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MICROSTRUCTURE CHANGES OF CONSTRUCTIONAL STEEL CAUSED AFTER CUTTING WITH CIRCULAR SAW

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Abstract: *The article deals with technology of cutting material using the circular saw. In the first part it is addicted to theoretical knowledge of the principle of cutting with saws and current use of the technology in industry. The cut of products of this technology is perpendicular and accurate but reaches variant values of roughness and using of this technology affects microstructural and hardness changes in the base material. This article presents quality of cut surfaces after cutting with this technology, pictures of microstructural changes of material and quality of the cut surface .*

Key words: *circular saw, quality, roughness, hardness.*

1. INTRODUCTION

Beginnings of saw utilization reach to time of Roman Empire, where there is the oldest historical documentation about saw with water drive from year 370. Roman poet AUSONIUS, who was prefect in Gaul, admires in his poem Mosella the beauty of river and its tributaries Kyll and Ruwer in German Trier region. about river Ruwer he writes, that it turns the wheels for milling of grains and draws the saws for polishing and cutting of marble. It is hard to imagine such a saw in accordance to technical instruments of those ages, especially when second oldest historical documentation about saw comes from 800 years later.

The base of counting file is cutting material with multi-wedge circular or belt tools, that is realizing on enginery – the saws (Table 1) [3].

2. CUTTING WITH SAWS

Cutting up with frame saw. The saw list is more wedge tool, that is held in carving frame and is executing in cutting straight-line reversal motion by which is feeding to the materials (Fig. 1).

The cutting effect is only half double stroke. The teeth only are on the one or both hands of the band. The bands are making from the tool or high-speed steel, that is 300 – 700 mm length and 1.5 – 3 mm coarse. The teeth are turn about kick-up that they are reducing friction. The lists are dividing according to the number of the teeth that fall on the unit length a fine teeth – dividing the hard and thinker materials, bastard-teeth and coarse teeth – dividing the soft materials.

Table 1

The sorts of the tools for different saws

Enginery	Sort of the tool
Frame saw	saw list
Ribbon saw	Saw band
Circular saw	Circular saw blade

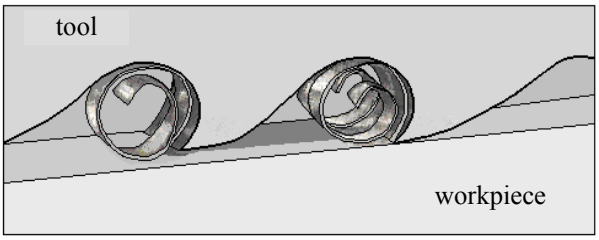

Fig. 1. The principle of cutting with saw.

Cutting up with the ribbon saw. The saw band is more wedge tool, that has the ends welding and it is developing closed whole. The band is characterized with the width and thickness of the list, the form, the gap and declination of teeth. The width of the list directly influences on the divide stability. The teeth of the saw band are always hardened, the band is soft. In feed is usually manual or mechanical. This method of dividing is similar to cutting up with the Frame saw, but the tool don't make reversing motion. The closed saw band is strained double rotating hidden disks, at which on his part is cutting material. The teeth only are on one side of the band. They are moving with fluent motion in the assigned part into workpiece and are taking away the splinter.

When choosing a form of teeth and separation too, in the saw list and the saw ban, it makes provision for sort and proportions of the cutting material.

The author Černoch shows in his summary of the methods for cutting material the divide with side jointer in two categories. In the first under the name: "The workpiece and the place of dividing are warm", he ranges dividing with the side jointer hot for dividing semi-products of the type: work, pig-iron, feeds in the branch of metallurgy – metallurgical works and iron-foundry. The second category: "The workpiece and the place of dividing are cold" is interested in cutting with side jointer in the mechanical engineering. Within the framework of the investigated methods dividing materials we are interested in terms of dividing with side jointer in mechanical engineering, i.e. in the work, in the cutting materials

Fig. 2. The creation of scobs during the cutting process with saw [1].

Table 2

The sorts of circulars and gearing

Sort of circular	Sort of gearing	Sort of circular
	soft	
compact	bastard	segmental
	heavy	

i.e. when "The work and the place of dividing are cold". The dissection with the circular saw is similar as milling operation. The tool is circular saw blade, similar as the side and face cutter, that is rotating round itself axis and that is moving to the work. Together it is taking away from the work the splinter until the material doesn't divide in need length (Fig, 2). The tool performs principal rotating cutting motion. The secondary motion is the shift into the cut, which is performed all the same with the tool. The work is hard held in clamping device of the saw. The shift on a single tooth is up to the mark cutter. The circumferential speed at the cutting edge is changing with the average of disk, because of more circular saws have some level of speed spindle [4].

The dividing with the side jointer we refer between classic technologies department. Nowadays that is working up with the untraditionally technologies of dividing (water current, plasma, laser). For purpose of confrontation studied events in cutting the metal material we has consider for advisable to study some events by cutting materials, to compare them and to search the positives and the negatives of cutting technologies [2].

The marked disadvantage of the side jointer against the untraditionally technologies dividing are:

- the production only surface cutting,
- the low speed of the disk,
- the big stock removal,
- the low level of work productivity.

Between the advantages belongs better cut evenness, low purchase costs for mechanism too.

3. TOOLS (Table 2)

The circular saw blades are multiwedge cutting tools, which are make per design features and dimension as solid and segmental encasstered cutting functional part.

3.1. The compact circulars

The compact circular saw blade – consists of one piece of material (Fig. 3). Circulars are made with the external diameter 20 – 900 mm; dimension of the pointed hole is depending on the external diameter. Witch the smaller diameters the circular is holded with the scabs on the both faces. The width of the circular is 0.2 – 6 mm.

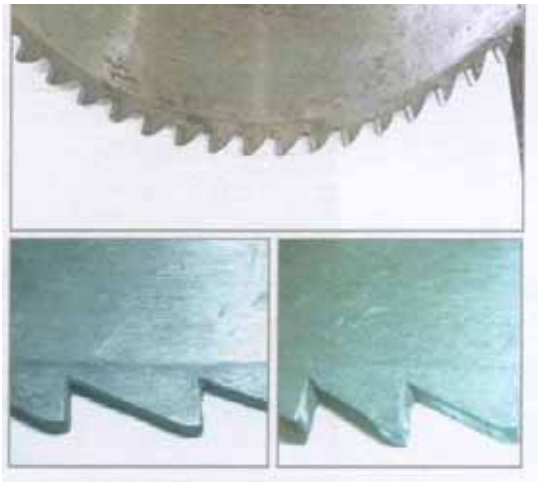

Fig. 3. The detail of the compact circular [1].

The circulars with the small width have right placed the dilatation cut-out in the body, that is enables the temperature dilatation of the circular by his warm during cutting and with this it defends its cross deformation or snap during the process of dividing. At the circulars with bigger diameters are on the sides the refined shallow scoring for convenience the supply cooling fluid to both of facing places of the cutting material.

3.2. The segmental circulars

These are the circulars with bigger diameters, by them the teeth are fed in the armature of circular from steel metal plate.

a) The circulars with the embedded teeth (Fig. 4), which are made from the high-speed steel or hard metals they are made with the external diameters 315 – 1810 mm. The width of the circular is 5 – 16 mm. The body of the circular is made from the alloyed structural steel, which is heat-treated on the stronghold more than 1000 MPa. In the body of circular are made radial groove, in which the single teeth are embedded and are fixed with the nit. The single teeth are possible changed when they are defective. The teeth are confirmed trough the use of soldering.

b) The circulars with the embedded segments (Fig. 5), which are made from the high-speed steel or hard metals, they are made with the external diameters 315 – 1810 mm. The width of the circular is 4 – 14 mm. The body of the circular is made from the alloyed structural steel. The single cutting segments on the

Fig. 4. The detail of the embedded cutting teeth [1].

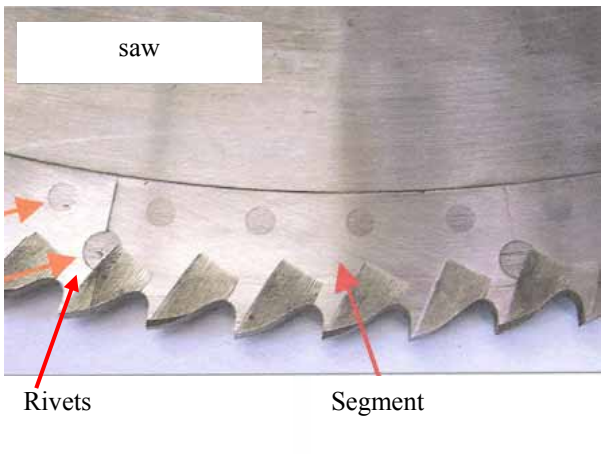

Fig. 5. The circulars with the embedded segments [1].

circular surface are engaged on the slip and grooves, which are coupled with the body by the nit, if need there is stuck too. These segments are possible to change, when they are damaged,

The tooth form of the circular saw blades are choose by the sort of dividing material, his hardness, stronghold, diameter and form of the cutting semi-product. Near at hand we have continuous working, the teeth are difficult modified, for example spring-set teeth, gradated and so. On the cutting down of the abrasion in the phase of the cut, the thickness of the tool has to be less than the width of the cut. From the material's sight the compact circular saw blades and segments are made from the tool high-speed steel 19 800, the list of the segment's circular saw blade are from the structural steel 11700, which is heat-treated steel on the stronghold 1050 – 1200 MPa.

3.3. The side saw

The side saws are made in the three constructions saw list is cutting from either side, from the top or from below (Fig. 6).

3.4. The thickness of cutting materials

In industry are installed equally powerful saws. The biggest saws use circulars with diameter 1500 mm. When we want to cut some profile, we have to know these principles and norms:

- for cutting of circuit full profile Ø d – diameter of circular $D = 3d$,
- for cutting of quadratic full profile $h \times h$ – diameter of circular D = (3 up to 3.5) h,
- for cutting of rectangle full profile $h \times s$ – diameter of circular $D = 1.5\ h$,
- for cutting of profiles I, U, – h_{max} D = (1.2 up to 1.5) $\times\ h$.

Maximal diameter of circular 1500 mm is useful for cutting:

- material of circuit full profile Ø d = 500mm,
- material of quadratic full profile $h \times h$, where is the h_{max} = 430 – 500mm,
- for cutting of rectangle full profiles and various profiles, master technologist suggest the parameters of the cutting process. The condition of circular saw is very important [1].

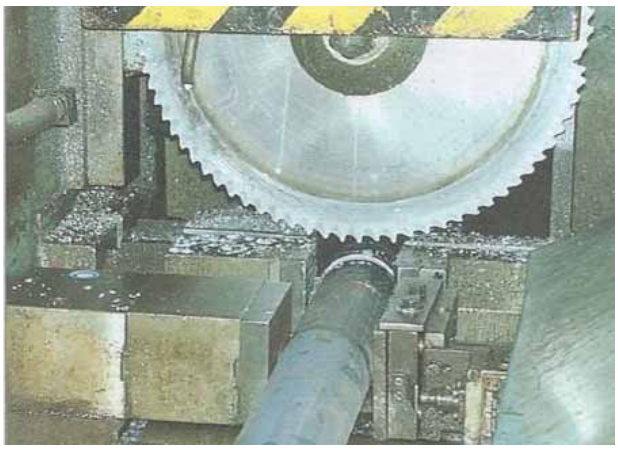

Fig. 6. The side saw – dividing from the top [1].

4. ROUGHNESS [1]

Experiment was realized with use of circular saw PHA27 that is designated to be used for cuts of large dimensions. As it allows to bind the disc of diameter up to 1000 mm it is suitable for cutting the metal workpieces with diameter up to 400 mm. We used saw disc– LENOX 21885 ST900048CT with diameter of 230 mm.

5. HEAT AFFECTED ZONE AFTER CUTTING

Criterion for detecting of depth of heat affected zone was hardness which was measure in the layer 2 mm under surface. Measurement was realizes on three lines of sample, i.e. 2 mm from the edge and in the middle of sample [2].

Results of the measurement by Vickers are showing none heat affected zone after cutting with circular saw. The hardness has the same values for all lines and samples (Fig. 8).

Fig. 7. Detail of cut surface after cutting with circular saw: steel ISO Fe510 [1].

Table 3

Values of roughness and cut uprightness after cutting with circular saw

Material	ISO Fe510
Roughness of surface Ra [µm]	5.25
Uprightness deviation [°]	107'
Uprightness deviation [mm]	0.079
Manufacturability of planes and surfaces	Planar cuts

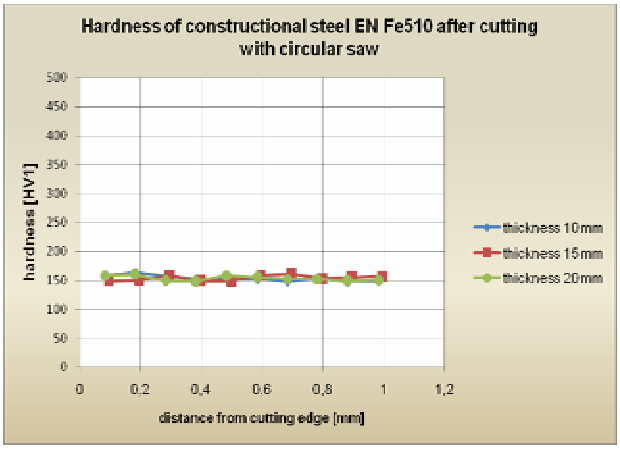

Fig. 8. Hardness of constructional steel EN Fe 510 after cutting with circular saw.

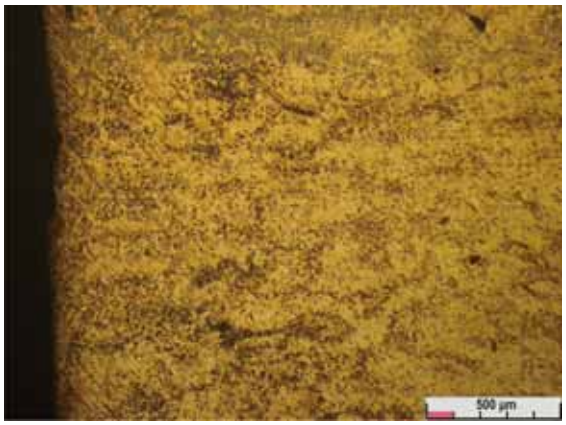

Fig. 9. The detail of microstructure in zoom 63×.

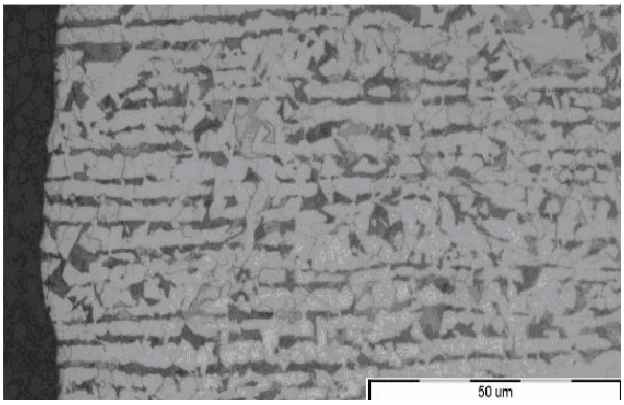

Fig. 10. Ferritic – perlitice material in zoom 600x [2].

6. CONCLUSIONS

With technology of cutting with saws there is the contact of circular saw blade with workpiece. In cut area (Fig. 7) it causes the creation of plastic deformation of steel structure. Figures 8, 9, and 10 show microstructure, plastic deformation of grain of ferritic – perlitic material.

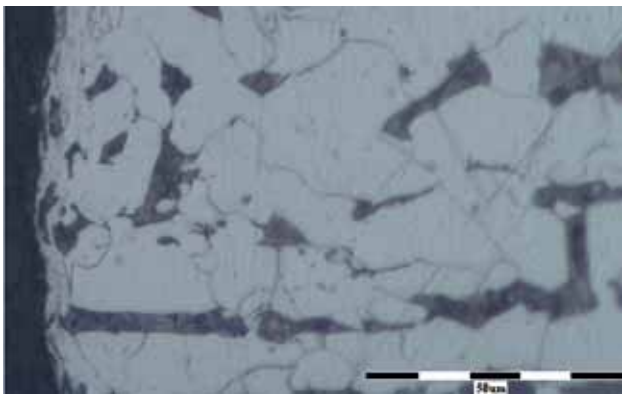

Fig. 11. Plastic deformation of the structure in steel in place of cutting in zoom 1000× [2].

Evaluation of thermal affected zone after cutting with circular saw (without use of cooling medium) was negative, as for all thicknesess of samples none thermal deformation of material was detected neither hardness increment.

As cutting with circular saw disc belongs to chip technologies and there is direct contact between cutting tool and workpiece, on surfaces that are cut it comes up to plastic deformation of grains of basic material.

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