VARIATION OF PARAMETERS OF CREEP OF A COMPOSITE MATERIAL BASED ON THE GROUND SURFACE FIBERGLASS C

Kouadri-Boudjelthia 1,2, A. Bouabdallah2, M. Tahar Abbas1
1Department of mechanics Faculty of Technology University of CHLEF ALGERIA
2LTSE Faculty of Physics, USTHB. Algiers ALGERIA

Abstract:

In order to analyze the influence of the surface density of glass fibers on creep C, we chose two composites of the same nature: unsaturated polyester matrix reinforced with glass fibers randomly oriented C for enhanced multidirectional but different mass per unit area, one of 450 g/m² and the other of 600g/m². We conducted tests on a device study SM106 creep under three different loads for each surface mass.

We attempted to determine the main parameters through experimental curves [1] which actually show a variation depending on the surface density.

We try, in particular, to model the creep behavior by a phenomenological relationship [2].

Our results were analyzed and discussed in the light of few data available.

1. Introduction

Many research carried out in different laboratories have progressed rapidly in recent decades and helped develop a number of materials that meet the requirements. Among the materials which are widely used in different industry sectors, the composite materials have many advantages over traditional materials: low weight, good electrical insulation, ease of implementation justifying their use increasingly common in modern industry, that is why when we are in the presence of a new material, we are tempted to test its properties or characteristics trying to owe its behavior under external stresses.

2. Creep of materials

In many applications, materials must withstand permanent loads for long periods of time in different climates [01], this is the case of storage tanks of water or other liquid, the plastic parts of electric machines, the vanes of a turbine rotor, the composite cylinders for acetylene etc.. Under these conditions, the material may continue to deform to such an extent that its usability is seriously compromised.

These deformations function of time, can be almost imperceptible but during the life of a structure sometimes they reach large values and even eventually result in a break, without increasing load [02]. This damage which strongly influences the mechanical behavior of composite materials in general and particularly those in which the fibers are randomly oriented result of many basic mechanisms of rupture such as micro cracks, breakage of the fibers per unit and inter laminar fracture or delamination that occurs either by decohesion of the fiber-matrix interface "debonding" is by tearing fibers "pull out" [03]. This damage mechanism can be demonstrated by laboratory tests [01] such as a short-term stress such as a tensile test where we note that there is an initial deformation simultaneously with the thought that load as shown in the diagram static stress-strain. If in any conditions, the continuous deformation, is maintained for a constant load, this additional deformation receives the name of creep and thus it is defined as "the part of the deformation resulting from the stress, which is a function of time."
3. Experiments and analysis

3.1 Experimental
The tests were performed on a machine tensile creep in which the creep test under different loads (217.78N, 257.02N, et 296.26N) Elongations are recorded by a comparator to 1/100 mm

1- Enclosure, 2- Test tube, 3- Comparator 4- Masses, 5- Arm of the level

1- Schema of the testing apparatus.

The dumbbell-shaped specimens (Figure 2) were performed in the laboratory according to British Standards BS (British Standard). Their dimensions in millimeters are summarized in the table below

![Figure 2. Test tube](image)

<table>
<thead>
<tr>
<th>a</th>
<th>b</th>
<th>c</th>
<th>D</th>
<th>e</th>
<th>L</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>66</td>
<td>4.6 à 5.5</td>
<td>25</td>
<td>8</td>
<td>1.5 à 1.8</td>
<td>92</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 1. Specimen dimensions in mm

3.2 Analysis of results
The experimental results for the three charges are grouped for each weight within the same graph

![Figure 3. Creep of the composite material to 450g/m².](image)

The creep behavior of our two composites is comparable to many similar plastic materials [05] and elongation-time curves obtained clearly show that the primary creep increased speed and decreasing the secondary creep progressing at a constant speed by constituting the major part of the process and we note that the flow of these two materials tends to a maximum value this is true for thermosetting polymers which our two part materials. This maximum is dependent on the strain, the surface density fiber and temperature.

3.3 Determination of creep behavior law
It is established law creep behavior \( \varepsilon \) function of time \( t \) (s)
Based on phenomenological relation [02]:
\[
\varepsilon = \varepsilon_0 + B\sigma^k t^l \tag{1}
\]
We try to adjust the creep parameters, namely B and k as a function of time t (s) and represent the creep constants characterizing the material considered.
ε, ε₀, σ are respectively tensile creep after a time t, the instantaneous deflection and the stress applied to the specimen. If we assume ε-ε₀ = ε* =Bσ^m t^k between two consecutive points 1 and 2 and for the same load, we have:

ε^*_1 = Bσ^m t^k (2)

ε^*_2 = Bσ^m t^k (3)

Report (2) on (3) we have:

ε^*_1 / ε^*_2 = (t_1 / t_2)^k (4)

whence k = [Log(ε^*_1 / ε^*_2)] / Log(t_1 / t_2) (5)

k_i = [Log(ε^*_i / ε^*_i+1)] / Log(t_i / t_{i+1}) (6)

k_moy = 1/n [Σ[Log(ε^*_i / ε^*_i+1)] / Log(t_i / t_{i+1})] (7)

For the calculation of the parameters m and B, we use the method of least squares. A program whose chart is below, can be calculated from tables of experimental values of creep parameters k, m and B.

The results are summarized in the tables below:

<table>
<thead>
<tr>
<th>Load</th>
<th>Surface density 450 g/m²</th>
<th>Surface density 600 g/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5 kg</td>
<td>0.153</td>
<td>0.165</td>
</tr>
<tr>
<td>3.0 kg</td>
<td>0.200</td>
<td>0.304</td>
</tr>
<tr>
<td>3.5 kg</td>
<td>0.220</td>
<td>0.361</td>
</tr>
</tbody>
</table>

Table 2. Evolution of the exponent k in accordance with the load

<table>
<thead>
<tr>
<th>Load</th>
<th>Surface density 450 g/m²</th>
<th>Surface density 600 g/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5 kg</td>
<td>0.801</td>
<td>0.932</td>
</tr>
<tr>
<td>3.0 kg</td>
<td>0.760</td>
<td>0.918</td>
</tr>
<tr>
<td>3.5 kg</td>
<td>0.723</td>
<td>0.724</td>
</tr>
</tbody>
</table>

Table 3. Evolution of the exponent m as a function of load

<table>
<thead>
<tr>
<th>Load</th>
<th>Surface density 450 g/m²</th>
<th>Surface density 600 g/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5 kg</td>
<td>0.118</td>
<td>0.155</td>
</tr>
<tr>
<td>3.0 kg</td>
<td>0.149</td>
<td>0.270</td>
</tr>
<tr>
<td>3.5 kg</td>
<td>0.154</td>
<td>0.318</td>
</tr>
</tbody>
</table>

Table 4. Evolution of the exponent B in function of the load

The influence of load on the parameter k notable particularly for the surface density 600 g/m². On the parameter m, the influence of the load is unremarkable and we see an accumulation values. For the parameter B, the development of B is nearly constant.

4. Conclusion
Determining values of parameters of creep under different loads from the experimental curves shows a real
influence of mass density of fibers with a dispersion of results, this because of the distribution of random orientation of the glass fibers in the resin and also because of the unpredictable nature of the phenomenon of creep.

We think that the composite material surface density of 600 g/m² better behavior but it does not mean that the composite material 450 g/m² is poor because it must also take into account the economic cost and also the working conditions.

References


[02] A. GHOUL, A. BOUABDALLAH, A. KOUADRI-BOUDJELTHIA
"Endommagement par fluage et vieillissement d’un matériau composite multidirectionnel Polyester-Fibre de verre” 5ème Journées de la matière condensée Société Française de Physique ”SFP”, 28-30 Août 1996 Orléans, FRANCE


[04] J.P. TROTIGNON, J. VERDU, M. PIPERAUD