

THEORETICAL CONSIDERATIONS ON THE MICROMECHANICS COMPOSITE MATERIALS

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Abstract: the efficiency of a composite material is distinguished by the top level of the technical characteristics and its properties. For their study, it appeals to a number of considerations, such as: minimum dimensions of the primary elements of reinforcement section, made up of fibres or threads; the high volumetric fraction ($V_f > 0.5$); knowledge of the geometry of reinforcement phases. These considerations lead to the concept of composite plate.

Keywords: composite, reinforcement, fibre, straw.

1. INTRODUCTION

The effectiveness of a composite material is distinguished by the top level of the technical characteristics and its properties. For their study, it appeals to a number of considerations, such as: minimum dimensions of the primary elements of reinforcement section, made up of fibres or threads; the high volumetric fraction ($V_f > 0.5$); knowledge of the geometry of reinforcement phases. These considerations lead to the concept of composite plate.

A composite tab is a thin layer of composite material consisting of a single reinforcement and the matrix corresponding to (Fig. 1).

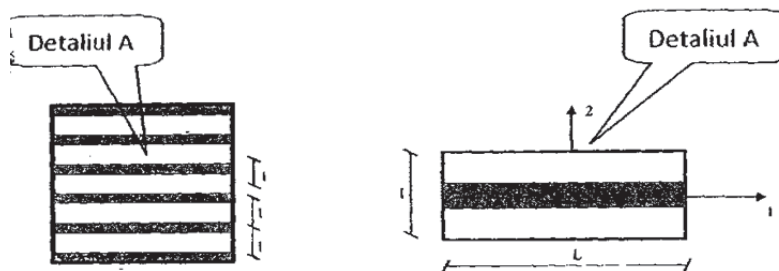


Fig. 1. Composite plate.

In practice, a composite material is composed of several straws that are studied on the basis of a representative elementary volume (VER). Characteristics of composite VER are shown in Figure 1 b), respectively: the distance between the wires, layer thickness (distance between the strands layer) – if there are several layers of arbitrary size. In this context, VER is the smallest part of the tensions and composite deformations are evenly distributed from the macroscopic point of view.

To study the properties of the composite should be provided:-VER site obtained by cross cutting of composite to be constant on the full length L (Fig. 2).

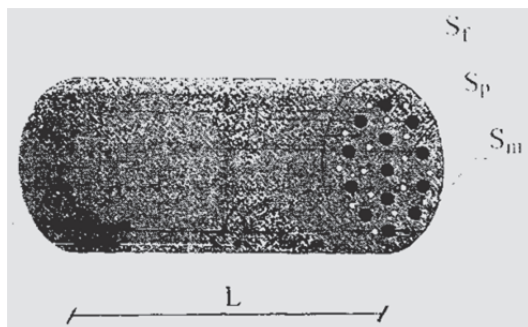


Fig. 2. Elementary volume VER:
 S_m – matrix surface; S_f – thread surface; S_p – surface of porosities; L – length of VER.

2. MATHEMATICAL RELATIONSHIPS OF VER

Table 1 presents the mathematical relations of VER.

Table 1

Geometric element name	Symbol	Mathematical relations	Comments
Cross-sectional area	S	$S = S_m + S_p + S_f$	
The volume of the VER.	V^*	$V^* = S \cdot L$	
The volume of the matrix	V_m^*	$V_m^* = S_m \cdot L$	
Volume conductors	V_f^*	$V_f^* = S_f \cdot L$	
Porozitatil or volume	V_p^*	$V_p^* = S_p \cdot L$	
The matrix mass	M_m	$M_m = V_m^* \cdot \rho_m$	ρ_m = density matrix
The mass of wires	M_f	$M_f = V_f^* \cdot \rho_f$	ρ_f = thread density
Composite mass	M	$M = M_m + M_f$	

Using relations in table 1 can be calculated:

Composite mass M

$$M = V_m^* \cdot \rho_m + V_f^* \cdot \rho_f \tag{1}$$

Composite volume V

$$V^* = V_m^* + V_f^* + V_p^* \tag{2}$$

Composite color density ρ

$$\rho = \frac{M}{V^*} = \frac{V_m^* \cdot \rho_m + V_f^* \cdot \rho_f}{V^*} \tag{3}$$

where:

$$\rho = V_f \cdot \rho_f + V_m \cdot \rho_m \tag{4}$$

It follows the volumetric fractions:

$$V_f = \frac{V_f^*}{V^*} ; \quad V_m = \frac{V_m^*}{V^*} ; \quad V_p = \frac{V_p^*}{V^*} \tag{5}$$

or

$$\rho = \frac{M}{V^*} = \frac{M_f}{\rho_f} + \frac{M_m}{\rho_m} + V_p^* \tag{6}$$

where:

$$\rho = \frac{1}{\frac{m_f}{\rho_f} + \frac{m_m}{\rho_m} + \frac{V_p^*}{M}} \tag{7}$$

with mass fractions

$$m_m = \frac{M_m}{M} ; \quad m_f = \frac{M_f}{M} \tag{8}$$

3. STUDY OF THE TENSION IN THE COMPOSITE

Tensions in the composite Media considered is given by:

$$\bar{\sigma}_i = \frac{1}{V^*} \int_{V^*} \sigma_i dV^* = \frac{1}{V^*} \left[\int_{V^*} \sigma_i dV^* + \int_{V_m} \sigma_i dV^* \right] \tag{9}$$

where σ_i are void in the pores of composite.

For composite material reinforced with fire in one direction, it is considered triortogonal system axes:

- axis 1 along the wires;
- axis 2 perpendicular to axis 1, defines the width of the armed unidirectional composite (Fig. 3.c), obtained by extension of VER (Fig. 3.b);
- axis 3 is perpendicular to the axis 1 and 2.

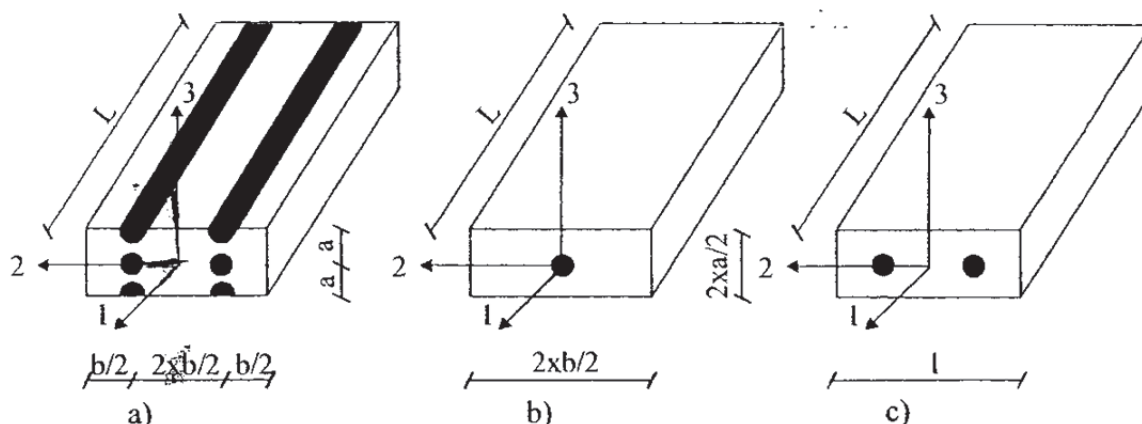


Fig. 3. Composite material reinforced with fire in one direction.

4. CONCLUSIONS

For the study of micromechanics composite slats, one must meet the following conditions:

– *the tab to be*: macroscopically homogeneous; linear elastic; orthotropic examination; without initial tension;

– *the fibers to be*: homogeneous; linear elastic; isotropic; arranged at equal intervals; perfectly aligned;

– *the array to be*: linear elastic; homogeneous; isotropic.

In these circumstances, there are no flaws in strings and arrays to interface between them.

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CONSIDERAȚII TEORETICE PRIVIND MICROMECHANICA MATERIALELOR COMPOZITE

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Rezumat Eficiența unui material compozit se remarcă prin nivelul superior al caracteristicilor tehnice și al proprietăților acestuia. Pentru studiul acestora, se face apel la o serie de considerații, cum ar fi: dimensiunile minime ale secțiunii elementelor primare ale armăturii, alcătuită din fibre sau fire; fracțiunea volumetrică a firelor ridicată ($V_f > 0,5$); cunoașterea geometriei fazelor armăturii. Respectarea acestor considerații conduce la noțiunea de lamelă compozită.