Geo-*tij*

SUBLOADING tij

Element Simulation Software

English version

Input Manual

Version 5.2: March, 2022

After preparing the Path.txt and Para.txt files, the executable file (e.g., SubloadingTij.exe) can be **double-clicked to calculate.**

Prepare two data files:
(1) '**Path.txt**'
(2) '**To.txt**'

Output file name always: '**Ana.cal**'

'Path.txt' Stress Path Data File
'Para.txt' Material Parameter Data File
All input formats are FREE format

format of input data file **'Path.txt'**

Line 1: NoPath =Number of paths to calculate

Line 2: Initial Stresses = $\sigma_{11(0)}$, $\sigma_{22(0)}$, $\sigma_{33(0)}$, $\tau_{12(0)}$, $\tau_{23(0)}$, $\tau_{31(0)}$ (real free format)

Line 3: (from line 3 to the line of 2+NoPath) Enter the NoPath route according to the following format:

Colm#1: Types of tests to analyze (the following four test names)

(1) Triaxial ! **Triaxial testing**
(2) StressControl ! **Tests that give stress pathways**
(3) StrainControl ! **Test to give strain path**
(4) Consolidation ! **Compression test**
(5) Biaxial ! **Plane strain test**

Colm#2: ➔ Test names (1), (**2**), and **(5)** specify drained and non-draining.
(a) **Drain**
(b) **Undrain**

➔In the test name **(3),** specify the target distortion, the number of divisions to the target, and the interval to be output.
: Target ε_{11}, ε_{22}, ε_{33}, γ_{12}, γ_{23}, γ_{31} (real free format), total division (integer free format), output interval (integer free format)

➔In the test name **(4),** the loading conditions are specified.
(a) **Isotropic**
(b) **OneDimensional**
(c) **K0condition**

Colm#3: ➔Test names (**1**)**, (5)** specify loading conditions.
(i) **pConstant**
(ii) **srConstant**
(iii) **saConstant**
(iv) **StrainControl**

➔In the test name **(2),** specify the stress of the target, the number of divisions to the target, and the interval to be output.

: Target $\sigma_{11}, \sigma_{22}, \sigma_{33}, \tau_{12}, \tau_{23}, \tau_{31}$ (real free format), total division (integer free format), output interval (integer free format)

➔Test names (4) (a) & (**4**) (**b**) indicate that the stress (σ_{11}) of the target is Specify the number of divisions to the target and the interval to be output.

: Target σ_{11} (real free format), total division (integer free format), output interval (integer free format)

➔ Test name (**4**) **(c)** shows the target Ko value, the target stress (σ_{11}), Specify the number of divisions to the target and the interval to be output.

: K0 (real free format), Target σ_{11} (real free format), total division (integer free format), output interval (integer free format)

Colm#4~: ➔ Test names (**1**)**,** (**5**) are target strain ($_{11}\varepsilon$), specify the number of divisions to the target and the interval to be output.

: Target ε_{11} (real free format), total division (integer free format), output interval (integer free format)

format of input data file '**Para.txt**'

Line 1: Model , Select Model
=1: Subloading t_{ij} Model
=2: Cam clay Model

When Model **= 2 (Cam clay Model)**

Line 2: Version , Original Cam clay Model か Modified Cam clay Model かの選択
=0: Original, =1: Modified

Line 3: Display material parameters (data and data are not loaded)
λ , κ, R_{CS}, N,ν , e_0, *a*, *pw*(*ρ*), Pa

Line 4: Input material parameters (, , λRκCS, N, ,, e_0 ν , *a*, *pw*(*ρ*),Pa)

Description of the material parameters of the Cam clay model:

λ: Compression index of normal dense wire (NCL) ($e-\ln p$ relation)

κ: NCL's swelling index ($e-\ln p$ relation)

Rcs: Limit State Line (CSL) Principal stress ratio during triaxial compression, $(\sigma_1/\sigma_3)_{CS(comp)}$ M(comp) = (q/p) with (critical state)

There is a relationship between the

$$R_{CS}=(3+2\mathrm{M}_{(comp)})/(3-\mathrm{M}_{(comp)})$$

N: NCL's gap ratio at atmospheric pressure (= 98kPa)

ν: Poisson ratio of elastic component

E_0: First-period gap ratio

a: Flag of whether or not to consider the influence of density and parameters for considering the influence of density

a=0. 0 Normal Cam clay model (elastic under overpressure pressure)

a>0.0 Subloading Cam clay mode。 Consider the effect of density in the following equation.

$$G(\rho)=a\cdot\rho^{pw(\rho)},\quad d\rho=-(1+e_0)\{G(\rho)/p\}\cdot\Lambda$$

pw(*ρ*): 関数 *G*(*ρ*) の power

Pa: Atmospheric pressure unit (98kPa, 10tf/m2 or 1.0kgf/cm2)! Determine the system of units for the analysis

Model = 1 (Subloading t_{ij} Model)の場合

Line 2: iVersion ,ρ and ωFlag.
=0: Original

Nakai &Hinokio(2004), Nakai et al(2011) and Nakai(2012)の発展則

$$d\rho=-(1+e_0)\sqrt{3}\{G(\rho)/t_N+Q(\omega)/t_N\}\cdot\Lambda,\quad G(\rho)=a\rho^{l_\rho}$$
$$d\omega=-(1+e_0)\sqrt{3}\{Q(\omega)/t_N\}\cdot\Lambda,\quad Q(\omega)=b_\omega\omega^{l_\omega}$$

.B The parameters (*a*, *ρb*) in *ωG*() and *Q*() here are the values of the above references. $1/\sqrt{3}$ It has doubled.

This version cannot be used when there is bonding and the (IC) component is considered.

=3: Alternative

$\rho\omega$Given the evolution law of and by

$$d\rho = -(1+e_0)\sqrt{3}\frac{G/(1+k_a X)+Q/(1+k_b X)}{t_N}\Lambda, \quad G = a\rho^{l_\rho}$$

$$d\omega = -(1+e_0)\sqrt{3}Q\left\|d\varepsilon_{ij}^p\right\| = -(1+e_0)\sqrt{3}Q\left\|\frac{\partial F}{\partial t_{ij}}\right\|\Lambda, \quad Q = b\omega^{l_\omega}$$

This Version can be used in all cases.

For this version, l=1 and $_\rho l_Q$=1 are sufficient.

Line 3: iCyclic & iCreep, Flag to determine whether repetition and time-effect properties are considered

=0: Do not consider repetition characteristics or time-effect characteristics

=1: Consider only temporal effect characteristics (iCyclic=0 & iCreep=1)

=10: Only repetition characteristics are considered (iCyclc=1 & iCreep=0)

=11: Consider repetition and time-effect characteristics (iCyclc=1 & iCreep=1)

Line 4: iAssoc , Plastic Strain Increment to express stress path dependence in strain increment direction

Flag to determine not to split (introduction of isotropic compression component (IC))

=0: $\begin{cases} d\varepsilon_{ij}^p = d\varepsilon_{ij}^{p(AF)} + d\varepsilon_{ij}^{p(IC)} & \text{if } h^p > 0 \ \& \ dt_N > 0 \\ d\varepsilon_{ij}^p = d\varepsilon_{ij}^{p(AF)} & \text{otherwise} \end{cases}$

iVersion=0 when considering the (IC) component.

=1: $d\varepsilon_{ij}^p = d\varepsilon_{ij}^{p(AF)}$ in every plastic region

When only the relevant flow law component (AF) is used

=3: $d\varepsilon_{ij}^p = d\varepsilon_{ij}^{p(AF)} + d\varepsilon_{ij}^{p(IC)}$ in every plastic region

When considering the (IC) component with iVersion=3.

Line 4: Elastic , Elastic Flag (default: H)

H: Nonlinear Hooke law

N: Hyper elastic type without tensile stress! Recommended

Line 5: Display material parameters (data and ass are not loaded)

(λ, κ, R_{cs}, N,ν , β, ξ, e_0, a^{AF}, a^{IC}, *pw*()ρ, *axk*, $Q_{\omega o}$, b_ω, *pw*(ω), *bxk,* Pa, *power*IC, *hlim*IC)

Line 6: Material Parameters Input

(λ, κ, R_{cs}, N, ν, β, ξ, e_0, a^{AF}, a^{IC}, *pw*()ρ, *axk*, $Q_{\omega o}$, b_ω, *pw*(ω), *bxk* , Pa, *power*IC, *hlim*IC)

Option: Not required when i Creep=0

If iCreep =1

Line 7: Enter parameters for time effect characteristics

λ_α $(, (-\dot{e})^p_{(equ)ref}, (-\dot{e})^p_{(equ)\min},) (-\dot{e})^p_{(equ)ini}$

(Note) Revisions in development

Option: Not required when iCyclic=0

If inCyclic =1
Line: Display repeating loading parameters (data and data are not read)

Line: Enter Recurring Loading Parameters
Values (a_{cyc}, km_{cyc}, kn_{cyc})

Description of material parameters of Subloading t_{ij} model:

λ: Compression index of normal dense wire (NCL) ($e - \ln p$ relation)

κ: NCL's swelling index ($e - \ln p$ relation)

Rcs: Limit state line (CSL) main stress ratio during triaxial compression, $(\sigma_1/\sigma_3)_{CS(comp)}$

M(comp) = (q/p) (critical state) with
There is a relationship between the
$R_{CS} = (3+2\mathrm{M}_{(comp)})/(3-\mathrm{M}_{(comp)})$

N: NCL's gap ratio at atmospheric pressure (= 98kPa)

ν: Poisson ratio of elastic component

β : Parameters that determine the shape of the stress-dilatancy relation.
βRecommend 1.0<<2.0
βAt =1.0, it has the same shape as the yield surface of the Original Cam clay model, but it is better avoided because it becomes a singularity in an isotropic stress state.
β As it grows, the yield curved surface becomes rounded.

ξ: dummy (ξ=100. Put in 0)

E_0: First-period gap ratio

a^{AF}: Parameters for considering density $\left(i.e.,\ G = a^{AF}\rho^{l_\rho}\right)$

a IC: A parameter of the density of the component (IC), but usually has the same value as a^{AF} (iVersion=0
It may be a different value only when iAssoc = 0)

$pw(\rho)=pl$: 関数 G の power;
Normally pw()=2.0 for iVersionρ=0, pw(ρ)=1.0

$k_a=axk$: parameter to adjust the shear of the function G in i version=3
iversion=0 must have axk=0.0

$Q_{\omega 0}$: Parameters that give the initial bonding effect $Q_{\omega 0} = b\omega_0^{\ l_\omega}$

b_ω: Parameters for considering bonding effect

$$i.e.,\ d\omega = -(1+e_0)\sqrt{3}\frac{Q}{t_N}\Lambda \ \ \&\ \ Q = b_\omega \omega^{pw(\omega)} \qquad \text{for iVersion} = 0$$

$$d\omega = -(1+e_0)\sqrt{3}Q\left\|\frac{\partial F}{\partial t_{ij}}\right\|\Lambda \ \ \&\ \ Q = b_\omega \omega^{l_\omega} \qquad \text{for iVersion} = 3$$

$pw(\omega)=l_\omega$: Power of the function ωQ() (usually pw(ω)=1.0)

$k_b=bxk$: iVersion=3 parameter to adjust the shear of function Q
For iVersion=0, bxk=0.0

Pa: A unit of atmospheric pressure (98 kPa, 10 tf/m2 or 1.0 kgf/cm2)! Determine the system of units for the analysis

$power$ IC: power of the function that determines the proportion of the (IC) components

$$\left(d\varepsilon_v^{p(IC)} = d\varepsilon_v^p \cdot \left(t_N/t_{N1}\right)^{powerIC} \quad \text{for iVersion} = 0; \quad d\varepsilon_v^{p(IC)} = d\varepsilon_v^p \cdot \left(\frac{\partial F}{\partial t_{kk}}\frac{t_N}{\sqrt{3}}\right)^{powerIC} \quad \text{for iVersion=3} \right)$$

$Power\ IC$>1.0: Less (IC)
$Power$IC<1.0: (Larger percentages of ICs)

iVersion=3 sets power IC=2

In iVersion=0, let power IC=1

wgt_IC: The proportion of the (IC) component is determined when iAssoc = 3.

wgt_IC =1: Conventional (AF+IC) model

wgt_IC =0: Same as (AF) model (iAssoc=1).

Along with this, *the previous h* p(^{IC})*C^p (=1.0+G+Q) The hlim IC that determines the lower limit value is given by *hlim*IC = 1.0 and fix on the program. 。

Comments:

4 Types of models

1) Model (AF+IC): The Original model considers the (IC) component
   iVersion=0 & iAssoc=0
2) Model (AF): Does not consider (IC) components in the Original model
   iVersion=0 & iAssoc=1
3) Model (AF+IC (alt)): Alternative model considers (IC) components
   iVersion=3 & iAssoc=3.
4) Model (AF (alt)): Do not consider (IC) components in the Alternative model
   iVersion=3 & iAssoc=1

When there is no bonding effect, if $_{\omega}Q$ 0 = 0.0, b_{ω} , $pw(\omega)$, k_b is not involved in the calculation

P.S. If you have any questions or requests about the program, please contact Shahin (shahinnit@gmail.com), Islamic University of Technology, Bangladesh or Nakai (nakai@geor.co.jp or nakai.teruo@nitech.ac.jp), to the Geo-Research Institute (Geo-tij)