TTNV101 – Drying of the concrete – identification of the parameters on the curve of loss of mass

Summarized:

The purpose of this test is to give an example of simulation of drying of the concrete and computation of the loss of mass. The curve of loss of mass is often used to identify the parameters of the models of drying.

It is a question of calculating the loss of mass (of water) in the course of time. One models in 3D a prismatic sample. The model of drying is `SECH_GRANGER`.

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1 Problem of reference

1.1 Geometry

One considers a quarter of the prismatic sample of $70 \times 70 \times 280\, mm$.

1.2 Properties of the material

In the equation of drying:

$$\frac{dC}{dt} - \mathrm{div}\left[D(C,T)\, grad\, C \right] = 0$$

the coefficient of diffusion D will be form `SECH_GRANGER` :

$$D(C,T) = A \exp(BC) \frac{T}{T_0} \exp\left[-QSR_K \left(\frac{1}{T} - \frac{1}{T_0} \right) \right]$$

- $A = 2{,}5\, 10^{-11}\, m^2/h$
- $B = 0.12$
- $T_0 = 273\,°K$

1.3 Boundary conditions and loadings

Field of uniform and constant temperature in the course of the time of $20\,°C$
Concentration imposed on edges of $C_{eq} = 29{,}31\, l/m^3$

1.4 Initial conditions

the initial water concentration is of $C_{eq} = 106{,}42\, l/m^3$

1.5 Transient

One computation drying over one period of $528\, h$.

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2 Quantities and

2.1 result reference solution of reference

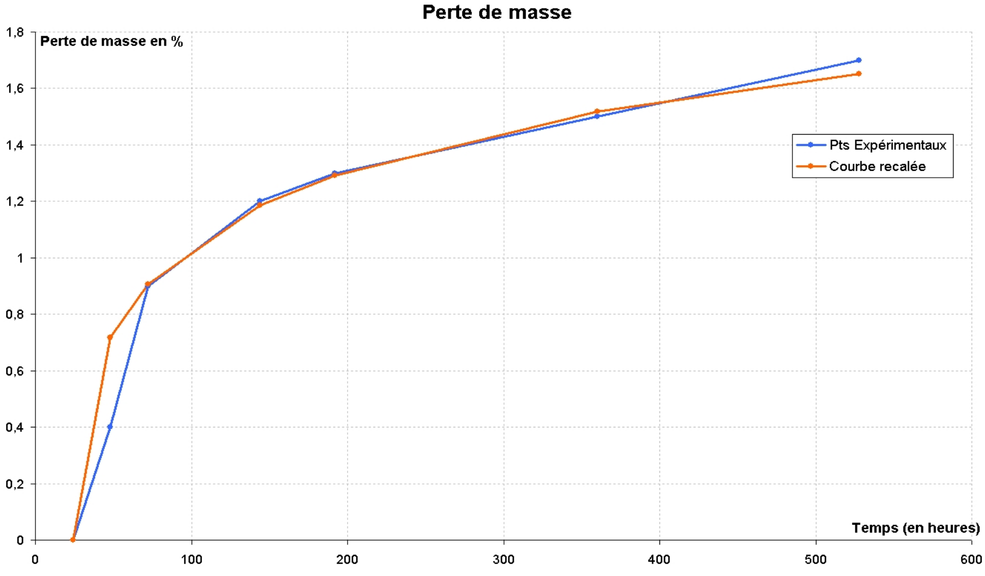
the values of reference are the statements of loss of mass during the test of drying exit of benchmark CONCRACK.

To compute: the water loss of the numerical test-tube at a given time, one must calculate successively:

1. for each finite element, the integral of the water concentration on the volume of the element: $\int_V C\,dV$ what is equivalent to the mass of remaining water in the finite element (in kg).
2. Somme quantities of remaining water $\sum_{éléments} \int_V C\,dV$: it is the total mass of remaining water in the sample (in kg)
3. the average water concentration (l/m3) while dividing by volume: $C_{moy} = \dfrac{\sum_{éléments} \int_V C\,dV}{V_{tot}}$
4. The lost mass (kg) is: $C_0 V_{tot} - \sum_{éléments} \int_V C\,dV$
5. The loss of mass (%) is: $\dfrac{C_0 - \sum_{éléments} \int_V C\,dV}{\rho_{beton} V_{tot}} = \dfrac{C_0 - C_{moy}}{\rho_{beton}}$

Stages 2 and 3 are results of the command `POST_ELEM` INTEGRAL `option` in Code_Aster.

One compares all the experimental points and the numerical points except the first which is not relevant.



2.2 Bibliographical references

[1] J. HAELEWYN, “Benchmark CONCRACK: Modelization of the concrete to the young age”, H-T64-2011-03057-FR notes.

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3 Modelization A

3.1 Characteristic of the modelization

One uses a modelization 3D_DIAG.

3.2 Characteristics of the mesh

The mesh contains 4300 elements of the type HEXA8.

3.3 Quantities tested and results

the loss of mass is tested.

Standard	identification of reference	Value of reference	Tolerance
to $t=48\text{h}$	"SOURCE_EXTERNE"	0.9	11.0%
to $t=48\text{h}$	"NON_REGRESSION"	0.972148	
to $t=144\text{h}$	"SOURCE_EXTERNE"	1.2	11.0%
to $t=144\text{h}$	"NON_REGRESSION"	1.32039	
to $t=192\text{h}$	"SOURCE_EXTERNE"	1.3	11.0%
to $t=192\text{h}$	"NON_REGRESSION"	1.41454	
to $t=360\text{h}$	"SOURCE_EXTERNE"	1.5	11.0%
to $t=360\text{h}$	"NON_REGRESSION"	1.62195	
to $t=528\text{h}$	"SOURCE_EXTERNE"	1.7	11.0%
to $t=528\text{h}$	"NON_REGRESSION"	1.74863	

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4 Summary of the results

This benchmark gives an example of computation of the loss of mass during a test of concrete drying. The variation observed between the values of reference and computation could be reduced by a better identification of the parameters of the model of diffusion.

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