SSNA103 - Chock of the parameters of the model of Weibull

Summary:

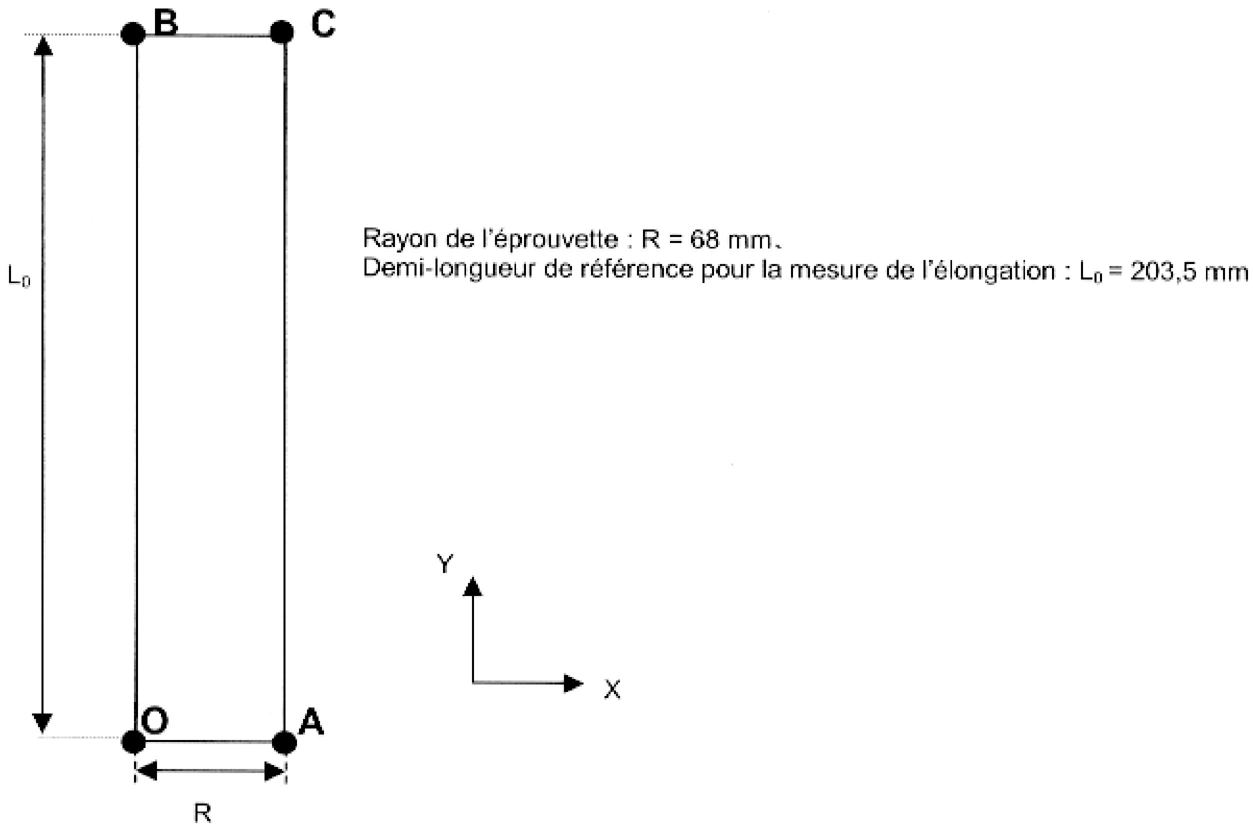
This test validates the order RECA_WEIBULL allowing the identification of the parameters m and σ_u model of Weibull.

The identification is carried out using a database made up of 45 tests, all carried out on smooth cylindrical test-tubes at three different temperatures, $-150°C$, $-100°C$ and $-50°C$. This database is obtained by random pulling of a representative sample of the statistical law of Weibull corresponding to values of m and σ_u fixed arbitrarily.

1 Problem of reference

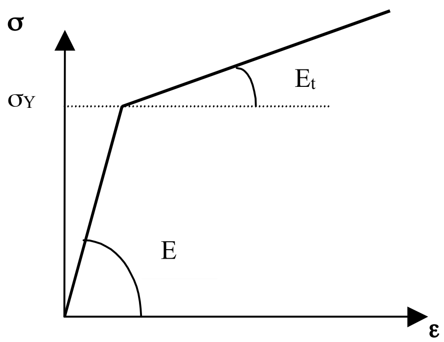
1.1 Geometry

Each test is carried out on a smooth cylindrical test-tube. For obvious reasons of symmetries, an axisymmetric modeling 2D of the quarter of the structure is sufficient.



1.2 Properties of material

One describes the behavior of material studied by an elastoplastic law of Von Mises with linear isotropic work hardening, `'VMIS_ISOT_LINE'`. The deformations used in the relation of behavior are the linearized deformations.



The Poisson's ratio does not depend on the temperature, $\nu=0,3$.

Values of the Young modulus E , tangent module E_t and of the elastic limit are given in the following table:

Temperature $[°C]$	**– 150**	**– 100**	**– 50**
$E[MPa]$	200000	200000	200000
$Et[MPa]$	2000	2000	2000
$\sigma_Y[MPa]$	750	700	650

1.3 Boundary conditions and loadings

By referring to the figure of the §1.1 the boundary conditions and loadings are the following:

On the segment BC ($Y=L_0$), imposed displacement following the direction OY :

$T[°C]$	**Displacement (** $l-l_0$ **) with the rupture for a reference length** l_0 **of** $203.5mm$ $[mm]$ The results for each temperature are classified by ascending order														
-50	10.68	28.78	30.31	31.66	32.53	33.90	34.38	35.82	36.69	37.09	37.37	37.49	38.45	39.77	44.39
-100	20.57	21.68	23.32	24.37	24.66	25.59	25.84	27.51	28.44	29.30	29.68	30.16	30.18	30.20	30.95
-150	11.33	14.70	14.79	14.90	18.62	18.87	19.00	19.37	19.61	20.07	21.19	22.79	23.28	24.17	24.41

On the segment OA ($Y=0$) displacements blocked according to the direction OY .
On the segment OB ($X=0$) displacements blocked according to the direction OX .

1.4 Initial conditions

Worthless constraints and deformations.

2 Reference solution

2.1 Method of calculating

No calculation is necessary to obtain the reference solution. Values m and σ_u (M and SIGM_REFE in the option WEIBULL of DEFI_MATERIAU) that one seeks to identify with *Code_Aster* are known and allow to generate the base of the experimental data. Thus, the elongations with rupture are in the following way given:

For each couple m and σ_u associated with a temperature of test, a sample of 15 values of constraint of Weibull to the rupture were determined by random pulling taking into account the following statistical law:

$$P_f(\sigma_w) = 1 - \exp\left[-\left(\frac{\sigma_w}{\sigma_u}\right)^m\right]$$

The constraint of Weibull is defined by:

$$\sigma_w = \sqrt[m]{\sum_i \left(\sigma_I^i\right)^m \frac{V_i}{V_0}}$$

The summation relates to volumes of matter V_i plasticized, σ_I^i indicating the maximum principal constraint in each one of these volumes (volume V_0 (VOLU_REFE in the option WEIBULL of DEFI_MATERIAU) is equal to $(50\,\mu m^3)$).

In the case of a request in simple traction with the assumption of the small deformations, the constraint of Weibull, σ_W, expresses itself according to the elongation with the rupture $(l-l_0)/l_0$, according to:

$$\sigma_W = \left[E_t\left(\frac{l-l_0}{l_0}\right) + \left(1-\frac{E_t}{E}\right)\sigma_Y\right]\sqrt[m]{\frac{V}{V_0}}$$

One thus deduces from this expression and preceding random pulling the values of the lengthenings with rupture deferred in the table of [§1.3].

2.2 Sizes and results of reference

Reference variables of m and σ_u used to create the bases of experimental tests are the following ones:

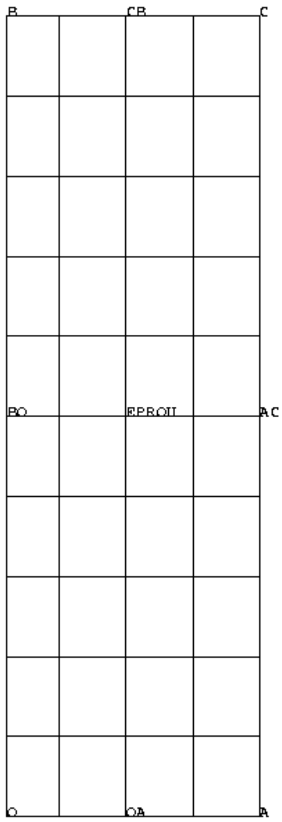
Temperature $[°C]$	**– 50**	**– 100**	**– 150**
m	24	24	24
σ_u $[MPa]$	2800	2700	2600

2.3 Uncertainties on the solution

Uncertainty on the solution cannot be given in a precise way. It can be rather high. Indeed, the values of reference can be found only if one considers experimental populations made up of an infinite number of samples.

3 Modeling A

3.1 Characteristics of the grid



GROUP_MA: CB
GROUP_MA: BO
GROUP_MA: OA

Many nodes: 149
Many meshs and types: 40 elements QUAD8

3.2 Sizes tested and results

Identification of one m commun run at the three experimental bases and of one σ_u by base.

Temperature $[°C]$	Reference		*Code_Aster*	
	m	σ_u $[MPa]$	m	σ_u $[MPa]$
– 50	24	2800	26.7	2536
– 100	24	2700	26.7	2428
– 150	24	2600	26.7	2372

3.3 Remarks

Although the variation enters the values of (m , σ_u) obtained with `RECA_WEIBULL` and their values of reference remains considerable, it is in conformity with the result sought taking into account the relatively low number of samples used for retiming (15 per temperature). To obtain the values of reference it would be necessary considerably to increase the number of samples per temperature (

$N>1000$). The noted variation remains however reasonable (about 10%). In addition, growth of σ_u according to the temperature is respected

4 Summary of the results

Results got by *Code_Aster* show that the automatic procedure of chock of the parameters of the models of Weibull functions and gives coherent results with the expected theoretical results.