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MODERN CONDITION MONITORING SYSTEMS OF ELEVATOR UNITS

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The paper considers the main systems for monitoring elevator equipment condition, their tasks and functionality. The dependence of the degree of elevator load on the number of storeys of the building is considered. The paper provides options for expanding the possibilities of dispatching systems for better safety of elevator structures.

Keywords: elevator, dispatching system, elevator load, maintenance, safety.

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СОВРЕМЕННЫЕ СИСТЕМЫ КОНТРОЛЯ СОСТОЯНИЯ ЛИФТОВЫХ УСТАНОВОК

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Рассмотрены основные системы для контроля за состоянием лифтового оборудования, их задачи и функциональные возможности. Установлена зависимость степени нагружения лифта от этажности здания. Предложены варианты расширения возможностей систем диспетчеризации для более качественного обеспечения безопасности лифтовых сооружений.

Ключевые слова: лифт, система диспетчеризации, нагрузки лифта, техническое обслуживание, безопасность.

Introduction. Every day a large number of people use elevator units to go up the high-rise buildings. At the same time, high-rise construction significantly prevails over low-rise construction. Thus, according to statistics, in 2018 the volume of construction of buildings with a height of 9 or more floors amounted to 86.3 % of the total volume of construction in Russia. Therefore, the number of elevators, both in houses and in institutions is constantly growing. Together with the growth of the number of elevators, the need for quality control of both the elevator units operation and their maintenance and repair increases. To meet these challenges, people use condition monitoring dispatching systems of elevator units [1, 2].

Main part. Currently the market of elevators control systems provides a big number of computer programs: software dispatching complex "OB" [3]; system of elevator dispatching, control, and communications SLDKS-1 [4]; elevators scheduling program MPultPro and others. These systems have a similar set of functions that allows you to control the elevator movement in real time and transmit information to the control panel of the dispatcher, which can simultaneously control several dozens of elevator units in various construction facilities.

The dispatching complex connected to the elevator provides the dispatcher with the following information:

- actuation of electrical safety circuits;
- unauthorized opening of the shaft doors in the normal operation mode;
- opening of the door (cover) of the elevator control device out of the machine room;
- actuation of the emergency call button from the elevator car;
- opening of the door of the machine, block rooms of the elevator, the door at the elevator shaft pit.

In addition, the control complex performs the following functions:

- two-way communication between the control room and the cabin (roof) of the elevator, the control room and the engine room;

• automatic check of the communication path with the elevator car;

• sound and light confirmation of the registration of the dispatcher call to negotiation from the elevator cabin and the machine room;

• remote disconnection of the elevator power supply at the command of the dispatcher;

• backup power to the elevator units from the local bus or from the accumulator battery and signaling the transition to backup power;

• protection of devices against the local bus getting high voltage lightning discharges and induced pulse overvoltage, as well as protection against short circuits on the local bus;

• changing the parameters of the elevator unit using the service tool;

• connection to microprocessor-based elevator control stations via serial interface;

• connection of the yellow and green pictograms in accordance with GOST R 51631-2008 [5];

• monitoring the health of the connected equipment;

• identification of incoming alarm: from what lift and what kind of signal.

As it can be seen from the description of functional capabilities of dispatching systems, they constantly monitor the elevator, as well as solve the problem of ensuring safe functioning of elevator devices. However, these control systems do not control the level of specific load experienced by elevator elements over a period of time. These programs signal to the dispatcher about already occurred failures or emergency, but do not allow generating a report on the loading conditions of elevator elements. The ultimate purpose of such information may be to justify the timing of maintenance or repair work in the inter-service interval, which would increase the level of safety in the operation of elevator units, as well as reduce operating costs. It is obvious that timely and qualitative routine maintenance works, the size and sequence of which have a scientific justification, will significantly reduce the risk of emergencies. At the same time, it should be emphasized that according to the available data [6], the program of service and maintenance of elevators of different number of storeys operating in different loading modes in terms of the number of cycles and the magnitude of the statistically equivalent load on the drive, ropes and other elements, differ little from each other. Thus, the frequency of routine maintenance and repair of identical models of passenger elevators operated under different conditions should be different to ensure a proper level of safe operation. The work [7] proposes a relationship for calculating elevator units equivalent load, taking into account the periodic changes of the load in each cycle and the frequency of use of the system. Equivalent in this case means the load received by all elements of the drive of the elevator taken by the engine shaft.

Fig. 1 demonstrates the results of the implementation of the algorithm of modeling the elevator operation modes using a computer program "Simulation of a passenger elevator" [8].

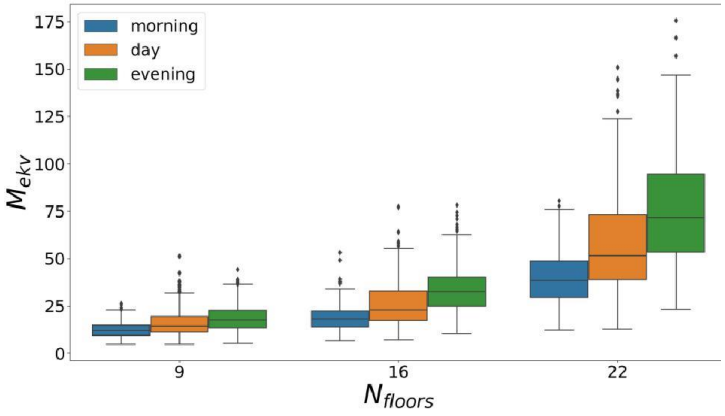

Fig. 1 Distribution of equivalent torques in each cycle of elevator movement: M_{ekv} — equivalent torque on a shaft of the engine; N_{floors} — number of storeys in a building

The study was conducted for three houses with 9, 16 and 22 floors, as well as in three different modes of operation of the elevator: morning, day and evening. The study showed that as the number of floors in a building increases, the dispersion of equivalent torques increases, the upper quartiles shift upwards, and the distributions deviate more and more from the normal pattern and there are many whippings. Evening mode is characterized by the movement of passengers on the upper floors, this leads to an overall increase in the equivalent torque of the engine and, as can be seen from Fig. 1, the evening mode of the building of lower number of storeys is more energy-intensive than the morning mode of the building of higher number of storeys.

Based on the results obtained, it can be concluded that the value of equivalent torques increases disproportionately to the increase in the number of storeys in the building. If the same models are used in buildings with different number of storeys, their operating time before the next maintenance or repair can be significantly different and, therefore, the control of the degree of elevator loading will have a positive impact on ensuring a higher level of safety.

Conclusion. For a more in-depth control over the degree of loading of each individual elevator, it is required to introduce additional controls into the already operating dispatching system. These means will allow fixing so-called equivalent loadings during operation, which can serve as an indicator of an elevator complex condition as a whole and the need of preventive and other types of maintenance works.

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