THE ANNALS OF "DUNAREA DE JOS" UNIVERSITY OF GALATI
FASCICLE XIV MECHANICAL ENGINEERING, ISSN 1224-5615
2006

COST OPTIMIZATION AT THE WORM CUTTER SPLINTING

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ABSTRACT

In order to get goods at the worm cutter splinting, an important method is to reduce the energetical charging and the cinematic unevennesses. It is explain that the costs are important to get a good price at the splinting process. During the splinting, there are a lot of unevenness aspects, that can be classified in two categories : - dynamic unevenness, regarding on the cutting edges charging during the splinting; and cinematic unevenness, regarding on the tooth's generation principle. The paper presents a method to determine the cinematic unevenness maximum value which is the base for a further analise in order to reduce it.

1. GENERALITIES

It is well known that the most precise possibility in the tooth processing is the worm cutter splinting. The proceeding has also some disadvantages, the most importance of them might be called unevennesses. These unevennesses are:

- dynamic unevennesses - regarding on the cutting edges charging during the splinting;
- cinematic unevennesses - regarding on the tooth's generation principle.

Because of the edge charging, which for the same tooth have very different values and also very different values for the whole cutting worm, the dynamic unevennessses generate shocks and vibrations.

These unevennesses usually settled the splinting parameters high values. It does not matter the tooth generating principle, because it does not matter the precision or the productivity.

Cinematic unevennesses generate profile deviation, which indicates the worm cutter will be use for (low or high precision).

In this situation it is important the

working principle because the splinting cinematic is affected and also the precision.

The aim of the present paper is to analyse the cinematic kind of unevennesses. It is proposed a mathematic calculus model in order to get the profile error inserted by flank working.

2. CALCULUS METHOD

It is presented in figure 1 the diagram that helps in the calculus from now on. In the diagram it can by seen 2(two) successive position of the cutting edge, *k-1* and *k* teeth.

These teeth' cutting edges are tangent with the involute profile in C^{k-1} and C^k points and the intersection of the splinted surfaces is in *I* point.

The profile error is the distance from the involute flank to the *I* point , or, the distance on the basic circle, between the profile involute and a involute parallel with the first one that goes through *I* point. The equation for the *k* tooth edge is:

$$\frac{Y - Y_V^k}{Y_M^k - Y_V^k} = \frac{Z - Z_V^K}{Z_M^K - Z_V^k} \tag{1}$$

The expression (1) may be also wrote:

$$Y\frac{Z_M^k - Z_V^k}{Y_m^k - Y_v^K} - Y_k^k\frac{Z_M^k - Z_V^k}{Y_M^k - Y_V^k} + Z_V^k = Z \tag{2}$$

From C^k point it is considered the perpendicular on the edge *k*. The perpendiculars family is described by the equation:

$$Z = Y\left(-\frac{Z_M^k - Z_V^k}{Y_M^k - Y_V^k}\right) + A \tag{3}$$

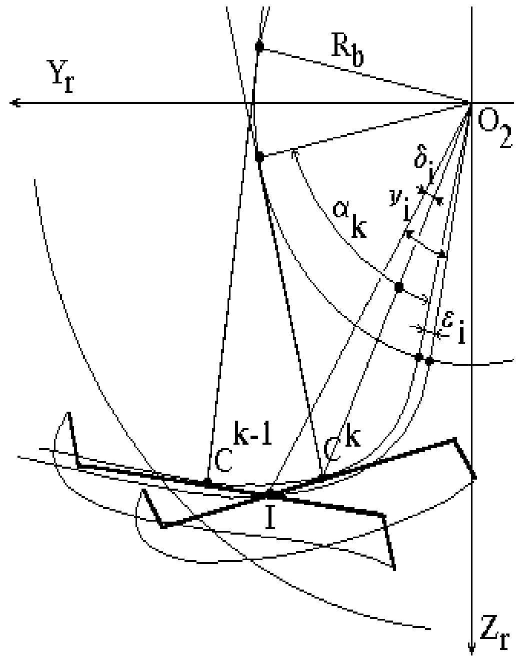

Fig.1 - Two successive positions of one tooth during the splinting

In the expression (3) A is a coefficient and it can by determined from the condition that the straight line described by (3) is tangent with the basic circle which equation is:

$$Z^2 + Y^2 = R_r^2 \tag{4}$$

If the expression (3) is insert in expression (4) it results:

$$Y^2\left(\frac{Y_M^k - Y_V^k}{Z_M^k - Z_V^k}\right)^2 + A^2 - 2AY\frac{Y_M^k - Y_V^k}{Z_M^k - Z_V^k} + Y^2 - R_b^2 = 0 \tag{5}$$

The single point tangent condition is that the two solutions of the equation (5) are identical:

$$A^2\left(\frac{Y_M^k - Y_V^k}{Z_M^k - Z_V^k}\right)^2 - \left[1 + \left(\frac{Y_M^k - Y_V^k}{Z_M^k - Z_V^k}\right)\right]\cdot\left(A^2 - R_b^2\right) = 0 \tag{6}$$

If $B = \frac{Y_M^k - Y_V^k}{Z_M^k - Z_V^k}$ (7)

From expression (6) results:

$A^2B^2 - A^2 + R_b^2 - A^2B^2 + B^2R_b^2 = 0$, or

$A^2 = R_b^2\,(1 + B^2)$, or

$$A = R_b \cdot \sqrt{1 + B^2} \tag{8}$$

It is possible now to determine the expression (3):

$$Z = -B \cdot Y + A \tag{9}$$

From the expression (2)

$$D = -Y_V^k \cdot \frac{Z_M^k - Z_V^k}{Y_M^k - Y_V^k} + Z_V^k,$$

then, (9) become: $Z = \frac{Y}{B} + D$ (10)

In these conditions, the C point is situated at the intersection between the straight lines with the equations (9) and (10)

$$\begin{cases} Y_C^k = \dfrac{B\cdot(A - D)}{1 + B^2} \\ Z_C^k = \dfrac{A + B^2\cdot D}{1 + B^2} \end{cases} \tag{11}$$

The involute that goes through the C^k point leads to:

$$\gamma_k = tg\alpha_k - \alpha_k, \quad \text{where} \tag{12}$$

$$\alpha_k = \arccos\frac{R_b}{R_C^k}, \quad \text{and}$$

$$R_C^k = \sqrt{Y_{C^k}^2 + Z_{C^K}^2}$$

Similarly, the involute that goes through I point leads to:

$$\gamma_i = tg\alpha_i - \alpha_i, \quad \text{where} \tag{13}$$

$$\alpha_i = \arccos\frac{R_b}{R_i}, \quad \text{and}$$

$$R_i = \sqrt{Y_{C_i}^2 + Z_i^2}$$

The angle δ_I is determined with:

$$\delta_I = arctg\frac{Z_C^k}{Y_C^k} - arctg\frac{Z_i}{Y_i} \tag{14}$$

Finally, it is obtained the ε_I angle:

$$\varepsilon_I = \gamma_i - \delta_I - \gamma_k \tag{15}$$

The poligonalization error, - a_p -, can by determined with the expression:

$$a_p = R_b \cdot \varepsilon_I \quad (16)$$

3. CONCLUSIONS

The above presented calculus model leads to the followings conclusions:

- The maximum profile error at a cutting worm processing with uncompleted edges from carbide plates, like in diagram 2, is 53µm .
- The maximum profile error at a normal cutting worm processing, is 13 µm.

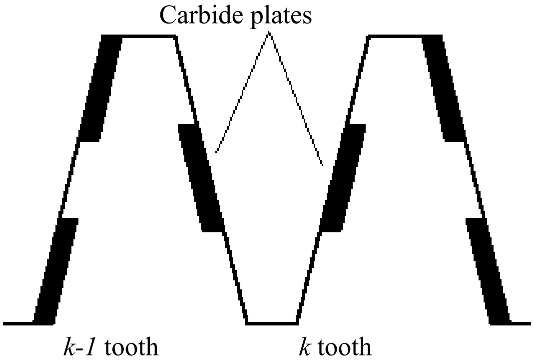

Fig.2 - Uncompleted cutting edges from carbide plates

Both situations show that the cutting worm with carbide plates can be also use at the finishing processing .

4. ESTIMATING RELEVANT COSTS

There are some others important parameters that influence the price. It is recommended to take into consideration all the influence factors.

The essence of incremental costing is to measure the cost incurred because a product is sold, or not incurred because it is not sold. Here we cannot delve into all the details of setting up a useful managerial accounting system. That task occupies an entire literature on "activity-based costing," to which we refer the reader interested in the details of cost management. For our purposes, it will suffice to caution that there are four common errors that managers frequently make when attempting to develop useful estimates of true costs.

- Beware of averaging total variable costs to estimate the cost of a single unit.

The average of variable costs is often an adequate indicator of the incremental cost per unit, but it can be dangerously misleading in those cases where the incremental cost per unit is not constant. The relevant incremental cost for pricing is the actual incremental cost of the particular units affected by a pricing decision, which is not necessarily equal to average variable cost.

- Beware of treating a single cost as either all relevant or all irrelevant for pricing.

A single cost on the firm's books may have two separate components—one incremental and the other not, or one avoidable and the other sunk—that must be distinguished. Such a cost must be divided into the portion that is relevant for pricing and the portion that is not. Even incremental labor costs are often not entirely unavoidable.

During the recession, some steel producers found when they considered laying off high-seniority employees that the avoidable portion of their labor costs was only a small part of their total labor costs. Their union contracts committed them to paying senior employees much of their wages even when laid off. Consequently, those companies found that the prices they needed to cover their incremental, avoidable costs were actually quite low, justifying continued operations at some mills even though those operations produced substantial losses when all costs were considered.

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