A Study on the recently noted models for the geomaterials

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지반재료에서 최근 주목받는 구성모델에 대한 연구

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Abstract

The proper selection and application of the constitutive model leads to successful prediction of the mechanical behavior for the geomaterials. Three models, which have been recently noted, were chosen and their contents have been briefly and conceptually described in this study.

1. Introduction

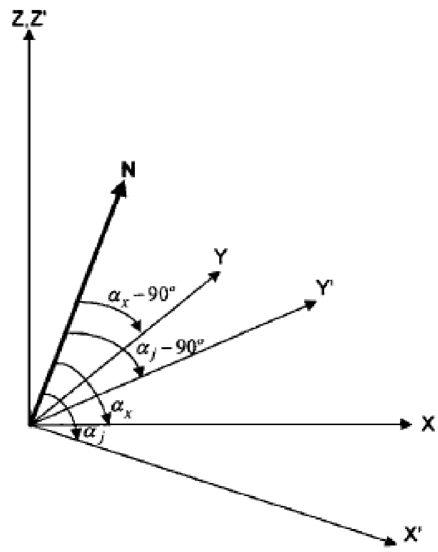
The appropriate analytical and numerical simulation of the predictive behaviors of the structure system to be constructed is extremely essential for the overall design of the geotechnical structures. The stress-strain behavior, which is called constitutive relation or model, is so fundamental in all simulation phases that various models have been proposed so far. However, the models need to be strictly verified for their applicabilities due to the feature of the discreteness of the geomaterials.

In this study, several constitutive models recently utilized with success for the simulation of geomaterial behaviors have been presented and briefly described.

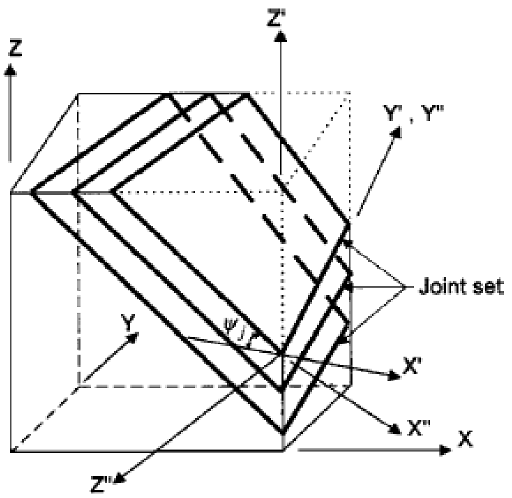
2. Description of models

2.1. Anisotropic Continuum Model

Smadhiya et al. derived a model to be able to simulate the anisotropic characteristics of the rock masses in 2008 [1]. The model is based on the continuum theory and capable of capture such various rock behaviors as intact rock, joint orientation, spacing, roughness, block size, and their stiffness. And the model has given satisfactory results for the case of large tunnels or caverns. Fig. 1 and Table 1 show respectively the coordinate system adapted and the material parameters for general rock masses.



(a) Coordinate description



(b) Orientation of joint set

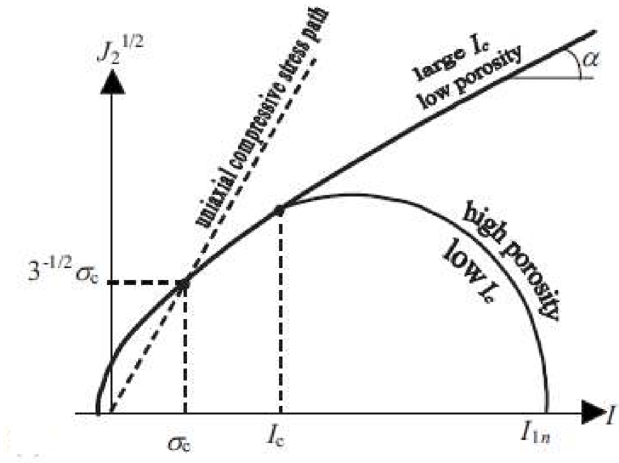
[Fig. 1] Orientation of axes with respect to joint plane [1]

[Table 1] Material parameters [1]

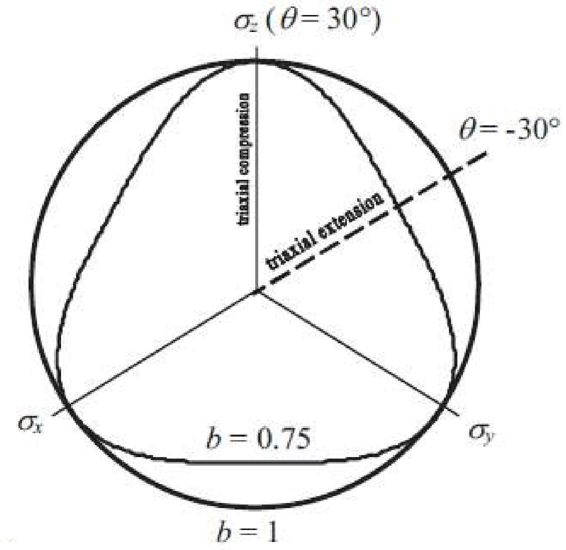
Material type	S. number	Property	Value
Intact rock	1	Young's modulus, E (MPa)	2,000
	2	Poisson's ratio, ν	0.4
	3	Unit weight, γ (kN/m^3)	25.0
Joint sets	4	Cohesion, c (MPa)	0.1
	5	Angle of friction, φ (deg)	30
	6	Normal stiffness, k_n (MPa/m)	3,300
	7	Shear stiffness, k_s (MPa/m)	330
	8	Spacing of joint, S_j (m)	1.0

2.2. Model with Multiaxial Criterion

The multiaxial Mises-Scheicher and Drucker-Prager(MSDP) model is assessed to successfully account for the mechanical behavior of geomaterials in the scheme of elastoplasticity(Aubertin and Li, 2004; Li et al, 2010)[2][3]. The model adopts the classical plasticity such as the associated flow rule and the consistency condition, etc. The yield function adopted in the model is presented in Fig. 2. The yield function with multiaxial ctriterion was compared with the results from the existing theoretical methods and validated for the stress contours in a circular opening for the cohesive soils. The model is based on the relatively simple but solid classical elastolasticity so if refined with the field and laboratory test results it is expected to be used for such more comprehensive cases as tunnesl and backfilled stopes.



(a) Conventional triaxial compression condition

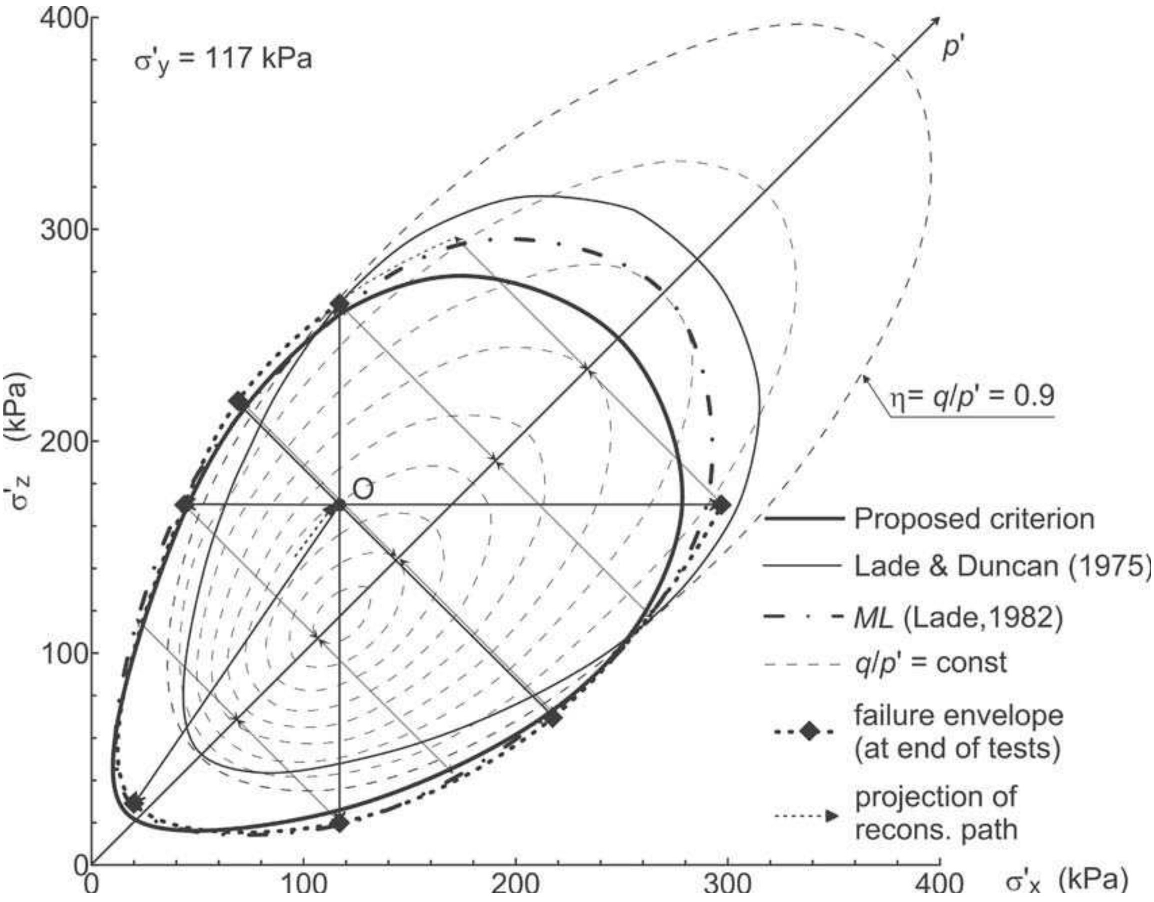


(b) criterion in the π plane

[Fig. 2] Schematic representation of the MSDP [3]

2.3. Modified Lade Model

Many constitutive equations have been proposed so far but it may not be true that the models appropriate for the overconsolidated stress state have been developed. This is mainly due that the overconsoliated state inevitably involves so many material parameters and very complicated mathematics. Fortuna modified the original Lade's models(Lade and Duncan, 1975; Lade, 1982) for the overconsolidated general stress state(Fortuna, 2011)[4][5][6]. Fig. 3 shows the comparisons of the models. This model could be expected to be widely used for the overconsolidated granular soils but the



[Fig. 3] Failure envelopes for the true triaxial tests [5]

applicability to the cohesive soils and its subsequent development needs to be further studied.

3. Conclusions

Three constitutive models for geomaterials, which are recently noted, are briefly presented in this study. The proper investigation and application of the models is required to wide usage of them.

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