Mathematical model for Conveyor belt 1600mm

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Summary
In this paper, we could observe the experiment planning method the rotational plans composed of second order in determining the driver power stations operating unit of N „ "the straps transportation B = 1600 [mm] in the work of excavators Rotor SRs- 1300 and SRs-470, in view of the capacity of these,, Q1 ", Q2 „" the two excavators, as well as the inclination of the tape carrier,, φ "with the purpose of optimization of the transport on the basis of minimum consumption Electricity,, e".

Key words:
Model, Tape, capacity, slope, consumption.

1. Formation of a mathematical model

X matrix of experiment planning for determining optimal power station operating conveyor belts B = 1,600 [mm], in view of capacity excavators SRs- 470 and SRs-1300 and their inclination can be put in the following form in the form 2k + 2k + no on this occasion that the first pose matrix of experimentation with planning we advance encoding variables (Q1, Q2, φk) through values (-1,0, + 1), where present. -1-the lower limit value, 0- The average value + 1, the upper limit value.

In equation (1) presented coding or transformations real values:

$$x_{mes} = \frac{x_{1\max} + x_{1\min}}{2} \qquad (1)$$

The methodology of the implementation of the research is done the combination of variables in order to avoid errors possible. Before beginning the research the parameters during the measurement of capacity excavators Rotor should adopt the initial values of plan experimentation: schedule excavator capacity E1, Q1hmes - E2-time capacity excavator, Q2hmes, the angle of slope tape φ Average conveyor. The value of these parameters can the problem arises if you arrange in advance the search steps who choose, but you must meet the requirements of equation (2).

$$\Delta x_i = \frac{x_{1\max} - x_{1\min}}{2} \qquad (2)$$

But in the case of table grape tone interval is not given variation, The search step for each parameter is selected as desired, butit should be noted that the parameters of who assume that More influence in the process should be taken with a small stand the factors that affect less in step with the process deals great. And according to the principle parameters of paved steps are: h1, h2 and h3.

Nr. proc	Kom. e plotë	experimental plan										y	*y	$(y_{mes}-y)^2$	$(y_i-y_{i+1})^2$
		x_0	x_1	x_2	x_3	x_1^2	x_2^2	x_3^2	x_1x_2	x_2x_3	x_2x_3				
1	Bashk. nr.k.pj. kal. 2^k	+1	-1	-1	-1	+1	+1	+1	+1	+1	+1	591	541.5	2447	
2		+1	+1	-1	-1	+1	+1	+1	-1	-1	+1	701	789.6	7852	
3		+1	-1	+1	-1	+1	+1	+1	-1	+1	-1	818	805	169	
4		+1	+1	+1	-1	+1	+1	+1	+1	-1	-1	891	874.17	283	
5		+1	-1	-1	+1	+1	+1	+1	+1	-1	-1	535	502.25	1073	
6		+1	+1	-1	+1	+1	+1	+1	-1	+1	-1	664	634.92	846	
7		+1	-1	+1	+1	+1	+1	+1	-1	-1	+1	828	805.21	519	
8		+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	867	982.82	13415	
9	Bashk. nr.k.pj. boshtë qendr. 2k	+1	-1.215	0	0	1.476	0	0	0	0	0	685	776.70	8409	
10		+1	1.215	0	0	1.476	0	0	0	0	0	851	899.32	2335	
11		+1	1.215	-1.215	0	0	1.476	0	0	0	0	572	597.12	631	
12		+1	0	1.215	0	0	1.476	0	0	0	0	954	902.65	2637	
13		+1	0	-1.215	0	0	0	1.476	0	0	0	701	681.15	394	
14		+1	0	0	1.215	0	0	1.476	0	0	0	664	657.41	43	
15	Bashk. - pikat në	+1	0	0	0	0	0	0	0	0	0	693	789.61	9334	9334
		b_o=789.6	b_1=50.46	b_2=125.7	b_3=9.8	b_{11}=32.8	b_{22}=26.9	b_{33}=81.5	b_{12}=15.9	b_{13}=1.88	b_{23}=9.9	734	749	50386	9334

The table above benefit regression surface the second order equation (3,4,5,6 and 7):

$$y = b_o + \sum_{i=1}^{3} b_i x_i + \sum_{i=1}^{3} b_{ii} x_i^2 + \sum_{i=1}^{3} b_{ij} x_i x_j \qquad (3)$$

The regression coefficients calculated according to the equation (3) and aftër replacement have won the following data:

$$b_o = 0.163(0y) - 0.0569\sum_{i=1}^{k=3}(iiy) \qquad (4)$$

$$b_i = 0.0732(iy) \qquad (5)$$

$$b_{ii} = 0.0625(iiy) + 0.0069\sum_{i=1}^{k=3}(iiy) - 0.0568(0y) \qquad (6)$$

$$b_{ij} = 0.125(ijy) \qquad (7)$$

Values (0y), (y), (iiy) and (ijy) are calculated according to the expression:

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(iy): $\sum_{i=1}^{k=3} x_i y$, (iiy): $\sum_{i=1}^{k=3} x^2{}_i y$, (ijy): $\sum_{i=1}^{k=3} x_i x_j y$ (8)

(0y) = 11015 (11y) = 8162.1 (12y) = -127

(1y) = 552.7 (22y) = 95555.5 (13y) = -15

(2y) = 1377.1 (33y) = 7909.7 (23y) = 74

(3y) = -107 (9)

After setting these mathematical model coefficients the second order, in the form 2k + 2k + and under no expressions of effective factors, it became possible to determine the model coefficients, Within the mathematical theory experimentation with plans composed of second order with Three factors, mathematical model required that expresses the interaction of the technical parameters of the workstation operating the tape will be:

$y=b_o+b_1 x_1 +b_2 x_2 +b_3 x_3 +b_{11} x_1^2 +b_{22} x_2^2 +b_{33} x_3^2 +b_{12} x_1x_2 +b_{13} x_1x_3 +b_{23} x_2x_3$ (10)

$b_o = 789.6$, $b_{11} = 32.8$, $b_{12} = -15.9$, $b_1 = 50.46$
$b_{22} = -26.9$, $b_{13} = -1.88$, $b_2 = 125.7$, $b_{33} = -81.5$
$b_{23} = 9.9$, $b_3 = -9.8$ (11)

This expression consists of coded variables factors analyzing where in this case the table. 1, in the penultimate column It is presented strength values than the driver guild station Action by the mathematical model parameters technological. Such a form of the mathematical model can not, It is considered final after the model should be performed dispersive analysis, which must first determine the error calculation of model coefficients, which are calculated according to the expressions:
In this experiment error case Në këtë rast gabimi i eksperimentit $\sigma^2\{y\}$ = 66, ndërsa $\sigma\{y\}$ = 8.12 ka vlerën e llogaritur.
After calculations the preceding calculations errors model coefficients are:
$\sigma\{b_o\}$ = 0.853, $\sigma\{b_i\}$ = 0.565 $\sigma\{b_{ii}\}$ = 0.739 dhe $\sigma\{b_{ij}\}$ = 0.551 .
(12)

Signification of model factors or response surface It is made to prove their viability in model paved. This is done for each sample by a factor implemented: the null hypothesis number of degrees of freedom f = 3, as degrees of freedom of the error coefficients and confidence level α = 12:05 tabular value is found by Student criterion: T * = 3183 Signification is made according to the "t" relations with equalizer below.

$$t_i = \frac{|b_i|}{\sigma\{b_i\}} \quad (13)$$

$t_1 = 89.2$ $t_{11} = 59.5$ $t_{12} = 21.48$
$t_2 = 222.3$ $t_{22} = 48.9$ $t_{13} = 2.53$
$t_3 = 17.27$ $t_{33} = 148$ $t_{23} = 13.36$

(14)

From the "t tests" calculated reports of signification Positive factors considered when all factors values are outside the range of (-2.03, 2:03) are significant and, therefore, the mathematical model of the surface that has the form of regression asked:

$Y = 789.6+50.46 x_1 +125.7 x_2 -9.8 x_3 +32.8 x_1^2 -26.9 x_2^2 - 81.5 x_3^2 -15.9 x_1x_2 -1.88 x_1 x_3 +9.9 x_2x_3$ (15)

In this case we say the alternative hypothesis of existence, to the different from zero is indeed so after finding surface the regression hypothesis controlled on adequate representation of the response function by means of expression, so that Preliminary values are calculated "yk" which are presented in column 15 of table 1, As we add and above for each a mathematical model, which describes a process of working systems or presents some different phenomena should be determined confidence interval according to "F" or criteria Fisher. The model reliability or otherwise called as well an adequate presentation of the mathematical model, usually done by Fisher criterion on the remaining variances equalizer S2m Experiment with square error calculated as follows:

$$F = \frac{S_M^2}{S_L^2} \quad (16)$$

The remaining variance for this case is calculated according to the equation 17.

$$s_M^2 = \frac{1}{f_{LE}}\left[\sum_{i=1}^{15}(y-\hat{y})^2 - \sum_{i=1}^{1}(y_0-\hat{y}_0)^2\right] \quad (17)$$

Where: fLE- number of degrees of freedom, which is calculated from equation 18.

$f_{LE} = N-k-1-(n_0-1)$, $f_{LE} = 15-3-1-(1-1)$, $f_{LE} = 11$. (18)

$s_M^2 = \frac{1}{11}(50386-9334)$, $s_M^2 = 3732$ (19)

The fair reflection problem (adequate) model or the response function can be reformulated by defining changing the observed values and those calculated in experiment

center. The remaining variance for this case is

$$S_L^2 = \frac{\sum_{i=1}^{n}\left(y_o - \hat{y}_o\right)^2}{f_l}, \; f_l = 1 \qquad (20)$$

From the last two columns of Table 1, this value can be calculate the change, while the remaining variance is: $S_L^2 = 9334$

While the calculated value of Fisher's criterion is: $F = \frac{3732}{9334}$, $F = 0.399$ The table value of criterion -F for security level α = 0.05, for number of degrees of freedom fLE = 11 for numerator and number of degrees of freedom fl = 1 for denominator in this case the value F is taken from tab. XI [41] according to Fisher.

$$F_t^* = 4.84.\ F < F_t^* \qquad (21)$$

2. Testing of the mathematical model

To draw the full conclusions on these links functional, the following figures are presented lines of response surfaces, considering each time factor which is absent in the model takes the value 0.

(Case 1), X3 = 0, Yi = f (X1, X2): (Case 2): X2 = 0, f (X1, X3) (case 3): X1 = 0, f (X2, X3) while the acquisition of values for the angle φ ,, "the capacity of Excavator Q2 and Q1 by analysing levels, can take (case 1): $X_3 = 0$, $Y_i = f(X_1, X_2)$:

(case 2): $X_2 = 0$, $f(X_1, X_3)$: (case 3): $X_1 = 0$, $f(X_2, X_3)$,

The acquisition of values for the angle φ,, "the capacity of Excavator Q2 and Q1 by analysing levels, can take these effects of the power unit and the driver handled the following cases:

For: $x_3 = 0$ (φ = 0.0355[rad] (2[°])

$$Y = 789.6+50.6\,x_1 +125.7\,x_2 +32.8\,x_1^2 -26.9\,x_2^2 -15.9\,x_1x_2$$

For: $x_2 = 0$ (Q2 = 1450[m3/h]) (22)

$$Y = 789.6+50.6\,x_1 -9.8\,x_3 +32.8\,x_1^2 -81.5\,x_3^2 -1.88\,x_1x_3$$

For: $x_1 = 0$ (Q3 = 630[m3/h]) (23)

$$Y = 789.6+125.7\,x_2 -9.8\,x_3 -26.9\,x_2^2 -81.5\,x_3^2 +9.9\,x_2x_3$$

While interpretation of the diagrams with this case is done in the MATLAB application program package.

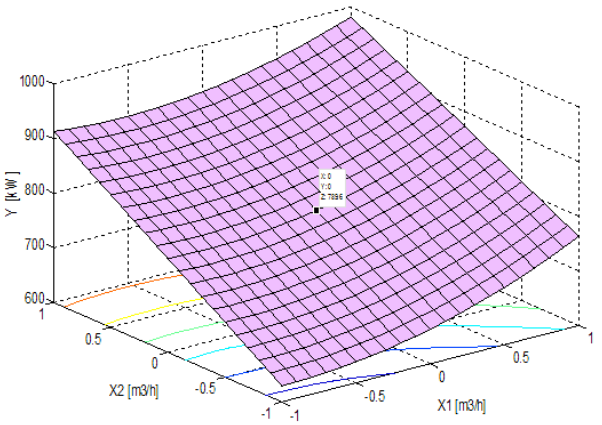

Fig. 1.1 Graphical Interpretation of Diagram X2 = 0 (Q2 = 1450 [m3 / h])

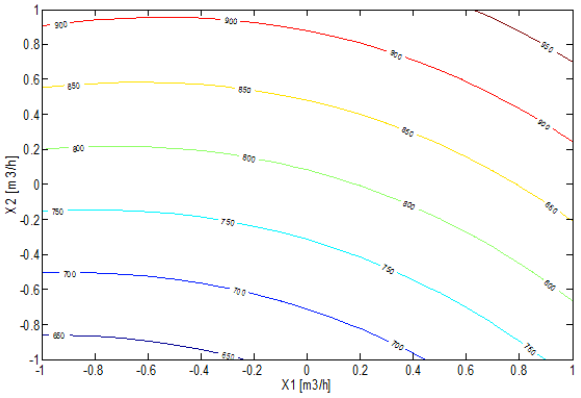

Fig. 1.2 Graphic Interpretation of the Power Diagram for the Conveyor Belt Angle X3 = 0 (φ = 0.0355 [rad] (2 [o])

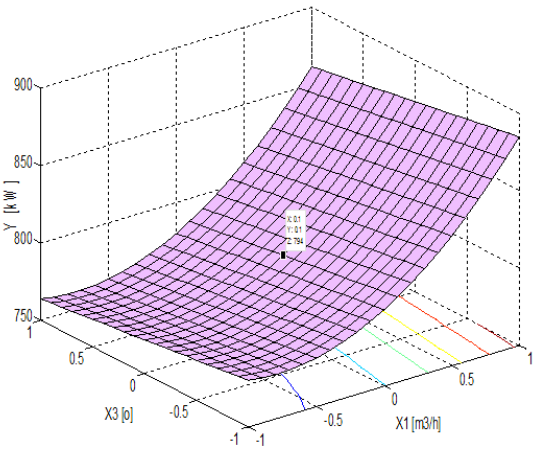

Fig. 1.3 Graphic diagram of power capacity diagram for excavator SRs-1300 X2 = 0 (Q2 = 1450 [m3 / h]).

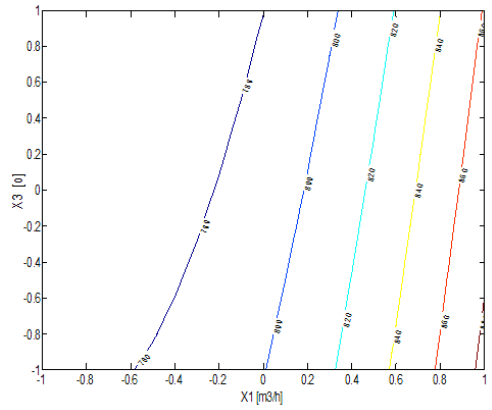

Fig. 1.4 Graphic Interpretation of Power Capacity Chart for Excavator Capacity SRs-1300 X2 = 0 (Q2 = 1450 [m3 / h])

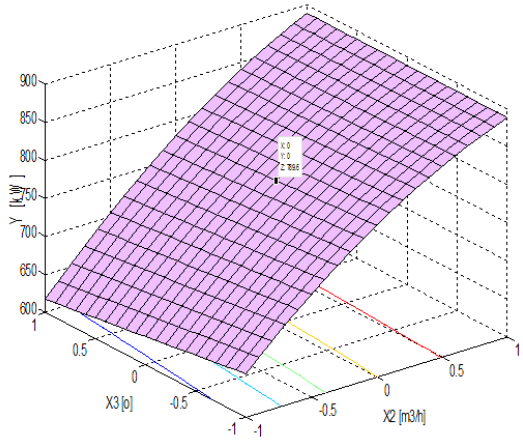

Fig. 1.5 Graphic Interpretation of Power Diagram for Excavator Capacity SRs-470, X1 = 0 (Q1 = 630 [m3 / h])

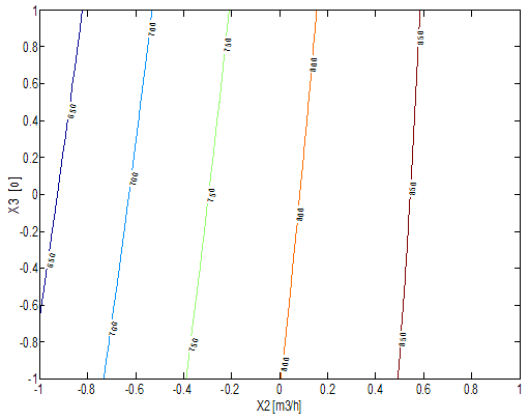

Fig. 1.6 Graphic diagram of power capacity diagram of excavator SRs-470, X1 = 0 (Q1 = 630 [m3 / h]

3. Analysis of diagrams for conveyor belts is 1600mm.

Analysis of variance was done on the level of reliability 0:05 (Or: 95% reliability). For proxy mathematical model It is elected by the full polynomial of the second degree, three variable independent. After elimination of coefficients that are free less important or influential in the dependent variability, they are acquired these models or surfaces of responses:

The model represents the necessary power Electromotor from specific energy consumption profit (Y1) is for 1600 mm, depending on the independent parameters in the process (X1- capacity excavator E1), (X2-capacity excavator E2), and (X3 - the angle of tilt φ carrier tape):

$$Y = 789.6+50.6 +125.7 +32.8 -26.9 -15.9 \quad (24)$$

The surface of the responses representing the values calculated by the surface grade is par for-1600 which is divided by (Y2), in Dependence the independent process parameters Technological excavators (X1-capacity excavator E1), (X2-capacity excavator E2), and (X3-angle the slope conveyors φ):

$$Y = 789.6+50.6 -9.8 +32.8 -81.5 -1.88 \quad (25)$$

Shows that although the two models are earned degree Second, they certainly do not represent the complete dependence of parameters examined, the factors are not dependent but in mutual dependence on one another. In Table 2 are show coded levels and real values which is conducted each experiment separately.

Table 2: Coded and natural levels of factors

Variabl	Results of influential variables				
Factorization of variables	- 1.215	- 1	0	+1	+1.215
X1: Excavator Q1 capacity	870	300	330	960	986
X2: capacity of excavator Q2	635	500	950	2400	671
X3: Slope angle is	0.035	0.017	0.0185	0.054	0.052

Table 3: Effective parameter function

Parameters	Function CB-1600	
	Calculated values	Values P
b_1	50.46	-107
b_2	125.7	
b_3	-9.8	
b_{12}	-15.9	74
b_{13}	-1.88	
b_{23}	9.9	
b_{11}	32.8	79
b_{22}	-26.9	
b_{33}	-81.5	

The surface of the specific energy consumption responses electric power depends on the electromotor (function Y1) in case when the angle of the bar inclination (φ) remains constant X3 = 0, the increase of a factor of two after the (X1) - the capacity of excavator (E-1) and (X2) -capacity excavator (E2), not It increases the power of electromotor for overburden transport.

Reduction of both capacity significantly excavators It reduces power electromotor for conveyor belts, and The best result is achieved when capacity reaches excavator value X2 = 0, and the capacity to raise X2> 1.

Likewise, the capacity of the excavator (X1> 1) It affects electromotor power to increase the value by 15% capacity at the beginning of the overburden transport, if it be constant beginning in paragraph 1, then power will electromotor be reduced.

In case when the capacity of the excavator (E2) then (E2) remains free Well amended X2 = 0, then the change of two parameters the other is not important, except that observed little impact The growth of electromotor power as well as the Expected impact of raising the specific energy consumption for transport of 1 [m3/H] overburden. The angle of inclination of conveyor belts and capacity excavators when reduced at the same time influence significantly decreasing the power electromotor (Y2), and the effect Their positive setting Y2 is only when their change It is reversed. Increasing the capacity of two excavators (X2) and growth the angle of inclination of conveyor tape (X3), resulting with a significant increase of power electromotor (Y1).

From In turn, the increase of one parameter and the reduction of another and conversely, negatively affect the strength of the electromotor transport of overburden. Increasing to one-time capacity excavators (X2) and tilt angle (X3), increases the power of electromotor, while raising the inclination angle (X3) before value of the excavator capacity (X2 = -1) maximizes power electric motor(Y2).

Lines of surfaces worked with answers MATLAB, helped us to visualize the influence of parameters factored in two important indicators of the excavator. In any case, the chosen concept of research (the experiment plan according to the central composite design), the conditions experimentation in the open field, is shown the fitting multivariable to investigate the influence of the influencing parameters and the concentration of their effects on key indicators calculation of electromotor power. Of course, in future research, the number of influencing factors It should be extended, by considering the angle of impact slope with the greatest corner in our mines totals value up to 120 The impact of this corner is very important. Under these conditions, the search for optimal process regime technological two excavators would be accomplished by risk the minimum possible.

Obviously, in this case, we are talking to search local optimum in the KEK mine, and research and discussion of the global optimum of the optimum of case to case, it remains to be investigated

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