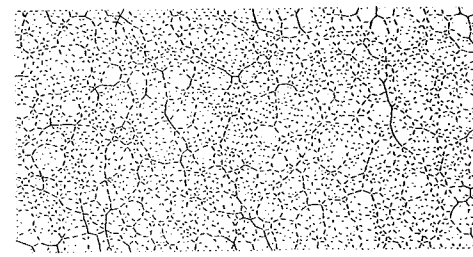
Figure 1 Model of an earthquake fault

(a) Distribution of elements (initial situation)
(b) Distribution of pore springs (initial situation)
(c) Distribution of normal forces (initial situation)

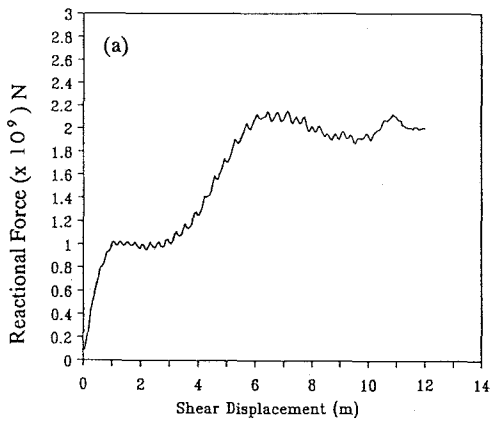


(b)

Maximum normal force = 229456848.0 N



(c)



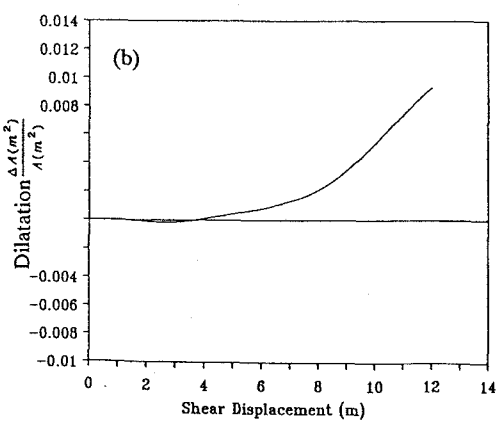


Figure 2 Dilatation and friction force

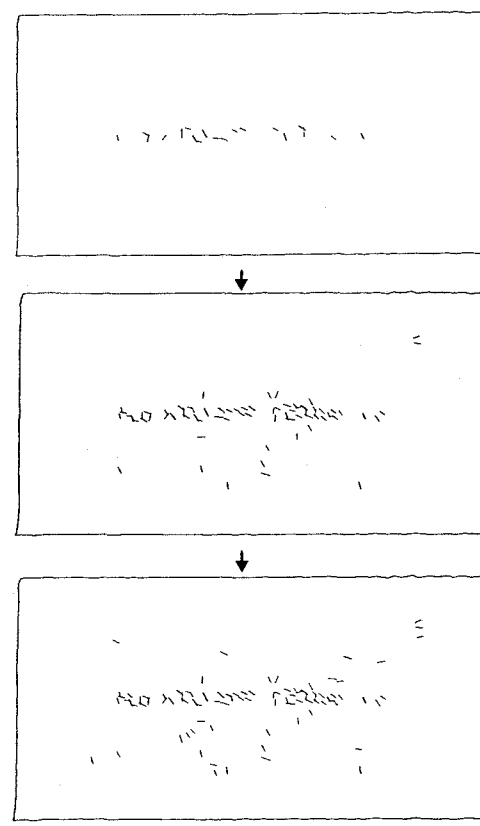


Figure 3 Progressive development of cracks