MFRON02 - Test of the interface *Code_Aster-MFront:* for laws of behavior of concrete and grounds

Summary:

This test validates certain metal or concrete behaviors with damage defined using *MFront* by comparison with behavior similar of *Code_Aster* .

Modeling C: this modeling makes it possible to validate the model of concrete creep of Burger with ageing.

Modeling G: this modeling makes it possible to validate the model of Drucker-Prager.

Modeling H: this modeling makes it possible to validate the call to mtest on a test similar to modeling C.

Modeling I: this modeling makes it possible to validate the use of Drucker-Prager (linear work hardening) in THM

Modeling J : this modeling makes it possible to validate the use D‘Iwan (law MFront) in one `KIT_THM`

Each modeling (except J) validate a law of behavior, generally by comparison with the results of the equivalent law of *Code_Aster*.

1 Modeling C

1.1 Characteristics of modeling

- Behavior tested: BurgerAgeiing.mfront. Law of creep of the concrete of Burger with ageing (cf [R7.01.35]).
- Modeling: creep test on an element (not material). Comparison with the tests of Kommendant for two clean creep tests:
  - concrete charged at 28 days, with a temperature of 20°C,
  - concrete charged at 90 days, with a temperature of 30°C,
- Properties material:

Concrete charged at 28 days

YOUN	31000
PEA	0.2
K_RS	1,956 E5
ETA_RS	4.797 E10
ETA_IS	1.57 E5
K_RD	5 E4
ETA_RD	1 E10
ETA_ID	1 E5
Alpha	1-2nd-6
Ea_R	0
Tref	20
ETA_FD	5,8e9
Cini	1
Ea_R	2100

Concrete charged at 90 days: only the Ea_R coefficient is modified because the temperature of reference is different from the temperature of the test.

Reference:

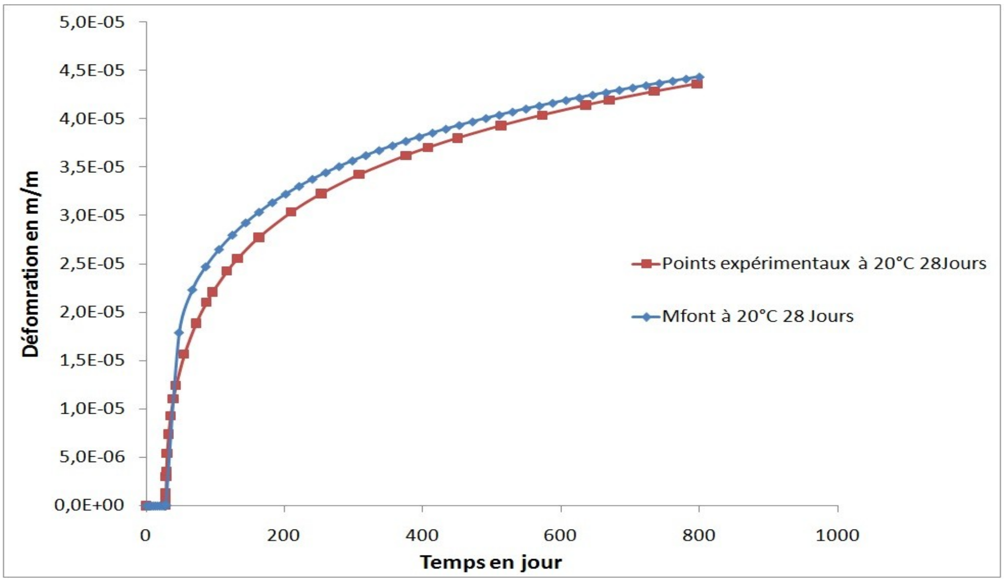
“Concrete study of properties for prestressed concrete reactor vessels”. **Kommendant G.J., Polivka Mr., and Pirtz D..** UCSESM 76-3, s.l. : General Atomic Company, Department of Civil Engineering, University of California, Berkeley, 1976.)

1.2 Sizes tested and results

Concrete charged at 28 days (deformation of creep ε_{zz}^{f} is provided by the variable interns V30)

Identification	Increment	Value of reference	Tolerance
ε_{zz}	20	$3.300E-05$	5%
ε_{zz}^{f}	20	$-1.563E-07$	5%
ε_{zz}^{f}	27	-2.87E-05	10%
ε_{zz}^{f}	32	-3.29E-05	5%
ε_{zz}^{f}	45	-3.93E-05	5%
ε_{zz}^{f}	60	-4.36E-05	5%

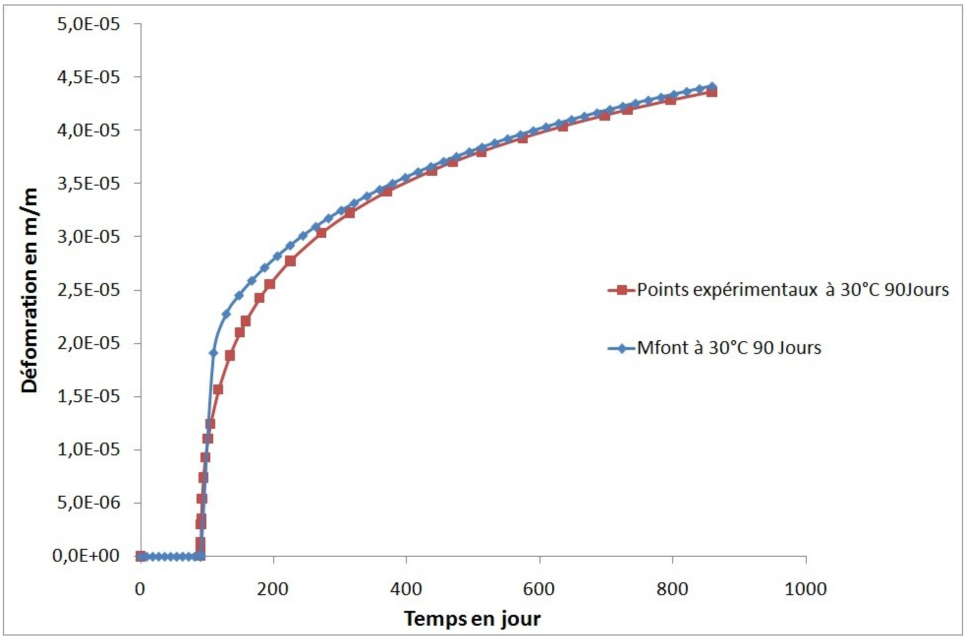
The calculated and experimental curves are the following ones:



Concrete charged at 90 days (deformation of creep ε_{zz}^{f} is provided by the variable interns V30)

Identification	Increment	Value of reference	Tolerance
ε_{zz}	20	$3.300E-05$	5%
ε_{zz}^{f}	20	-1.57E-07	5%
ε_{zz}^{f}	25	-2.65E-05	10%
ε_{zz}^{f}	35	-3.42E-05	5%
ε_{zz}^{f}	45	-3.94E-05	5%
ε_{zz}^{f}	60	-4.36E-05	5%

The calculated and experimental curves are the following ones:


5,0E-05
4,5E-05
4,0E-05
3,5E-05
3,0E-05
2,5E-05
2,0E-05
1,5E-05
1,0E-05
5,0E-06
0,0E+00
Défomration en m/m
0
200
400
600
800
1000
Temps en jour
Points expérimentaux à 30°C 90Jours
Mfont à 30°C 90 Jours

2 Modeling G

2.1 Characteristics of modeling

- Behavior tested: DruckerPrager.mfront. Associated elastoplastic law of Drucker-Prager [cf R7.01.16], the criterion being defined by: $F(\sigma)=\sigma_{eq}+a\,tr(\sigma)/3-k\leq 0$

  The coefficients has and K are defined starting from the properties material in the following way:
  $a=-3\dfrac{\tau-1}{\tau+1}$ and $k=2\dfrac{\sigma_c\tau}{\tau+1}$

- Modeling is equivalent to that of a file mtest (not material) of Mfront:
  a material point is subjected to an imposed deformation $\varepsilon_{xx}=5\quad 10^{-3}t$

- the properties material are: $E=200\,GPa$, $\nu=0{,}3$, $\tau=0.6$, $\sigma_c=150\,MPa$,

2.2 Sizes tested and results

The reference solution is that of the tests of Mfront reference:

Identification (t=1)	Reference	Tolerance
$\sigma_{xx}(MPa)$	90	0.1 %

3 Modeling H

3.1 Characteristics of modeling

This modeling makes it possible to validate the call to mtest. Data of mtest (file mfron01h.22) correspond to that of modeling C.

3.2 Sizes tested and results

One tests here simply the code return of mtest: it is worth 0 if the execution occurred well.

4 Modeling I

4.1 Characteristics of modeling

Behavior tested: DruckerPragerEcroLin.mfront:
Law of Drucker - Prager with linear work hardening (cf [R7.01.16]).

Modeling: similar to the test wtnp114a: the pressure of liquid is imposed worthless everywhere.

Moreover with regard to the mechanical part, one imposed an elastic law by choosing for the mechanical law of Drucker Prager a very high elastic limit.

The results are identical to wtnp114a:

Localization	Size	Reference	% tolerance
A	ε_{xx}	-6.9034482759000 10^{-4}	$<10^{-4}$
	ε_{yy}	-1.6765517241400 10^{-3}	$<10^{-4}$
B	ε_{xx}	-6.9034482759000 10^{-4}	$<10^{-4}$
	ε_{yy}	-1.6765517241400 10^{-3}	$<10^{-4}$
C	u_x	-1.3806896558000 10^{-3}	$<10^{-4}$
	u_y	-3.3531034482800 10^{-3}	$<10^{-4}$
	ε_{xx}	-6.9034482759000 10^{-4}	$<10^{-4}$
	ε_{yy}	-1.6765517241400 10^{-3}	$<10^{-4}$
D	ε_{xx}	-6.9034482759000 10^{-4}	$<10^{-4}$
	ε_{yy}	-1.6765517241400 10^{-3}	$<10^{-4}$

5 Modelisation J

5.1 Characteristics of modeling

Behavior tested: Iwan
The isotropic elastic properties of material are:

- $E=5.8\,GPa$
- $\nu=0.3$
- $\rho=2764\,kg.m^{-3}$

Parameters of the model of Iwan (modeling B) are:

- $\gamma_{\mathrm{ref}}=2.00\mathrm{e}\text{-}4$
- $\mathrm{n}=0.1$

5.2 Sizes tested and results

The values tested are values of not-regression bus this test does nothing but vérifeir possiibltié to connect a law MFront in KIT_THM.

Localization	Size
A	ε_{xx} ε_{yy}
B	ε_{xx} ε_{yy}
C	u_x u_y ε_{xx} ε_{yy}
D	ε_{xx} ε_{yy}

6 Summary of the results

The results are satisfactory and validate the interface enters *Code_Aster* and MFRONT in 3D, axisymmetric and plane constraints, for behaviors of concrete or grounds.