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THESIS

MODELLING OF SOIL STRUCTURE BEHAVIOUR DURING MONOTONIC AND CYCLIC LOADING

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Thesis submitted in partial fulfilments of the requirements
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APPROVAL PAGE

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THIS THESIS HAS BEEN APPROVED
IN THE PRESENTATION
ON 22th JANUARY 2009

Approved by Tutors

Dr.Eric Vincens

STATEMENT OF THE THESIS ORIGINALITY

I, hereby, declare that the following thesis, entitled:

MODELLING OF SOIL STRUCTURE BEHAVIOUR DURING MONOTONIC AND CYCLIC LOADING

That had been made and examined to complete part of the qualifications to be a Magister of Engineering at Postgraduate Program of Civil Engineering, University of Indonesia, is original; is not a duplication of another published thesis, nor being used to get Master Degree in University of Indonesia or in any other colleges, universities and institutions; except the references that had been informed as per printed.

Lyon, January 22nd, 2009

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ABSTRACT

MODELLING OF SOIL STRUCTURE BEHAVIOUR DURING MONOTONIC AND CYCLIC LOADING

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Several studies have already been published in order to better understand the behaviour of interfaces. Different experimental methods, including direct shear tests, simple shear test, and tortional ring test, and also various constitutive models were presented to modelize the behaviour of the interface. These studies revealed that the main factors that affect the behaviour of the interface include the roughness of the interface, the soil mineralogy, the soil density, and the normal stress applied. This work was therefore directed primarily to better understand the overall behaviour of the interface and the influence of these factors in a monotonic and cyclical solicitation. Through the simulation of a direct shear test at constant normal stress (CNL) in FLAC 5.0, several typical behaviours, including degradation of shearing resistance and contractancy-dilatancy, have been observed and modelled. At first, the law of Mohr-Coulomb and its correspondent failure criterion have been implemented. Then several models have been proposed to model more precisely the behaviour. Finally, two cyclicals laws, the law of Ramberg-Osgood law and Byrne, originally developed for the soil, have been implemented in this model. This study has verified the consistency of the results and has determined whether the injection of such laws is sufficient to modelize the behaviour of the interface under cyclic loading.

This English version is a translation of the French version,
if there any ambiguities in the phrases please refer to the French one.

Pour

ma mère et mon père, Dewi et Ir,

ma sœur et mon frère, Rani et Imran,

et pour Rakha et mon amour Victor

TABLE OF CONTEXT

LIST OF NOTATIONS

Δu_n^{irr}	Irreversible normal displacement variation
ϕ	Friction angle
τ	Shear stress
α	Ramberg-Osgood model's parameter
ε	Deformation tensor
β	Dilatancy model's parameter
γ	Amplitude of the tangential displacement, u_s at the considered ½ cycles
ψ	Dilatancy angle
ε^e	Elastic part of the deformation tensor
ε^p	Plastic part of the deformation tensor
τ_c	Cyclic shear stress at the last peak detected
ϕ_{car}	Characteristics state's friction angle
ϕ_{cr}	Critical state's friction angle
ϕ_m	Current friction angle
ϕ_{max}	Maximum shear resistance state friction angle
σ_n	Effective normal stress
σ_{res}	Effective reference normal stress (100 kPa)
ϕ_{res}	Large strain (residual) state's friction angle
a	Non-linear stiffness model's parameter
a_2	Dilatancy model's parameter
b	Dilatancy model's parameter
c	Cohesion
C_1	Byrne law's parameter
C_2	Byrne law's parameter
D_{50}	Average diameter of the soil particuls
ID	Initial relative density $ID = \frac{e_{\max} - e}{e_{\max} - e_{\min}}$
e	Voids $e = V_{vide} / V_{solide}$

G	Volume compresibility module of soil
K	Shear module of soil
k	Spring stiffness
k_n	Interface's normal stiffness
k_s	Interface's tangential stiffness
l	Interface's thickness
L_m	Surface length
M	Characteristic state coefficient $M = \tan\phi_{car} = \tau_{car} / \sigma_{n_{car}}$
m	Massing law coefficient
M_{cr}	Critical state coefficient on the shear stress curve (τ, us)
n	Non-linear stiffness model's parameter (HERTZ law's parameter)
P_h	Applied horizontal loading
P_v	Applied vertical loading
R	Shear stress softening model
r	Ramberg-Osgood model's parameter
R_{cri}	Limit value of the interface normalized roughness
R_n	Interface normalized roughness $R_n = R_t / D_{50}$
R_t	Aspérité ou la rugosité maximum de surface de structure
u_n	Normal displacement
u_n^{irr}	Irreversible normal displacement
u_s	Tangential displacement

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