

## НЕТРАДИЦІЙНІ ВИДИ ТРАНСПОРТУ. МАШИНИ ТА МЕХАНІЗМИ

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### RESEARCH OF INFLUENCING OF PROJECT DISCRPTIONS OF ELEVATOR ON PARAMETERS OF ITS DRIVE

**Purpose.** One of basic elements of band bucket elevators is their drive. For determination of power drive it is necessary to conduct calculations on standard by methods, in what it is needed to expend enough time. One of project parameters is productivity of elevator. It is necessary to build parametric dependence of power drive of elevator on its design capacity that takes into account a type and descriptions of load, lifting height, standard sizes and parameters of buckets and tapes. **Methodology.** Using the method of hauling calculation of band buckets elevators, the parametric dependences of power drive of high-speed elevators are built with deep and shallow buckets from their productivity at fixed type of load and height of getting up. **Findings.** It is set on the basis of the built parametric dependences that the change function of a size of elevator power from design capacity (at fixed to the lifting height, load type, rate of tape movement) is piecewise and droningly increasing. The intervals of project values of productivity, which provide the permanent size of elevator power drive are certain in a general view. As the example of application of the recived results the construction process of power drive dependence from design capacity of elevator of shotblasting room, which is intended for transporting of the metallic shot using for consolidating of carriage springs, is considered. For concrete type of load and lifting height of such elevator graphic dependence of power drive on productivity was built. **Originality.** Parametric dependences of elevator power drive on its design capacity were first built, which take into account a type and physical and mechanical descriptions of load, lifting height, standard sizes and parameters of buckets and tapes. **Practical value.** The use of the built dependences enables in relation to rapid determination of approximate value of power drive of vertical high-speed elevators with deep and shallow buckets on the stage of planning and to execute the high-quality selection of its basic elements at concrete project descriptions: type of load, productivity, lifting height.

*Keywords:* elevator; bucket; drive; power; productivity; load

#### Introduction

Today it is hard to imagine any industry field without the use of transporting cars. Machines of continuous transport are the basis of complex

mechanization of cargo handling and industrial process. They increase the work productivity and production efficiency. The bucket belt elevators are the separate type of continuous transport machines. The elevators are lifts of vertical action

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and used for vertical and high-angle (angle 60–82 °) transportation of bulk and manufactured cargo without intermediate loading and unloading. The use of elevators as an intermediate means of transport makes it possible to have a compact transport scheme, which occupies small space. They are used in the chemical, metallurgical, machine-building industry, production of construction materials, coal preparation plants, food plants and in granaries.

The main publications that describe the structure, design features, operational and design values of the elevators are [3, 4, 5, 6, 7, 9, 10]. It is necessary to calculate the reels, the traction unit (tapes), traction calculation and to perform the selection of the main elements of the driving unit for determination the parameters of elevator drive, and in particular its capacity. The order of performing such calculations are described in detail in [6, 7]. But, the definite part of time is spent during the attraction of such elevator drive calculation methodology. For the process of elevator drive design improvement, it is desirable to have a scheme which allows simplifying calculations to determine the desired value for the drive power depending on design capacity in a particular type of cargo and the height of its ascent.

### Purpose

The aim of this work is building of a parametric dependence of the elevator power drive from its design capacity, which takes into account the type and characteristics of the cargo, lifting height, standard dimensions and parameters of the buckets and tapes.

### Methodology

The value of the drive power of the elevator depends on many parameters. The main parameters are: type of cargo, design capacity and lifting height. For further study we will define the basic components of the overall calculation of the elevator which in varying degrees depends on design capacity. These include: linear capacity of buckets (capacity and disposed step of the buckets); width, number of strips and linear weight of tape; the required distributed weight of the load; linear load on the working branch; draft force on the drive drum.

Linear capacity of elevator buckets:

$$\frac{i_0}{t} = \frac{P}{3,6\nu\rho\psi} = \frac{P}{\alpha}, \quad (1)$$

where  $\alpha = 3,6\nu\rho\psi$  – value, that takes into account the properties of the transported cargo,  $t \cdot m/l \cdot h$ ;  $\psi$  – coefficient of bucket charge (according to the physical and mechanical properties of cargo);  $t$  – disposed step of buckets, m;  $\rho$  – cargo density, t/m<sup>3</sup>;  $\nu$  – tape speed, m/s.

According to the meaning of linear capacity of the elevator bucket that is calculated by the formula (1) the type and disposed step of buckets are selected by the table 1 [7]. The selection of bucket type depends on the material properties that is transported. The deep buckets are used for easily granular, powdered and small parts of cargoes; shallow – for difficult bulk materials.

With the aim of taking into account the subsequent calculations of the physical and mechanical properties of the cargo that is transported, we'll build a correspondent table of the elevator parameters, defined in table 1, the value of performance, expressed by the formula (1) in parts of the coefficient  $\alpha$ . The obtained data will be posted in tables 2 and 3 for elevators with deep and shallow buckets accordingly.

On the basis of design value capacity of the elevator productivity and the type of transported material, parameters of the bucket, the step of their disposition on the tape, and the necessary width of the tape are selected by tables 2 and 3. Characteristics of deep and shallow bucket (width, the bucket outreach, bucket height and capacity) are shown in table 4.

The tapes of State standart 23831-79, State standart 20-85 are used in the bucket elevator as the traction units. The rubber and fabric tapes of State standart 20-85 type BKNL-150 are accepted as a traction units of bucket elevator for the determination of further researches. The actual number of tape strips can be 3, 4, 5, 6.

The thickness of the tape is determined by the formula

$$\delta_s = \delta_r + i\delta_p + \delta_n, \quad (2)$$

where  $\delta_r = 3$  mm,  $\delta_n = 1,5$  mm is the thickness of the rubber plates with working and non-working sides of the tape;  $\delta_p = 1,6$  mm is the thickness of one fabric strip.  $i$  is the number of strips.

Table 1

## Value of linear capacity of buckets

Bucket width $B_k$ , mm	Tape width $B$ , mm	Disposed step of the bucket $t$ , mm	Bucket			
			deep		shallow	
			$i_0$ , l	$\frac{i_0}{t}$ , l/m	$i_0$ , l	$\frac{i_0}{t}$ , l/m
100	125	200	0,2	1	0,1	0,5
125	150	320	0,4	1,3	0,2	0,66
160	200	320	0,6	2	0,35	1,17
200	250	400	1,3	3,24	0,75	1,87
250	300	400	2,0	5	1,4	3,5
320	400	500	4,0	8	2,7	5,4
400	500	500	6,3	12,6	4,2	8,4
500	650	630	12	19	–	–
650	800	630	18	28,6	–	–
800	1000	800	32	40	–	–
1 000	1 200	800	45	56,25	–	–

Table 2

## Dependence of parameters of deep buckets on the productivity to the elevator

Bucket width $B_k$ , mm	Tape width $B$ , mm	Disposed step of buckets $t$ , mm	Bucket capacity $i_0$ , л	Elevator effectiveness, t/h
100	125	200	0,2	$\alpha$
125	150	320	0,4	$1,3\alpha$
160	200	320	0,6	$2\alpha$
200	250	400	1,3	$3,24\alpha$
250	300	400	2,0	$5\alpha$
320	400	500	4,0	$8\alpha$
400	500	500	6,3	$12,6\alpha$
500	650	630	12	$19\alpha$
650	800	630	18	$28,6\alpha$
800	1 000	800	32	$40\alpha$
1 000	1 200	800	45	$56,25\alpha$

Table 3

## Dependence of parameters of shallow buckets on the productivity to the elevator

Bucket width $B_k$ , mm	Tape width $B$ , mm	Disposed step of buckets $t$ , mm	Bucket capacity $i_0$ , л	Elevator effectiveness, t/h
100	125	200	0,1	$0,5\alpha$
125	150	320	0,2	$0,66\alpha$
160	200	320	0,35	$1,17\alpha$

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End of table 3

Bucket width $B_k$ , mm	Tape width $B$ , mm	Disposed step of buckets $t$ , mm	Bucket capacity $i_0$ , л	Elevator effectiveness, t/h
200	250	400	0,75	1,87 $\alpha$
250	300	400	1,4	3,5 $\alpha$
320	400	500	2,7	5,4 $\alpha$
400	500	500	4,2	8,4 $\alpha$

Table 4

## Description of buckets to the elevator

Type of the bucket	Internal sizes of the bucket, mm				Capacity of the bucket, l
	width $B_k$	departure $A_k$	hight	$R$	
Curved deep D	100	50	65	25	0,1
	100	75	80	25	0,2
	125	90	95	30	0,4
	160	105	110	35	0,6
	200	125	135	40	1,3
	250	140	150	45	2,0
	320	175	190	55	4,0
	400	195	210	60	6,3
	500	235	255	75	12
	650	250	275	80	18
	800	285	325	85	32
1 000	310	355	95	45	
Curved shallow S	125	65	85	30	0,2
	160	75	100	35	0,35
	200	95	130	40	0,75
	250	120	160	55	1,4
	320	145	190	70	2,7
400	170	220	85	4,2	

The weight of one meter of tape is determined by the formula

$$q_s = 10^{-6} B \delta_s \rho_s g, \quad (3)$$

where  $\rho_s = 1100 \text{ kg/m}^3$  is a density of the tape.

Using the formula (2) and (3) for calculation, we presented the table of width and linear weight of tape with different number of stripes and its compliance of elevator productivity for deep and shallow buckets.

Distributed weight per 1 m of the tape is determined by the formula:

$$q_v = \frac{Pg}{3,6v} = \beta P, \quad (4)$$

where  $\beta = \frac{g}{3,6v}$  is the coefficient, which depends on the speed tape,  $\text{N}\cdot\text{s}/\text{kg}\cdot\text{m}$ .

The dependence of the distributed weight of the cargo from the design capacity is calculated by the formula (4) and shown in table 7.

Table 5

**Linear weight of ribbons for deep buckets**

Width of tape $B$ , mm	Linear weight of tape when $i = 3$ , N/m	Linear weight of tape when $i = 4$ , N/m	Linear weight of tape when $i = 5$ , N/m	Linear weight of tape when $i = 6$ , N/m	Elevator effective- ness, t/h
125	12,5	14,7	16,8	19,0	$\alpha$
150	15,0	17,6	20,2	22,8	$1,3\alpha$
200	20,1	23,5	27,0	30,4	$2\alpha$
250	25,1	29,4	33,7	38,0	$3,24\alpha$
300	30,1	35,3	40,4	45,6	$5\alpha$
400	40,1	47,0	53,9	60,8	$8\alpha$
500	50,1	58,8	67,4	76,0	$12,6\alpha$
650	65,2	76,4	87,6	98,8	$19\alpha$
800	80,2	94,0	107,8	121,6	$28,6\alpha$
1 000	100,3	117,5	134,8	152,0	$40\alpha$
1 200	120,3	141,	161,7	182,4	$56,25\alpha$

Table 6

**Linear weight of ribbons for shallow buckets**

Width of tape $B$ , mm	Linear weight of tape when $i = 3$ , N/m	Linear weight of tape when $i = 4$ , N/m	Linear weight of tape when $i = 5$ , N/m	Linear weight of tape when $i = 6$ , N/m	Elevator effective- ness, t/h
125	12,5	14,7	16,8	19,0	$0,5\alpha$
150	15,0	17,6	20,2	22,8	$0,66\alpha$
200	20,1	23,5	27,0	30,4	$1,17\alpha$
250	25,1	29,4	33,7	38,0	$1,87\alpha$
300	30,1	35,3	40,4	45,6	$3,5\alpha$
400	40,1	47,0	53,9	60,8	$5,4\alpha$
500	50,1	58,8	67,4	76,0	$8,4\alpha$

Linear weight of tape with buckets is determined by the formula

$$q_h = q_s + \frac{m_k g}{t}, \quad (5)$$

where  $m_k$  is bucket weight, kg (table 8).

Linear load on working branch is given by:

$$q_r = q_h + q_v. \quad (6)$$

Tentative mass of deep and shallow buckets are shown in table 8 [7].

Using the formula (5)-(6) and taking into account the data of table 8, we define the linear dependence of the load on the working branch of the elevator from the performance values in the deep and shallow buckets. The results of the calculations for tapes with different numbers of stripes are shown in tables 9, 10.

Traction calculation of bucket tape elevator is performed by the method of the outline traversing, the basic principle of which is the revelation of the characteristic points of the route where the change in tension of the tape takes place.

Table 7

Distributed weight of load				
Width of tape $B_k$ , mm	Distributed weight during the elevator work with shallow buckets, N/m	Elevator productivity with shallow buckets, N/m	Distributed weight during the elevator work with deep buckets, N/m	Elevator effectiveness with deep buckets, N/m
100	$0,5\alpha\beta$	$0,5\alpha$	$\alpha\beta$	$\alpha$
125	$0,66\alpha\beta$	$0,66\alpha$	$1,3\alpha\beta$	$1,3\alpha$
160	$1,17\alpha\beta$	$1,17\alpha$	$2\alpha\beta$	$2\alpha$
200	$1,87\alpha\beta$	$1,87\alpha$	$3,24\alpha\beta$	$3,24\alpha$
250	$3,5\alpha\beta$	$3,5\alpha$	$5\alpha\beta$	$5\alpha$
320	$5,4\alpha\beta$	$5,4\alpha$	$8\alpha\beta$	$8\alpha$
400	$8,4\alpha\beta$	$8,4\alpha$	$12,6\alpha\beta$	$12,6\alpha$
500	–	–	$19\alpha\beta$	$19\alpha$
650	–	–	$28,6\alpha\beta$	$28,6\alpha$
800	–	–	$40\alpha\beta$	$40\alpha$
1 000	–	–	$56,25\alpha\beta$	$56,25\alpha$

Table 8

## Tentative mass of buckets to the elevator

Bucket weight, mm	Wall thickness, mm	The weight of one bucket, kg	
		Deep	Shallow
100	2	0,5	0,4
125	2	0,7	0,6
160	2	0,9	0,7
200	3	2	1,5
250	3	3	2
320	3	5	5
400	4	11	10
500	5	18	–
650	5	23	–
800	6	28	–
1 000	6	33	–

Table 9

## The linear loading on a working branch at deep bucket

Bucket width $B_k$ , mm	Distributed cargo weight $q_v$ , N/m	Linear load on the working branch in tape with $i = 3$ $q_r$ , N/m	Linear load on the working branch in tape with $i = 4$ $q_r$ , N/m	Linear load on the working branch in tape with $i = 5$ $q_r$ , N/m	Linear load on the working branch in tape with $i = 6$ $q_r$ , N/m	Elevator effectiveness, t/h
100	$\alpha\beta$	$37+\alpha\beta$	$39,2+\alpha\beta$	$41,3+\alpha\beta$	$43,5+\alpha\beta$	$\alpha$
125	$1,3\alpha\beta$	$36,4+1,3\alpha\beta$	$39+1,3\alpha\beta$	$41,6+1,3\alpha\beta$	$44,2+1,3\alpha\beta$	$1,3\alpha$
160	$2\alpha\beta$	$47,7+2\alpha\beta$	$51,1+2\alpha\beta$	$54,6+2\alpha\beta$	$58+2\alpha\beta$	$2\alpha$

Bucket width $B_k$ , mm	Distributed cargo weight $q_v$ , N/m	Linear load on the working branch in tape with $i = 3$ $q_r$ , N/m	Linear load on the working branch in tape with $i = 4$ $q_r$ , N/m	Linear load on the working branch in tape with $i = 5$ $q_r$ , N/m	Linear load on the working branch in tape with $i = 6$ $q_r$ , N/m	Elevator effectiveness, t/h
200	3,24 $\alpha\beta$	74,1+3,24 $\alpha\beta$	78,4+3,24 $\alpha\beta$	82,7+3,24 $\alpha\beta$	87+3,24 $\alpha\beta$	3,24 $\alpha$
250	5 $\alpha\beta$	103,6+5 $\alpha\beta$	108,8+5 $\alpha\beta$	113,9+5 $\alpha\beta$	119,1+5 $\alpha\beta$	5 $\alpha$
320	8 $\alpha\beta$	138,1+8 $\alpha\beta$	145+8 $\alpha\beta$	151,1+8 $\alpha\beta$	158+8 $\alpha\beta$	8 $\alpha$
400	12,6 $\alpha\beta$	265,7+12,6 $\alpha\beta$	274,4+12,6 $\alpha\beta$	283+12,6 $\alpha\beta$	291,6+12,6 $\alpha\beta$	12,6 $\alpha$
500	19 $\alpha\beta$	345,2+19 $\alpha\beta$	356,4+19 $\alpha\beta$	367,6+19 $\alpha\beta$	378,8+19 $\alpha\beta$	19 $\alpha$
650	28,6 $\alpha\beta$	438+28,6 $\alpha\beta$	451,8+28,6 $\alpha\beta$	465,6+28,6 $\alpha\beta$	479,4+28,6 $\alpha\beta$	28,6 $\alpha$
800	40 $\alpha\beta$	443,3+40 $\alpha\beta$	460,5+40 $\alpha\beta$	477,8+40 $\alpha\beta$	495+40 $\alpha\beta$	40 $\alpha$
1 000	56,25 $\alpha\beta$	524,6+56,3 $\alpha\beta$	545,3+56,3 $\alpha\beta$	566+56,3 $\alpha\beta$	586,7+56,3 $\alpha\beta$	56,25 $\alpha$

Table 10

## The linear loading on a working branch at shallow bucket

Bucket width $B_k$ , mm	Distributed cargo weight $q_v$ , N/m	Linear load on the working branch in tape with $i = 3$ $q_r$ , N/m	Linear load on the working branch in tape with $i = 4$ $q_r$ , N/m	Linear load on the working branch in tape with $i = 5$ $q_r$ , N/m	Linear load on the working branch in tape with $i = 6$ $q_r$ , N/m	Elevator effectiveness, t/h
100	0,5 $\alpha\beta$	32,1+0,5 $\alpha\beta$	34,3+0,5 $\alpha\beta$	36,4+0,5 $\alpha\beta$	38,6+0,5 $\alpha\beta$	0,5 $\alpha$
125	0,66 $\alpha\beta$	33,4+0,66 $\alpha\beta$	36+0,66 $\alpha\beta$	37,8+0,66 $\alpha\beta$	40,4+0,66 $\alpha\beta$	0,66 $\alpha$
160	1,17 $\alpha\beta$	41,5+1,17 $\alpha\beta$	44,9+1,17 $\alpha\beta$	48,4+1,17 $\alpha\beta$	51,8+1,17 $\alpha\beta$	1,17 $\alpha$
200	1,87 $\alpha\beta$	61,9+1,87 $\alpha\beta$	66,2+1,87 $\alpha\beta$	70,5+1,87 $\alpha\beta$	74,8+1,87 $\alpha\beta$	1,87 $\alpha$
250	3,5 $\alpha\beta$	79,1+3,5 $\alpha\beta$	84,3+3,5 $\alpha\beta$	89,4+3,5 $\alpha\beta$	94,6+3,5 $\alpha\beta$	3,5 $\alpha$
320	5,4 $\alpha\beta$	138,1+5,4 $\alpha\beta$	145+5,4 $\alpha\beta$	151,1+5,4 $\alpha\beta$	158+5,4 $\alpha\beta$	5,4 $\alpha$
400	8,4 $\alpha\beta$	246,1+8,4 $\alpha\beta$	254,8+8,4 $\alpha\beta$	263,4+8,4 $\alpha\beta$	272+8,4 $\alpha\beta$	8,4 $\alpha$

In addition the tension in the next point ( $i + 1$ ) is the sum of the tape tension in the point ( $i$ ) and the resistance of the tape movement on the section between these points:

$$S_{i+1} = S_i + W_{i,i+1} \quad (7)$$

In case of a drum drive speed (Fig. 1) by clockwise the minimum tension will be at the point 2 –  $S_2$ . Such tension in the tape at normal material scooping satisfies the condition:

$$S_2 = S_{\min} \geq 5q_v \quad (8)$$

The strength of the tension at the point 3 consists of a resistance force on the drum and resistance of cargo scooping  $W_{2-3}$ :

$$S_3 = kS_2 + W_{2-3} \quad (9)$$

where  $k = 1,08$  is the coefficient of tension increase in the tape with buckets during the drum rounding.

Resistance of scooping material is determined by the formula

$$W_{2-3} = \frac{k_z q_v}{g} \quad (10)$$

where  $k_z$  is the coefficient of scooping (Nm/kg), which is determined by the specific work, that is expended on scooping of 1 kg material. When the speed of buckets is  $v = 1,0 \dots 1,25$  m/s,  $k_z = 12,5 \dots 25$  Nm/kg for pulverous and small pieces materials and  $k_z = 20 \dots 40$  N/m for middle pieces materials.

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Thus, substituting the formulas (8) and (10) in (9) we have:

$$S_3 = q_v \left( 5,4 + \frac{k_z}{g} \right). \quad (11)$$

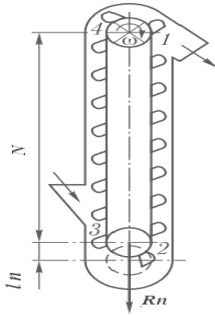


Fig. 1. Chart tape bucket of the elevator

Choosing the meaning  $k_z = 25 \text{ Nm/kg}$  (it satisfies all cargoes) we have:

$$S_3 = 7,95q_v. \quad (12)$$

The tension forces in the points 1 and 4 are determined by the formulas:

$$S_4 = S_{nb} = S_3 + W_{3-4} = 7,95q_v + q_r H, \quad (13)$$

$$S_1 = S_{zb} = S_2 + W_{2-1} = 5q_v + q_h H, \quad (14)$$

where  $H$  – height of cargo lifting, m.

The dependence of the tension forces values at the point 4, calculated by the formula (13), from the value of design capacity, the type of bucket and the number of strips of tape are summarized in tables 11–12:

Table 11

The strength of tension in a point 4 at deep buckets

Bucket width $B_k$ , mm	The strength of tension in the tape with $i = 3$ $S_4$ , N	The strength of tension in the tape with $i = 4$ $S_4$ , N	Elevator effectiveness, t/h
100	$37N + \alpha\beta(7,95+N)$	$39,2N + \alpha\beta(7,95+N)$	$\alpha$
125	$36,4N + 1,3\alpha\beta(7,95+N)$	$39N + 1,3\alpha\beta(7,95+N)$	$1,3\alpha$
160	$47,7N + 2\alpha\beta(7,95+N)$	$51,1N + 2\alpha\beta(7,95+N)$	$2\alpha$
200	$74,1N + 3,24\alpha\beta(7,95+N)$	$78,4N + 3,24\alpha\beta(7,95+N)$	$3,24\alpha$
250	$103,6N + 5\alpha\beta(7,95+N)$	$108,8N + 5\alpha\beta(7,95+N)$	$5\alpha$
320	$138,1N + 8\alpha\beta(7,95+N)$	$145N + 8\alpha\beta(7,95+N)$	$8\alpha$
400	$265,7N + 12,6\alpha\beta(7,95+N)$	$274,4N + 12,6\alpha\beta(7,95+N)$	$12,6\alpha$
500	$345,2N + 19\alpha\beta(7,95+N)$	$356,4N + 19\alpha\beta(7,95+N)$	$19\alpha$
650	$438N + 28,6\alpha\beta(7,95+N)$	$451,8N + 28,6\alpha\beta(7,95+N)$	$28,6\alpha$
800	$443,3N + 40\alpha\beta(7,95+N)$	$460,5N + 40\alpha\beta(7,95+N)$	$40\alpha$
1 000	$524,6N + 56,3\alpha\beta(7,95+N)$	$545,3N + 56,3\alpha\beta(7,95+N)$	$56,25\alpha$

Continuation of table 11

The strength of tension in a point 4 at deep buckets

Bucket width $B_k$ , mm	The strength of tension in the tape with $i = 5$ $S_4$ , N	The strength of tension in the tape with $i = 6$ $S_4$ , N	Elevator effectiveness, t/h
100	$41,3N + \alpha\beta(7,95+N)$	$43,5N + \alpha\beta(7,95+N)$	$\alpha$
125	$41,6N + 1,3\alpha\beta(7,95+N)$	$44,2N + 1,3\alpha\beta(7,95+N)$	$1,3\alpha$
160	$54,6N + 2\alpha\beta(7,95+N)$	$58N + 2\alpha\beta(7,95+N)$	$2\alpha$
200	$82,7N + 3,24\alpha\beta(7,95+N)$	$87N + 3,24\alpha\beta(7,95+N)$	$3,24\alpha$
250	$113,9N + 5\alpha\beta(7,95+N)$	$119,1N + 5\alpha\beta(7,95+N)$	$5\alpha$
320	$151,1N + 8\alpha\beta(7,95+N)$	$158N + 8\alpha\beta(7,95+N)$	$8\alpha$
400	$283N + 12,6\alpha\beta(7,95+N)$	$291,6N + 12,6\alpha\beta(7,95+N)$	$12,6\alpha$



## НЕТРАДИЦІЙНІ ВИДИ ТРАНСПОРТУ. МАШИНИ ТА МЕХАНІЗМИ

End of table 11

Bucket width $B_k$ , mm	The strength of tension in the tape with $i = 5$ $S_4$ , N	The strength of tension in the tape with $i = 6$ $S_4$ , N	Elevator effectiveness, t/h
500	$367,6N+19\alpha\beta(7,95+N)$	$378,8N+19\alpha\beta(7,95+N)$	$19\alpha$
650	$465,6N+28,6\alpha\beta(7,95+N)$	$479,4N+28,6\alpha\beta(7,95+N)$	$28,6\alpha$
800	$477,8N+40\alpha\beta(7,95+N)$	$495N+40\alpha\beta(7,95+N)$	$40\alpha$
1000	$566N+56,3\alpha\beta(7,95+N)$	$586,7N+56,3\alpha\beta(7,95+N)$	$56,25\alpha$

Table 12

**The strength of tension in a point 4 at shallow buckets**

Bucket width $B_k$ , mm	The strength of tension in the tape with $i = 3$ $S_4$ , N	The strength of tension in the tape with $i = 4$ $S_4$ , N	Elevator effectiveness, t/h
100	$32,1N+0,5\alpha\beta(7,95+N)$	$34,3N+0,5\alpha\beta(7,95+N)$	$0,5\alpha$
125	$33,4N+0,66\alpha\beta(7,95+N)$	$36N+0,66\alpha\beta(7,95+N)$	$0,66\alpha$
160	$41,5N+1,17\alpha\beta(7,95+N)$	$44,9N+1,17\alpha\beta(7,95+N)$	$1,17\alpha$
200	$61,9N+1,87\alpha\beta(7,95+N)$	$66,2N+1,87\alpha\beta(7,95+N)$	$1,87\alpha$
250	$79,1N+3,5\alpha\beta(7,95+N)$	$84,3N+3,5\alpha\beta(7,95+N)$	$3,5\alpha$
320	$138,1N+5,4\alpha\beta(7,95+N)$	$145N+5,4\alpha\beta(7,95+N)$	$5,4\alpha$
400	$246,1N+8,4\alpha\beta(7,95+N)$	$254,8N+8,4\alpha\beta(7,95+N)$	$8,4\alpha$

End of table 12

**The strength of tension in a point 4 at shallow buckets**

Bucket width $B_k$ , mm	The strength of tension in the tape with $i = 5$ $S_4$ , N	The strength of tension in the tape with $i = 6$ $S_4$ , N	Elevator effectiveness, t/h
100	$36,4N+0,5\alpha\beta(7,95+N)$	$38,6N+0,5\alpha\beta(7,95+N)$	$0,5\alpha$
125	$37,8N+0,66\alpha\beta(7,95+N)$	$40,4N+0,66\alpha\beta(7,95+N)$	$0,66\alpha$
160	$48,4N+1,17\alpha\beta(7,95+N)$	$51,8N+1,17\alpha\beta(7,95+N)$	$1,17\alpha$
200	$70,5N+1,87\alpha\beta(7,95+N)$	$74,8N+1,87\alpha\beta(7,95+N)$	$1,87\alpha$
250	$89,4N+3,5\alpha\beta(7,95+N)$	$94,6N+3,5\alpha\beta(7,95+N)$	$3,5\alpha$
320	$151,1N+5,4\alpha\beta(7,95+N)$	$158N+5,4\alpha\beta(7,95+N)$	$5,4\alpha$
400	$263,4N+8,4\alpha\beta(7,95+N)$	$272N+8,4\alpha\beta(7,95+N)$	$8,4\alpha$

The dependence of the values of the tension forces at the point 1 is calculated by the formula (14) the value of design capacity, the type of

bucket and the number of strips of tape are summarized in tables 13-14.

Table 13

**The strength of tension in a point 1 at deep buckets**

Bucket width $B_k$ , mm	The strength of tension in the tape with $i = 3$ $S_1$ , N	The strength of tension in the tape with $i = 4$ $S_1$ , N	The strength of tension in the tape with $i = 5$ $S_1$ , N	The strength of tension in the tape with $i = 6$ $S_1$ , N	Elevator effec- tiveness, t/h
100	$37N+5\alpha\beta$	$39,2N+5\alpha\beta$	$41,3N+5\alpha\beta$	$43,5N+5\alpha\beta$	$\alpha$
125	$36,4N+6,5\alpha\beta$	$39N+6,5\alpha\beta$	$41,6N+6,5\alpha\beta$	$44,2N+6,5\alpha\beta$	$1,3\alpha$
160	$47,7N+10\alpha\beta$	$51,1N+10\alpha\beta$	$54,6N+10\alpha\beta$	$58N+10\alpha\beta$	$2\alpha$
200	$74,1N+16,2\alpha\beta$	$78,4N+16,2\alpha\beta$	$82,7N+16,2\alpha\beta$	$87N+16,2\alpha\beta$	$3,24\alpha$

End of table 13

Bucket width $B_k$ , mm	The strength of tension in the tape with $i = 3$ $S_1, N$	The strength of tension in the tape with $i = 4$ $S_1, N$	The strength of tension in the tape with $i = 5$ $S_1, N$	The strength of tension in the tape with $i = 6$ $S_1, N$	Elevator effectiveness, t/h
250	103,6N+25 $\alpha\beta$	108,8N+25 $\alpha\beta$	113,9N+25 $\alpha\beta$	119,1N+25 $\alpha\beta$	5 $\alpha$
320	138,1N+40 $\alpha\beta$	145N+40 $\alpha\beta$	151,1N+40 $\alpha\beta$	158N+40 $\alpha\beta$	8 $\alpha$
400	265,7N+63 $\alpha\beta$	274,4N+63 $\alpha\beta$	283N+63 $\alpha\beta$	291,6N+63 $\alpha\beta$	12,6 $\alpha$
500	345,2N+95 $\alpha\beta$	356,4N+95 $\alpha\beta$	367,6N+95 $\alpha\beta$	378,8N+95 $\alpha\beta$	19 $\alpha$
650	438N+143 $\alpha\beta$	451,8N+143 $\alpha\beta$	465,6N+143 $\alpha\beta$	479,4N+143 $\alpha\beta$	28,6 $\alpha$
800	443,3N+200 $\alpha\beta$	460,5N+200 $\alpha\beta$	477,8N+200 $\alpha\beta$	495N+200 $\alpha\beta$	40 $\alpha$
1 000	524,6N+281,5 $\alpha\beta$	545,3N+281,5 $\alpha\beta$	566N+281,5 $\alpha\beta$	586,7N+281,5 $\alpha\beta$	56,25 $\alpha$

Table 14

**The strength of tension in a point 1 at shallow buckets**

Bucket width $B_k$ , mm	The strength of tension in the tape with $i = 3$ $S_1, N$	The strength of tension in the tape with $i = 4$ $S_1, N$	The strength of tension in the tape with $i = 5$ $S_1, N$	The strength of tension in the tape with $i = 6$ $S_1, N$	Elevator effectiveness, t/h
100	32,1N+2,5 $\alpha\beta$	34,3N+2,5 $\alpha\beta$	36,4N+2,5 $\alpha\beta$	38,6N+2,5 $\alpha\beta$	0,5 $\alpha$
125	33,4N+3,3 $\alpha\beta$	36N+3,3 $\alpha\beta$	37,8N+3,3 $\alpha\beta$	40,4N+3,3 $\alpha\beta$	0,66 $\alpha$
160	41,5N+5,85 $\alpha\beta$	44,9N+5,85 $\alpha\beta$	48,4N+5,85 $\alpha\beta$	51,8N+5,85 $\alpha\beta$	1,17 $\alpha$
200	61,9N+9,35 $\alpha\beta$	66,2N+9,35 $\alpha\beta$	70,5N+9,35 $\alpha\beta$	74,8N+9,35 $\alpha\beta$	1,87 $\alpha$
250	79,1N+17,5 $\alpha\beta$	84,3N+17,5 $\alpha\beta$	89,4N+17,5 $\alpha\beta$	94,6N+17,5 $\alpha\beta$	3,5 $\alpha$
320	138,1N+27 $\alpha\beta$	145N+27 $\alpha\beta$	151,1N+27 $\alpha\beta$	158N+27 $\alpha\beta$	5,4 $\alpha$
400	246,1N+42 $\alpha\beta$	254,8N+42 $\alpha\beta$	263,4N+42 $\alpha\beta$	272N+42 $\alpha\beta$	8,4 $\alpha$

Traction force with regard to the resistance to rotation of the drive drum is determined by the formula

$$F_0 = S_4 - S_1 + (k' - 1)(S_4 + S_1), \quad (15)$$

where  $k' = 1,08$  is the coefficient of resistance to the drive drum rotation.

After the algebraic transformations in formula (15) we have:

$$F_0 = 1,08S_4 - 0,92S_1. \quad (16)$$

The value of traction force with regard to the resistance to rotation of the drive drum depending on the values of the design capacity, the type of bucket (deep and shallow) and the number of tape strips are summarized in table 15-16:

Table 15

**Traction force on a drive drum at deep bucket**

Bucket width $B_k$ , mm	Traction force of the tape with $i = 3$ $F, N$	Traction force of the tape with $i = 4$ $F, N$	Elevator effectiveness, t/h
100	5,9N+ $\alpha\beta(4+1,08N)$	6,3N+ $\alpha\beta(4+1,08N)$	$\alpha$
125	5,82N+1,3 $\alpha\beta(4+1,08N)$	6,2N+1,3 $\alpha\beta(4+1,08N)$	1,3 $\alpha$
160	7,63N+2 $\alpha\beta(4+1,08N)$	8,2N+2 $\alpha\beta(4+1,08N)$	2 $\alpha$
200	11,9N+3,24 $\alpha\beta(4+1,08N)$	12,5N+3,24 $\alpha\beta(4+1,08N)$	3,24 $\alpha$
250	16,6N+5 $\alpha\beta(4+1,08N)$	17,4N+5 $\alpha\beta(4+1,08N)$	5 $\alpha$
320	22,1N+8 $\alpha\beta(4+1,08N)$	23,2N+8 $\alpha\beta(4+1,08N)$	8 $\alpha$
400	42,5N+12,6 $\alpha\beta(4+1,08N)$	43,9N+12,6 $\alpha\beta(4+1,08N)$	12,6 $\alpha$

**Traction force on a drive drum at deep buckets**

Bucket width $B_k$ , mm	Traction force of the tape with $i = 3$ $F$ , N	Traction force of the tape with $i = 4$ $F$ , N	Elevator effective- ness, t/h
500	$55,2N+19\alpha\beta(4+1,08N)$	$57N+19\alpha\beta(4+1,08N)$	$19\alpha$
650	$70,1N+28,6\alpha\beta(4+1,08N)$	$72,3N+28,6\alpha\beta(4+1,08N)$	$28,6\alpha$
800	$70,9N+40\alpha\beta(4+1,08N)$	$73,7N+40\alpha\beta(4+1,08N)$	$40\alpha$
1 000	$83,9N+56,3\alpha\beta(4+1,08N)$	$87,2N+56,3\alpha\beta(4+1,08N)$	$56,25\alpha$
Bucket width $B_k$ , mm	Traction force of the tape with $i = 5$ $F$ , N	Traction force of the tape with $i = 6$ $F$ , N	Elevator effective- ness, t/h
100	$6,6N+\alpha\beta(4+1,08N)$	$7N+\alpha\beta(4+1,08N)$	$\alpha$
125	$6,7N+1,3\alpha\beta(4+1,08N)$	$7,1N+1,3\alpha\beta(4+1,08N)$	$1,3\alpha$
160	$8,7N+2\alpha\beta(4+1,08N)$	$9,3N+2\alpha\beta(4+1,08N)$	$2\alpha$
200	$13,2N+3,24\alpha\beta(4+1,08N)$	$13,9N+3,24\alpha\beta(4+1,08N)$	$3,24\alpha$
250	$18,2N+5\alpha\beta(4+1,08N)$	$19,1N+5\alpha\beta(4+1,08N)$	$5\alpha$
320	$24,2N+8\alpha\beta(4+1,08N)$	$25,3N+8\alpha\beta(4+1,08N)$	$8\alpha$
400	$45,3N+12,6\alpha\beta(4+1,08N)$	$46,7N+12,6\alpha\beta(4+1,08N)$	$12,6\alpha$
500	$58,8N+19\alpha\beta(4+1,08N)$	$60,6N+19\alpha\beta(4+1,08N)$	$19\alpha$
650	$74,5N+28,6\alpha\beta(4+1,08N)$	$76,7N+28,6\alpha\beta(4+1,08N)$	$28,6\alpha$
800	$76,4N+40\alpha\beta(4+1,08N)$	$79,2N+40\alpha\beta(4+1,08N)$	$40\alpha$
1 000	$90,6N+56,3\alpha\beta(4+1,08N)$	$93,9N+56,3\alpha\beta(4+1,08N)$	$56,25\alpha$

Table 16

**Traction force on a drive drum at shallow buckets**

Bucket width $B_k$ , mm	Traction force of the tape with $i = 3$ $F$ , N	Traction force of the tape with $i = 4$ $F$ , N	Elevator effective- ness, t/h
100	$5,1N+\alpha\beta(4+1,08N)$	$5,5N+\alpha\beta(4+1,08N)$	$0,5\alpha$
125	$5,3N+1,3\alpha\beta(4+1,08N)$	$5,8N+1,3\alpha\beta(4+1,08N)$	$0,66\alpha$
160	$6,6N+2\alpha\beta(4+1,08N)$	$7,2N+2\alpha\beta(4+1,08N)$	$1,17\alpha$
200	$9,9N+3,24\alpha\beta(4+1,08N)$	$10,6N+3,24\alpha\beta(4+1,08N)$	$1,87\alpha$
250	$12,7N+5\alpha\beta(4+1,08N)$	$13,5N+5\alpha\beta(4+1,08N)$	$3,5\alpha$
320	$22,1N+8\alpha\beta(4+1,08N)$	$23,2N+8\alpha\beta(4+1,08N)$	$5,4\alpha$
400	$39,4N+12,6\alpha\beta(4+1,08N)$	$40,8N+12,6\alpha\beta(4+1,08N)$	$8,4\alpha$

Continuation of table 16

**Traction force on a drive drum at shallow buckets**

Bucket width $B_k$ , mm	Traction force of the tape with $i = 5$ $F$ , N	Traction force of the tape with $i = 6$ $F$ , N	Elevator effective- ness, t/h
100	$5,8N+\alpha\beta(4+1,08N)$	$6,2N+\alpha\beta(4+1,08N)$	$0,5\alpha$
125	$6,0N+1,3\alpha\beta(4+1,08N)$	$6,5N+1,3\alpha\beta(4+1,08N)$	$0,66\alpha$
160	$7,7N+2\alpha\beta(4+1,08N)$	$8,3N+2\alpha\beta(4+1,08N)$	$1,17\alpha$
200	$11,3N+3,24\alpha\beta(4+1,08N)$	$12N+3,24\alpha\beta(4+1,08N)$	$1,87\alpha$

End of table 16

Bucket width $B_k$ , mm	Traction force of the tape with $i = 5$ $F$ , N	Traction force of the tape with $i = 6$ $F$ , N	Elevator effective- ness, t/h
250	$14,3N+5\alpha\beta(4+1,08N)$	$15,1N+5\alpha\beta(4+1,08N)$	$3,5\alpha$
320	$24,2N+8\alpha\beta(4+1,08N)$	$25,3N+8\alpha\beta(4+1,08N)$	$5,4\alpha$
400	$42,1N+12,6\alpha\beta(4+1,08N)$	$43,5N+12,6\alpha\beta(4+1,08N)$	$8,4\alpha$

Kinematic chart of the elevator drive is shown in Fig. 2.

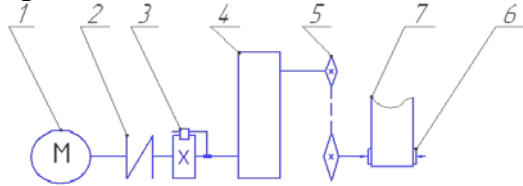


Fig. 2. Chart of the elevator drive:  
1 – engine; 2 – elastic clutch; 3 – stopping device (arresting);  
4 – reducing gear; 5 – chain transmission;  
6 – drive drum; 7 – tape

The coefficient of the drive useful effect performance duty is determined by the formula:

$$\eta = \eta_r \eta_l \eta_m, \quad (17)$$

where  $\eta_r = 0,96$  – coefficient of the reducing gear useful effect performance duty;  $\eta_l = 0,95$  – coefficient of the chain transmission useful effect performance duty;  $\eta_m = 0,98$  – coefficient of the sleeve useful effect performance duty.

Therefore

$$\eta = \eta_r \eta_l \eta_m = 0,96 \cdot 0,95 \cdot 0,98 = 0,89.$$

The power of the engine is determined by the formula

$$P = \frac{F_0 v}{1000 \eta}. \quad (18)$$

Design power of the engine is determined by the formula

$$P_r = n_u P, \quad (19)$$

where  $n_u = 1,1 \dots 1,2$  – margin of power coefficient.

As far as  $\eta = 0,89$  and  $n_u = 1,1$ , then from the formula (18) and (19) we receive:

$$P_r = \frac{F_0 v}{1000 \eta} = 0,001 F_0 v. \quad (20)$$

The dependence of the calculated engine power from the values of the design capacity, the type of bucket, the number of tape strips, the speed of belt movement and the lifting height of the load is calculated by the formula (20) that based on the data tables 15-16 are summarized in tables 17-18:

Table 17

#### Design engine power at deep buckets

Bucket width $B_k$ , mm	Engine power when the tape is $i = 3$ $P$ , W	Engine power when the tape is $i = 4$ $P$ , W	Elevator effective- ness, t/h
100	$(5,9N+\alpha\beta(4+1,08N))v$	$(6,3N+\alpha\beta(4+1,08N))v$	$\alpha$
125	$(5,82N+1,3\alpha\beta(4+1,08N))v$	$(6,2N+1,3\alpha\beta(4+1,08N))v$	$1,3\alpha$
160	$(7,63N+2\alpha\beta(4+1,08N))v$	$(8,2N+2\alpha\beta(4+1,08N))v$	$2\alpha$
200	$(11,9N+3,24\alpha\beta(4+1,08N))v$	$(12,5N+3,24\alpha\beta(4+1,08N))v$	$3,24\alpha$
250	$(16,6N+5\alpha\beta(4+1,08N))v$	$(17,4N+5\alpha\beta(4+1,08N))v$	$5\alpha$
320	$(22,1N+8\alpha\beta(4+1,08N))v$	$(23,2N+8\alpha\beta(4+1,08N))v$	$8\alpha$
400	$(42,5N+12,6\alpha\beta(4+1,08N))v$	$(43,9N+12,6\alpha\beta(4+1,08N))v$	$12,6\alpha$
500	$(55,2N+19\alpha\beta(4+1,08N))v$	$(57N+19\alpha\beta(4+1,08N))v$	$19\alpha$
650	$(70,1N+28,6\alpha\beta(4+1,08N))v$	$(72,3N+28,6\alpha\beta(4+1,08N))v$	$28,6\alpha$
800	$(70,9N+40\alpha\beta(4+1,08N))v$	$(73,7N+40\alpha\beta(4+1,08N))v$	$40\alpha$
1 000	$(83,9N+56,3\alpha\beta(4+1,08N))v$	$(87,2N+56,3\alpha\beta(4+1,08N))v$	$56,25\alpha$

End of table 17

**Design engine power at deep buckets**

Bucket width $B_k$ , mm	Engine power when the tape is $i = 5$ $P, W$	Engine power when the tape is $i = 6$ $P, W$	Elevator effective- ness, t/h
100	$(6,6N+\alpha\beta(4+1,08N))v$	$(7N+\alpha\beta(4+1,08N))v$	$\alpha$
125	$(6,7N+1,3\alpha\beta(4+1,08N))v$	$(7,1N+1,3\alpha\beta(4+1,08N))v$	$1,3\alpha$
160	$(8,7N+2\alpha\beta(4+1,08N))v$	$(9,3N+2\alpha\beta(4+1,08N))v$	$2\alpha$
200	$(13,2N+3,24\alpha\beta(4+1,08N))v$	$(13,9N+3,24\alpha\beta(4+1,08N))v$	$3,24\alpha$
250	$(18,2N+5\alpha\beta(4+1,08N))v$	$(19,1N+5\alpha\beta(4+1,08N))v$	$5\alpha$
320	$(24,2N+8\alpha\beta(4+1,08N))v$	$(25,3N+8\alpha\beta(4+1,08N))v$	$8\alpha$
400	$(45,3N+12,6\alpha\beta(4+1,08N))v$	$(46,7N+12,6\alpha\beta(4+1,08N))v$	$12,6\alpha$
500	$(58,8N+19\alpha\beta(4+1,08N))v$	$(60,6N+19\alpha\beta(4+1,08N))v$	$19\alpha$
650	$(74,5N+28,6\alpha\beta(4+1,08N))v$	$(76,7N+28,6\alpha\beta(4+1,08N))v$	$28,6\alpha$
800	$(76,4N+40\alpha\beta(4+1,08N))v$	$(79,2N+40\alpha\beta(4+1,08N))v$	$40\alpha$
1 000	$(90,6N+56,3\alpha\beta(4+1,08N))v$	$(93,9N+56,3\alpha\beta(4+1,08N))v$	$56,25\alpha$

Table 18

**Design engine power at shallow buckets**

Bucket width $B_k$ , mm	Engine power when the tape is $i = 3$ $P, W$	Engine power when the tape is $i = 4$ $P, W$	Elevator effectiveness, t/h
100	$(5,1N+\alpha\beta(4+1,08N))v$	$(5,5N+\alpha\beta(4+1,08N))v$	$0,5\alpha$
125	$(5,3N+1,3\alpha\beta(4+1,08N))v$	$(5,8N+1,3\alpha\beta(4+1,08N))v$	$0,66\alpha$
160	$(6,6N+2\alpha\beta(4+1,08N))v$	$(7,2N+2\alpha\beta(4+1,08N))v$	$1,17\alpha$
200	$(9,9N+3,24\alpha\beta(4+1,08N))v$	$(10,6N+3,24\alpha\beta(4+1,08N))v$	$1,87\alpha$
250	$(12,7N+5\alpha\beta(4+1,08N))v$	$(13,5N+5\alpha\beta(4+1,08N))v$	$3,5\alpha$
320	$(22,1N+8\alpha\beta(4+1,08N))v$	$(23,2N+8\alpha\beta(4+1,08N))v$	$5,4\alpha$
400	$(39,4N+12,6\alpha\beta(4+1,08N))v$	$(40,8N+12,6\alpha\beta(4+1,08N))v$	$8,4\alpha$

End of table 18

**Design engine power at shallow buckets**

Bucket width $B_k$ , mm	Engine power when the tape is $i = 5$ $P, W$	Engine power when the tape is $i = 6$ $P, W$	Elevator effectiveness, t/h
100	$(5,8N+\alpha\beta(4+1,08N))v$	$(6,2N+\alpha\beta(4+1,08N))v$	$0,5\alpha$
125	$(6,0N+1,3\alpha\beta(4+1,08N))v$	$(6,5N+1,3\alpha\beta(4+1,08N))v$	$0,66\alpha$
160	$(7,7N+2\alpha\beta(4+1,08N))v$	$(8,3N+2\alpha\beta(4+1,08N))v$	$1,17\alpha$
200	$(11,3N+3,24\alpha\beta(4+1,08N))v$	$(12N+3,24\alpha\beta(4+1,08N))v$	$1,87\alpha$
250	$(14,3N+5\alpha\beta(4+1,08N))v$	$(15,1N+5\alpha\beta(4+1,08N))v$	$3,5\alpha$
320	$(24,2N+8\alpha\beta(4+1,08N))v$	$(25,3N+8\alpha\beta(4+1,08N))v$	$5,4\alpha$
400	$(42,1N+12,6\alpha\beta(4+1,08N))v$	$(43,5N+12,6\alpha\beta(4+1,08N))v$	$8,4\alpha$

**Findings**

Analyse the impact of the design capacity of the elevator shotblasting room to the power of necessary drive should be conducted. Shotblasting room is used to strengthen the metal springs of car by the method of shot peening. For automation work of such room the elevator is used, that transports the spent shot in feed hopper of shotblasting machine of the rotary type. The steel shot of State standart 3184-95 with diameter of 1,2-1,4 mm is used for the strengthen of the springs. Given the physical and mechanical properties of steel shot (can be attributed to hard-running granular bulk cargo), the tape elevator with disposed buckets and centrifugal unloading was selected. The speed of the tape is  $v = 1,45$  m/s; the fill factor bucket  $\psi = 0,6$ ;  $\rho = 7,2$  t/m<sup>3</sup> is the shot density in accordance with State standart 3184–95; lifting height of the load  $H = 4,5$  m.

Under these conditions, the coefficients are equal to:

$$\alpha = 3,$$

$$6\nu\rho\psi = 3,6 \cdot 1,45 \cdot 7,2 \cdot 0,6$$

$$= 22,55 \text{ t} \cdot \text{m/l per h};$$

$$\alpha\beta = 3,6\nu\rho\psi \frac{g}{3,6\nu} = \rho\psi g$$

$$= 7,2 \cdot 0,6 \cdot 9,8 = 42,34 \text{ N/m}^3$$

The dependence of the design power of the electric drive motor of an elevator from the design capacity are shown in table 19.

Given the standard values of three-phase asynchronous briefly closed motors power of 4A series with synchronous rotation speed of 1000 rpm, table of design capacity and necessary engine power correspondence was built for the elevator drive of shotblasting room.

Table 19

**Design engine power at deep buckets**

Bucket width $B_k$ , mm	Engine power when the tape is $i = 3$ $P$ , W	Engine power when the tape is $i = 4$ $P$ , W	Engine power when the tape is $i = 5$ $P$ , W	Engine power when the tape is $i = 6$ $P$ , W	Elevator effectiveness, t/h
100	5 382,0	585,0	587,0	589,6	22,55
125	745,0	747,6	750,8	753,4	29,31
160	1 137,7	1 141,4	1 144,6	1 148,6	45,1
200	1 840,0	1 843,9	1 848,5	1 853,1	73,1
250	2 828,0	2 833,2	2 838,4	2 844,3	112,75
320	4 495,7	4 502,9	4 509,4	4 516,6	180,4
400	7 130,9	7 140,1	7 149,2	7 158,3	284,1
500	10 695,0	10 706,8	10 718,5	10 730,2	428,45
650	16 014,0	16 028,4	16 042,8	16 057,1	644,9
800	22 220,2	22 238,4	22 256,1	22 274,3	902
1 000	31 171,2	31 192,7	31 214,9	31 236,4	1 268,4

Table 20

**Engine power at deep buckets**

Bucket width $B_k$ , mm	Engine power $P$ , kW	Type of engine	Elevator effectiveness, t/h
100	0,75	4A80A6U3	22,55
125	1,1	4A80B6U3	29,31
160	1,5	4A90L6U3	45,1

End of table 20

Bucket width $B_k$ , mm	Engine power $P$ , kW	Type of engine	Elevator effectiveness, t/h
200	2,2	4A100L6U3	73,1
250	3,0	4A112MA6U3	112,75
320	5,5	4A132S6U3	180,4
500	11,0	4A160S6U3	428,45
650	18,5	4A180M6U3	644,9
800	30	4A200M6U3	902
1 000	37	4A225M6U3	1 268,4

Analyzing the results of calculations presented in table 20, we conclude that the dependence of the power drive of the elevator from its design capacity (at fixed lifting height, type of cargo, the speed of movement of the tape) in general is a piecewise continuous monotonically increasing function that is continuous on the left side at the point of rupture. In this case values effectiveness given in the last column of the table 20 should be considered where the power value changes and equals to the corresponding value given in the second column of the table 20. But to the value 29,31 t/h capacity is equal to 0,75 kW due to the minimality of such power in a number of engines of this class. The graph of the capacity of the elevator drive shotblasting room on the value of design capacity was built according to the results of calculations (Fig. 3).

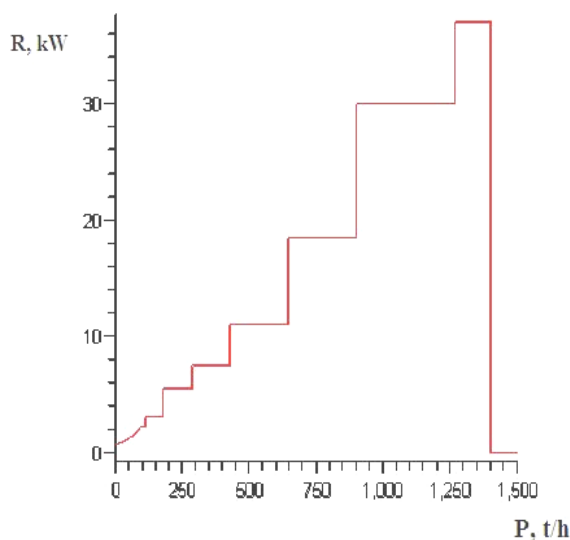


Fig. 3. Dependence of the elevator drive power from the productivity

### Originality and Practical value

A parametric dependence of the elevator power drive from its design capacity was built, and it takes into account the type and characteristics of the load, the lifting height, standard dimensions and parameters of the buckets and tapes.

Using the built dependencies enables relatively fast to determine an approximate value of power over the vertical speed elevators with deep and shallow buckets and perform the high-quality selection of its key elements by specific design characteristics: type of load, productivity, lifting height.

On the bases of the proposed approach the impact of the design capacity of the elevator shotblasting room to the required drive was analysed.

### Conclusions

The parametric dependence of the values of drive power from its design capacity was built for the bucket tapes elevators. It gives the opportunity to obtain the necessary value of drive power based on the type and physical and mechanical properties of cargoes, the value of the lifting height and design capacity, using only one formula for calculation. The obtained results of the power drive generation process from the expected capacity of the elevator shotblasting room, which is designed to strengthen the car springs are used as an example of attracting. According to the standard of bucket parameters and characteristics of electric motors, the parametric and graphic dependences of drive power from the design capacity was built for

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such type of elevators. It is proved that the function changes of the elevator capacity value from design capacity (at fixed lift height, type of cargo and the speed of the tape) are piecewise continuous and monotonically increasing.

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## ДОСЛІДЖЕННЯ ВПЛИВУ ПРОЕКТНОЇ ПРОДУКТИВНОСТІ ЕЛЕВАТОРУ НА ПОТУЖНІСТЬ ЙОГО ПРИВОДУ

**Мета.** Одним із основних елементів стрічкових ковшових елеваторів є їх привід. Для визначення потужності приводу необхідно провести розрахунки за стандартними методиками, для чого потрібно витратити достатньо часу. Одним із проектних параметрів є продуктивність елеватору. В статті необхідно побудувати параметричну залежність потужності приводу елеватору від його проектної продуктивності, яка



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враховує тип та характеристики вантажу, висоту підйому, стандартні розміри і параметри ковшів та стрічок. **Методика.** Використовуючи методіку тягового розрахунку стрічкових ківшевих елеваторів, побудовані параметричні залежності потужності приводу швидкохідних елеваторів із глибокими та мілкими ковшами від їх продуктивності при фіксованому типі вантажу та висоті підйому. **Результати.** На основі побудованих параметричних залежностей встановлено, що функція зміни величини потужності елеватору від проектної продуктивності (при фіксованих висоті підйому, типу вантажу, швидкості руху стрічки) є кусково-сталою та монотонно зростаючою. Визначені в загальному вигляді інтервали проектних значень продуктивності, які забезпечують постійну величину потужності приводу елеватору. В якості прикладу залучення отриманих результатів розглянуто процес побудови залежності потужності приводу від проектної продуктивності елеватору дробометної камери, який призначений для транспортування металевго дробу, що використовується при зміцненні вагонних пружин. Для конкретних типу вантажу та висоті підйому такого елеватору побудовано графічну залежність потужності його приводу від продуктивності. **Наукова новизна.** Вперше виведені параметричні залежності потужності приводу елеватору від його проектної продуктивності, які враховують тип та фізико-механічні характеристики вантажу, висоту підйому, стандартні розміри та параметри ковшів і стрічок. **Практична значимість.** Використання побудованих залежностей дає можливість відносно швидкого визначення приблизного значення потужності приводу вертикальних швидкохідних елеваторів із глибокими та мілкими ковшами на стадії проектування. Також можливим є виконання якісного підбору його основних елементів при конкретних проектних характеристиках: тип вантажу, продуктивність, висота підйому.

*Ключові слова:* елеватор; ківш; привід; потужність; продуктивність; вантаж

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## ИССЛЕДОВАНИЕ ВЛИЯНИЯ ПРОЕКТНЫХ ХАРАКТЕРИСТИК ЭЛЕВАТОРА НА ПАРАМЕТРЫ ЕГО ПРИВОДА

**Цель.** Одним из основных элементов ленточных ковшевых элеваторов является их привод. Для определения мощности привода необходимо провести расчеты по стандартным методиками, для чего нужно потратить достаточно времени. Одним из проектных параметров является производительность элеватора. Необходимо построить параметрическую зависимость мощности привода элеватора от его проектной производительности, которая учитывает тип и характеристики груза, высоту подъема, стандартные размеры и параметры ковшей и лент. **Методика.** Используя методіку тягового расчета ленточных ковшевых элеваторов, построены параметрические зависимости мощности привода быстроходных элеваторов с глубокими и мелкими ковшами от их производительности при фиксированных типе груза и высоте подъема. **Результаты.** На основе построенных параметрических зависимостей установлено, что функция изменения величины мощности элеватора от проектной производительности (при фиксированных высоте подъема, типе груза, скорости движения ленты) является кусочно-постоянной и монотонно возрастающей. Определены в общем виде интервалы проектных значений производительности, которые обеспечивают постоянную величину мощности привода элеватора. В качестве примера применения полученных результатов рассмотрен процесс построения зависимости мощности привода от проектной производительности элеватора дробометной камеры, которая предназначена для транспортировки металлической дробы, используемой при упрочнении вагонных пружин. Для конкретного типа груза и высоты подъема такого элеватора построена графическая зависимость мощности его привода от производительности. **Научная новизна.** Впервые выведены параметрические зависимости мощности привода элеватора от его проектной производительности, которые учитывают тип и физико-механические характеристики груза, высоту подъема, стандартные размеры и параметры ков-

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шей и лент. **Практическая значимость.** Использование построенных зависимостей дает возможность относительно быстрого определения приблизительного значения мощности привода вертикальных быстроходных элеваторов с глубокими и мелкими ковшами на стадии проектирования. Также возможным является выполнение качественного подбора его основных элементов при конкретных проектных характеристиках: тип груза, производительность, высота подъема.

*Ключевые слова:* элеватор; ковш; привод; мощность; производительность; груз

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