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

Summary:

The objective of this test is to give an example of simulation of drying of the concrete and calculation of the loss of mass. The curve of loss of mass is often used to identify the parameters of the laws 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 law of drying is `SECH_GRANGER`.

1 Problem of reference

1.1 Geometry

One considers a quarter of the prismatic sample of $70\times70\times280\,mm$.

1.2 Properties of 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 the 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 calculation drying over one period of $528\,h$.

2 Reference solution

2.1 Sizes and results of reference

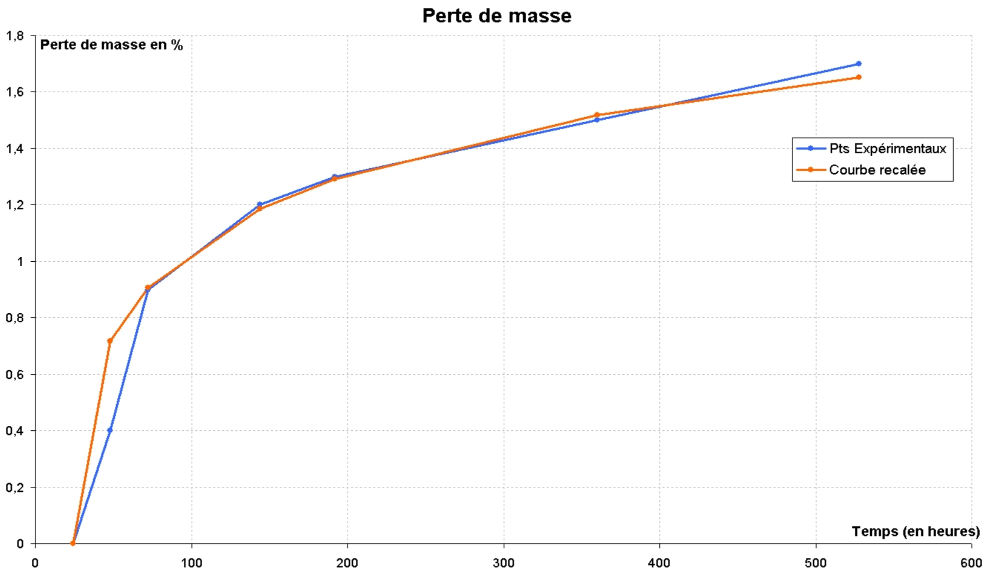
The values of reference are the statements of loss of mass during the test of drying exit of benchmark CONCRACK.

To calculate the water loss of the digital test-tube at a given moment, 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 with the remaining volume of water (in L).
2. Somme of the quantities of remaining water $\sum_{éléments} \int_V C\,dV$: it is LE volume water total remaining in the sample (in L).
3. Average water concentration (in l/m ³) while dividing by volume: $C_{moy} = \frac{\sum_{éléments} \int_V C\,dV}{V_{tot}}$
4. LE volume lost (in L) is: $C_0 V_{tot} - \sum_{éléments} \int_V C\,dV$ and masses it lost (in kg) is: $\rho_{eau}(C_0 V_{tot} - \sum_{éléments} \int_V C\,dV)$ with $\rho_{eau} = 1\,kg/l$.
5. The loss of mass (%) is: $100 \times \frac{\rho_{eau}(C_0 V_{tot} - \sum_{éléments} \int_V C\,dV)}{\rho_{beton} V_{tot}} = 100 \times \frac{\rho_{eau}(C_0 - C_{moy})}{\rho_{beton}}$ with $\rho_{beton} = 2410\,kg/m^3$.

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

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



2.2 Bibliographical references

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

3 Modeling A

3.1 Characteristics of modeling

A modeling is used 3D_DIAG.

3.2 Characteristics of the grid

The grid contains 4300 elements of the type HEXA8.

3.3 Sizes tested and results

The loss of mass is tested.

Identification	Type of reference	Value of reference	Tolerance
with $t=48\text{h}$	'SOURCE_EXTERNE'	0.9	11.0%
with $t=48\text{h}$	'NON_REGRESSION'	0.972148	
with $t=144\text{h}$	'SOURCE_EXTERNE'	1.2	11.0%
with $t=144\text{h}$	'NON_REGRESSION'	1.32039	
with $t=192\text{h}$	'SOURCE_EXTERNE'	1.3	11.0%
with $t=192\text{h}$	'NON_REGRESSION'	1.41454	
with $t=360\text{h}$	'SOURCE_EXTERNE'	1.5	11.0%
with $t=360\text{h}$	'NON_REGRESSION'	1.62195	
with $t=528\text{h}$	'SOURCE_EXTERNE'	1.7	11.0%
with $t=528\text{h}$	'NON_REGRESSION'	1.74863	

4 Summary of the results

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