수정이중면 모델의 타당성 분석

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Validation of Modified Two-Surface Model

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Abstract

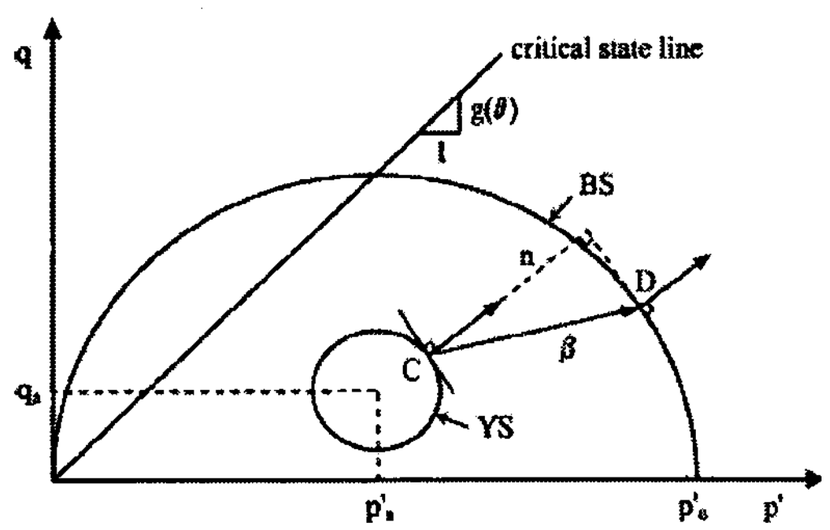
In this study the modified Two-Surface model was validated by comparing the model prediction with the results of the experiments carefully performed. It was seen that the modified Two-Surface model was capable of more realistically simulating the behaviors of clayey specimens, specially over-consolidated specimens. This is attributed mainly to the smooth transition rule from the elastic to elastoplastic regions.

1. Introduction

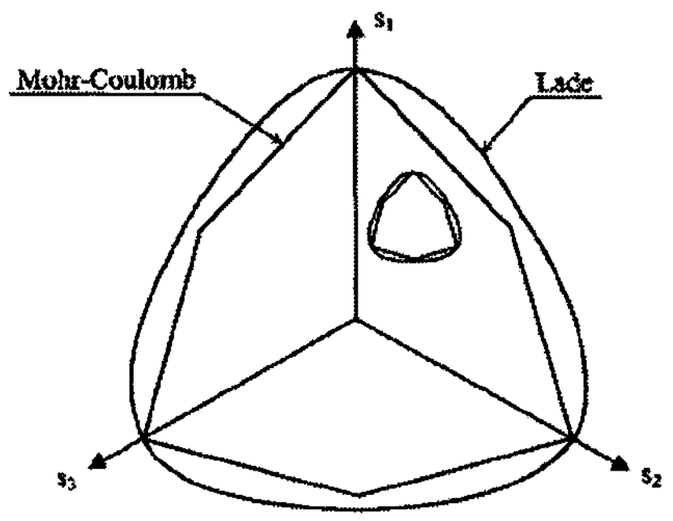
Numerous constitutive models based on the kinematic hardening plasticity have been used to obtain more realistic behavior of overconsolidated soils(Dafalias and Herrmann 1980, Desai et al. 1986). However, most of the kinematic hardening models do not simulate a smooth transition from elastic to elastoplastic behavior(Grammatikopoulou et al. 2006). The model proposed by Grammatikopoulou et al. (2006), extended from the two-surface bubble model by Al-Tabbaa and Wood in 1989, has a novelty that a hardening modulus results in a smooth elastoplastic transition and in realistic stiffness degradation curves. This study presents the validation of the modified Two-Surface model by comparing the model prediction with the experimental results.

2. Modified Two-Surface Model

The modified Two-Surface model introduces a single kinematic yield surface within the modified Cam-Clay bounding surface(Fig. 1 a). The Yield surface, within which the behavior is assumed



(a)Yield and Bounding Surfaces



(b)Deviatoric Section through Yield and Bounding Surfaces

Fig. 1. Modified Two-Surface Model (Grammatikopoulou et al. 2006)

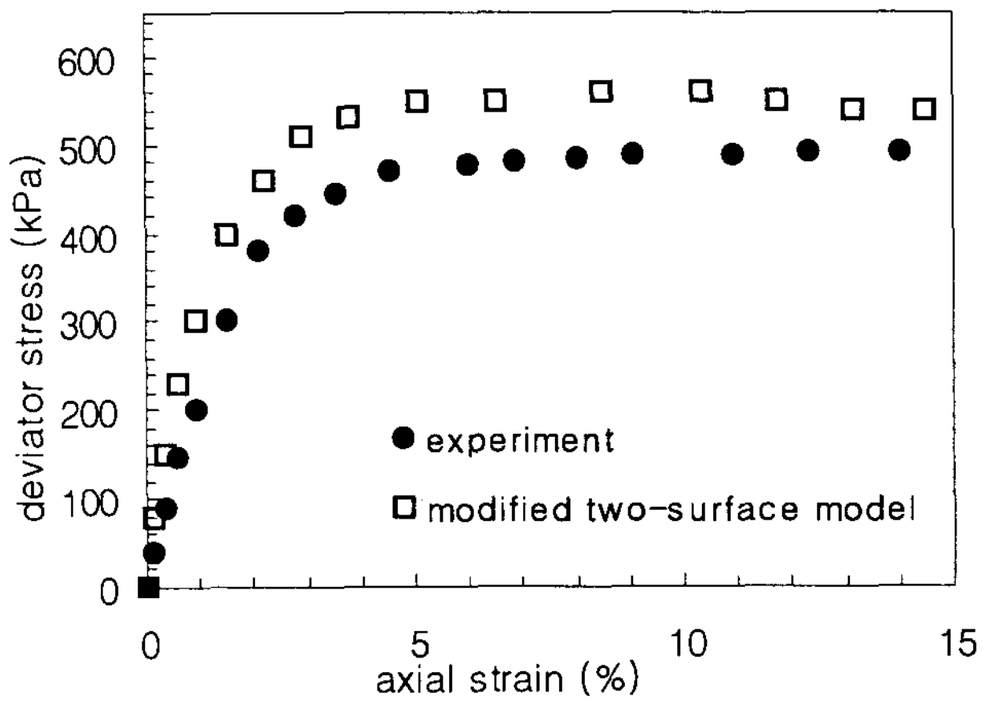
elastic, is of the same elliptical shape as the bounding surface in the p′-q space, and can take either the shape of a Mohr-Coulomb hexagon(Fig. 1 b) or the general shape by van Eekelen(1980). The salient features of the model are such as a hardening modulus ensuring a smooth transition from elastic to elastoplastic behavior, the various shape of the yield and plastic potential surfaces in the deviatoric plane, an improved translation rule for the yield surface specially when the two surfaces are in contact, and the concept of changing the active yield surface. Details on the model are referred to Grammatikopoulou et al(2006).

3. Model Parameters

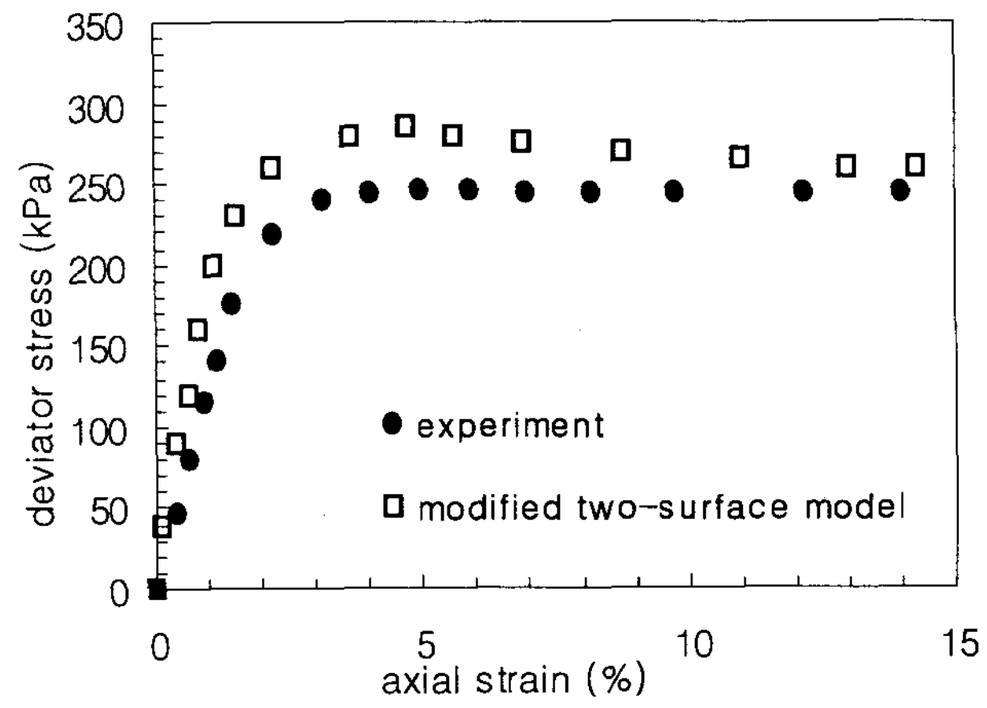
When a Mohr-Coulomb hexagon is used for the yield surface in the deviatoric plane the model requires nine model parameters. Five of them have their origin in the modified Cam-Clay model, λ the slope of the isotropic normal compression line in ln v-ln p', κ the slope of the elastic part of the swelling line in ln v-ln p', μ Poisson's ratio, ϕ the angle of shearing , N the specific volume of the isotropic compression line at p'=1kPa. The additional parameters are R the ratio of the size of the yield surface to that of the bounding surface, a the parameter in the hardening function, Y and Z control the shape of the yield and plastic potential surfaces in the deviatoric plane.

4. Discussion and Comparison with Experimental Results

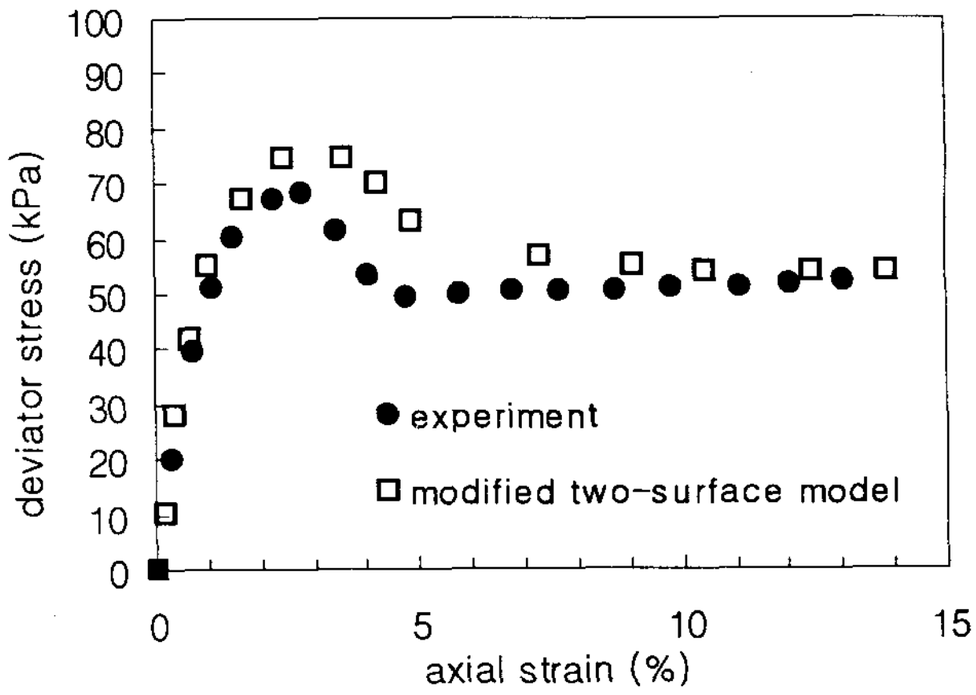
The standard triaxial compression tests were performed using the kaolin specimens prepared under normally, lightly over-consolidated(OCR=2), and heavily over-consolidated(OCR=10) conditions. The parameter values were determined as: λ =0.268, κ=0.058, μ=0.3, ϕ'=22.1°, N=3.43, R=0.016, a =6.0, Y=0.0, and Z=1.0. The values cloud be determined from the standard isotropic and triaxial test except that Poisson's ratio is conventionally assumed and a needs trial and error method(Al-Tabbaa et al. 1989).



(a) normally consolidated specimen



(b) lightly over-consolidated specimen



(c)heavily over-consolidated specimen

Fig. 2. Stress-strain Curves

Fig. 2 presents the stress-strain curves from the model prediction and experiment. The curves predicted by the model are reasonably well

reproduced specially and relatively for the specimens with the stress history of over-consolidation. This result is attributed partly to the use of the Mohr-Coulomb hexagon as the yield surface, and also to the inadequate transition rule so far when the yield and bounding surfaces make contact.

The model predicts the smooth, rather than abrupt, stiffness degradation curves regardless of the values of the parameter *a*. The conventional kinematic hardening models predict abrupt drops in stiffness, once yielding is initiated, which are attributed to the nonsmooth transition from elastic to elastoplastic behavior(Grammatikopoulou et al. 2006).

Though the model prediction gives a reasonable result the discrepancy lies in the lack of the experimental stress paths required to determine the parameter values. Further parametric studies are needed.

5. Conclusions

It was proven to be possible that the modified Two-Surface model has the capacity of more realistic simulation of the behaviors of clayey specimens, specially over-consolidated specimens. This is associated with the smooth transition rule from the elastic to elastoplastic regions. A broad usage of the model could be expected if the parametric study would be adequately conducted.

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