ASPECTS RELATED TO CUTTERS DESIGNED FOR MANNUAL FEEDING

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Abstract
The milling represents the operation with the highest weight in the assembly of the processes of wood chipping, furniture and other finite products manufacture. As a consequence this is the subject of high importance both in research and especially in industrial application.

Key words: milling, kinematical parameters, kinematical parameters.

INTRODUCTION

The safety operation in wood cutting processes represents a main issue which is also embedding several aspects. These aspects target the wood cutting machine, wood cutting tool, work safety appliances and equipments, etc. In this paper we shall present several aspects related to work safety, and cutting machines and tools manufacturing. References will be made in the case of the cutters employed/used in the cases of the cutting machines with manual feeding, these ones being in a larger proportion.

MATERIALS AND METHODS

Cutting machines used for manual feeding

A manual feeding represents the manual leading and pushing the wood piece, without employing grips/catching or leading devices. The manufacturing principle in the case of these wood cutting machines consists in limiting the chip thickness, and the chip void width (Figure 1). Limiting the maximum thickness of the chip is performed through constructive measures and it has to be of 1.1mm max throughout the entire thickness of the profile. The size which characterises the maximum thickness is h] = (Di - D_2):2 where D1 represents the blade diameter where D_2 represents the catcher diameter.

In the case of cutting machines used with manual feeding, the limitation of the chip maximum thickness (the presence of the catchers) is compulsory. In this manner, the feeding in case of every blade is limited, and so they are the manual feeding, and the risk situation potentially harmful to the worker, who could "catch" his fingers into the cutter's blades.

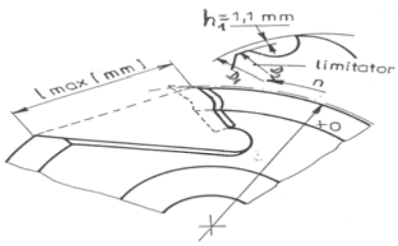

Fig.1.

The limitation of the feeding for every blade /knife results from the equation:

$$a_{\max} = 2u_z\sqrt{\frac{h}{D}}$$

Where a_{max} represents the maximum thickness of the chip, a_{max} =1.1 mm, h – cutting deepness while D – Blades diameter

Out of this it results the following equation:

$$u_{z\,max} = \frac{a_{\max}}{2}\sqrt{\frac{D}{h}} = 0{,}55\sqrt{\frac{D}{h}}$$

For example: for D = 100 mm and h = 10 mm, it results a maximum feeding/knife of 1.7 mm.

From this equation it results the following: as deeper the depth cut is (cutting effort increases), as smaller the maximum allowed feeding for every knife is. Thus, the worker who performs the manual feeding is protected, but so they are the cutting tool and the cutting machine.

From the above mentioned it results that the cutters having a limited chip thickness (at 1.1mm) decreases the return of the wood pieces in the opposite direction of feeding direction and diminishes the risks of injuries for the worker. The worker even if he "catches" his finger in the cutter, the catchers diminishes the risk for the worker to chop off his fingers.

The second condition that must be fulfilled by the cutters with manual feeding is represented by the presence of a chip void as small as possible, while the cutter blade must have a round shape; thus, in the case of a potential contact between the workers' fingers and the cutter, the consequences of the accident would be reduced.

For that, the maximum admitted length of the chip void l_{max} is set according to the circle described by the cutter blade (See Figure 1) according to the following equations:

l_{max} = 0,235 D + 7,2 mm for 16 < D < 80 mm

l_{max} = 0,1D +18 mm for 80 < D < 250 mm

l_{max} = 43 mm for D > 250 mm.

For example, in the case of a cutter having a 120 mm diameter, l_{max} resulted is equal to 0.1.120+18 = 30 mm.

The third condition for the cutters with manual feeding is the return behaviour. The return occurs when the cutting force component which acts in opposite direction against the feeding is larger than the feeding force. This component depends upon several factors, among which the most important is the revolution direction of the cutter as against the feeding direction and the cutting force strength. If the revolution and the feeding direction are both the same, the return risk is reduced. But if the revolution direction is contrary to the feeding direction (general case) than the return depends upon the cutting force strength; the latest one is depending upon several factors among which the wood species, the feeding for every knife, the cutting depth, and the knives wear (abrasion), the knives' geometry, etc. The cutting force may be expressed as following:

$$F = K.a_{\max}.b = 2K.u_z.\sqrt{\frac{h}{D}}b = 1{,}1.K.b$$

where K is the specific cutting resistance and b is cutting width.

From the previous theoretical and experimental studies it results that the largest influence upon F and F_0 forces is represented by the blade wear (abrasion), as a consequence, the return phenomenon occurs especially in the case of cutting tools having torn cutting blades.

The influence of the blade wear (abrasion) is higher on the F_0 force, causing "in fact" the rejection of the wood piece by the cutting tool and thus facilitating the possibility for the worker to "catch" his fingers into the cutting tool. As a consequence, the cutters with manual feeding must be sharpened periodically and attentively: one must not perform any work using cutters with worn out blades.

Within return testing conditions one set a report/ratio between the cutting speed v against the return speed v_r, and this one has to be the following $v/v_r > 0.25$. In order to set the values of this report the following conditions must be fulfilled:

- The automat release of the return
- Cutting speed v = 40 m/s – beech species
- Cutting depth h = 10 mm
- worn out blades (after 3 working hours)
- Cutting width b = 40 mm.

The experimental studies performed with cutters on manual feeding, using "pork tails" as simulating elements instead of human hands showed that the report $v/v_r < 0.25$ is fulfilled and the pork tails were not chopped, but they showed only superficial cuts on their surface. As a consequence, the danger to chopping off the fingers is eliminated.

The cutters with manual feeding must have on their block the inscription - MANUAL FEEDING – and the maximum r.p.m. (number of revolutions per minute).

RESULTS AND DISCUSSIONS

In the Figures 3 & 4 are presented three cutters with manual feeding. By repeated sharpening operations the value of blade lobe is being diminished over the cutter's circumference. A 0.5 mm minimum value for this lobe is accepted, where the maximum feeding per knives is of:

$$u_z = \frac{a_{\max}}{2}\sqrt{\frac{D}{h}} = 0,25\sqrt{\frac{D}{h}}$$

Fig.2.

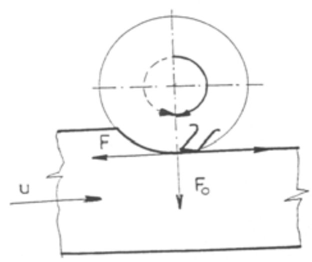

Figure 2

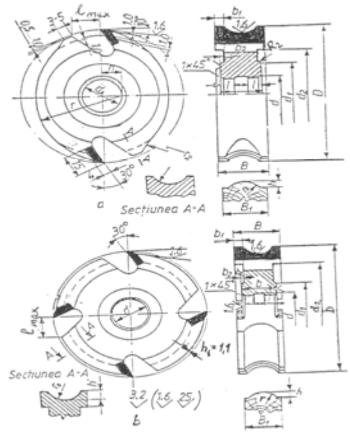

Fig.3. Freze cu limitarea avansului pe dinte

Figure 3 Cutter with limited feeding per knife

For example, for D = 100 mm and h = 10 mm, it results that $u_2max \sim 0.8$ mm/knife.
If the feeding per knife is larger than the resulted value, the wood piece hit behind the knife, the feeding speed being thus limited.

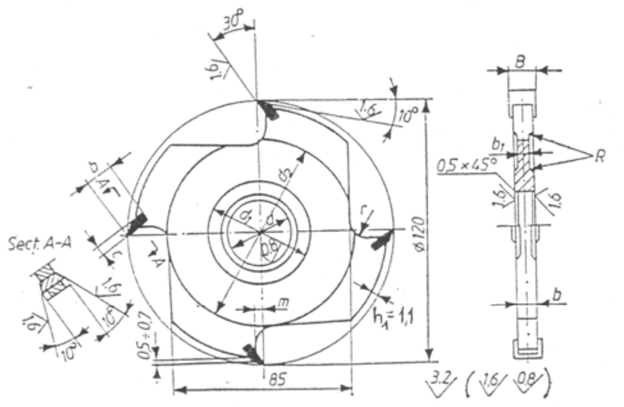

Fig.4. Freză cu limitarea avansului pe dinte

Figure 4. Cutter with limited feeding per knife

Form the analysis of the above mentioned ratio it results that the maximum value of the knife feeding depends upon the D/h report, so it depends upon the cutter's diameter and the cutting depth. As a consequence, this value decreases at higher cutting depths and smaller cutters diameters.

In the case where the blade lobe overcomes the cutter's circumference one suggests that the knives re-plating and re-making their initial geometry. Thus, the company SC ASCO TOOLS SA Codlea is currently performing re-coating activities, re-sharpening, balancing and the re-making of initial geometry of all knives.

In re-using the cutters with manual feeding, the cutting speeds shall be more reduce than in the case of cutters with manual feeding due to the safety operation condition. Thus, the following values are showed:

- Massive wood (soft and hard textures)

v = 40 - 60 m/s for the alloy steel blades
v = 40 - 70 m/s for the sintered hard cutting alloy (SMC)
- Plates (PAL, PFL, PAF, plywood)
v = 45 - 70 m/s for SMC blades
- Hard plates or plates covered in plastic layers
v = 40 - 60 m/s for SMC blades

CONCLUSIONS

In the case of the cutters with semi-mechanical feeding, the h1 distance, namely h1 = (D1 - D2):2 is 10 mm at maximum. The semi-mechanic feeding is the feeding achieved through devices which suppresses the contact between the worker's hand and the wood piece. In this manner, the return force of the piece is diminished and the injury risk diminishes.

The cutters designed for semi-mechanical feeding must show the – SEMI-MECHANICAL FEEDING – mark.

The cutters designed for mechanical feeding do not face any restrictions related to the presence of some catchers, their safety operation being fulfilled by the intermediate of some other elements enclosed in their construction which will be dealt with in a subsequent publication. All these cutters must show the –MECHANICAL FEEDING – mark.

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