SSNV205 – Drained cyclic shear test with constant isotropic pressure

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.

One is interested in this CAS-tests in the laws of behavior of Hujeux (modeling A) and Iwan (modeling B), the two currently available laws in *Code_Aster* for the cyclic granular material behavior.

In modeling A, Lrealization of these tests also makes it possible to validate the introduction of the cyclic thresholds déviatoires model of behavior of Hujeux has, the results of Code_Aster are compared with the results got with the GEFDyn software for the same model of behavior.

In modeling B, the results got with the model of Iwan are compared with those of modeling with the model of Hujeux, by considering similar curves of behavior for the two models.

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

Parameters of the model of Iwan (modeling B) are:
- $\gamma_{\mathrm{ref}}=2.00\mathrm{e}\text{-}4$
- $\mathrm{n}=0.78$

L be elastic modules must be updated for the confining pressure of the test, because $n^e\neq 0$.

Using the tool CALC_ESSAI_GEOMECA, one is able to compare the curves of behavior for the two models in terms of reduction of the modulus of secant rigidity and damping hysteretic.

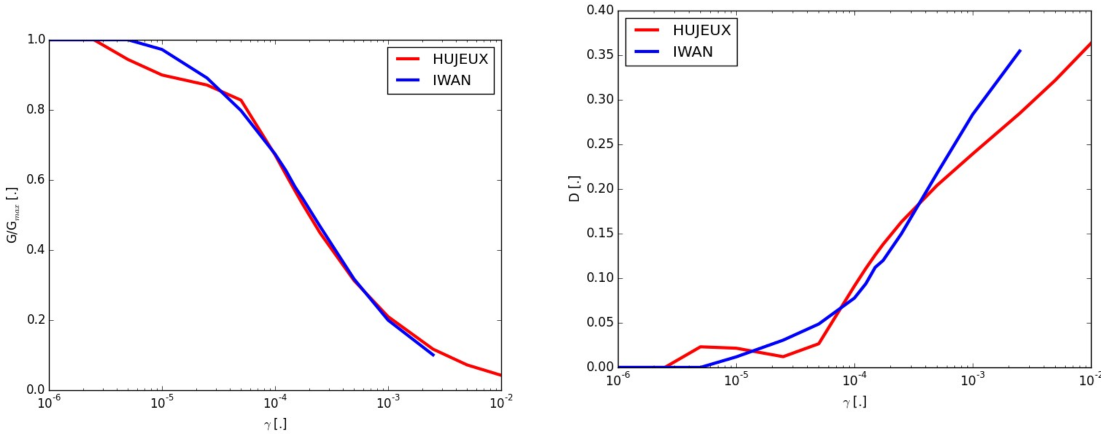


Figure 1 – Curves of behavior for the models of Hujeux and Iwan

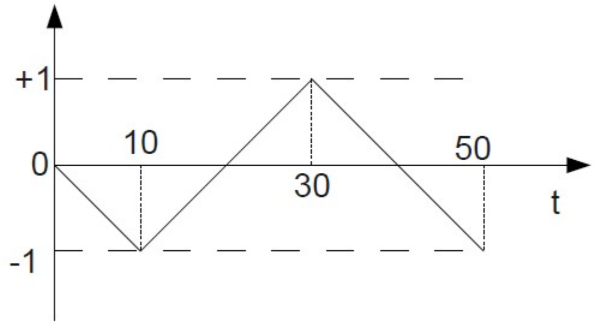
1.3 Boundary conditions and loadings

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:

- $d\sigma_{xx}=d\sigma_{yy}=d\sigma_{zz}=0$
- $d\varepsilon_{yz}=d\varepsilon_{zx}=0$

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



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

1.4 Initial conditions

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

2 Reference solution for modeling A

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

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%

4 Modeling B

4.1 Characteristics of modeling

The order is used `SIMU_POINT_MAT` with `SUPPORT=POINT`.

4.2 Characteristics of the grid

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

4.3 Sizes tested and results

The sizes tested and results are the following:

- evolution of the stress shear during the loadings, `SIXY`

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

One recalls that for this modeling one compares the results got by the model of Iwan with those of the model of Hujeux obtained in modeling A.

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

Identification	Type of reference	Value of reference	Tolerance
$SIXY-INST=5$	'AUTRE_ASTER'	-1259.3243448744	5%
$SIXY-INST=10$	'AUTRE_ASTER'	-2462.7975417813	5%
$SIXY-INST=30$	'AUTRE_ASTER'	2466.8646345014	5%
$SIXY-INST=50$	'AUTRE_ASTER'	-2459.6074144164	5%

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

Identification	Type of reference	Value of reference	Tolerance
$SIXY-INST=5$	'AUTRE_ASTER'	-7176.9064750495	5%
$SIXY-INST=10$	'AUTRE_ASTER'	-10145.337714444	8%
$SIXY-INST=20$	'AUTRE_ASTER'	4211.6280455068	5%
$SIXY-INST=30$	'AUTRE_ASTER'	10168.207641876	8%
$SIXY-INST=40$	'AUTRE_ASTER'	-4187.8912522105	5%
$SIXY-INST=50$	'AUTRE_ASTER'	-10123.83079066	8%

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

Identification	Type of reference	Value of reference	Tolerance
$SIXY-INST=5$	'AUTRE_ASTER'	-19488.466443205	5%
$SIXY-INST=10$	'AUTRE_ASTER'	-24272.532994658	5%
$SIXY-INST=20$	'AUTRE_ASTER'	14771.427020076	5%

$SIXY-INST=30$	'AUTRE_ASTER'	24346.990829393	5%
$SIXY-INST=40$	'AUTRE_ASTER'	-14787.939443998	5%
$SIXY-INST=50$	'AUTRE_ASTER'	-24381.246915809	5%

5 Summary of the results

This test makes it possible to compare the results of two models of behavior for the answer in cyclic granular material shearing.

Modeling A allowed 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.

Modeling B made it possible to check that the model of Iwan makes it possible to get results close to the model of Hujeux (well off approximately 5%), but with an easy calibration (2 parameters).