Comparable parameters for assessing the quality of gantry cranes

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Abstract. Container cranes are specialized lifting equipment, which is widely used for moving loads of container from one mode to another. Such devices are used for handling containerized cargo of various weights. The main feature of container gantry cranes is the ability to manage a large work area, involving the way different types of transport. But there is a problem of exploitation and maintenance of container crane. Which serve to extend the life of the container gantry crane .This paper proposes a complex criterion allowing the assessment of comparable efficiency in possible designs of gantry cranes. To establish promising designs gantry cranes and their rational parameters developed basic criteria of comparability: specific energy criterion, the criterion weight hourly work criterion packaging criterion specific metal, the unit cost criterion, the criterion of efficiency gantry crane. We give a comprehensive criterion for assessing the quality of gantry cranes. The author is led to a new coefficient K_6 factor performance criteria gantry cranes, which allows in conjunction with other criteria for receiving the first authors to evaluate the quality of gantry cranes.

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Introduction

Gantry cranes are one of the most popular and effective types of modern lifting equipment. Gantry cranes are largely similar to outboard and bridge cranes, but, if the latter mainly work in enclosed spaces where it is possible to contain them to ceilings and walls, gantry cranes are used in open areas. The gantry crane remains the preferred method of transportation for open warehouses, loading docks in factories, railway stations and so on [1].

Container gantry cranes are specialized lifting equipment which is widely used for the movement of freight-container type from one type of transport to another. Such devices are used for the unloading of container cargoes, usually of varying different weights. The main benefit of the container gantry cranes is their ability to occupy and manage a large working area, on which various types of transport are used. Container gantry cranes improve the performance of cargo handling operations and, on occasion, are used in freight and cargo terminals due to high turnover [2]. Very often this type of lifting equipment is set on site for large industrial enterprises, where is the reception goods is common and integral to entrepreneurial success.

Any gantry container crane can be equipped with a variety of load handling mechanisms for carrying out a certain type of work operations regarding the movement of goods. Such equipment can be manual, automatic or semi-automatic.

Gantry container cranes can be compounded, or with one or a pair of consoles. For work in maritime ports, the devices are equipped with a lifting console. Equipment of this type, which is mounted on the transmission deck, cargo is usually directly placed on and taken from the vessel.

At other terminals with smaller turnover, there is less so a need for high speed processing of containers. As a rule, gantry cranes of this type are described as being of a more general purpose. Their capacity ranges from 8 to 10 tons and, in most cases, these cranes deal with containers equipped with rafters or special cargo frames.

Gantry cranes for container transshipment may be modified for use in different climate zones. All devices are also equipped with a special anti-theft device. It is, also, imperative to have a limit on capacity, in order to exclude the possibility of damage to the unit during operation, therefore overload should never exceed above the nominal 15%. In addition to adherence to the overload requirements on such devices, additional sound and lighting system that guarantees the full safety of work must be implemented. During operation constant control of track facilities direct rail crane ways are absolutely essential [3].

Gantry cranes, by virtue of structure, are appreciated due to many different parameters. Analysis of the work performed by gantry cranes allows us to conclude that different countries use more than 50 types of gantry cranes, therefore, a concrete analysis based on this wide variety parameters very difficult and virtually impossible.

For each of the analyzed class machines, one can choose several parameters that have a decisive influence on the realization of the machine's design. The settings should be comparable and their

combination can be called a parametric model of the analyzed system of machines.

Item comparable parameters was chosen from several major provisions:

the obtained parameters should allow the comparative analysis of the level of perfection various cranes of this class, both in quantitative and qualitative surveys;

comparable parameters should be compared not only technical, but also economic efficiency of the analyzed machines;

based upon the theory of calculation and design, in order to simplify the mathematical analysis of comparable parameters should have a small range of variation of the values within the analyzed class cranes.

all parameters can categorize cranes individually into one or more parties, but, in general, comparable parameters should adequately characterize any gantry crane of this class

the provided parameters should allow the comparative analysis of the level of execution of various cranes of this class, both in quantitative and qualitative surveys;

comparable parameters should be not only technical in nature, but also rooted in the economic efficiency of the analyzed equipment;

based on the theory of calculation and design, in order to simplify the mathematical analysis of comparable parameters, there should be a small range of variation for the values within the analyzed class cranes.

The following provisions were imposed on the selected cranes.

A large body of gantry cranes is subject to the uniform conditions and specific models that differ depending on the influence of a similar input;

2. the given «model» may describe any gantry crane of different parameters or type;

3. the occurance and representative of the whole population in the examined research for each machine class is equiprobable.

4. Considering the law of large figures, it is supposed that, on the basis of a study of a sample of «K» models (with a sufficient degree of statistical confidence), the distribution of the parameters for all the machines is included within the set.

A study of the basic technical characteristics of gantry cranes indicates that they are characterized by following parameters: capacity reference, TC; the length of the crane reference, m; weight of crane and components reference, t; speed of movement of the trolley reference, m/s; - speed of movement of the crane and components reference, m/s; the total capacity of engines components reference, kW; and height of hook lifting reference, M.

From works [4,5,6,7], we may determine that the best comparability assessment conditions for the quality of the given machines are provided when using complex parameters, each of which includes several indicators, namely the technical and economic characteristics of this strata of products.

Main part

For assessment of constructions gantry cranes us complex criterion comparability, including the physical and mechanical properties of indicators described in the mode of operation of gantry cranes. These performance indicators include: capacity, speed, time of work, degree of mobility, and the following geometric parameters:

$$Y = (K_1, K_2, K_3, ..., K_n). \qquad (1)$$

In formula (1), specific criteria of comparability gantry cranes is enumerated.

- reference criterion specific energy intensity; - reference criterion specific hour of work; - reference criterion of the packaging; - reference criterion specific metal consumption; - reference criterion unit cost; - reference criterion health of a gantry crane.

- K_1 – reference criterion specific energy intensity;

- K_2 – reference criterion specific for hourly work;

- K_3 – reference criterion of the packaging;

1) K_4 – reference criterion specific metal consumption

- K_5 – reference criterion of unit cost;

K_6 – reference criterion for work capacity for a given gantry crane.

The obtained criteria contain feasibility and operational factors.

In the interesting of establishing a promising set of structures, gantry cranes and their rational parameters of the basic criteria of comparability were enumerated as follows:

$$K_1 = \frac{N}{ПН}, \qquad (2)$$

where reference - height of the shipment; reference - engine power lifting mechanism; reference - functional criterion; reference - hour performance of a gantry crane. Here reference, where reference is the capacity of the crane, reference - frequency cycle; - the Criterion of specific hour of work per unit mass of the cargo:

in which H represents the height of the shipment;

N - represents the engine power of the lifting mechanism;

$ПН$ - represents the functional criterion;

$П$ - represents the functional criterion;

Here $П = QZ$, in which Q – represents the lifting crane, Z – represents the frequency cycle;

- Criterion for specific hourly work output per unit mass of cargo:

$$K_2 = \frac{ПН}{M_{гр}}, \qquad (3)$$

where reference $M_{гр}$ - cargo mass;

- Criterion packagings expressed by the ratio of the mass of the crane reference to the weight of the lifted and moved reference $M_{гр}$

$$K_3 = \frac{M_{мк}}{M_{гр}}, \qquad (4)$$

- The criterion of specific metal consumption, expressing the design perfection

$$K_4 = \frac{M_{гр}}{M_{кр}}, \qquad (5)$$

where reference - weight of the shipment; reference - weight of gantry crane; - Criterion unit cost of gantry crane

where $M_{гр}$ - represents mass of the cargo;

$M_{кр}$ - mass of the gantry crane;

- Criterion for the aggregate cost of the gantry crane

$$K_5 = \frac{C}{QH}, \qquad (6)$$

where reference is the cost of a gantry crane.

where C - is the cost of a gantry crane.

Actual performance can be defined using the formula:

$$П_ф = \sum_{i=1}^{n} Z_1 \cdot Q_1, \qquad (7)$$

We introduce the coefficient $K_г$

$$П_ф = QZ \cdot K_{Гр} \cdot K_B \cdot K_Г, \qquad (8)$$

- coefficient of utilization of machine capacity, reference; reference - availability factor; reference - the actual work time mechanisms gantry cranes during a specified calendar period of reference.

where K_b - is the coefficient of machine utilization over time, $K_b = \frac{t_p}{z}$;

$K_{гр}$ - coefficient utilization of the machine load capacity, $K_{гр} = \frac{Q_{ср}}{Q}$;

$K_Г$ - represents the availability factor;

t_p - actual work time machanism of gantry cranes during a specific period of work t_{k_0}.

The above coefficient of performance, or availability factor for the design of machines, is set to less than one, where there is 0,98, and in instances where the process of operation depending on the time and duration of operation are reduced, the limit value is calculated to 0,63, therefore the operation is operated within 0,98 to 0.63[8,9].

We denote t_c. the useful life of machinery as a reference to be operated within 0,98-0,63, therefore limiting the life will reference $t_{пр}$ when reference $K_Г$=0,63. Hence, the graph of dependence of the health of the crane will be depends on the time of figure-1.

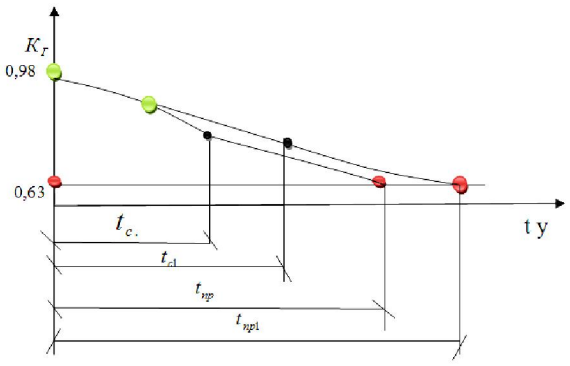

Figure1. Diagram dependency coefficient of crane availability over time

As a result of this research, we have provided a comprehensive criterion (1) allowing to assess the efficiency of the considered design of the gantry cranes, providing the following proof [10]:

$$Y = (K_1, K_2, K_3, K_4, K_5, K_6). \qquad (9)$$

Figure 1 t_{np} and t_{np1} - limit values valve life, respectively, to improve the design and then when the t_{np1} limit increases the service life of the crane.

Thence $$\Delta = t_{np1} - t_{np} \qquad (10)$$

where Δ - while increasing the life of the crane in the process of improvement.

Conclusion

Thus, in this paper a comprehensive criterion for assessing the quality of gantry cranes. The author is led new K_6 factor criterion operability gantry cranes, which allows in conjunction with other criteria derived first authors evaluate the quality of gantry cranes.

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