I-74 MICROSLIP MODEL OF STRAIN LOCALIZATION IN SAND DEFORMATION

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1. INTRODUCTION

The highly localized deformation of sand under a triaxial loading, in the form of a narrow shear band, is a well observed phenomenon. Because the formation of shear band usually subjects load carrying capacity, the phenomenon has been the focus of extensive studies for the last few decades.

In the theoretical approach to the problem, great efforts have been made to apply the bifurcation theory (macroscopic approach). Studies from microscopic point of view have also been attracting lots of attention for the construction of the constitutive equation of sand. However there are still a number of problems which micromechanics of granular materials must solve in order to predict strain localization. In this study, a microslip model is proposed, which describes the processes of growth and interaction of the individual microslips. The extension of the present approach is considered to provide comprehensive answers to the fundamental questions such as, why does shear band occur? what is the effects of the boundaries? etc.

2. MICROSLIP MODEL

The main mechanism of sand deformation is considered to be the slips at the contact points of sand particles associated with their displacements and rotations. Here the deformation of sand is modelled by microslips at initial defects distributed in an elastic body. Microslips represent inelastic behavior (slips between sand particles) and the elastic body surrounding microslips takes care of the elastic constrains. The interaction effect between each microslip, which is considered to be one of the most important factors, can be studied by investigating the growth and interaction of the individual microslips.

For illustration, we consider several parallel defects shown in Fig.1, where an infinite plane is considered to simplify the problem. The boundary conditions along the microslips are as follows:

$\tau_s = \sigma_n \tan\Phi c$ on microslip

$\tau_s = \sigma_n \tan\Phi o$ on initial defect ($\Phi c<\Phi o$)

where τ_s is the shear stress and σ_n is the normal stress. The normal displacement is continuous across the slip plane and the stress is bounded at the end of the microslip ($K_{II}=0$). The original problem is solved by introducing the method of pseudo-traction which takes account of the interaction effects between microslips.

3. RESULTS AND DISCUSSION

Fig.2 shows the growth of microslips in case of 5 defects. As the stress ratio exceeds the 5.4 level, the central slip becomes quite active than the rest, taking a leading role in the deformation process. This seems to agree with the experimental observations that shear band always starts in the center of the sand specimen. As the stress ratio approaches its maximum value, drastic change in the deformation pattern occurs; while the remaining two slips in the leading diagonal direction accelerate, the other slips start to shrink. It is worth of mentioning that upon reaching the maximum stress ratio, unloading begins while the

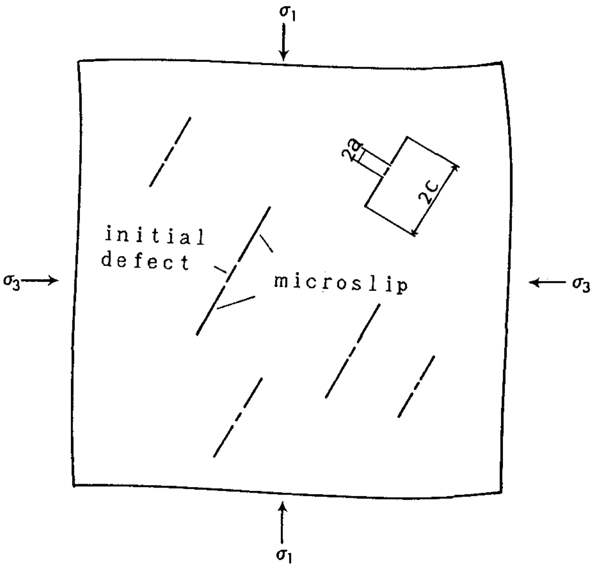

Fig. 1 An Infinite Plane with Initial Defects and Microslips

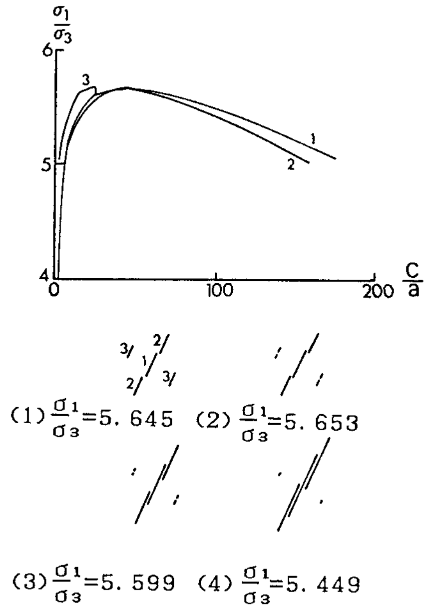

Fig. 2 Microslip Length vs Load with 5 Defects

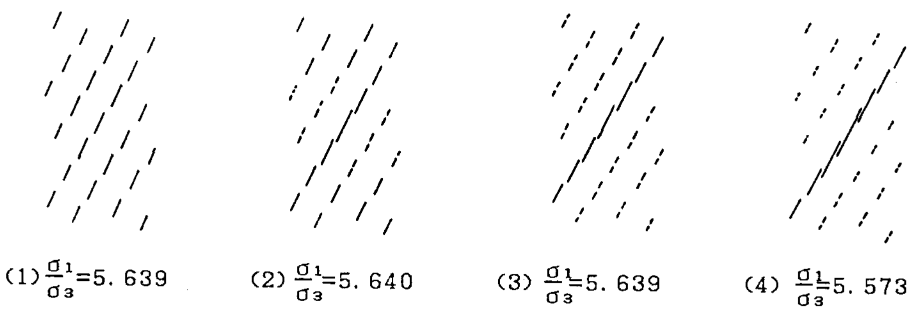

Fig. 3 Microslip Growth Patterns with 25 Defects

shear band continues to develop. One more illustrative example with a larger number of defects are given in Fig.3, the growth of the diagonal inclined microslips again leads to a shear band formation.

4. CONCLUDING REMARKS

A microslip model for the strain localization during sand deformation is proposed, which takes account of the interaction effects among microslips. The strain localization as well as the strain softening feature have been reproduced by the present model. The problems such as the characterization of the width of a shear band, the boundary effects on strain localizations, are still under investigation.

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