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Analysis of the Influence of Geometric Characteristics of the Saw and the Gasket of Saw Gin on the Life of Saw at Different Distances between the Saw

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Abstract

In our work we consider the geometric characteristics of the saw and gasket of saw gin as well as define acceptable normal load for saw gin at different distances between the saw. To determine the deformation saws which is under a compressive force it is necessary to determine force of normal stress σx that creates cross sectional saws in which stress is uniformly distributed. Stability and strength of saws are characterized. If the normal stress is not evenly distributed in the cross section of the saws there is a complex deformation (torsion, bending, and other complex deformations). In such cases, the strength and stability of saws are determined not only by its size but also on other complex geometrical characteristics with cross-section of saws and gasket. We conducted research about saw and gasket at different distances between the saw. Determined the optimal parameters between the saw distances, using the geometric characteristics in order to ensure the sustainability of saws at work in dynamic loads. Using these indicators, we can simulate the best option of working parts of gin and increase the life of saws twice.

Keywords: Distance between saws; Gin; Working chamber saw two cylinders; Saw teeth deformation; Breaking point; Profile of saw teeth; Dynamic loads styling; Shaft is stabilized insert

Introduction

It Was considered prevent wear of the saw tooth saw cylinder and shaft by mathematical analysis of the saw cylinder at different shaft lengths and number of blades, by simulated the transverse vibrations with different amounts of drinking and between saw gaskets brought the best option, which has a positive effect on the strength of the shaft. As a result, developed, gin, which reduces bending vibration, but it increases performance by two staggered cylinders saw in one of the working chamber [1-4].

But, in all gins durability of the saw is important for the production costs. By using saws with improved geometric parameters and normal stresses can be increased the durability of the saw. Therefore, we decided to determine the normal stress using complex geometric characteristics of saw at different distances. Developed recommendations and determined the optimal parameters for the practical use of working of old profile teeth of saws and new profile teeth of saw.

Theoretical Statically Analyze of Saw Cylinder

To determine the normal stress we would have to calculate the center of gravity. Determining the product of inertia Yc and Zc which pass through the center of gravity. Determining the position of the central axes U and V. Determining the amount of the moment of inertia relatively the position of the central axis. Creating an ellipse of inertia by identifying the main radius of gyration (Tables 1-5).

Defining the center of gravity of the cross section with respect to the coordinates YOZ.

$$Y_c = \frac{Y_1 \cdot F_1 + Y_2 \cdot F_2}{F_1 + F_2};\ Y_1 = \frac{B_1}{2};\ Y_2 = B_1 + \frac{B_2}{2};$$

Name of Detail	B_1	H_1	$F_1=B_1*H_1$	$J_{Y1} = \frac{B_1 \cdot H_1^3}{12};$	$J_{Z1} = \frac{H_1 \cdot B_1^3}{12};$
Saw	0.1	16	1.6	34,13	0,0013

Table 1: Determining the Saw of inertia Yc and Zc which pass through the center of gravity.

Name of Detail	B_2	H_2	$F_2 = B_2 * H_2$	$J_{Y2} = \frac{B_2 \cdot H_2^3}{12};$	$J_{Z1} = \frac{H_2 \cdot B_2^3}{12};$
Gasket between saws	1,4	8	11,2	60	2
	1,6	8	12,8	68	3
	1,8	8	14,4	77	4
	2,0	8	16	85	5
	2,2	8	17,6	94	6

Table 2: Determining the different Gaskets of inertia Yc and Zc which pass through the center of gravity.

B_1	H_1	B_2	H_2	F_2	F_1	Z_1	Z_2	Y_1	Y_2	Z_c	Y_c
0.1	16	1,4	8	11,2	1.6	8	4	0.05	0.75	4.5	0.66
0.1	16	1,6	8	12,8	1.6	8	4	0.05	0.85	4.44	0.67
0.1	16	1,8	8	14,4	1.6	8	4	0.05	0.95	4.4	0.86
0.1	16	2,0	8	16	1.6	8	4	0.05	1.05	4.36	0.95
0.1	16	2,2	8	17,6	1.6	8	4	0.05	1.15	4.33	1.05

Table 3: Determining the different size Gaskets and saw of inertia Yc and Zc which pass through the center of gravity.

a_1	a_2	b_1	b_2	J_{Y1}	J_{Y2}	J_{Z1}	J_{Z2}	J_{YC}	J_{ZC}	J_{YCZC}
3.5	-0.5	-0.61	0.09	34,13	60	0,0013	2	116,53	2,68	-3,92
3.56	-0.44	-0.62	0.18	34,13	68	0,0013	3	124,88	4,03	-4,54
3.6	-0.4	-0.81	0.09	34,13	77	0,0013	4	134,17	5,17	-5,18
3.64	-0.36	-0.9	0.1	34,13	85	0,0013	5	142,4	6,45	-5,87
3.67	-0.33	-1	0.1	34,13	94	0,0013	6	151,59	7,77	-6,45

Table 4: Will be Defined centrifugal moment inertia in saw and gasket.

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No	B_1 cm	B_2 cm	J_U=J max	J_V=J min	$F=(F_1+F_2)$ cm²	R_U cm	R_V cm
1	0,1	1,4	116,65	2,55	12.8	3.01	0.44
2	0,1	1,6	125,04	3,86	14.4	2.94	0.51
3	0,1	1,8	134,37	4,97	16	2.89	0.55
4	0,1	2,0	142,65	6,19	17.6	2.84	0.59
5	0,1	2,2	151,87	7,49	19.2	2.81	0.62

Table 5: Let's define the main moments of inertia.

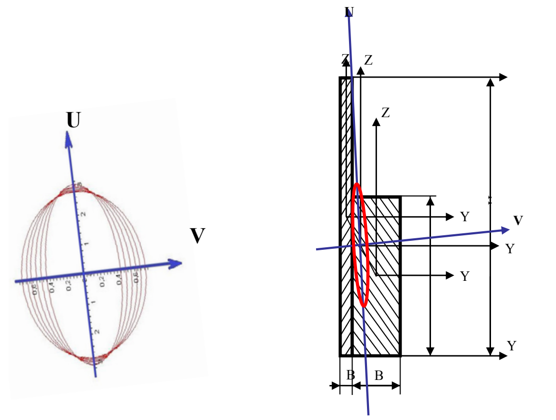

Figure1: The principal ellipse of inertia.

No	B_1 cm	B_2 cm	J_U=J max	J_V=J min	$F=(F_1+F_2)$ cm²	R_U cm	R_V cm
1	0,1	1,4	116,65	2,55	12.8	3.01	0.44
2	0,1	1,6	125,04	3,86	14.4	2.94	0.51
3	0,1	1,8	134,37	4,97	16	2.89	0.55
4	0,1	2,0	142,65	6,19	17.6	2.84	0.59
5	0,1	2,2	151,87	7,49	19.2	2.81	0.62

Table 6: The define principal radius of inertia.

$$Z_c = \frac{Z_1 \cdot F_1 + Z_2 \cdot F_2}{F_1 + F_2};\ Z_1 = \frac{H_1}{2};\ Z_2 = \frac{H_2}{2};$$

Defined by the formula coordinates Yc and Zc, putting on the scale by observing the drawing. After determining the point of suppressing data, we define the point C. Defined the relative central axes Yc and Zc centrifugal inertia in sectional saws and gasket between saws.

$$J_{yc} = \left[J_{y1} + a_1^2 F_1\right] + \left[J_{y2} + a_2^2 F_2\right];$$

$$J_{zc} = \left[J_{Z1} + b_1^2 F_1\right] + \left[J_{Z2} + b_2^2 F_2\right];$$

$$J_{ycZc} = \left\lfloor J_{y1Z1} + a_1 b_1 F_1\right\rfloor + \left\lfloor J_{y2Z2} + a_2 b_2 F_2\right\rfloor;$$

$$a_1 = Z_1 - Z_c;\ a_2 = Z_2 - Z_c;\ b_1 = Y_1 - Y_c;\ b_2 = Y_2 - Y_c;$$

We define the centrifugal inertia in the form of tiles;

$J_{Y1Z1}=0;\ J_{Y2Z2}=0$

We define the direction of the central axis:

$$tg2\alpha_0 = \frac{-2J_{YCZC}}{J_{YC} - J_{ZC}};\ \alpha_0 = \frac{arctg}{2};$$

α_0 - as it has a positive result, we rotate the central axis U and V counterclockwise relatively Zc coordinate.

We define the principal moments of inertia according to the formula:

$$J_{U,V} = J\max,\min = \frac{J_{YC} + J_{ZC}}{2} \pm \frac{1}{2}\sqrt{\left(J_{YC} - J_{ZC}\right)^2 + 4J_{YCZC}{}^2};$$

J_U=J max;

J_V=J min;

We define the principal radius of inertia by the following formula:

$$R_U = \sqrt{\frac{J_U}{F}};\ R_V = \sqrt{\frac{J_V}{F}};$$

According to certain data we construct stiffness of ellipse Figure 1 and Table 6.

Centrally compressed rods in addition to the calculation of the strength is necessary to be counted on the stability, before loss of stability, vertical axis of saw is bent and the saw makes joint actions at the same time: compression and bending Figures 2, 3 and Tables 7-12.

The smallest value of the compressive force at which the saw loses the ability to maintain gravity of straight linear form is called the critical force and is denoted Pk.

Even with a slight excess of the critical load values appear unacceptably large deflections and stresses, so state of the saw corresponding critical force should be considered dangerous. (marginal). In order to ensure certain stability reserve, it is necessary to satisfy the condition:

$$P \le [P];$$

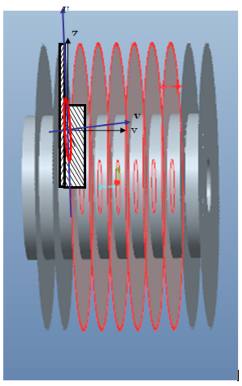

Figure 2: Constructions of an ellipse of rigidity on a shaft.

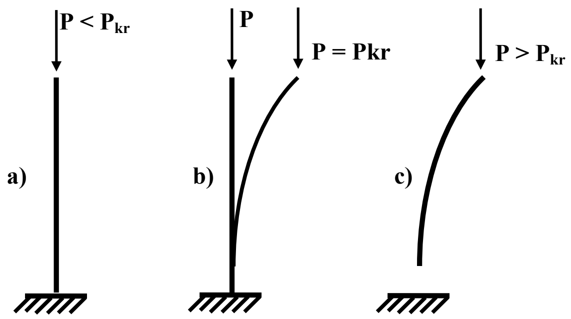

Figure 3: In order to ensure certain stability reserve, it is necessary to satisfy the current condition.

Mark of a steel	Temperature	The elasticity module
12ХФМ; СТ45; У8	20	E=210 Гра
12ХФМ; СТ45; У8	25	E=209.5 Гра
12ХФМ; СТ45; У8	30	E=209 Гра
12ХФМ; СТ45; У8	35	E=208.5 Гра
12ХФМ; СТ45; У8	40	E=208 Гра
12ХФМ; СТ45; У8	45	E=207.5 Гра

Table 7: The module of elasticity for steels 12ХФМ; СТ45; У8 at different working temperatures.

Mark of a steel	Temperature	The elasticity module
P9	20	220 Гра
P9	25	219.5 Гра
P9	30	219 Гра
P9	35	218.5 Гра
P9	40	218 Гра
P9	45	217.5 Гра

Table 8: The module of elasticity for steel P9 at different working temperatures.

Mark of a steel	Temperature	The elasticity module
Ст3сп5	20	E=200 Гра
Ст3сп5	25	E=199.5 Гра
Ст3сп5	30	E=199 Гра
Ст3сп5	35	E=198.5 Гра
Ст3сп5	40	E=198 Гра
Ст3сп5	45	E=197.5 Гра

Table 9: The module of elasticity for steel Ст3сп5 at different working temperatures.

B_2 cm	μ	L cm	Temper	E MPa	Jmin	P_k Mpa	λ
1,4	2	16	25°	2.1	2,55	0,051	12.54
1,6	2	16	25°	2.1	3,86	0.078	8.29
1,8	2	16	25°	2.1	4,97	0.100	6.43
2,0	2	16	25°	2.1	6,19	0.125	5.16
2,2	2	16	25°	2.1	7,49	0.151	4.27
1,4	2	16	30°	2.09	2,55	0,051	12.54
1,6	2	16	30°	2.09	3,86	0.077	8.29
1,8	2	16	30°	2.09	4,97	0.100	6.43
2,0	2	16	30°	2.09	6,19	0.124	5.16
2,2	2	16	30°	2.09	7,49	0.150	4.27
1,4	2	16	35°	2.085	2,55	0,051	12.54
1,6	2	16	35°	2.085	3,86	0.077	8.29
1,8	2	16	35°	2.085	4,97	0.099	6.43
2,0	2	16	35°	2.085	6,19	0.124	5.16
2,2	2	16	35°	2.085	7,49	0.150	4.27
1,4	2	16	40°	2.08	2,55	0,051	12.54
1,6	2	16	40°	2.08	3,86	0.077	8.29
1,8	2	16	40°	2.08	4,97	0.099	6.43
2,0	2	16	40°	2.08	6,19	0.123	5.16
2,2	2	16	40°	2.08	7,49	0.150	4.27
1,4	2	16	45°	2.07	2,55	0,05	12.54
1,6	2	16	45°	2.07	3,86	0.076	8.29
1,8	2	16	45°	2.07	4,97	0.099	6.43
2,0	2	16	45°	2.07	6,19	0.123	5.16
2,2	2	16	45°	2.07	7,49	0.149	4.27

Table 10: 12Х1МФ And CT45 Critical force Pk (the loss of stability in elastic stage) with different distance between of saw's.

$$[P]=\frac{P_K}{(n)y};$$

Here [P] - allowable load

B_2 cm	μ	L cm	Temper	E MPa	Jmin	$P_{k\ Mpa}$	λ
1,4	2	16	25°	2.2	2,55	0,054	12.54
1,6	2	16	25°	2.2	3,86	0.081	8.29
1,8	2	16	25°	2.2	4,97	0.105	6.43
2,0	2	16	25°	2.2	6,19	0.131	5.16
2,2	2	16	25°	2.2	7,49	0.158	4.27
1,4	2	16	30°	2.19	2,55	0,053	12.54
1,6	2	16	30°	2.19	3,86	0.081	8.29
1,8	2	16	30°	2.19	4,97	0.104	6.43
2,0	2	16	30°	2.19	6,19	0.130	5.16
2,2	2	16	30°	2.19	7,49	0.157	4.27
1,4	2	16	35°	2.185	2,55	0,053	12.54
1,6	2	16	35°	2.185	3,86	0.081	8.29
1,8	2	16	35°	2.185	4,97	0.104	6.43
2,0	2	16	35°	2.185	6,19	0.130	5.16
2,2	2	16	35°	2.185	7,49	0.157	4.27
1,4	2	16	40°	2.18	2,55	0,053	12.54
1,6	2	16	40°	2.18	3,86	0.081	8.29
1,8	2	16	40°	2.18	4,97	0.104	6.43
2,0	2	16	40°	2.18	6,19	0.129	5.16
2,2	2	16	40°	2.18	7,49	0.157	4.27
1,4	2	16	45°	2.175	2,55	0,053	12.54
1,6	2	16	45°	2.175	3,86	0.080	8.29
1,8	2	16	45°	2.175	4,97	0.104	6.43
2,0	2	16	45°	2.175	6,19	0.129	5.16
2,2	2	16	45°	2.175	7,49	0.156	4.27

Table 11: P9 Critical force Pk (the loss of stability in elastic stage) with different distance between of saw's.

B_2 cm	μ	L cm	Temper	E MPa	Jmin	$P_{k\ Mpa}$	λ
1,4	2	16	25°	2.0	2,55	0,049	12.54
1,6	2	16	25°	2.0	3,86	0.074	8.29
1,8	2	16	25°	2.0	4,97	0.095	6.43
2,0	2	16	25°	2.0	6,19	0.119	5.16
2,2	2	16	25°	2.0	7,49	0.144	4.27
1,4	2	16	30°	1.99	2,55	0,048	12.54
1,6	2	16	30°	1.99	3,86	0.073	8.29
1,8	2	16	30°	1.99	4,97	0.095	6.43
2,0	2	16	30°	1.99	6,19	0.118	5.16
2,2	2	16	30°	1.99	7,49	0.143	4.27
1,4	2	16	35°	1.985	2,55	0,048	12.54
1,6	2	16	35°	1.985	3,86	0.073	8.29
1,8	2	16	35°	1.985	4,97	0.094	6.43
2,0	2	16	35°	1.985	6,19	0.118	5.16
2,2	2	16	35°	1.985	7,49	0.143	4.27
1,4	2	16	40°	1.98	2,55	0,048	12.54
1,6	2	16	40°	1.98	3,86	0.073	8.29
1,8	2	16	40°	1.98	4,97	0.094	6.43
2,0	2	16	40°	1.98	6,19	0.117	5.16
2,2	2	16	40°	1.98	7,49	0.142	4.27
1,4	2	16	45°	1.97	2,55	0,048	12.54
1,6	2	16	45°	1.97	3,86	0.073	8.29
1,8	2	16	45°	1.97	4,97	0.094	6.43
2,0	2	16	45°	1.97	6,19	0.117	5.16
2,2	2	16	45°	1.97	7,49	0.142	4.27

Table 12: Ст3сп5 Critical force Pk (the loss of stability in elastic stage) with different distance between of saw's.

$(n)_y$ - required coefficient of stability reserve;

Critical force Pk (the loss of stability in elastic stage) is given by Euler's formula:

$$P_K = \frac{\pi^2 EJ_{min}}{(\mu \cdot l)^2};$$

E-modulus of elasticity;

Jmin- minimum moment of inertia of the cross section;

μ - so-called reduction factor which depends on the length of the method of fixing the ends of the rod or the saw; Figure 4 shows several types of fixing rod and indicate the relevant values of the coefficient. μ - the so-called coefficient f length is given.

Stress that is resulting in a cross section of the rod when reaching compressive force to the critical value, called the critical σk. Euler's formula is valid if (critical stress does not exceed the limit of proportionality). Usually, the condition of applicability of Euler's formula is expressed in terms of the rod flexibility **λ** is calculated by the formula.

$$\lambda = \frac{\mu \cdot l}{i_{min}};$$

Where

l-length of saw or rod

I_{min} – minimum moment of inertia

Conclusion

Results of research show the geometric characteristics of the saw and gasket of saw gin as well as define acceptable normal load for saw gin at different distances between the saw. In such cases, the strength and stability of saws are determined not only by its size but also on other complex geometrical characteristics with cross-section of saws and gasket.

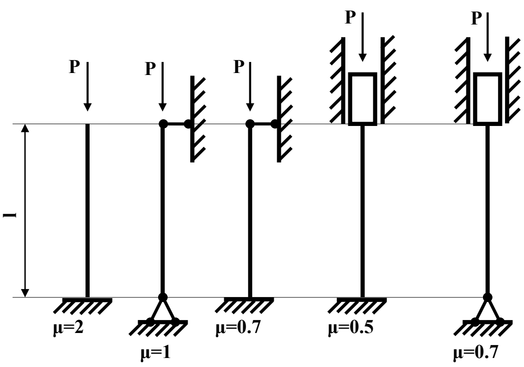

Figure 4: Shows several types of fixing rod and indicate the relevant values of the coefficient μ - the so-called coefficient of length is given.

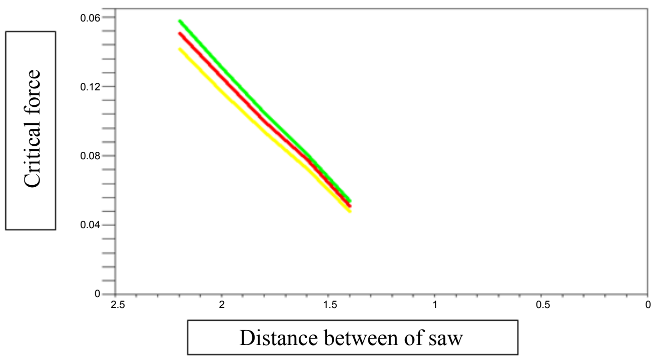

Figure 5: Interrelation critical force with the different size of gasket.

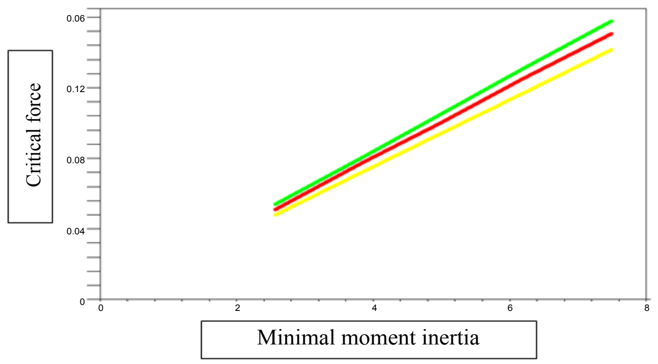

Figure 6: Interrelation critical force with the minimal moment inertia.

For example in Figure 5, we can, clearly will see influences between watchful distances on stability using different types of steels. The result has shown that at 45 degrees stability of steel is high at between saw distances of 22 mm. Also we have revealed that tool steel P9 has the greatest indicator of stability of critical force.

In Figure 6, we can see that increases of an indicator, the minimum moment of inertia leads to stability increase (critical force) saw a disk. From this follows that we can looking on an ellipse of inertia and having measured its positions from any point of an ellipse, to predict stability of a detail to certain loadings.

We conducted research about saw and gasket at different distances between the saw. Determined, the optimal parameters, between the saw distances, using the geometric characteristics in order to ensure the sustainability of saws, at work in dynamic loads. Using these indicators, we can simulate the best option of working parts of gin and increase the life of saws twice.

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