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STUDY REGARDING THE IMPROVEMENT OF THE ANGLE OF ATTACK (2κ) OF THE BORERS DURING THE REMAKING OF POLYMERIC COMPOSITE MATERIALS

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Abstract: *Owing to the physical and mechanical properties, the composite materials bring up special problems at the remaking by splinting. In this work, there are a series of results obtained experimentally and a study regarding the improvement of the angle of attack (2κ) of the borers during the remaking by perforating the composite materials with polymeric matrix and wired glass.*

Key words: *composite material, piercing, remaking.*

1. INTRODUCTION

This work presents a study regarding the remaking feature in the piercing of the composite materials with polymeric matrix reinforced with glass fibers.

Concerning the advantages offered by these materials such as: much harness, good mechanical resistance, high resistance to wearing and corrosion, one can ask the question why these materials aren't used in industrial application more often. One of the reasons is their remaking feature.

In using the composite materials reinforced with fibers, there are two big fields of production: processing in order to get a high dimensional precision and processing by perforating for fast joining.

The composite materials don't have a homogenous structure and their processing feature is completely different from the „isotrope" homogenous materials like steel or cast iron [1].

The processing of the polymeric composite with fibers needs fundamentally different requirements and condition from the processing conditions of metals.

Moreover, the processing of the polymeric composite with fibers is also influenced by the characteristics of the type of fiber, the number of strata, the orientation of the fiber, its size, the material of the matrix, which simply increase the number of parameters that influence the processing feature. [2]

2. CONDITION OF EXPERIMENTATION

In order to establish the geometrical characteristics of the tools used in the processing by perforating the polymeric composite materials, one has studied the influence of the angle at edge of the classical helicoids borers over the variation of the forces and moments of splinting. [3].

For this study a stand of experimentations was used (Figs. 1 and 2).

The machine tools used;

- boring machine GU25;
  – power of work: 2.3 KW;
  – gamma of rotations: 28…2 240 rot/min;
  – gamma of advances: 0.08…0.25 mm/rot.

The characteristics of the splintering tools:

- helical drills: Φ7, Φ8, Φ10, Φ12, Φ14 with 2κ = 130° of Rp5 cu HRC 62

The characteristics of the polymeric composite material that has been studied:

- probe structure:
  – polyester resin HELIOPOL 4231 ATX;
  – glass fiber.

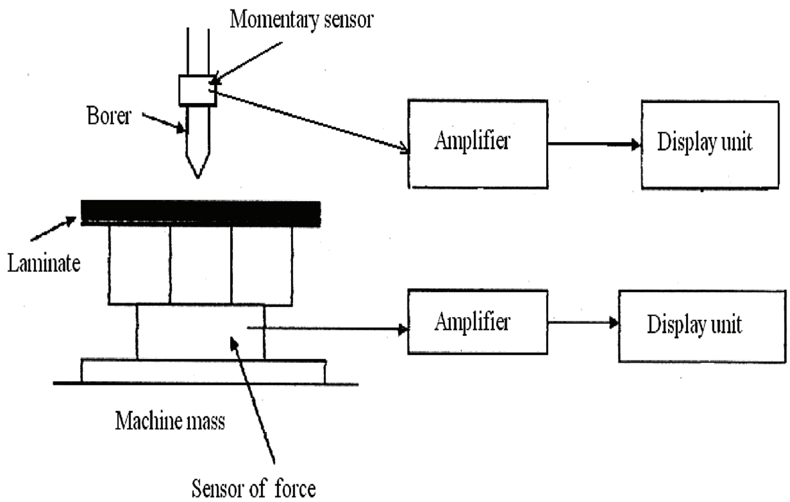

Fig. 1. The schematic representation of the stand of determination.

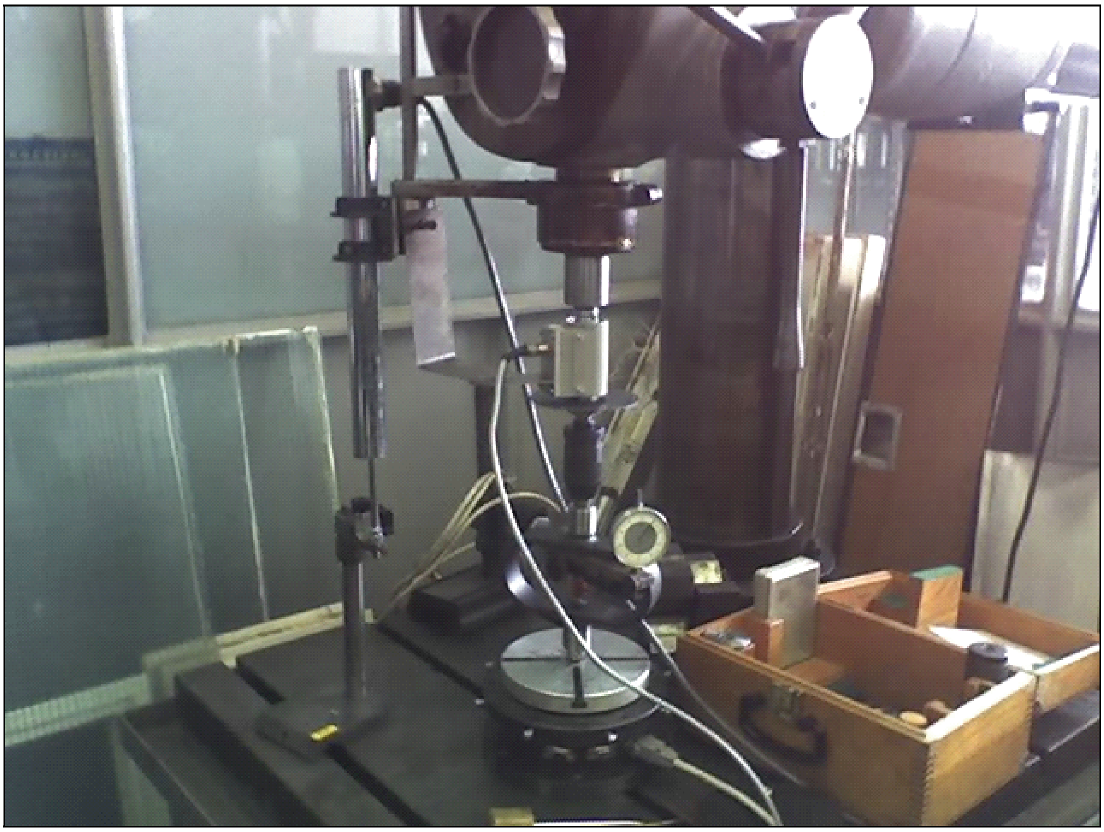

Fig. 2. The image of the stand of determinations with the force moment pickup and the registration system.

- polyester resin HELIOPOL 4231 ATX:
  – viscosity (23°C) DIN 53211 (65–80) s;
  – gel Time HELIOS KM 3205 (5–11) min;
  – acid Number DIN EN ISO 3682 30 mg KOH/g;
  – styrene Content DIN EN ISO 3251 (40–45)%;
  – density ISO 2811 (1 100–1 150) kg/m^3m;
  – flash Point ISO 367 34°C.
- Glass fiber CSM-450-1900 (STRATIMAT)
  – is made out of E type glass fiber;
  – time to dissolve the binder in styrene, max.60 s;
  – specific weight ISO 4605 450 g/m^2m;
  – width ISO 5026 100 cm;
  – humidity ISO 3344 0.2%.

In order to measure the axial forces of splintering one used a pickup for measuring the processing forces, made in The T.C.M. Department, I.M.S.T. Faculty [4].

In order to measure the moments of splinting at piercing, a Hettinger pickup of moments was used, which was set on the axle of the boring machine.

For the display of the registration made by the pickup of forces and the pickup of moments, a N2300 electric dynamic tensometer is used.

The gauging of the pickup of forces was made with a lab dynamometer which bears a maximum loading of 10 kN compression read on a comparator with dial with the division value of 0.01 mm and an average constant value of gauging for the forces was obtained:

$$K_F = 6.9 \text{ N/div.}$$

The gauging of the pickup of moments was made with a dynamometrical spanner projected and made in The T.C.M. Department, getting an average constant value of gauging for moments:

$$K_F = 0.09 \text{ Nm/div.}$$

During the determinations, the same splintering parameters were kept, registering the variation of the forces and moments of splintering.

The result of these determinations is in Table 1.

3. THE IMPROVEMENT OF THE ANGLE OF ATTACK (2κ) OF THE BORERS ON THE BASIS OF VARIATION OF THE AXIAL FORCES OF SPLINTERING

Using the coefficient of gauging of the forces

$$K_F = 6.9 \text{ N/div.}$$

Table 1

The registrations of the influence of the angle at the edge (2κ) over the forces and moments of splintering

Nr. crt.	Angle at the edge 2κ [°]	Advance *s* [mm/rot]	Rotation *n* [rot/min]	Speed splintring *v* [m/min]	Forces [div.]	Forces [N]	Moments [div.]	Moments [Nm]
1	113	0.125	355	11.15	16	110.4	12	1.08
2	146	0.125	355	11.15	11	75.9	9.5	0.85
3	136	0.125	355	11.15	12	82.2	10	0.90
4	126	0.125	355	11.15	12	82.2	9	0.81

on the basis of the registered divisions, the values of the axial forces of splintering are calculated in this way:

$$F_1 = 16 \cdot 6.9 = 110.4 \text{ N};$$

$$F_2 = 11 \cdot 6.9 = 75.9 \text{ N};$$

$$F_3 = 12 \cdot 6.9 = 82.8 \text{ N};$$

$$F_4 = 12 \cdot 6.9 = 82.8 \text{ N}.$$

Using de angle at the edge (2κ), as a variable, on the basis of the determined value of the axial force of splintering, one sets out the chart of function F (2κ), like in Fig. 3.

After setting out this variation of the axial force of splintering according to the angle at the edge, a parabola is obtained.

We write the equation of variation of the axial force of splintering according to the variation of the angle at the edge 2κ in this way:

$$F = a(2\kappa)^2 + b(2\kappa) + c. \quad (1)$$

In this equation, replacing the values of the angle at the edge that are used and the values of the axial force of splintering that are registered; one gets a system of four equations with three unknown quantities.

Solving this system leads to the determination of the coefficients a, b, c in equation (1).

$$a = 0.065$$

$$b = -17.64$$

$$c = 1273.73.$$

Result the function of regression by force:

$$F = 0.065(2\kappa)^2 + 17.64(2\kappa) + 1273.73 \ \text{[N]}. \quad (2)$$

With these values of the coefficients, from the equation of the variation of the axial force of splintering according to the angle at the edge (2κ), asking the condition of the minimum of the splintering force, one determines the value of the best angle of attack, which is:

$$2\kappa = 135.7°.$$

For this value of the angle of attack, an axial minimum force of splintering results:

$$F = 76.9 \text{ N}.$$

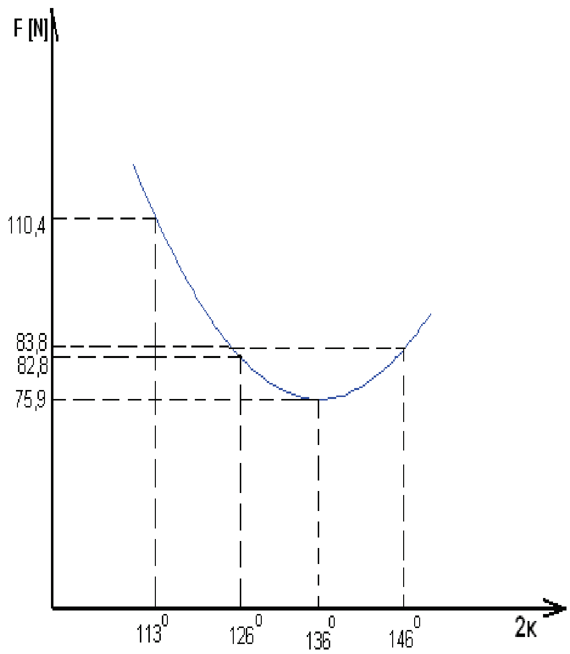

Fig. 3. The variation of the axial force of splintering according to the angle at the edge (2κ) of the borer.

4. THE IMPROVEMENT OF THE ANGLE OF ATTACK (2κ) OF THE BORERS OF FROM THE POINT OF VIEW OF THE VARIATION OF THE MOMENTS OF SPLINTERING

On the basis of the results registered in Table 1 and by means of the coefficients of gauging of the moments determined:

$$K_M = 0.09 \text{ Nm/div}.$$

one determines the moments of splintering:

$$M_1 = 12 \cdot 0.09 = 1.08 \text{ Nm};$$

$$M_2 = 11 \cdot 0.09 = 0.99 \text{ Nm};$$

$$M_3 = 8 \cdot 0.09 = 0.72 \text{ Nm};$$

$$M_4 = 9 \cdot 0.09 = 0.81 \text{ Nm}.$$

Using the angle at the edge (2κ) as a variable, on the basis of the determined values of the moments of splintering, one sets out (Fig. 4) chart of function M(2κ).

Similar to the forces of splintering, the variation of the moments of splintering according to the variation of the angle at the edge (2κ) has also the form of a parabola.

We write the equation of variation of the moments of splintering according to the variation of the angle at the edge 2κ) in this way:

$$M = a_1(2\kappa)^2 + b_1(2\kappa) + c_1. \quad (3)$$

In this equation, replacing the value of the angle at the edge that are registered, one gets a system of four equations with three unknown quantities. Solving this

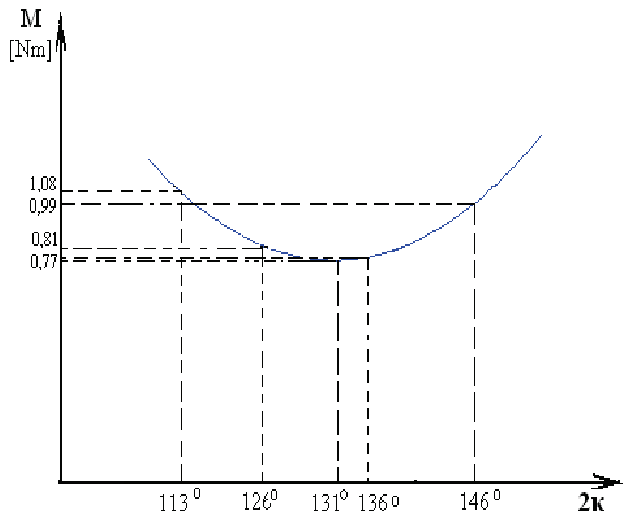

Fig. 4. The variation of the moments of splintering according to the edge (2κ) of the borer.

system leads to the determination of the coefficients a,b,c in equation (3).

$$a_1 = 9.55\cdot10^{-4};\ b_1 = -0.25;\ c_1 = 17.136.$$

It results the function of regression by moments:

$$M = 9.55\cdot10^{-4}(2\kappa)^2 - 0.25(2\kappa) + 17.136. \qquad (4)$$

With these values of the coefficients, from the equation of the variation of the moments of splintering according to the angle at the edge (2κ), asking the condition of the minimum of the moments, one determines the value of the best angle of attack, which is:

$$2\kappa = 131°$$

For this value of the angle of attack, a minimum moment of splintering results:

$$M = 0.77\ \text{Nm}.$$

5. CONCLUSIONS

As a result of the theoretical and experimental research, the following have been rendered evident:

In order to measure the forces of splintering at piercing, one used a pickup for measuring the forces of processing equipped with resistive electrical translator of the Hottinger type.

In order to measure the moment of splintering at piercing, one used a pickup of moments of the Hottinger type, which was set on the axle of the boring machine.

One determined the values of the angle at the edge of the border of 2κ =135.7°, for which the forces of splintering have minimum values (F = 76.9 N).

It has been determined that the values of the angle at the edge of the border of 2κ =131°, for which the moments of splintering have minimum values (M = 0.77 Nm).

With the values that are obtained, one choose the nearest value from the tool catalogues, respectively, 2κ = 130°, a value which is also in the catalogues of the firms producing tools (Dormer, as the best angle used in the processing of the composite materials).

In the experimentation, coolant fluids were not used because of their abrasive action over the splintering tool.

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