A New Energy-Saving Method for Assessing the Degree of Layer Distribution When Drilling Polymer Composite Materials

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Abstract: The use of a new method of detecting layer titration during the drilling of polymer composite materials makes it possible to know in advance the appearance of defects in the holes and received possible treatment. The area of damaged areas around the hole can be determined in different ways. The use of modern RDB machines when drilling holes allows you to change the cutting tool to a similar diameter and continue processing when drilling a single hole.

Keywords: Drill, rentgen light, layer, tremor, thunder, scanning microscope.

Introduction.

Mechanical processing of polymer composite materials (PKM) has a number of specific features determined by the uniqueness of their structure and properties. Composites made of metal have anisotropy with specific properties [1]. The alternation of binder and metal layers affects the periodic change of the mechanical and thermophysical properties of the material, as well as its processing properties during the pushing movement of the tool. When developing a technological operation, it is recommended to take into account the processing in relation to the durability of PCM. It provides up to 20% saving of electricity.

Controlling the roughness of the processed composite surface in production conditions is a more complicated process than that of metals. Due to the special polymer structure, there are no comparison samples of surface roughness for composites. In this regard, quality control of the processed surface is carried out using measuring devices.

The tool must be sharp for processing layered compositions. The slag sticking to the drill leads to breakage of the cutting tool and the appearance of cracks, as a result of which movement of the machined surface occurs. The quality of the holes decreases, the height parameters increase the roughness of the surface, cracks are formed at the exits of the drill [3].

An increase in the processing route reduces the efficiency of operations and increases the working time of the machine, as a result of which the technological cost increases. Surface roughness is more affected by feed from machining modes than cutting speed. An increase in the amount of thrust leads to an increase in axial shear force, under the influence of which unsheared layers of the composite appear. (Picture1)
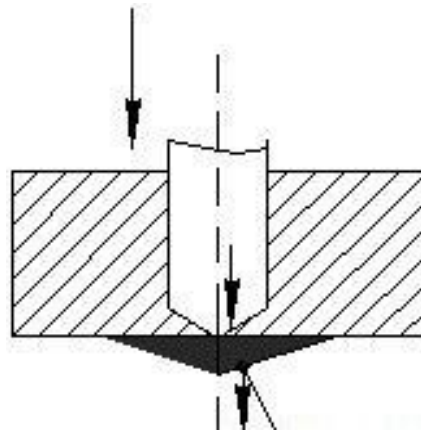
Picture1. Occurrence of surface irritation

The following are the methods of control of cracking in the processing technology of polymer composite materials (Picture 2)

A scanning electron microscope was used to determine the diameter of the maximum damaged area around the hole (Picturee 3). The value of titration was calculated by:

$$F_d = \frac{D_{max}}{D}, \quad [2]. \tag{1}$$

Here, Fd is the value of friction, Dmax is the maximum damaged diameter around the hole, and D is the nominal hole diameter.

$$F_R = R_{max} - R \tag{2}$$

According to the figure, the accuracy of the holes was defined as the accuracy in each layer.

The diameter of the hole in the PKM layer, which has a coefficient of thermal expansion close to zero, exceeds the nominal size by 5 μm after processing [4].
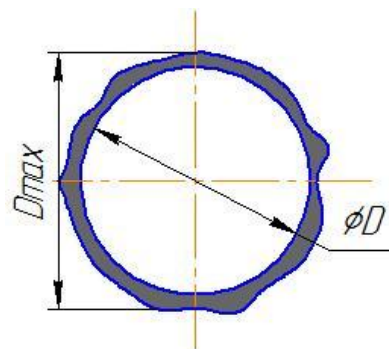

Fig. 2. The scheme of determining the dimensions of the crack according to the ratio of diameters

The area of damaged areas around the hole can be determined in different ways. Samples of the cleaned holes can be preserved in a chemical medium and the following image can be obtained through X-rays.
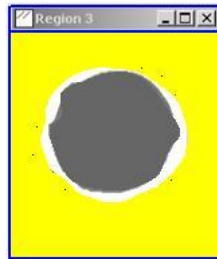
Figure 3. Detection of cysts by radiography

The area of the gray hole in the picture is the area of the white color.

The DRAT size of the hole circumference is defined as the ratio of the maximum damaged area around the hole DMAR to the nominal area of the hole A_{AVG}:

$$D_{RAT} = \frac{D_{MAR}}{A_{AVG}}, \qquad (3)$$

The area of delicacy can be determined by expressing it as a percentage of the nominal area of the hole.

$$DF = \frac{A_{del} - A_{nom}}{A_{nom}} \times 100\% \qquad (4)$$

where DF is the percentage of shrinkage, Adel is the area of the damaged area around the hole, Anom is the nominal area of the hole.

Methods for determining the value of Fda sets were used by Durao. The applied formula takes into account the maximum damaged diameter around the hole and this area (5).

$$F_{da} = a \frac{D_{max}}{D} + \beta \frac{A_{max}}{A} \qquad (5)$$

where Dmax and Amax are the maximum diameter and area of the bundles around the hole; D, A - nominal diameter and area of the hole; a, b are significant parameters of each relationship ($\alpha + \beta = 1$).
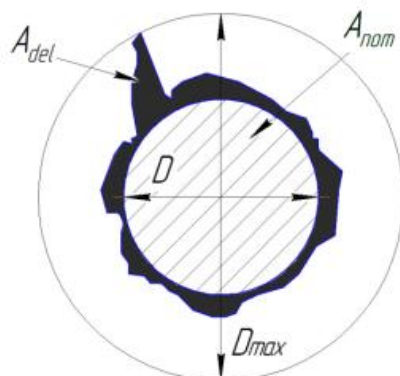

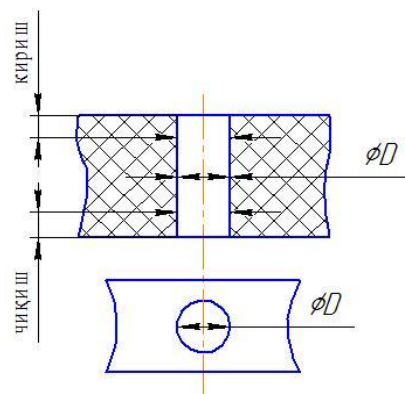**Figure 4. The scheme of detection of titrations**

Figure 5. Scheme of measurement of processed holes

The analysis of the cases showed that the geometry of processing the holes in carbon fiber products is accompanied by the formation of a crack that does not have a regular shape. In this case, it is recommended to use expressions (3) - (4) taking into account the area of defective areas

to achieve the correct result. According to the figure, the accuracy of the holes was defined as the accuracy in each layer.

Conclusion

The use of a new method of determining the thickness of the layer during drilling of polymer composite materials made it possible to predict the appearance of defects in the holes and prevent possible problems. The area of damaged areas around the hole can be determined in different ways. The use of modern RDB machines during drilling made it possible to change the cutting tool to a similar diameter during drilling of a single hole and continue processing.

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