Report on the COE research activity

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Topic of my research is 「Development of high precise fracture control technique for recycling and treating solid wastes」. Information regarding the dynamic fracture properties of solid material such as rock and concrete is of considerable importance in controlling the fracture under dynamic loads. In the study reported here, a series of dynamic tensile test using Hopkinson's effect and Brazilian test were conducted to determine the dynamic tensile strength and investigate the fracture propagation under dynamic loads. The dynamic tensile tests were simulated by using a suggested dynamic fracture process analysis to examine the fracture process and mechanism of solid materials subjected to dynamic loads. The studies mentioned above were extended to investigate the influence of applied stress waveform on the fracture process in rock, and examine the effect of a guide hole between the charge holes on the fracture control in a PMMA specimen. The findings of these studies are summarized as follows:

1. It was pointed out that the dynamic tensile strength based on Hopkinson's effect combined with the spalling phenomena is influenced by the inhomogeneity of the rock, the stress rate, crack arrests due to the stress released at adjacent microcracks, and the crack propagation velocity, as well as other factors.

2. In the dynamic Brazilian test, the compressive fractures around the end of mortar specimen contacting the loading points causes the peak stress of the specimen and the tensile fractures contributes to the failure of the specimen after the peak stress.

3. The fracture processes were affected more by the rise time increases than by the decay time. A higher stress-loading rate increased the number of radial cracks and led to intense stress release around running cracks. The stress release caused by adjacent cracks interfered with crack extension and resulted in shorter crack propagation. At lower stress-loading rates, the number of cracks and the crack arrest caused by the stress released at adjacent cracks were reduced, leading to longer crack extension. These analyses revealed that the earlier preferential crack branching occurred, the greater the extension of the crack.

4. Model experiments using PMMA specimens and electric detonator were simulated using a dynamic fracture process analysis to investigate the efficiency of guide hole to controlling fracture propagation. It was confirmed that the guide hole method is applicable in field usage.

Publications:

1. Cho Sang Ho, Nakamura Yuichi and Kaneko Katsuhiko, 2004, Dynamic fracture process of rock subjected to stress wave and gas pressurization, *International Journal of Rock Mechanics and Mining Science*, Vol. 41, No. 3, page. 433
2. Cho Sang Ho and Kaneko Katsuhiko, 2004, Influence of the applied pressure waveform on the dynamic fracture processes in rock, *International Journal of Rock Mechanics and Mining Science* (in press)
3. Cho Sang Ho and Kaneko Katsuhiko, 2004, Rock Fragmentation Control in Blasting, *Material Transactions* (in press)
4. Nakamura Yuichi, Cho Sang Ho, Michiyo Yoneoka, Yamamoto Masaaki and Kaneko Katsuhiko, 2004, Model experiments on crack propagation between two charge holes in blasting, *Science and Technology of Energetic Material*, (in press)
5. Cho Sang Ho, Yang Hyung Sik and Kaneko Katsuhiko, 2004, Influence of the initiation error of the delay detonator on the rock fracture process in smooth blasting, *Tunnel and Underground*,(currently submitted)

Presentations:

1. Cho Sang Ho and Kaneko Katsuhiko, 2004, Influence of applied pressure waveform on the dynamic fracture processes in rock, *EIT-JAPAN-AIT Joint Workshop on Modern Computation Methods in Rock Engineering, Bangkok, Tailand*, November, 2003
2. Kawamichi Masaki, Cho Sang Ho and Kaneko Katsuhiko, Influence of delay timing on the rock fragmentation in bench blasting, *The Mining and Material Processing Institute of Japan, Tokyo, Japan*, March, 2004