SSNV205 – Drained cyclic shear test with constant isotropic pressure with the model of Hujeux

Summary:

The drained cyclic shear test with constant isotropic pressure makes it possible to simulate the loss of stiffness of a ground according to the amplitude of the cyclic deformations applied. These tests also make it possible to determine the dissipation introduced during cycles of loading.
The realization of these tests also makes it possible to validate the introduction of the cyclic thresholds déviatoires model of behavior of Hujeux, the results of Code_Aster are compared with the results got with the GEFDyn software for the same model of behavior

1 Problem of reference

1.1 Geometry

One considers an element not.

1.2 Properties of material

The isotropic elastic properties of material are:
- $E=619\,MPa$
- $\nu=0.3$

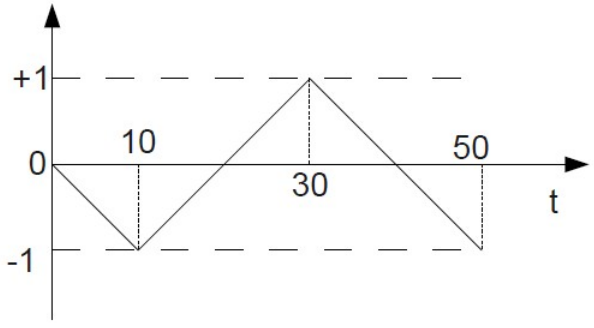
The parameters material of the model of Hujeux are:
- $n^e=0.4$, $\beta=24$, $b=0.2$, $d=2.5$
- $\varphi=33°$, $\psi=33°$, $P_{c0}=-1.00\,MPa$, $P_{ref}=-1.00\,MPa$
- $a_{cyc}=1.00\text{e}-4$, $a_{mon}=8.00\text{e}-3$
- $c_{cyc}=1.00\text{e}-1$, $c_{mon}=2.00\text{e}-1$
- $r^d_{ela}=5.00\text{e}-3$, $r^i_{ela}=1.00\text{e}-3$, $r^{d,c}_{ela}=5.00\text{e}-3$, $r^{i,c}_{ela}=1.00\text{e}-3$
- $r_{hys}=5.00\text{e}-2$, $r_{mob}=9.00\text{e}-1$
- $x_m=1.0$, $\alpha=1.0$

1.3 Boundary conditions and loadings

For recall, use of the order SIMU_POINT_MAT allows to directly impose a field of deformations and/or constraints.

One imposes a worthless evolution during the loading for the following components of the tensors forced and deformations:
- $\mathrm{d}\sigma_{xx}=\mathrm{d}\sigma_{yy}=\mathrm{d}\sigma_{zz}=0$
- $\mathrm{d}\varepsilon_{yz}=\mathrm{d}\varepsilon_{zx}=0$

One imposes the following evolution for the shearing strains, $\mathrm{d}\varepsilon_{xy}$:



One carries out several calculations independent with the same type of loading, but the amplitude of deformations varies according to the following values: $[2\text{e-}5, 2\text{e-}4, 2\text{e-}3]$

1.4 Initial conditions

The state of initial stresses is isotropic and corresponds to a pressure of $50\,\mathrm{kPa}$.

2 Reference solution

2.1 Method of calculating

The reference solution is obtained starting from the equivalent simulations carried out with the computation software by the finite element method, GEFDyn, developed at the Central School Paris.

2.2 Sizes and results of reference

The sizes and results of reference provided by GEFDyn are the following:

- evolution of the stress shear during the loadings
- evolution of the plastic voluminal deformation

2.3 Uncertainties on the solution

Uncertainties on the solution are directly related to the precision required to assume convergence of digital calculation carried out with GEFDyn, that is to say $1e\text{-}6$ into relative.

2.4 Bibliographical references

[1] D.Aubry, A.Modaressi. GEFDyn, Manuel Scientifique. Central school Paris, LMSS-Chechmate, 1996.

3 Modeling A

3.1 Characteristics of modeling

The order is used SIMU_POINT_MAT with SUPPORT=POINT.

3.2 Characteristics of the grid

The grid does not exist and calculations are restricted at a point of Gauss

3.3 Sizes tested and results

The sizes tested and results are the following:
- evolution of the stress shear during the loadings, SIXY
- evolution of the plastic voluminal deformation, V23

One carries out three independent calls to the order SIMU_POINT_MAT where only the amplitude of the loading varies.

Case 1: $d\varepsilon_{xy} = 2e\text{-}5$

Identification	Type of reference	Value of reference	Tolerance
$SIXY - INST = 5$	'SOURCE_EXTERNE'	-1260	1%
$SIXY - INST = 10$	'SOURCE_EXTERNE'	-2465	1%
$SIXY - INST = 20$	'SOURCE_EXTERNE'	54.03	1%
$SIXY - INST = 30$	'SOURCE_EXTERNE'	2463	1%
$SIXY - INST = 40$	'SOURCE_EXTERNE'	55.78	2%
$SIXY - INST = 50$	'SOURCE_EXTERNE'	-2465	1%
$V23 - INST = 10$	'SOURCE_EXTERNE'	-1,828e-9	1%
$V23 - INST = 20$	'SOURCE_EXTERNE'	-1,828e-9	1%
$V23 - INST = 30$	'SOURCE_EXTERNE'	-5,74e-9	1%
$V23 - INST = 40$	'SOURCE_EXTERNE'	-5,74e-9	1%
$V23 - INST = 50$	'SOURCE_EXTERNE'	-9,65e-9	1%

Case 2: $d\varepsilon_{xy} = 2e\text{-}4$

Identification	Type of reference	Value of reference	Tolerance
$SIXY - INST = 5$	'SOURCE_EXTERNE'	-7207	1%
$SIXY - INST = 10$	'SOURCE_EXTERNE'	-10170	1%
$SIXY - INST = 20$	'SOURCE_EXTERNE'	4223	1%
$SIXY - INST = 30$	'SOURCE_EXTERNE'	10150	1%
$SIXY - INST = 40$	'SOURCE_EXTERNE'	-4243	2%

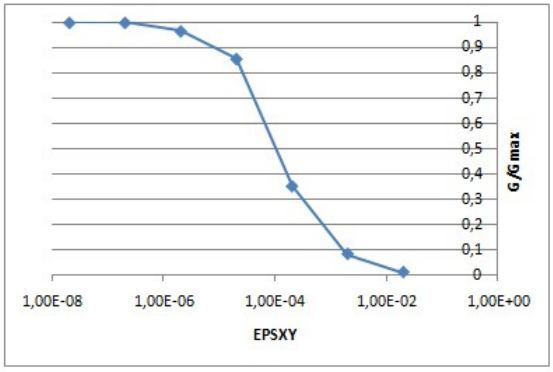
$SIXY-INST=50$	'SOURCE_EXTERNE'	-10170	1%
$V23-INST=5$	'SOURCE_EXTERNE'	-3,593e-6	3%
$V23-INST=10$	'SOURCE_EXTERNE'	-1,402e-5	1%
$V23-INST=20$	'SOURCE_EXTERNE'	-2,265e-5	1%
$V23-INST=30$	'SOURCE_EXTERNE'	-4,492e-5	1%
$V23-INST=40$	'SOURCE_EXTERNE'	-5,354e-5	1%
$V23-INST=50$	'SOURCE_EXTERNE'	-7,578e-5	1%

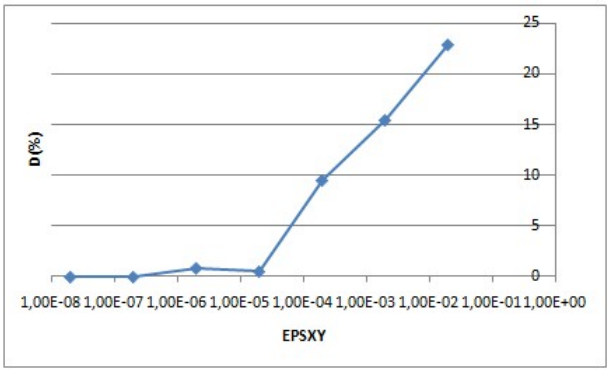
Case 3: $d\varepsilon_{xy}=2e-3$

Identification	Type of reference	Value of reference	Tolerance
$SIXY-INST=5$	'SOURCE_EXTERNE'	-19591	1%
$SIXY-INST=10$	'SOURCE_EXTERNE'	-24320	1%
$SIXY-INST=20$	'SOURCE_EXTERNE'	14793	1%
$SIXY-INST=30$	'SOURCE_EXTERNE'	24310	1%
$SIXY-INST=40$	'SOURCE_EXTERNE'	14887	2%
$SIXY-INST=50$	'SOURCE_EXTERNE'	-24426	1%
$V23-INST=5$	'SOURCE_EXTERNE'	-1,323e-4	1%
$V23-INST=10$	'SOURCE_EXTERNE'	-2,377e-4	1%
$V23-INST=20$	'SOURCE_EXTERNE'	-6,958e-4	1%
$V23-INST=30$	'SOURCE_EXTERNE'	-9,885e-4	1%
$V23-INST=40$	'SOURCE_EXTERNE'	-1,4475e-3	1%
$V23-INST=50$	'SOURCE_EXTERNE'	-1,7348e-3	1%

3.4 Remarks

On the basis of these test, one is now able to describe according to the shearing strains the reduction in the stiffness of the ground, that is to say to characterize his nonlinear behavior. To reproduce these data, the users must use the tool CALC_ESSAI_GEOMECA.





4 Summary of the results

This test made it possible to validate the behavior of the model of Hujeux under cyclic loading in comparison with results on the code of reference of this model of behavior.