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The Impact of Area and Shape of Tool Cut on Chain Saw Performance

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Abstract

The cutting design of the chain saw is defined by the number, the arrangement and the geometry of the cutting tools. When using chisel cutting tools, the cross sectional area of the cut and the shape of the groove are determined by the width and depth of the cut. The laboratory tests analyzed the impact of the cross sectional area and the shape of the cut on the forces and the specific energy. The testing was performed on a linear cutting machine with tool holders and cutting tools in real-scale size. According to the processed statistical data, increasing the cross sectional area of the cut reduces the specific energy, whereby the width of the cut has a considerably larger impact. The tests have shown that besides the cross sectional area of cut, the shape of the surface also affects the forces and specific energy. Through increasing the width to depth ratio upon a constant cross sectional area of the cut, the value of the specific energy and the cutting forces are reduced. Above the width to depth ratio of 2.5 the cutting forces and the specific energy appear to be constant.

Keywords

dimension stone, chain saw, cutting forces, specific cutting energy, cut area

1. Introduction

Chain saws are used as the main or auxiliary machines upon quarrying of dimension stone. The performance of chain saws depends on a number of factors, which can be classified into two main groups: the geological characteristics of the deposit, & the constructional and the operational parameters of a chain saw. Besides the structural features of the rock mass, the most significant physical and mechanical characteristics affecting chain saw performance are the uniaxial compressive strength, the shore scleroscope hardness and the Cerchar abrasivity index (**Copur et. al, 2011; Tumac et al., 2013; Tumac, 2014**). Although rock characteristics have a considerable impact on the chain saw performance, this paper primarily analyses the impact of constructional parameters. Constructional parameters, especially the design of lacing patterns for the cutting tools are different and depend on the manufacturer. The lacing design determines the arrangement and the geometry of cutting tools. Due to the fact that the impact of the construction of the cutting chain on the chain saw performance has not been researched enough, the selection of a chain saw and cutting elements depends solely on the recommendations of the manufacturer. According to the research works performed so far, it can be concluded that the existing chain constructions are not optimal enough (**Copur, 2010; Copur et al., 2011; Hekimoglu, 2014; Dagrain et al., 2013**).

Copur (**2010**) presented the guidelines how to increase the efficiency of the existing chain constructions. They are based on the results obtained in the testing conducted by means of a linear cutting machine in which the cutting tools were shaped in a way to simulate various sideways angles. The previous tests confirmed that the increase of the cutting depth reduces the specific energy, whereas the forces on the cutting tool are increasing (**Copur, 2010**). The reason lies in the fact that the increased depth of the cut enlarges the cut surface, whereby the quantity of the cut-off material is

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considerably larger compared to the used-up energy. **Dagrain** (**2011**) conducted tests on a linear cutting machine, using more than forty cutting sequences of various geometrical parameters. The obtained data points to the fact that certain chain constructions are more efficient than others in view of the specific energy and the tool wear. The in-situ tests have shown that in the case of using electrical hydraulic saws, the increase of the ratio between the cart speed and the chain speed increases the depth of the cut and reduces the specific cutting energy (**Korman et al., 2015a**). **Hekimoglu** (**2014**) concluded that the specific energy may be reduced by 45% if the length of the cutting sequence is doubled.

In view of the reduction of the specific energy, most of the research works performed so far have been oriented towards an increase in the depth of a cut. However, the larger cut surfaces may be obtained by an increased cut width. The cutting forces and the specific energy are reduced with an increase in the cut width. Therefore, in bit design using rectangular cutters, it is much more interesting to use large cutters than narrow cutters (**Dagrain, 2001**). Accordingly, the laboratory tests have been performed on a linear cutting machine in order to analyse the impact of the width and depth of a cut on the cutting forces and the specific energy.

1.1. Impact of chain construction on chain saw performance

The operational element of the chain saw is an arm with an endless chain that carries cutting tools. The chain is started by a sprocket which is connected to the main driving engine through the gear unit. The chain consists of sequences which appear in turns and their number depends on the arm length i.e. the chain. The sequences consist of the chain units connected by links. On each chain unit there is a tool holder with cutting tools. The number of tool holders within the sequence depends on the type of the rock to be cut and on the type of sawing (dry or wet sawing procedure). **Figure 1** shows the chain sequence consisting of 8 tool holders and 13 cutting tools.

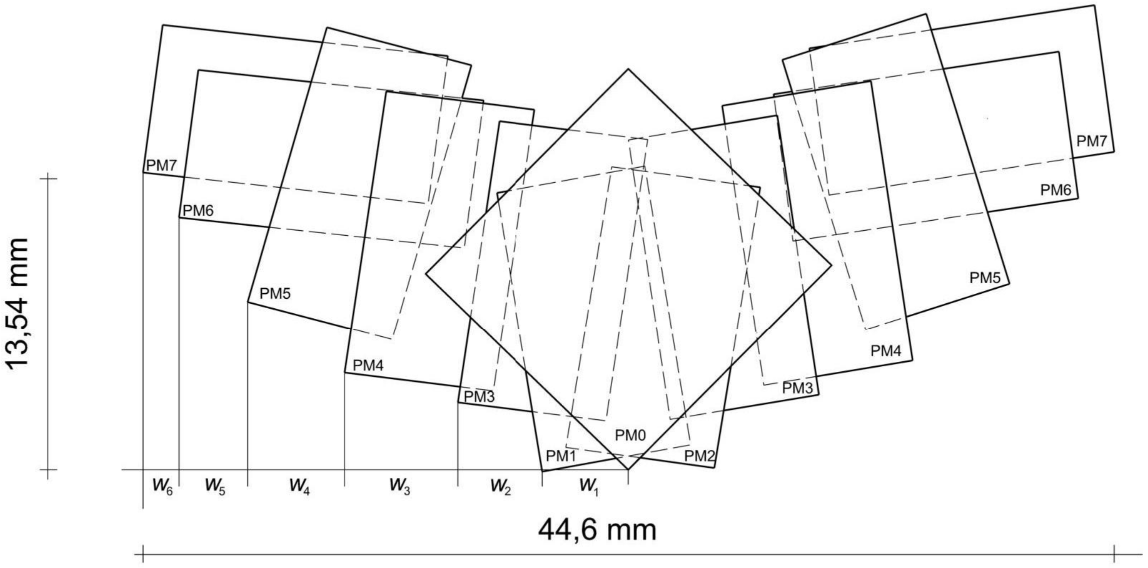

Figure 1: The lacing design of a cutting sequence

The first cutting tool in the sequence is used to open up the cut, whereas the following ones are used to widen the cut. Cutting tools are symmetrically arranged, which enables the even distribution of the total strain i.e. a reduced strain per tool holder, which considerably affects irregular cutting and prevents the overload of the machine. The arrangement and position of the cutting tools on the cutting chain depend on the characteristics of the rock mass and are determined by the construction of the cutting chain, which depends on different manufacturers.

The width of the cut *w* of the specific cutting tool is determined by the construction of the cutting sequence. **Figure 1** shows that the widths of the cutting tools are different and depend on their position and the arrangement within the sequence. The cutting depth *d* of the cutting tools upon operation of the chain saw depends on the cart speed, the chain speed, the length of the cutting sequence and the angle between the arm and the cutting direction. The relation between the cut depth and the stated values is determined by the following expression (**Mellor, 1976**):

$$d = \frac{U}{u_t} \cdot S \cdot \sin\varphi \tag{1}$$

Where:
d – depth of cut (m),
U – cart speed (m/s),
u_t –chain speed (m/s),
S – cutting sequence length (m),
φ – cutting angle (°).

The energy used for cutting depends on the surface cut by the cutting tool in contact with the rock. In the case of chisel cutting tools, it is determined by the depth of the cut and the cut width. **Richard et al**. (**2010**) analyzed the impact of the shape of the cut surface and the shape of the cutting tool on the specific energy and the cutting forces. According to the tests it can be concluded that the force and the specific energy depend on the surface and the shape of the cross sectional area (see **Figure 2**).

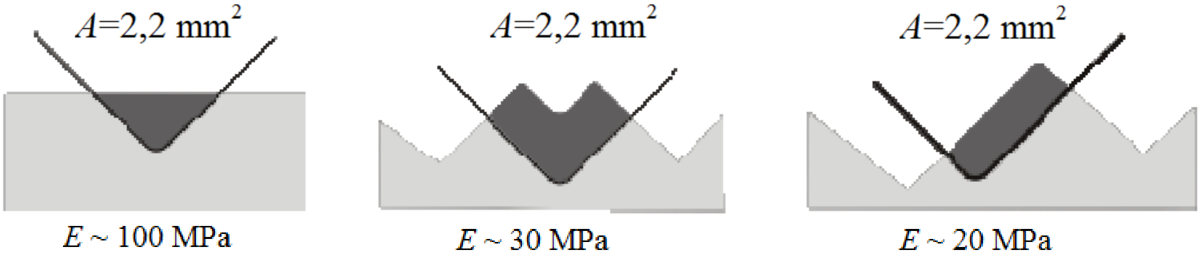

Figure 2: The impact of geometrical shape of a cut on cutting energy (Richard et al., 2010)

The rock cutting is associated with the two types of failure modes depending on the depth of the cut (**Richard et al. 1998**). The ductile mode occurs at shallow depths of a cut and is characterized by a steady flow of a crushed material ahead of the cutter. At larger depths of a cut, brittle failure occurs and is characterized by the propagation of a crack ahead of the cutter. Apart from a cutting and a frictional component, it was found that the total forces are affected by a component that depends on the groove geometry **(Dagrain et al., 2001)**. **Dagrain (2001)** extended the original Detournay and Defourny model by introducing a parameter ι which denotes the number of side walls in groove geometry. This parameter is used to describe the relationship between the groove geometry and the cutting forces. **Dagrain (2001)** verified this new model by a series of tests on a Rock Strength Device using different cutter geometries and cutting profiles. Based on the results, he concluded that the specific energy is increased by increasing the side effect related to the number of groove walls. Furthermore, he concluded that for a given depth of cut, the specific energy decreases with an increase of the cutter width. Based on the above discussion, it can be concluded that the width and depth of a cut will have a significant influence on chain saw performance. Furthermore, the width to depth ratio has a significant influence on chain design, since the width of a cut is defined by the number of cutting tools in a cutting sequence. The optimal number of cutting tools in a cutting sequence will depend on the optimal width to depth ratio. Accordingly, the objective of this study is to investigate the influence of the width to depth ratio on chain saw performance.

2. Laboratory tests

There is currently no standard for rock cuttability. Therefore, laboratory tests were carried out on a linear cutting machine which is a modified shaping machine equipped with a triaxial force transducer attached to the cutter head and connected to a data acquisition device. The force transducer is constructed in a way that enables the installation of the tool holder of the chain saw with the cutting tools in their real-scale size (see **Figure 3**). Tools made of tungsten carbide with a rectangular prism geometry have been used. The application of this method in the simulation of the cutting process was confirmed by previous studies (**Korman et al., 2015b**). The samples used for the laboratory tests were collected in the exploitation field of dimension stone "Redi" near Trogir, Croatia. The samples were sawn to dimensions of 200 mm x 150 mm x 70 mm in accordance with the vice dimensions and the maximum stroke length of the linear rock cutting machine.

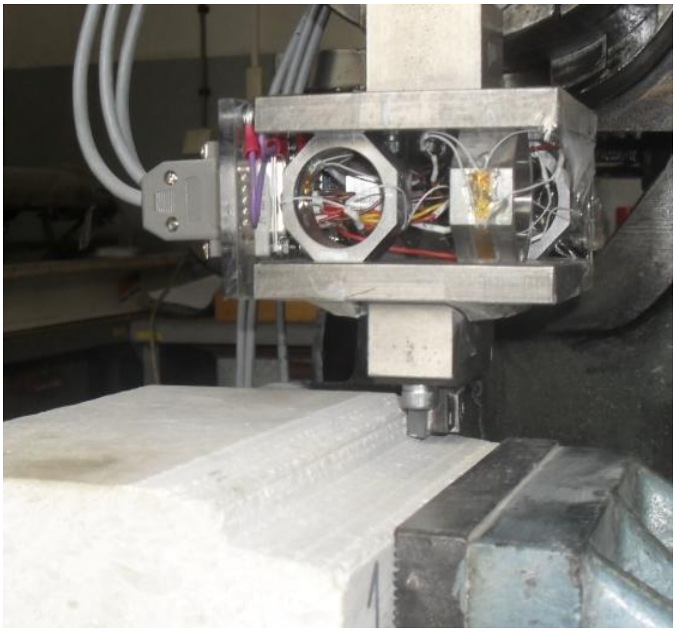

Figure 3: Force transducer

According to the conducted mineralogical and petrographical analysis, the stone is qualified as recrystallized limestone of organogenic origin. The average bulk density of the samples is 2610 kg/m^3 and the average compressive strength of the stone, determined from cubic samples of 50 mm edges, is 111.2 MPa (**Bobesić, 2006**).

The tests were carried out in the unrelieved cutting mode, i.e. in the conditions with one side wall. In order to ensure the required conditions, the height of the side wall was kept at a minimum of 5 mm (see **Figure 4**). The constant values during the testing were: cutting speed (0.4 m/s), the rake angle (-5.5°), the sideways angle (5.9°) and the sideways rake angle (5.3°) of the cutting tool. The laboratory tests were divided into two parts. The first part comprised the analysis of the impact of the cut area on the forces and the specific energy, whereas the second part analyzed the impact of the shape of the cut surface.

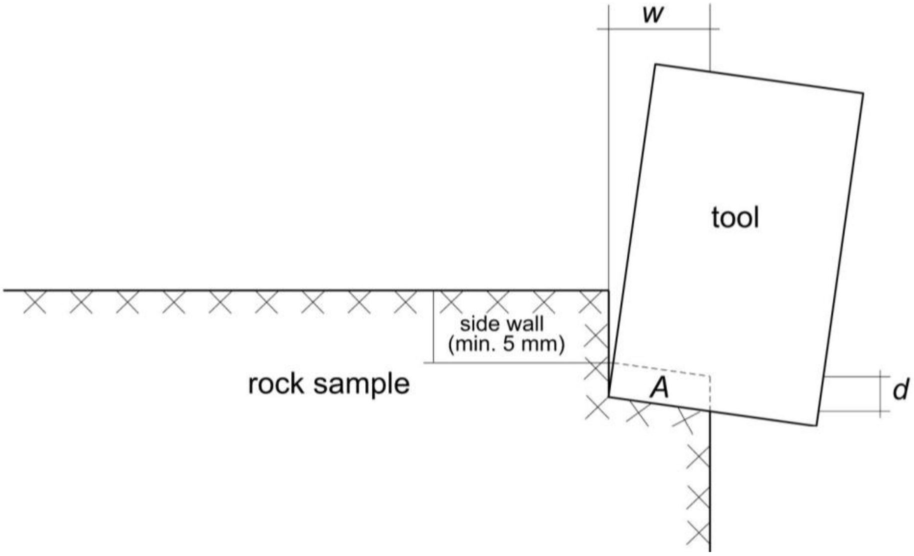

Figure 4: Scheme of testing procedure

During each specific testing the cutting force F_c, the normal force F_n and the sideways force F_f were measured at the testing speed of 4800 Hz. The cutting force data were used to calculate the cutting energy. Since the value of the cutting force is not constant during cutting, the cutting energy was calculated by using the numerical integration of cutting force per cutting tool path length. Based on the values of the cutting energy and the volume of the cut, the specific energy was calculated for each series of testing. In the case of ductile failure mode, it is possible to calculate the volume of a cut geometrically on the basis of the area and the length of the cut (**Dagrain, 2011**). During the experiments, brittle fracture was observed and therefore the calculation of the volume of a cut on the basis of geometric shape is very unreliable. In order to calculate the volume of a cut more precisely, the volume was determined on the basis of the ratio between the mass of the rock chips and the sample's bulk density. The mass of the rock chips is determined by measuring the mass of the sample before the beginning of the experiment and after each series of experiments.

3. Analysis of results and discussion

In the first part of testing, the impact of the cut area on the specific energy and the cutting forces was analyzed. The tests were divided into twenty series, i.e. twenty different combinations of the depth values and cut widths. Each test series was repeated for a minimum of five times. In the case of smaller values of cut surfaces a larger number of repetitions were made, in order for the mass of the rock chips to be at least ten times larger than the resolution of the scale. The results of the tests are presented in **Table 1**.

Table 1: Results of testing impact of cut area on cutting forces and cutting energy

Width of cut *w*	**Depth of cut *d***	**Area of cut *A***	**Average values**		**Average cutting forces**			**Specific Cutting Energy *Se***
			Volume of cut	**Cutting energy**	F_c	F_f	F_n	
(mm)	(mm)	(mm^2)	(mm^3)	(J)	(N)	(N)	(N)	(MJ/m^3)
0.5	0.2	0.1	0.02	5.9	29.2	34.9	14.3	260.3
0.5	0.4	0.2	0.04	7.3	36.2	48.1	14.5	190.1
0.5	0.6	0.3	0.07	9.8	48.4	68.4	15.9	145.8
0.5	0.8	0.4	0.09	13.1	64.7	104.4	14.5	145.6
0.5	1.0	0.5	0.10	14.7	72.8	115.0	12.4	143.2
1.0	0.2	0.2	0.05	7.2	35.4	42.9	27.3	151.6
1.0	0.4	0.4	0.09	10.7	52.9	67.9	38.6	123.0
1.0	0.6	0.6	0.12	11,8	58.5	75.4	31.1	102.3
1.0	0.8	0.8	0.15	15.7	77.6	110.7	27.1	101.8
1.0	1.0	1.0	0.20	16.2	80.0	114.7	28.7	80.7
1.5	0.2	0.3	0.07	8.0	39.4	30.5	48.2	111.4
1.5	0.4	0.6	0.10	10.1	50.0	55.5	42.7	98.3
1.5	0.6	0.9	0.15	13.4	66.2	84.3	41.5	86.8
1.5	0.8	1.2	0.17	14.4	71.3	98.4	31.8	86.3
1.5	1.0	1.5	0.29	18.4	90.5	121.1	44.4	62.6
2.0	0.2	0.4	0.12	12.1	59.9	52.1	67.9	104.5
2.0	0.4	0.8	0.14	13.4	69.8	75.6	60.1	92.7
2.0	0.6	1.2	0.19	15.2	71.9	81.3	57.0	82.0
2.0	0.8	1.6	0.23	17.0	83.9	104.0	53.3	73.2
2.0	1.0	2.0	0.32	18.9	93.0	115.9	57.8	58.2

A statistical analysis was made on the basis of the obtained results. **Figure 5** presents the impact of the area of a cut on the specific cutting energy. The diagram shows that the specific energy decreases if the area of a cut increases. The reason for this is the fact that the increased depth and/or width considerably enlarge the quantity of the cut-off material compared to the used up energy upon cutting. The largest decrease of the specific energy of 51% can be observed upon the enlarged cut surface from 0.1 mm^2 to 0.5 mm^2. In the case of the enlarged cut space from 0.5 mm^2 to 1.0 mm^2 the specific energy is reduced by 26% and by 16% upon its enlargement from 1.0 mm^2 to 1.5 mm^2. Further enlargement of the cut surface results in minor energy reductions. However, in such cases the values of the cutting force on the cutting tool considerably increase (see **Figure 6**).

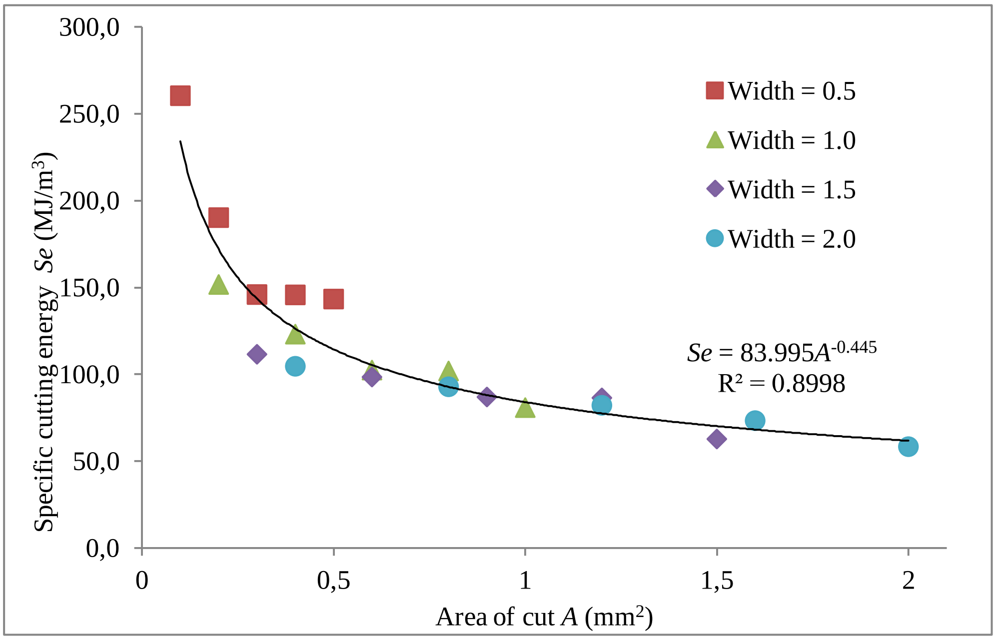

Figure 5: The impact of the cross sectional area on specific energy

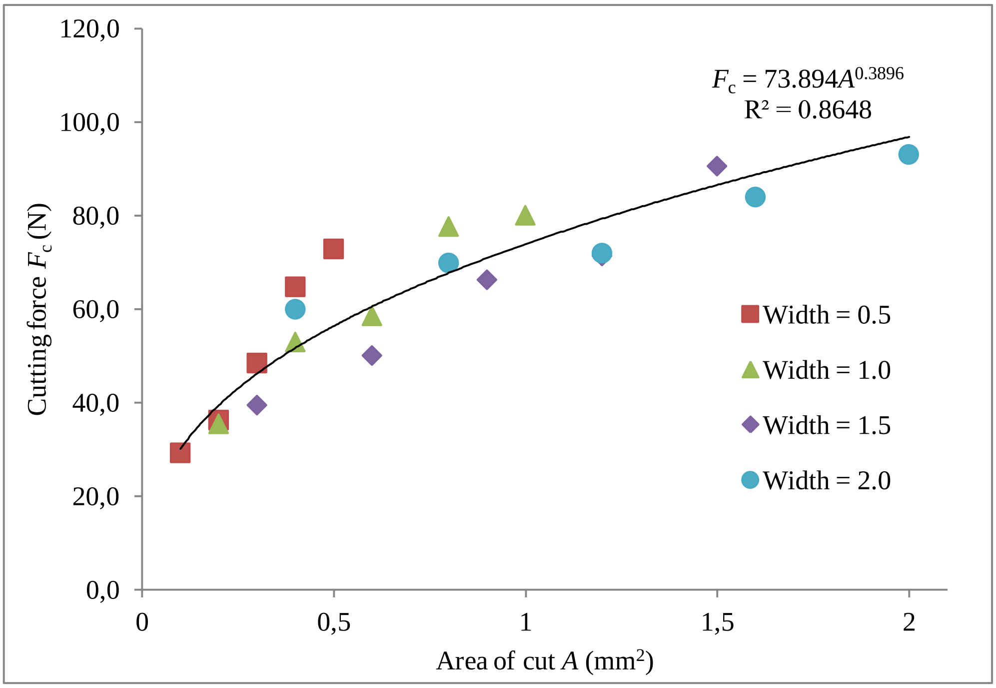

Figure 6: The impact of cross sectional area on cutting force

The above stated analyses have shown that the area of a cut affects the specific energy and the cutting force. However, the analyses have not shown the individual influence of the width and the depth of a cut. Accordingly, a multiple regression analysis was performed to identify independent variables that are significantly correlated to the specific energy and cutting forces. **Table 2** shows the multiple regression analysis results of the relationship between the cutting force and the width and depth of a cut. The estimated equation for the presumed model is:

$$F_c = 10.3226 + 15.7834 \cdot w + 54.2047 \cdot d \tag{2}$$

Where:
F_c – cutting force (N),
w – width of cut (mm),
d – depth of cut (mm).

Table 2: Results of multiple regression analysis of the relationship between cutting force and width and depth of a cut

	R= 0.97415519 R^2=0.94897833 *F(2.17)=158.10 p<.00000 Std.Error of estimate: 4.4488*					
N=20	*Beta*	Std.Err. of *Beta.*	*B*	Std.Err. of B	*t*(17)	*p*-level
Intercept			10.323	3.223	3.202	0.005221
Width of cut *w*	0.486	0.055	15.783	1.780	8.869	0.000000
Depth of cut d	0.844	0.055	54.205	3.517	15.412	0.000000

Due to the obtained determination coefficient R^2 = 0.95 it can be concluded that there is a considerable interdependence of the cutting force upon the presumed independent characteristics. The coefficient of the error probability of the presumed model *p* shows that the error probability is less than 5%, which points to the significant interdependence. The standardized correlation coefficients *Beta* show that the cut depth has a considerably higher impact on the value of the cutting force, compared to the cut width. **Table 3** shows the multiple regression analysis results of the relationship between the normal force and width and depth of the cut. The estimated equation for the presumed model is:

$$F_n = 4.3437 + 29.1688 \cdot w - 7.2462 \cdot d \tag{3}$$

Where:
F_n – cutting force (N),
w – width of cut (mm),
d – depth of cut (mm).

Table 3: Results of multiple regression analysis of the relationship between normal force and width and depth of a cut

	R= .97209939 R^2= .94497722 *F(2.17)=145.98 p<.00000 Std.Error of estimate: 4.3013*					
N=20	*Beta*	Std.Err. of *Beta.*	*B*	Std.Err. of B	*t*(17)	*p*-level
Intercept			4.344	3.12	1.39	0.1814
Width of cut *w*	0.965	0.057	29.169	1.72	16.95	0.0000
Depth of cut d	-0.121	0.057	-7.246	3.40	-2.13	0.0480

The results of the regression analysis show that the cut width has a considerably higher impact on the value of the normal force, compared to the cut depth. The individual influence of the cut depth and cut width on the specific cutting energy has also been determined by the multiple regression analysis. The summary of the analysis is presented in **Table 4**. The estimated equation for the presumed model is:

$$Se = 241.6364 - 61.4836 \cdot w - 82.9303 \cdot d \tag{4}$$

Where:
Se – specific cutting energy (MJ/m^3),
w – width of cut (mm),
d – depth of cut (mm).

Table 4: Results of multiple regression analysis of the relationship between specific cutting energy and width and depth of a cut

	R= .89047795 R^2= .79295097 *F(2.17)=32.553 p<.00000 Std.Error of estimate: 23.063*					
N=20	*Beta*	Std.Err. of *Beta*.	*B*	Std.Err. of B	*t*(17)	*p*-level
Intercept			241.636	16.711	14.460	0.000000
Width of cut *w*	-0.736	0.110	-61.484	9.225	-6.665	0.000004
Depth of cut d	-0.502	0.110	-82.930	18.233	-4.548	0.000285

According to the obtained correlation coefficient $R^2 = 0.79$, it can be concluded that there is a relatively significant interdependence of the cutting energy on the presumed independent characteristics. In this case, the cut width has a higher impact on the specific cutting energy than the cut depth. As in the previous model, the coefficient of the error probability of the presumed model *p* shows that the error probability is less than 5%, which points to the significant interdependence. The conducted analyses have shown that the increased width and/or depth of the cut by chain saws can reduce the specific cutting energy. However, the specific cutting energy is not the only criterion for the selection of the optimal chain design. The enlargement of the cut surface causes the increased forces on the tool, which increases tool wear. Therefore it can be concluded that there is an optimum ratio between the cut width and the cut depth in which the ratio between the used up energy and the tool wear is the most favourable. Accordingly, the impact of the ratio between the cut width and the cut depth on the forces and the specific energy has been analysed. The tests were performed on various values of the cut depth and the cut width with a constant value of the cut surface. Each round of the testing was repeated ten times. The results of the tests are presented in **Table 5**. It should be noted that measured normal force is perpendicular to the tool holder and depends on the orientation of the real normal force. The real normal force is perpendicular to the cutting edge of the tool and is calculated as follows:

$$F_N = \sqrt{{F_n}^2 + {F_f}^2} \tag{4}$$

Where:
F_N – real normal force on tool (N),
F_n – normal force on tool holder (N),
F_f – sideways force (N).

Table 5: Results of testing impact of ratio between the cut width and cut depth and specific cutting energy

Width of cut w	**Depth of cut d**	**Area of cut A**	**Width to depth Ratio w/d**	**Average measured forces**			**Real normal force**	**Specific Cutting Energy Se**
				F_c	F_f	F_n	F_N	
(mm)	(mm)	(mm^2)	-	(N)	(N)	(N)	(N)	(MJ/m^3)
2.00	0.20	0.4	10.0	48.7	46.6	57.5	74.0	93.41
1.60	0.25	0.4	6.4	50.2	56.8	51.5	76.7	96.32
1.30	0.31	0.4	4.2	51.3	62.3	46.5	77.8	98.42
1.00	0.40	0.4	2.5	51.8	68.1	41.4	79.7	122.00
0.67	0.60	0.4	1.1	58.0	85.9	31.3	91.5	125.05
0.50	0.80	0.4	0.6	66.8	104.9	23.4	107.5	157.22
0.40	1.00	0.4	0.4	75.5	127.9	15.6	128.8	162.97
0.33	1.20	0.4	0.3	85.1	149.8	6.8	149.9	195.79

Table 5 shows that the values of the forces and the specific energy do not only depend on the cut surface, but also on the shape, the width and the depth of aa cut. **Figure 7** presents the impact of the width to depth ratio on the cutting forces. Upon the constant area of cut, the increased width to depth ratio reduces the cutting forces acting on the tool. The cutting forces appear to be constant above a ratio w/d of 2.5. However, normal force acting perpendicular to the tool holder increases with the increase of the width to depth ratio. The increase of the normal force is due to the fact that the orientation of the real normal force is changing with the width and the depth of a cut.

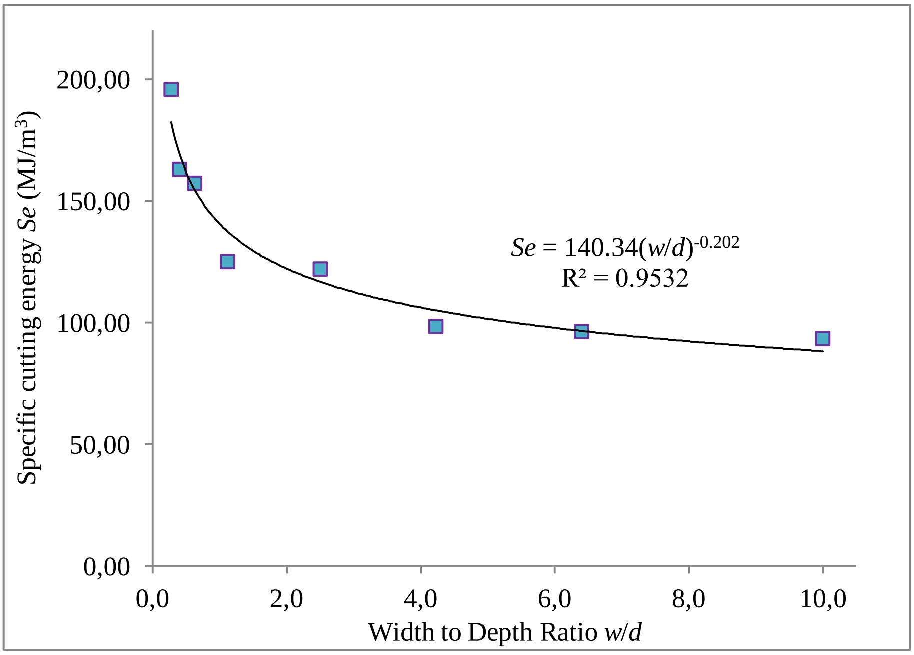

Figure 7: The impact of width to depth ratio on cutting forces and specific cutting energy

Besides the cutting force and the normal force, the sideways forces also have a significant impact on the tool's wear. If it is presumed that the chain is ideally symmetrical, the sideways forces should be neutralizing each other. However, during the previous tests it was found that upon the construction of the chains there are certain deviations from the symmetry axis. The consequence of this is that the increase of the cut depth results in the increased sideways force (**Korman et al., 2015b**).

Due to the reduction of the cutting force, the increase of the width to depth ratio on the constant area of a cut will result in the reduction of the specific cutting energy (see **Figure 8**). Besides cutting forces, specific energy also appears to be constant above a width to depth ratio of 2.5. Below this ratio, the specific energy and the cutting forces increase linearly with an increase of the depth to width ratio. The width to depth ratio has a significant influence on the chain design, since the number of cutting tools in the sequence depends on the optimal width to depth ratio. Based on the above discussion, it can be concluded that the width to depth ratio should not be below 2.5 when operating chain saw machines. It is especially significant in the case of electrical chain saws, where the depth of a cut can be adjusted by the chain and the cart speed. It should be noted, however, that this ratio can change depending on the type of rock and the cutting tool geometries. Furthermore, an increase of the width to depth ratio will increase the normal force acting on the tool holder. Thrust force acting on the arm of the chain saw is directly related with the normal force acting on the tool holder that depends on the orientation of the real normal force. Therefore, thrust force on the cutting arm depends on the width to depth ratio and cutter geometry.

The ratio between the width and the depth of the cut can be increased through the reduction of the cut depth and/or the enlargement of the width of the cut. The cutting depth depends on the operational parameters and the length of the sequence. Based on previous research, it can be concluded that the reduction of the cut depth would reduce the efficiency of chain saws (**Copur, 2010; Copur et al., 2011**). In contrast to this, a larger cut width can only be achieved through the change of the chain construction, i.e. by reducing the number of cutting tools in the cutting sequence. A reduced number of tools in the cutting sequence would decrease the cutting force and the specific energy.

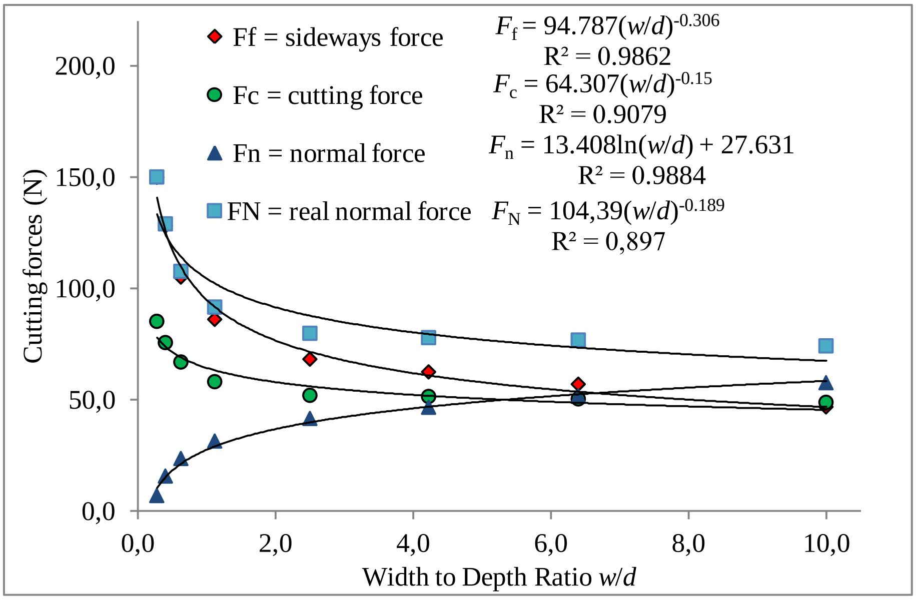

Figure 8: The impact of width to depth ratio on cutting energy

4. Conclusion

This paper presents the analysis of the impact of the cut area and the surface shape of a cut of cutting tools on the forces and the cutting energy. The analysis was observed in the relieved cutting mode i.e. in the conditions with one side wall. The tests have shown that an enlarged cut surface increases the forces on the cutting tool, whereas the specific cutting energy decreases. Based on the results of the multiple regression analysis of the relationship between the cutting force and width and depth of the cut, it can be concluded that the cut depth has a larger impact on the cutting force, while the width of a cut has a larger impact on the normal force. The specific energy is reduced if the cut depth and the cut width are enlarged, whereby the cut width has a significantly higher impact. Besides the area of a cut, it has been found that the shape of the cut, i.e. the ratio between the cut width and the cut depth significantly affects the chain saw performance. The specific energy and the cutting forces can be reduced if the ratio between the cut width and the cut depth is increased, under the condition that the cut surface remains constant. The cutting forces and the specific energy appear to be constant above the width to depth ratio of 2.5, while below this ratio they increase linearly with the increase of the depth to width ratio. The ratio between the width and the depth of the cut can be increased through the reduction of the cut depth and/or the enlargement of the width of the cut. Accordingly, the larger cut width may be achieved only through the reduction of the number of cutting tools within the cutting sequence. The number of cutting tools in the sequence depends on the optimal width to depth ratio, whereby the relationship between the used up energy and the wear of the cutting tools is most favourable. To determine the optimal width to depth ratio, additional experiments should be carried out on different types of rocks and on different types of cutting tool geometries. Further tests should also analyze the relationship between the width to depth ratio and tool wear.

5. Acknowledgements

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Sažetak

Utjecaj površine i oblika reza reznih pločica na učinak lančane sjekačice

Konstrukcijom lanca lančane sjekačice određen je broj, raspored i geometrijske veličine reznih pločica. Kod kvadratičnih reznih pločica površina i oblik reza određeni su širinom i dubinom reza. Laboratorijskim ispitivanjima analiziran je utjecaj površine i oblika reza na sile i specifičnu energiju rezanja. Ispitivanja su provedena na uređaju za pravocrtno rezanje stijena s nosačima i reznim pločicama u prirodnoj veličini. Laboratorijska ispitivanja podijeljena su u dva dijela. U prvome dijelu ispitivanja analiziran je utjecaj površine reza na sile i energiju rezanja, dok je u drugome dijelu ispitivanja analiziran utjecaj oblika površine reza. Tijekom svakoga pojedinačnog ispitivanja mjerena je tangencijalna, vertikalna i bočna sila brzinom uzorkovanja od 4800 Hz. Na temelju vrijednosti tangencijalne sile i prijeđenoga puta rezne pločice izračunana je energija rezanja. Statističkom obradom podataka ustanovljeno je da se povećanjem površine reza specifična energija rezanja smanjuje, pri čemu širina reza ima znatno veći utjecaj od dubine reza. Na temelju rezultata regresijske analize višestruke ovisnosti sila o širini i dubini reza proizlazi da dubina reza ima znatno veći utjecaj na vrijednost tangencijalne sile, dok vrijednost normalne sile ovisi o širini reza. Osim površine reza ispitivanjima je ustanovljeno da oblik površine također utječe na sile i energiju rezanja. Povećanjem omjera širine i dubine reza, pri konstantnoj površini, smanjuju se vrijednosti sila i specifične energije rezanja. Pri većim omjerima od 2,5 vrijednosti sila i specifične energije rezanja približno su konstantne. Omjer širine i dubine reza moguće je povećati smanjenjem dubine reza i/ili povećanjem širine reza. Kod lančanih sjekačica veću širinu reza moguće je ostvariti isključivo smanjenjem broja reznih pločica unutar reznoga segmenta. Broj reznih pločica u reznome segmentu ovisi o optimalnome omjeru širine i dubine reza, pri kojemu je omjer utrošene energije i reznih alata najpovoljniji.

Ključne riječi

arhitektonsko-građevni kamen, lančana sjekačica, sile rezanja, specifična energija rezanja, površina reza