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DETERMINATION OF OPTIMAL GEOMETRIC PARAMETERS OF CAR LIFT

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The use of lifting equipment in auto maintenance facilitates access to the units and parts of motor vehicles, as well as reducing the labor intensity of maintenance works during their implementation, which leads to increased labor productivity of service employees. The development of quality auto maintenance is possible under the condition of improving the efficiency of workers, which is largely facilitated by the full mechanization and automation of technological processes [1].

Topicality of the problem. An increase in the number of passenger cars, the complexity of their design and presentation of stringent requirements for the technical condition of the car causes the need to improve the system of car maintenance.Development and production of new models of car lifts require additional capital investments and development of the material base of car maintenance and repair production. A wide choice of reliability, service life, conditions and modes of operation, model and load capacity predetermine operation of various car service enterprises in the service market.When selecting lifting equipment to perform maintenance and current repair works, only the design or operational indicators of the elevator are analyzed. And the economic performance indicators are considered separately, not in conjunction with other indicators, also do not take into account the measurement of technological equipment parameters as wear and tear and aging during operation, as well as the associated increase in operating costs.

The results of the work, when implemented in the practice of design, will provide a reasonable reduction in the present costs of equipping the lifting equipment in car service stations and operation of carlift at the expense of more advanced methods of calculation and design [2,3].

In the work, known methods of mechanics, analytical and numerical methods of analysis are used. Excel 2010 was used for data processing and solving mathematical problems.A generalized method developed by G.M. Elanchik is used to investigate and calculate possible tachograms. This method makes it possible to establish the relationship between all the elements of tachograms in a general form. The scheme of the research method is shown in Figure1.

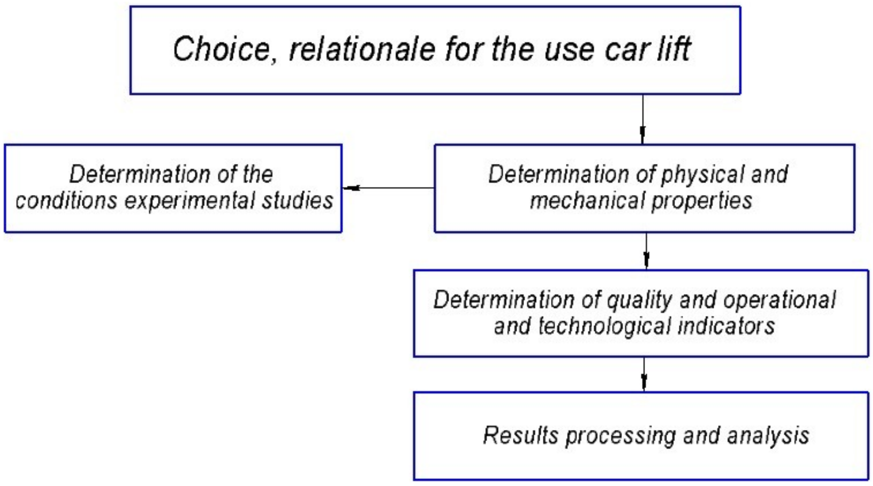

Figure 1. Program of experimental research.

The object of the study: carlifts of Heshbon, Norberg, Oma, Ravaglioli, Rotary lift, Sivik, Trommelberg.

The main characteristics of car lifts: lifting capacity, lifting speed and height, ground clearance, type of construction. Lifting capacity characteristics depend on the weight of the vehicle, and the equipment must safely lift vehicles to a certain height [4,5,6].

Analysis and review of existing designs showed that the most popular are electro-hydraulic and -mechanical car lift. The predominant majority of car lift at large car service centers are: two-column, four-column and scissor lift.Stationary elevators today are the vast majority of the manufactured car lift, designed for service and maintenance posts at the production and technical base.

The problem of selection and placement of the lift at service stations is quite complicated, since its solution requires taking into account many different factors. However, the solution of these issues will not only reduce capital investments in the development of the material base of service enterprises, but also reduce the cost of maintenance and repair work, as well as reduce transport costs.Consider solving this problem using the example of the city of Nur-Sultan. At service stations for passenger cars different types of foreign-made car lift are used. Technical characteristics of the lifts are given in the table 1 below. [7,8,9].

Table 1. Technical characteristics of the lifts

	Brand	Model	Capability	Lifting time	Lowering time	Max height
1	Heshbon	HL-51G	3500	60-70	30-100	1780
2		HL-27M	6000	50-60	30-40	1800
3	Nordberg	N412A-4T	4000	45	22	1800
4		N631L-3	3000	55	22	1850
5		4122A-4T	4000	52	22	1900
6		4455	5500	45	30	1750
7	Oma	526B (450AT)	4000	50	45	1750
8	Ravaglioli	RAL	4500	35	35	2000
9		RAV 4655L	6500	75	60	2012
10		RAV 4505L	5000	43	30	2050
11		KPS244HEK	3200	50	50	2040
12	Rotary lift	ATO77	3500	45	40	1880
13		SPOA1 0	4500	25	19	2195
14	Sivik	ПГА-5000	5000	60	60	1858
15	Trommelberg	tst45sw	4500	50	40	1850
16	Sivik	ПГА-3500-Е	3500	50	75	1750

The graph figure 2shows a clearer view of the lifting capacities of different car lift.

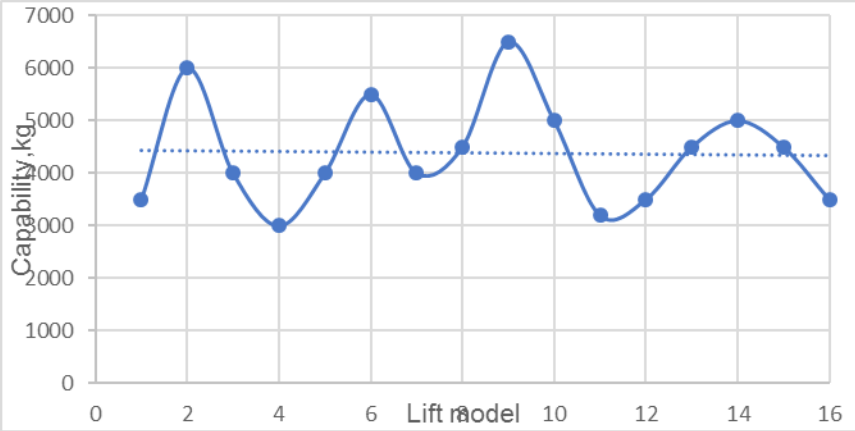

Figure 2. Lifting capacities.

Based on the statistical analysis data obtained, the average value payload was 4387,5, the variance was 952343,75, the standard deviation was 1007,89, and the coefficient of variation was 22,97.Sampling distribution functions or histograms play an important role in estimating the degree of dispersion of random variables. In probability theory, there are "goodness-of-fit criteria" for assessing the validity of a distribution law fitted to the data. One of the main criteria of agreement is the Pearson criterion $\square^2$ (chi-square), which in this case was 0.77.Most lifts operate automatically. Changing the lifting speed of the vehicles is done by means of automatic devices. These devices are included in the engine control system, according to a pre-calculated tachogram, which is repeated every cycle of the lift. As a consequence, the automatic operation of the lifts is carried out according to a planned program.

Therefore, for each type of lift, it is necessary to select such a tachogram of its operation that would provide the optimum control mode corresponding to the least necessary motor power and the highest efficiency factor of the hoist [10,11,12].

The lifting speed is a function of time

$$\vartheta = f(t) \qquad (1)$$

This formula can be represented in the coordinate axes $v - t$ by an arbitrary curve with a base equal to a predetermined duration of motion.

Differential equations of motion of each component need to be written when studying dynamical problems of mechanical systems with direct use of Newton's second law or Abtaining principle, and it often results in the troublesome solving process.

The calculation of ascent tachograms is based on the following basic principles of kinematics:

1. Ascent acceleration is equal to the tangent angle to any point of the velocity curve

$$tg\gamma = \frac{d\vartheta}{dt} = a \qquad (2)$$

2. The area of the velocity diagram is equal to the path taken by the lift pump.

Let us distinguish on the velocity diagram an elementary strip with height and base, the area of which is equal to ϑdt, then the area of the whole velocity diagram is equal to:

$$\int_0^t \vartheta dt = \int_0^H dx = H \qquad (3)$$

Given an area *H* and a base *t*, it is possible to construct an infinite number of tachograms, each of which has a certain value of the velocity set:

$$a = \frac{\vartheta_{max}}{\vartheta_{av}} \qquad (4)$$

The acceleration rate multiplier, which is one of the main parameters determining the engine power and efficiency of hoists, has been set.

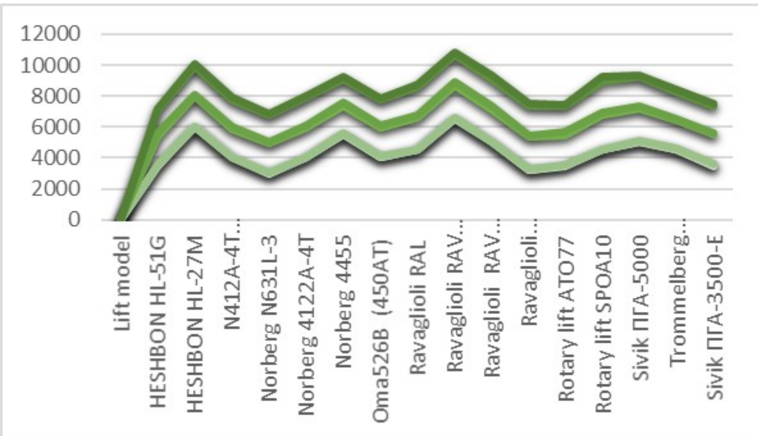

Figure 3. Value depending on the model of the car lift.

The article shows the classification of car lift, which used in the technological process of car service station, analyzes the design features and proposed the optimal range of their load capacity. According to the results of the analysis of technological features, there are recommendations for equipping service stations with elevators and increasing their utilization.

Experience in using the car lifts at service stations showed the undeniable advantages in comparison with the inspection trenches, as they take up little space, provide better working conditions and maximum accessibility to the serviced units and assemblies of vehicles from the bottom and side [13,14].

Efficiency of the use of elevators for vehicles at service stations depends primarily on the adaptability and their design to carry out maintenance work on them in specific technological areas, as well as indicators of the degree and rationality of their use depending on the time. The higher adaptability of an elevator design to carry out technical influences on the car, the less labor intensity and cost of their performance and the higher productivity of a post, a site zone and service stations as a whole [15,16].

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