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# RESEARCH OF OPERATING RELIABILITY OF PORTAL CRANES "GANZ" 5-30 RIVER PORT

*Abstract. Portal cranes are a key piece of equipment in any modern port. They perform the indispensable function of moving cargo between ships and the coastal zone, guarantee prompt and productive handling of containers, various cargoes, bulk materials and other types of products, which directly affects the speed of cargo turnover and profitability of the port. The efficiency of loading and unloading operations in river ports is largely determined by the availability and serviceability of portal cranes. However, unfortunately, in Ukraine a significant part (over 90%) of these cranes have already exhausted their service life, but continue to be actively used. This creates a serious problem, as stable and uninterrupted operation of portal cranes is critical for continuous functioning of the port infrastructure.The study analyzed malfunctions of the mechanisms of GANZ portal cranes with a lifting capacity of 5 tons that occur during operation under heavy load conditions in a river port. Within the framework of the study, 16 cranes of the same type with a lifting capacity of 5 tons, operating in the grapple mode in the water areas of river ports, were selected.*

*Data from the maintenance and repair logs of these cranes for the period from 2015 to 2022 were used for the analysis.*

*Based on the collected data, the availability factors were calculated.*

*The analysis of the study results showed that the largest number of failures was found in the mechanisms for moving, lifting and changing the reach of the crane boom. The main reasons for the failure of the lifting mechanisms are the wear of brake pulleys, destruction and wear of shafts and bearings in gearboxes. The failures of the slewing mechanisms are mainly due to damage to the coupling that connects the gearbox to the open gear. Failures of the boom outreach change mechanisms are caused by damage to the rack and pinion teeth, hinge joints, bearings, and dampers.*

*The identified malfunctions of the mechanisms were caused by non-compliance with the established requirements for their operation and repair. The cause of defects in the mechanisms is a violation of the operating procedures and repair processes.*

*Keywords: portal crane, reliability, availability, failure.*

**Introduction.** Portal cranes are the real workhorses of any modern port. These powerful and tall structures play a critical role in the process of transferring cargo from ship to shore and back again [1-11]. They ensure efficient and fast handling of containers, general cargo, bulk materials and other types of goods, which directly affects the speed of turnover and

economic efficiency of the port [2-11] . Loading and unloading operations in river ports largely depend on portal cranes [1-11]. Unfortunately, in Ukraine, the majority of these cranes (over 90%) have already reached the end of their service life, but continue to be heavily used [4-8]. This poses a serious problem, as the reliable operation of portal cranes is critical for the smooth functioning of port lines [2-11]. The operation of such cranes under cyclic loads leads to the accumulation of fatigue damage, which increases the risk of breakdowns and accidents. Therefore, ensuring the safe and reliable operation of portal cranes, either through modernization or replacement, is a crucial task [1-13].

Given that portal cranes are a key element of the technological process, their reliable and uninterrupted operation directly affects the efficiency of port lines [2,4-9].

**Literature Review**

Nowadays, insufficient attention is paid to the study of reliability of portal crane mechanisms operated for more than 35 years in sea and river ports, as evidenced by the analysis of works [1-9].

Insufficiently in-depth study of processes occurring in metal structures significantly reduces the probability of timely detection and prevention of various defects.The use of cranes with defects can lead to the destruction of metal structures and accidents with casualties. In this regard, each portal crane requires individual and detailed study [6,9]. Given the annual increase in the volume of cargo transshipment in the world, this problem is of particular relevance. Predicting equipment breakdowns is crucial to minimize maintenance costs, downtime and safety risks [13-16].

**The purpose of this paper** is to analyze failures of mechanisms of portal cranes “GANZ” 5 with overtime periods of operation in the river port.

**Research methodology and results.** For the study, 16 cranes of the same type, each with a lifting capacity of 5 tons, were selected, operating in grab mode in the waters of sea and river ports.

The information contained in the relevant maintenance and repair logs of the respective cranes from 2015 to 2022 was used for the analysis. The frequency of visual inspection of the cranes was once every six months during the observation period.

Statistical data on crane failures were collected directly at the ports, at the place of crane operation, from crane operation passports and logbooks, as well as from the shift mechanic's department and other port services,

Reliability analysis of portal cranes implies consideration of the working process as a set of failure and recovery flows. As a key reliability parameter a complex indicator - availability factor - is used (Кг):

$$К_{г} = \frac{T_{м}}{T_{м} + T_{в}} \quad (1)$$

where *Тм* - is the average operating time between crane failures for a specified period of time;

*Тв* - is the average recovery time for a specified period of time.



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The availability factor is determined by two key parameters: the length of time the unit has been in operation *Тм* and the time taken to repair the unit *Тв*. Repair time represents the period required to repair a crane malfunction. This indicator is of paramount importance in evaluating and comparing different designs, as it directly reflects the crane's ability to perform its functions over a period of time. This makes it possible to analyze the dynamics of changes in the characteristics of various crane installations depending on their service life.

The availability factor was determined for each of the 16 cranes and the results were averaged (Fig**.** 1).

A comparison of crane reliability levels shows two extremes (Fig.1), which are associated with the arrival of investors in ports and, consequently, an increase in the amount of money spent on crane maintenance and repair.

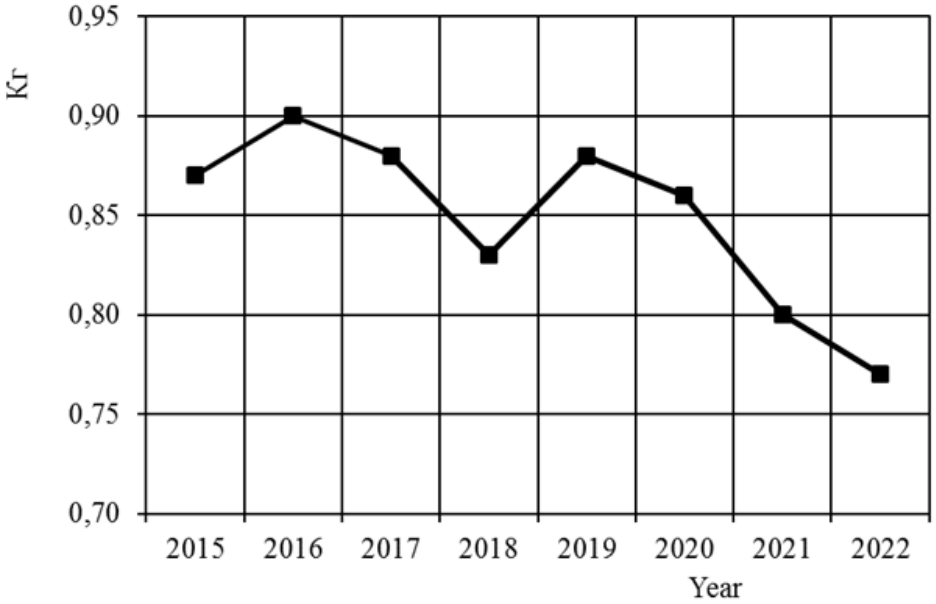


Figure 1 - Dependence of average values of availability coefficients Кг on portal cranes operation time (year)

The histogram of probability distribution of the amount of cargo lifted by the portal crane in each cycle of its operation, during the transshipment of bulk materials under the warehouse-ship option for the navigation period is shown in Fig. 2.

Analysis of the results of the study showed that the largest number of failures was identified in the traveling, lifting and luffing mechanisms of the crane (Fig..3).

The main causes of failures of lifting mechanisms are wear of brake pulleys, destruction and wear of shafts and bearings in gearboxes. Failures of slewing mechanisms are mainly associated with damage to the coupling connecting the gearbox to the open gear. The main causes of failure of lifting mechanisms are brake drum wear, damage and wear of shafts and bearings in the gearboxes. Failure of slewing mechanisms is most often associated with damage to the coupling connecting the gearbox to the open gear. In addition, in the process of research at half of the cranes was found wear of rollers of slewing and support devices.

The key element of any crane installation is the lifting mechanism.The analysis of Fig. 2 shows that during the working shift the crane mechanisms are subjected to uneven load. In

reality, the trajectory of the grab is formed under the combined influence of the lifting, boom reach, swivel and running gear. Fluctuations in luffing speed cause inconsistencies in grab velocity due to the flexible steel wire connection. To address this, the grab's speed alteration must be managed and attuned until synchronization is achieved. This is due to the uneven scooping of cargo by the grapple. In addition, as follows from the figure, two grapples with different scooping volumes were used for cargo reloading.

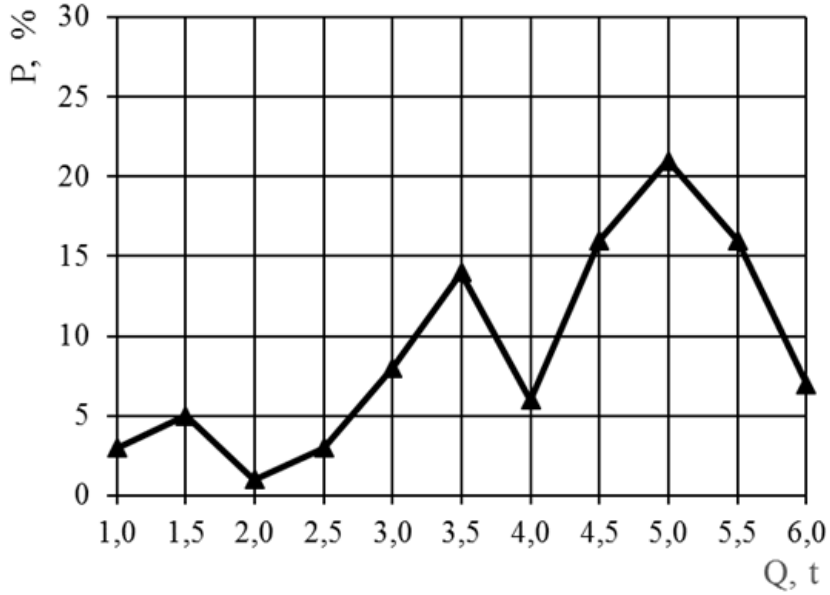


Figure 2 - The histogram of probability distribution of the amount of cargo lifted by the portal crane in each cycle of its operation, during the transshipment of bulk materials under the warehouse-ship option for the navigation period

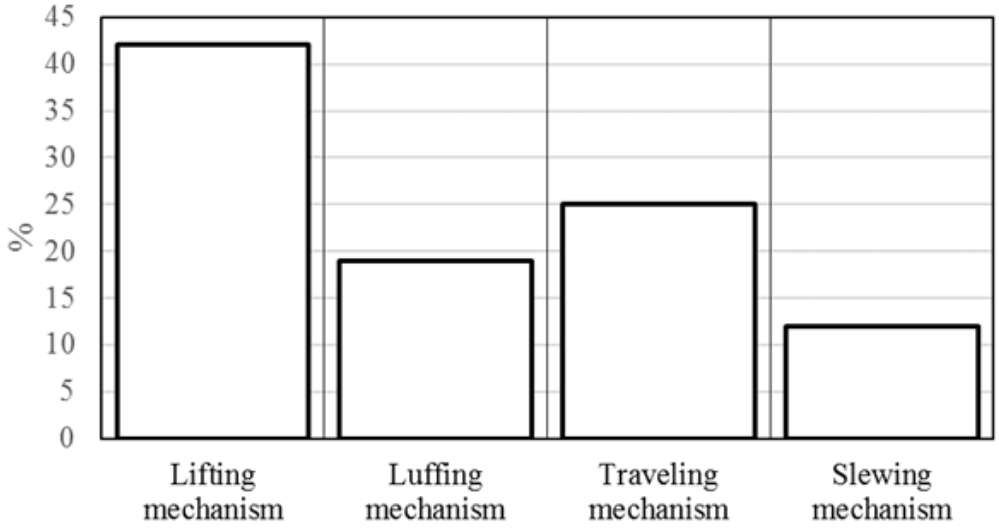


Figure 3 - Luffing mechanism of portal crane «Ganz»

The main failures of the traveling mechanism come from the gearbox and the open gear support (Fig.4).

It should be noted that they were similar to failures of the crane “Gantz ”16.



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Failures of the boom outreach mechanisms are related to damage of rack teeth, swivel joints, bearings and dampers. Replacement of shock absorbers is not difficult. It should also be noted the following failures of the outreach mechanism: loosening of gearbox fastening, damage of laths, lath attachment units to the boom, wear of shock absorber rods.

Among the most typical failures of the boom and metal structures it should be noted: cracks in the lower portal tighteners, welds of the lower column support and portal head, damage of fastening bolts. The appearance of cracks can be attributed to poor welding quality and unsuccessful design.

In almost all the examined stocky metal structures, water was found inside.

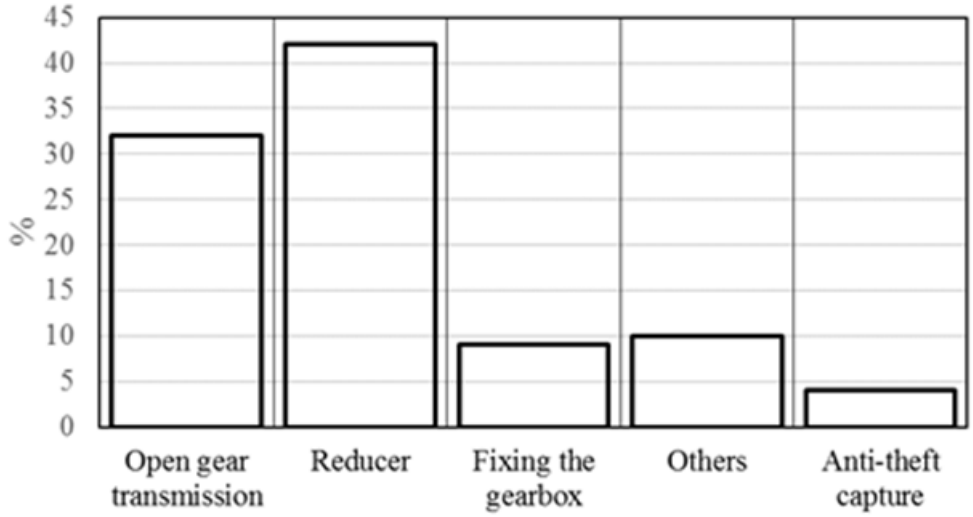


Figure 4 -The main failures of the traveling mechanism portal crane «Ganz»

Practically in all examined chunky metal structures water was found inside, which contributes to premature failure, Besides, in 3 cranes corrosion damage of elements of metal structures of the boom was revealed, which exceeds permissible norms. As a consequence, the booms of the cranes were replaced with new ones. These lesions can be explained by gross violation of painting technology and untimely maintenance and repair activities.

The defects in the mechanisms were caused by non-compliance with the rules of use and improper repair. Violation of the rules of use and repair technology led to defects in the mechani In the course of the study, the nature of the damage occurring in the crane mechanisms was determined. The information obtained will allow specialists involved in the operation of crane equipment to optimize the planning of preventive maintenance work, as well as the volume and range of spare parts and components needed for replacement.sms.Improper operation and poor repair caused defects in the mechanisms.

**Conclusions.** The study analyzed malfunctions of the mechanisms of GANZ portal cranes with a lifting capacity of 5 tons that occur during operation under heavy load conditions in a river port. Within the framework of the study, 16 cranes of GANZ of the same type with a lifting capacity of 5 tons, operating in the grapple mode in the water areas of river ports, were selected. When comparing different portal crane models, the availability factor serves as a key reliability indicator to gauge their performance. Defects in machinery are the result of non-compliance with operating rules and repair technology. It was found that the

main causes of failure of the lifting mechanisms are wear of brake drums, damage and wear of shafts and bearings in gearboxes. The failure of the lufing mechanisms is mostly due to damage to the clutch that connects the gearbox to the open gear. Failures of the boom outreach change mechanisms are caused by damage to the rail teeth, hinge joints, bearings and damping devices. In the course of the conducted research, the specifics of damage occurring in the mechanisms of crane equipment were revealed. The data obtained will allow crane operators to plan preventive maintenance more efficiently, as well as determine the optimal volume and range of spare parts and components needed for replacement. Predicting equipment breakdowns is crucial to minimize maintenance costs, downtime and safety risks. Predicting equipment breakdowns is crucial to minimize maintenance costs, reduce downtime, and prevent safety hazards.

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***Дослідження експлуатаційної надійності портальних кранів "ГАНЦ" 5-30 річкових портів***

*Портальні крани є ключовим обладнанням будь-якого сучасного порту. Вони виконують незамінну функцію переміщення вантажів між суднами та прибережною зоною, гарантують оперативну та продуктивну обробку контейнерів, різноманітних вантажів, сипучих матеріалів та інших видів продукції, що безпосередньо впливає на швидкість вантажообігу та прибутковість порту. Ефективність вантажно-розвантажувальних робіт у річкових портах значною мірою визначається наявністю та справністю портальних кранів. Але, на жаль, в Україні значна частина (понад 90%) цих кранів вже відпрацювала свій ресурс, але продовжує активно використовуватися. Це створює серйозну проблему, оскільки стабільна та безперебійна робота портальних кранів є критичною для безперебійного функціонування портової інфраструктури. У дослідженні проаналізовано несправності механізмів портальних кранів GANZ вантажопідйомністю 5 тонн, які виникають під час експлуатації в умовах великого навантаження в річковому порту. У рамках дослідження було відібрано 16 однотипних кранів вантажопідйомністю 5 тонн, що працюють в грейферному режимі на акваторіях річкових портів.*

*Для аналізу були використані дані журналів технічного обслуговування та ремонту цих кранів за період з 2015 по 2022 рік.*

*На основі зібраних даних розраховано коефіцієнти доступності.*

*Аналіз результатів дослідження показав, що найбільшу кількість відмов виявлено в механізмах переміщення, підйому та зміни вильоту стріли крана. Основними причинами виходу з ладу підйомних механізмів є знос гальмівних шківів, руйнування та зношення валів і підшипників у коробках передач. Відмови механізмів повороту в основно-*

*му пов'язані з пошкодженням муфти, яка з'єднує коробку передач з відкритою передачею. Відмови механізмів зміни вильоту стріли викликані пошкодженням зубів зубчастої рейки, шарнірних з'єднань, підшипників і амортизаторів.*

*Виявлені несправності механізмів виникли внаслідок недотримання встановлених вимог щодо їх експлуатації та ремонту. Причиною дефектів механізмів є порушення режиму експлуатації та ремонтних процесів.*

*Ключові слова: портальний кран, надійність, готовність, відмова.*

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