Evaluation of ground motions generated from the splay fault of 1896 Rikuu earthquake - Preliminary study by dynamic rupture simulation

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1 Introduction
In the Tohoku region, there are many reverse fault-type inland crustal earthquakes caused by inversion tectonics, but some of them have east-dip conjugates secondary fault to the west-dip main fault, such as the 2008 Iwate–Miyagi Nairiku earthquake. In the case of the Iwate-Miyagi Nairiku Earthquake, no seismic fault was found on the fault extension on the east-dip fault, but an example of a seismic fault was found on the fault extension on the splay fault was the Kawafune Fault of the 1896 Rikuu Earthquake. It is important to evaluate the seismic motion caused by the activity of the secondary fault on the conjugate side of the main fault in the evaluation of the ground motion located in the upper part of the main fault. The purpose of this study is to evaluate the ground motion generated from the splay fault for the 1896 Rikuu earthquake. As a preliminary study, in the case of the 1896 Rikuu Earthquake, since the measured values of the ground surface displacement were compiled by Matsuda et al. (1980), a dynamic rupture simulation model consistent with these observation data was constructed. The ratio of energy released from the main fault (Senya fault) and the splay fault (Kawafune fault) was evaluated.

2 Analysis Model
A dynamic rupture simulation was performed for the 1896 Rikuu earthquake using a 2D finite element method. The reason for the 2D assumption was that in the 1896 Rikuu Earthquake, the Kawafune fault appears on the eastern part of the Senya fault and the splay fault has occurred in response to the large displacement undergone by the main fault. Such a phenomenon can be simplified and simulated even with a 2D model. Based on the results of the Earthquake Research Institute(2001), an analysis model was made as shown in the figure. The ground near the fault is modeled as a homogeneous except for the surface layer.

3 Simulation analysis of main fault
First, the analysis was performed considering the rupture of only the main fault. At this time, the stress drop in the fault is determined in proportion to the ground stiffness around the fault based on Andrews (1980), and the dynamic parameters such as stress drop and strength excess were set so as to match the measured values of the ground surface displacement reported by Matsuda et al. (1980). As a result, the amount of stress drop was 2.0MPa in the main area.

4 Simulation analysis of main fault and splay fault
Next, the same frictional constitutive law and initial stress as the main fault were applied to the splay fault. A stress drop of 2.0MPa resulted in almost no activity in the splay fault. However at stress drop of 1.0 MPa, the displacement of the splay fault occurred, and the slip on the ground surface of the main fault and ratio of displacement of main fault and splay fault was almost the same as the measured value reported by Matsuda et al. (1980).
Using the analysis results, the sharing ratio of seismic moment generated from each of the main fault and the splay fault was compared. The sharing ratio of the splay fault was found to be more than ten percent. However, since the length of the splay fault in the actual measurement is clearly shorter than that of the main fault, the seismic moment released by the splay fault is expected to be smaller than the result of the

2D model when considering the heterogeneity in the fault length direction. Similar results were obtained for the ground motion near each fault.

5 Future works

For the Rikuu Earthquake, seismic intensity or housing collapse ratio distribution has been studied in detail in previous studies. The results obtained from the dynamic simulation model in the current study will be reflected in the kinematic simulation model, and the ground motions released from the Kawafune fault will be compared to the existing ground motion evaluation and observed seismic ground motion intensity of the 1896 Rikuu earthquake.

Keywords: splay fault, dynamic rupture simulation, Evaluation of ground motion, secondary fault