Numerical simulation of dynamic process of an earthquake

Yongen Cai and Ren Wang

Geodynamic Research Center of Peking University Department of Geology, Peking University, Beijing,100871, China (e-mail: yonen@pku.edu.cn; phone: 86 10 6275 5441).

Abstract

In this investigation, we use a new numerical method LDDA (Lagrangian Discontinuous Deformation Analysis)[1-2] to simulate a dynamic process of an earthquake occurring on strike slip fault, The method can be used to solve the dynamic problem with discontinuous deformation block system, it grows up on the base of the finite element method with domain decomposition algorithm [3-4] and DDA (Discontinuous Deformation Analysis) [5] and overcomes the weakness of the classical Lagrangian multiplier method by using domain decomposition algorithm and obviously prevails over the penalty method in the satisfaction of constrain conditions. The process of solving the problem by LDDA is as follows:

1) find total contact points (Lagrangian multiplier points) between blocks according to the contact criteria of the DDA,
2) solve the forces on the contact points between blocks by domain decomposition method.
3) calculate the displacement and stresses caused by the contact forces in term of the FEM for each block.

In mechanics, the earthquake occurrence can be considered as the results when the shear stress on the fault overcomes the frictional resistance of the fault. The LDDA method will be used to simulate the dynamic process by changing the frictional state of the fault[6] in the following example. The geometry of the model used in the study is shown in Fig. 1. The fault is simulated by contact element across which the displacement is discontinuous when slip occurs. The initial stress field is induced by applying displacements on the boundaries of the model. Under the state the frictional coefficient of the middle section (thick line) is changed from 1.0 to 0.1, it starts the dynamic process of fault sliting. The computed results of the dynamic process are shown in Figs. 2 and 3. Fig. 2 shows the “Seismographs” of the x-, y- components of the displacement at “station” A, B, C and D. It shows that the “elastic rebound” is about 7cm at A at time 0.03 sec. after the start of sliding, but the residual displacement found at time 5.0 sec.(quasi-static state) is less than this magnitude. At other locations the displacements are also not recovered to their initial displacement. Fig. 3 shows the contours of the change in displacement and maximum shear stress caused by earthquake at different time.

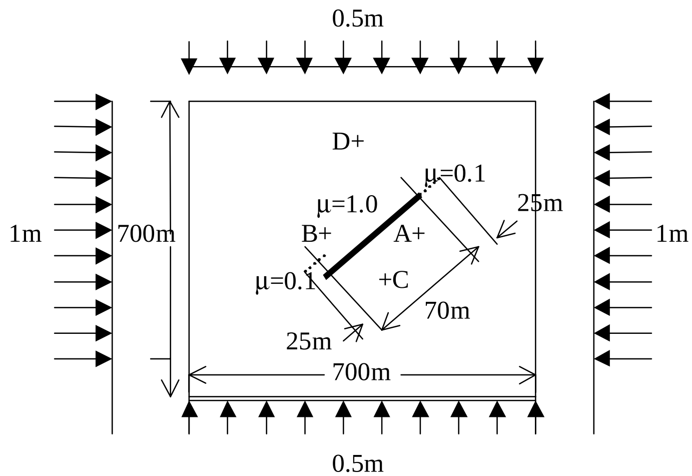


Fig. 1 Model geometry and boundary conditions

We see from the results that 1) the relative displacement of the fault obtained after this simulated earthquake is less than the maximum reached at the initial moment of the dynamic process, 2) The maximum shear stress drop obtained is about 38Mpa at the fault and decreases away from the fault, 3) P and S wave can not be identified at the earthquake source region.

Although the material model and geometry shapes in the examples are very simple the results still reveal some very interesting phenomena and are helpful for understanding the dynamic process of earthquake events, especially for the discontinuous deformation dynamic problems.

The method will be used to simulate the dynamic process of earthquake migration in a fault network

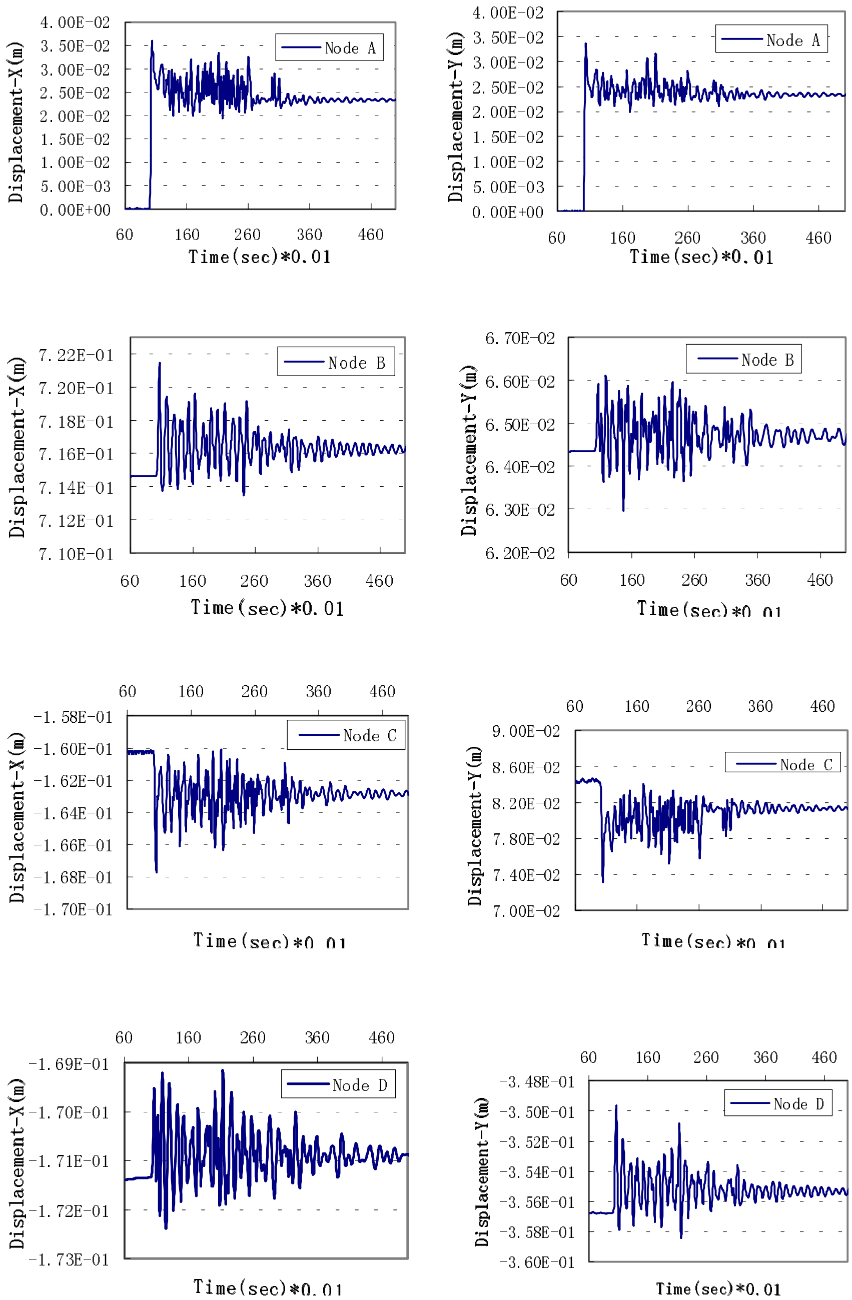
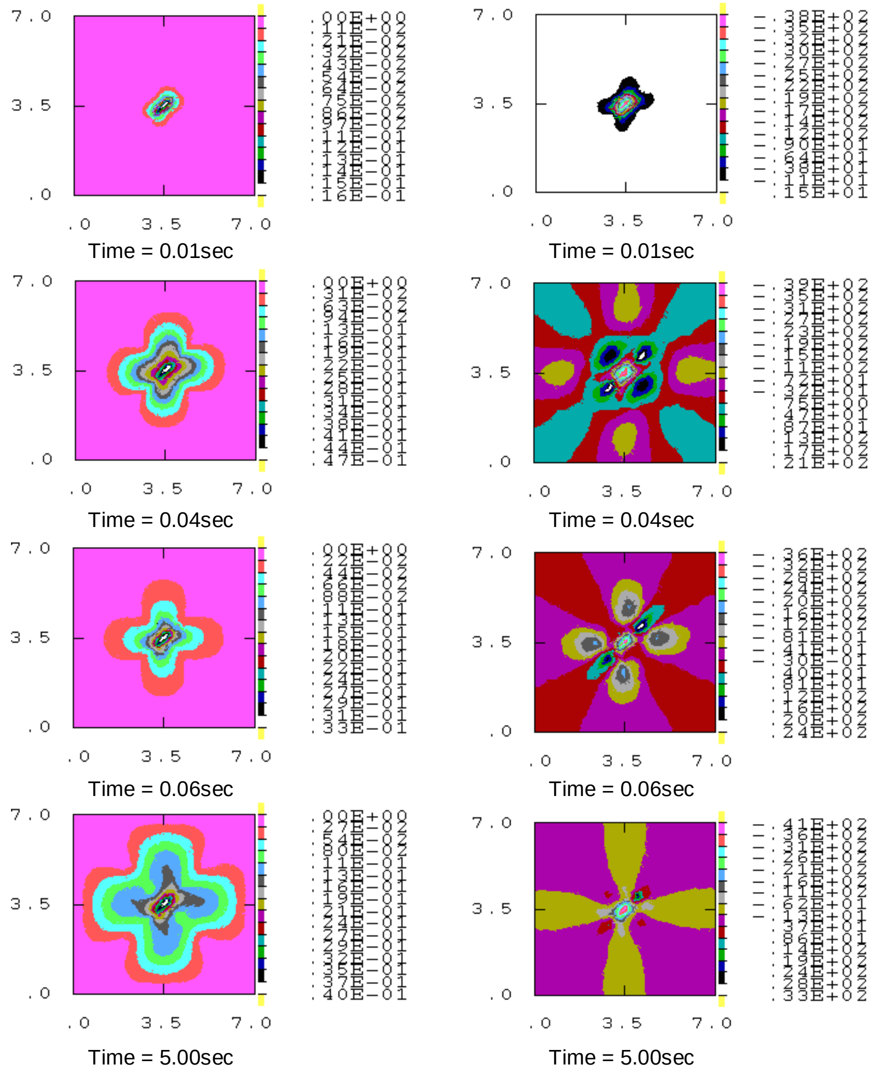


Fig. 2 the x-, y- components of the displacement process at A, B, C and D



(a) (b)

Fig. 3 a) Contours of the change of displacement. b) Contours of the change of maximum shear stress.

Acknowledgement

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