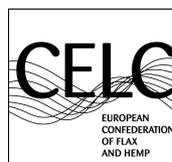


Guideline

Methodology of uses

Standard data sheet template for preforms – composite sector



2015

Manual for the Technical Datasheets

Flax & Hemp Preforms

Random mats, weaves, non-crimp fabrics, UD layers, rovings/yarns

The structure of the datasheets is the same for first four preforms. It is divided in four main parts:

- Description of the fibre,
- Description of the fabric,
- Chemical treatment and
- Mechanical properties

The fifth, yarn/roving data sheet is divided differently in five main parts:

- Composition of the roving/yarn,
- Description of the roving/yarn,
- Chemical treatment,
- Mechanical properties of impregnated roving/yarn and
- The mechanical properties of dry yarn/roving (backcalculated data).

All data are measured following international standards, in line with glass and carbon fibre benchmarks. For every property that is mentioned in the datasheet, the related standard (ISO-standard) is mentioned.

The guideline is set in order to help in comparing in a reliable and objective way the characteristics and properties of different preforms coming on the market.

1) Identification of the preform

Here a name and/or identification (code, number...) for the preform should be given. It is important that this name is only referring to **one** preform. Every other type (e.g. having a different areal weight) should have another name.

2) Description of the fibres and fabric/preform

This is information which should be known from the production of the preform. Therefore this information should be provided by the producers of the preform themselves. The **density of flax and hemp** fixed at $1,45\text{g/cm}^3$. So always the same density should be used, as this gives a better impression to the composite part manufacturers. Measuring the density of fibres is not a straightforward technique and therefore very expensive. By fixing the density this can be avoided.

The **composition** has to be given in volume %. Mention every material which is in the preform:

- if two types flax are used, mention both with their respective volume%.
- if there is a polymer added to the roving/yarn, give the volume%. Also the type (PP or PE, or...) and the brand name of the polymer should be mentioned.

Some parameters (for example binding style in a weave) are known from the production of the preforms.

For **weaves**, the linear density of rovings or yarns should be delivered by the yarn/roving producer or by the spinning company, and they should measure it according to their standard.

For all properties which have to be measured, it is important that **the standards mentioned in the data sheet are followed**.

One property has to be **calculated**, namely the **areal volume**. Therefore the areal weight is divided by the flax fibre density, which we propose to fix at 1,45g/cm³. Keep in mind that with mixed fibres the density will be different. This result has to be divided by 1000 to obtain the correct units (areal weight in g/m², areal volume in mm³/mm², density in 1,45g/cm³):

$$\text{areal volume} = \frac{\text{areal weight}}{\text{density}} * \frac{1}{1000}$$

In the part **treatment** one has to fill out only non-confidential information. This means that one does not have to mention how the fibre or preform is treated, but **for which purpose**. This purpose can be: to compatibilize the fibre or preform with a certain matrix, or against moisture absorption, or for improved fire resistance. The recipes of the treatments are confidential, and should not be mentioned. When there is no treatment, one should also mention this.

3) Mechanical properties of a laminate

This information is very important. Most of the flax preform producers cannot measure this themselves. In that case, a testing laboratory or research institute should be asked to do perform these tests.

It is important that as much as possible information is provided on the way the test samples have been produced. For **thermoset** composites this is at least:

- **Number of layers** (*they should all have the same orientation, for instance all weave layers positioned in warp direction*)
- **V_f** (*volume fraction of fibres in the composite*)
- **Thickness**
- **Type of thermoset resin:** Epoxy x, UP, ... (*mention matrix properties (from datasheet) like stiffness and density*)
- **Curing cycle**

if a **thermoplastic** matrix is used, the following relevant information of the processing should be mentioned:

- **Number of layers**
- **V_f**
- **Thickness**
- **Type of thermoplastic matrix:** PP, PE ... (*mention matrix properties (from datasheet) like stiffness and density*)
- **Processing conditions:**
 - Temperature
 - Pressure
 - Time

Recommandations:

- A fibre volume fraction (V_f) of minimum 25% \pm 5% is recommended. However, in case of thermoplastic composites where the thermoplastic matrix is already present in the preform (for instance by using commingled yarns) the fibre volume fraction is fixed and cannot be changed.
- Keep track of the warp and weft direction for weaves, and of the machine and cross direction for random mats and non-crimp fabrics.

Calculation of the fibre volume fraction

A flax or hemp fibre density of 1.45 g/cm³ (ρ_{fibre}) is considered for the calculations of the fibre volume fraction in the composite V_f , using the following Equation 1:

$$V_f (\%) = \frac{\rho_{surf} \cdot N}{10 \cdot \rho_{fibre} \cdot h} \quad (\text{Eq. 1})$$

Where ρ_{surf} is the aerial density (g/m²) and ρ_{fibre} is the density (g/cm³) of the fibers, N is the number of layers used and h is the composite laminate thickness (in mm).

A second method can be used to determine the fibre volume fraction: using the weight of the fibre and the weight of the composite, it is possible to calculate the fibre volume fraction (Eq.2) with the hypothesis that there is no porosity.

$$V_f (\%) = \frac{\frac{m_f}{\rho_f}}{\frac{m_f}{\rho_f} + \frac{m_c - m_f}{\rho_{res}}} \times 100 \quad (\text{Eq. 2})$$

Where ρ_{res} is the density of the resin (in g/cm³), m_f is the mass (in grams) of the fibres and m_c is the mass of the impregnated bundle.

The **mechanical properties** should be **measured according to the standards** mentioned in the datasheet. Otherwise the presented values make no sense. Also know that just mentioning the standard is not enough, one really has to work according the instructions of the standard. It is

important that **two** stiffness values are mentioned. The first one measured between 0 and 0.1% strain, the second one between 0.3 and 0.5% strain. For the **non-crimp fabrics** it is important that it is made very clear which direction the tests were performed. In this case a drawing of the stacking sequence will be very useful in case of complex fabrics.

Finally, also the **recommended storage and processing conditions** have to be mentioned. This is important, otherwise the customers will never obtain the same properties.

The calculation of the two Young's moduli E1 and E2

The calculation of the modulus is made according to the ISO 527 for tensile testing and ISO14125 for flexural testing. The difference from the standard are that:

- E₁: The stiffness calculated between 0 and 0,1% strain
- E₂: The stiffness calculated between 0,3 and 0,5 % strain
- The strength at maximum strain
 - only samples which break in between the grips are valid
- The failure strain in %

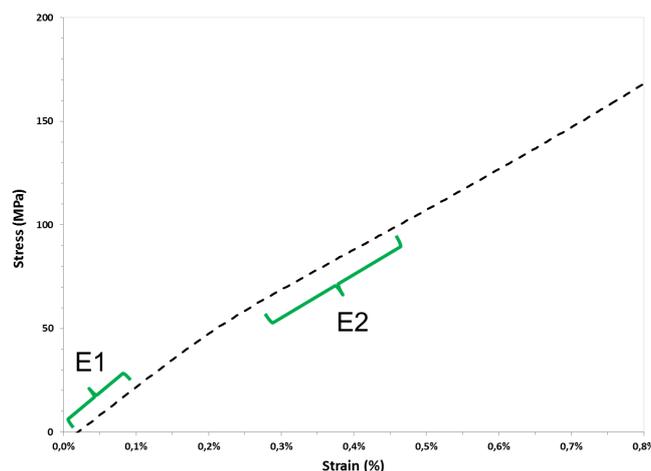


Figure 1: Zone where E1 and E2 should be calculated

The reason for calculating 2 values for the stiffness is because there can be a decrease in stiffness around 0.2% strain; the amount of decrease depends on the type of preform. It is important to mention both values, because both values can be relevant for design purposes.

Back-calculated fibre/yarns properties (*only for roving/yarn data sheets*)

For the roving/yarn data sheets, the Impregnated Fibre Bundle Test (IFBT) has to be used. Please see separate guidelines for IFBT sample manufacturing and testing, also provided by CELC. From the measured composite properties on this “impregnated fibre bundle”, the following properties can be backcalculated:

- From an **impregnated roving** (having no twist!), the properties of **flax fibres**, as they are present and behave in a composite, can be determined
- From an **impregnated bundle of yarns** (having a certain twist), the properties of **(twisted) flax yarns**, as they are present and behave in a composite, can be determined

The back calculation the fibre/yarn properties is performed using the following formulas:

$$E_f = \frac{E_c - E_m + (1 - V_f)}{V_f}$$

$$\sigma_f = \frac{\sigma_c - \sigma_m + (1 - V_f)}{V_f}$$

Where, E_f is the modulus of the fibre, E_m is the modulus of the matrix and V_f is the fibre volume fraction, σ_f is the strength of the fibre and σ_m the strength of the matrix (*moduli are given in GPa, strengths in MPa*). In the calculation, the σ_m is the stress in the matrix at the failure strain which can be calculated assuming elastic deformation of the matrix: $\sigma_m = E_m \times \epsilon_c$.

4) Additional information

In the next part one can mention other properties, which are measured or can be determined. This part is **not** mandatory. If no extra information is available, one should not fill out this section. It is however advised that if this section is filled out, also the relevant standards are used (and mentioned). If data sheets of subcomponents are available, e.g. matrix or yarn/roving data sheet, please mention it here.

The preform producer commits to filling out the template with data and information according to the “manual of uses” in reference.

The characteristics and properties mentioned in the template should be measured following international standards. Preform producer commits to respect this policy and to fill out the appropriated data following the methods described in the international standards, and the guidelines provided.

The contents (=filled out data) of the technical data sheets are under the responsibility of the company providing the data sheets.



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