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Ultimate distortion of circular saw

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Abstract: *Ultimate distortion of circular saw*. Below paper presents modes and effects of the transverse distortion of circular saw. Also shown is dependence which determines ultimate distortion of circular saw.

Keywords: wood cutting, circular sawing machine

INTRODUCTION

During wood cutting by means of circular saw, due to action of transverse load and limited stiffness of the saw, it comes to transverse distortion of the saw. Effects of that distortion depend on characteristics and value of the saw's distortion [WASIELEWSKI, ORŁOWSKI]. In case of slowly changing thrust force it comes to distortions which are direct effect is lowered cutting precision. It happens however, that saw's distortion can reach such values that lead to destruction of the saw and material, what endangers whole cutting system and the operator.

Analysis of modes and effects of transverse distortion of circular saw enables better understanding of its behaviour during cutting process, what can lead to increased precision and safety during cutting by means of circular saw.

MODES AND EFFECTS OF TRANSVERSE DISTORTION OF CIRCULAR SAW

Analysis of modes and effects of transverse distortion of circular saw during slowly changing loads can show areas of different behaviour of the saw (fig.1). The ultimate distortion is very characteristic value. The ultimate distortion is its such value by which edge of the cat material being closer to spindle axis touches body of the saw (fig.1c). The value of this distortion is considered as ultimate because it separates two different behaviour of saw during cutting process.

In case of saw's distortion smaller than ultimate value ($f < f_g$) (fig. 1b) the only negative effect is decreased cutting precision. In such conditions, body of the saw does not have contact with cut material. Transverse load of the saw results only from thrust force on cutting blade and change of that value causes change of the saw's distortion.

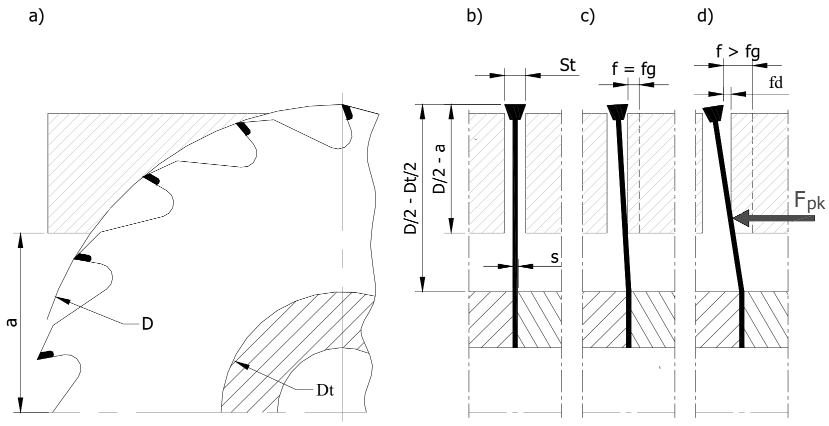

Fig.1. Distortion of the saw during cutting process, where : a) cutting scheme, b) no distortion, c) ultimate distortion, d) destructive distortion

In case of distortion bigger than ultimate value ($f > f_g$) (fig. 1d) it may come to destruction of the saw what is dangerous both for the machine and for the operator. In such conditions it comes to contact between saw's body and cut material. Cut material pressing on the body near the edge of the material being closer to spindle axis with F_{pk} force causes that blades create new surface further away by f_d value from the surface which is currently pressing saw's body. As the effect, this new surface is creating even bigger distortion of the saw. Saw is acting then as system with positive feedback striving to even bigger distortion what eventually leads do saw's destruction. Sample saw destroyed that way is shown in fig.2.

Fig.2. Sample saw destroyed due to distortion higher then ultimate

This drawing shows visible friction marks caused by pressure of cut material onto saw's body. That mark is located away from the blades (as in fig.1d). Due to significant distortion it came to destruction of the saw resulting from separation of the saw's part located between pressing rings and the body.

VALUE OF THE ULTIMATE DISTORTION OF CIRCULAR SAW

Assuming that :

- there are no plastic or elastic distortion of cut material,
- distortion of the saw along radius is linear,

value of the ultimate distortion f_g can be determined by (fig.1) :

$$\frac{(St-s)/2}{D/2-a}=\frac{f_g}{(D-Dt)/2} \quad (1)$$

where :

$$f_g=\frac{(St-s)(D-Dt)}{4(D/2-a)} \quad (2)$$

Because of the safety reasons, during cutting process one needs to strive for value of saw's distortion f was smaller than ultimate value f_g .

$$f<f_g \quad (3)$$

Saw's distortion value depends on slowly changing transverse load of the saw F_p and its static stiffness k, which depends also on geometrical features of the saw
(k =f(D, Dt, s,...)) [WASIELEWSKI]

$$f=\frac{F_p}{k} \quad (4)$$

Taking (4) and (2) into (3) we receive inequality, which secures saw from destruction.

$$\frac{F_p}{k}<\frac{(St-s)(D-Dt)}{4(D/2-a)} \quad (5)$$

Using dependence (5) in reality is however difficult. It results from the fact that beside geometrical features describing cutting system, in dependence (5) appears thrust force value F_p, which is difficult to assess. It results from the fact that thrust force F_p depends on many factors and also it changes during cutting process.

During analysis of (2) and (4), it can be seen that similar factors of cutting system can influence value of saw's distortion f and ultimate value f_g. It causes that those values are interdependent. It means, that in safe system (with high value of ultimate distortion f_g) saws can have high distortion values f, what decreases cutting precision. In case of precise cutting (small values of saw's distortion f), value of ultimate distortion f_g should have low values, what causes higher probability of saw's destruction. Conducted analysis shows dependence between precision and safety of cutting.

SUMMARY

Awareness of the dependence describing distortion of the circular saw enables proper selection of cutting process factors in order to increase precision and safety of cutting by means of circular saw.

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Streszczenie: *Graniczne odkształcenie piły tarczowej.* W niniejszym artykule opisano przyczyny i efekty poprzecznego odkształcenia piły tarczowej. Przedstawiono również zależność, na podstawie której wyznaczyć można graniczną wartość odkształcenia piły tarczowe.

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