



# Rate Dependent Constitutive Model for Soft Soil Large Strain Creep with Variable Shear Modulus

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## Abstract

In this paper a rate dependent viscoplastic constitutive model is presented for soft soils. This model is based on the long-term creep tests under hydro static stress conditions. In this model the viscosity considered as shear stress relaxation; therefore viscosity affects only the shear stress or strain. Mohr-Coulomb failure criterion is employed to plastic calculations. Shear modulus is considered as stress, strain and time dependent. Time dependency of the shear modulus is related to the occurred viscoplastic deformations. Numerical calculations show the applicability of the presented model for viscoplastic calculations.

**Keywords:** Constitutive model, Creep, Soft soil, Shear Modulus.

## 1. INTRODUCTION

Results of the long time creep tests on soft soil show that the creep deformation of these samples under hydrostatic stress condition is less than creep deformations of same soil sample under deviatoric stress condition (Van Baars, 2003). In fact most part of the creep deformation is the result of shear stress relaxation or plastic shear strain occurrence. Therefore shear stress and shear strain have the main role in soft soil creep modeling that needs more attention about shear stress-strain relationship in the constitutive model. In the most of the constitutive models, elastic shear modulus of soils is assumed a constant parameter or a constant poisson ratio is used to calculate the shear modulus as a function of bulk modulus in soft soil models. Based on the thermodynamics laws, application of a constant shear modulus or poisson's ratio in constitutive models violates the energy preservation principal (Houlsby et al. 2005). Shear modulus of soft is a stress and strain dependent parameter. Small strain shear modulus is a power function of confining pressure and over consolidation ratio (OCR) and large strain shear modulus is a function of shear strain. Strain dependent shear moduli are used widely in soil dynamics while the range of the shear strains under dynamic loads is smaller than long term shear strain of soft soils. Also elastic small strain shear modulus of the soft soils changes by the time. In fact that is not time dependent but it is dependent on the occurred plastic shear strains.

The purpose of the article is to draw attention to the variation of the stress and strain dependent elastic shear modulus in viscoplastic constitutive model.

## 2. Variation of Elastic Shear Modulus of Clay

Soft soils rarely exhibit recoverable behavior. They are elastic only for a particular stress range and over consolidation ratio (OCR) also in the elastic range their stress-strain relationship is nonlinear. In soil mechanics, bulk modulus is usually defined linearly dependent on pressure. The relationship between bulk and shear modulus would be used to calculate the shear modulus by a constant poisson ratio. Application of a constant poisson ratio leads to non-conservative elastic response (Houlsby et al. 2005). Therefore in the constitutive formulations, the variation of the poisson ratio or shear modulus must be considered besides the