Impact of the use of isolation and passive guides on the crane cab ride comfort

Wpływ zastosowania wibroizolacji biernej prowadników kabiny dźwigu na komfort jazdy

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The article presents the engineering methods used to improve the comfort of lifting devices commonly called lifts. The authors focused their attention particularly on the aspect of the elevator cabin silence by using sliding guides with inserts with passive insulation (a layer of vibration damping from the running track guide system). To this end, measurements were made sound level in the cabin and on the cabin, by means of conventional sliding guides and sliding guides of passive isolation. The measurements were compiled and compared in terms of their applicability and impact on the noise level inside the elevator cab.
KEYWORDS: elevator guide, elevator comfort, vibro insulation methods of elevator cab

Comfort means of transport is a very important issue, having a direct impact on travel safety. Feelings related to comfort depend on factors that characterize the environment in which the passenger is traveling, such as: vibration, temperature, humidity, noise, passenger position, lighting and time of exposure of the passenger to these factors. Despite the knowledge of factors determining comfort, it is difficult to quantify it because of the subjective nature of perception of external stimuli by the passenger.

The most influential factors influencing the feeling of driving comfort in transport are the vibration and the level of noise (noise), which is dependent on the frequency of vibration generated. In the case of passenger lifts, increased noise levels during driving are particularly disadvantageous due to the small size of the cabs, which may in some cases cause adverse psychosomatic symptoms. This makes lifting equipment designers put increasing emphasis on improving the facilities offered comfort by reducing noise and vibration felt by the passengers.

In the literature, there are numerous publications on passenger lifts and comfort of using them. The individual systems of the chassis-cab are described in publications [1-4, 5-7, 11]. The authors of the publication [5, 9-11] describe methods for the assessment of noise and vibration in the cabin lifts, as well as attempt to evaluate their causes and methods to minimize them. Insufficient is the number of publications on methods of reducing noise in the cabins of passenger lifts with special emphasis on modern engineering materials used for the manufacture of sliding guides.

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Construction of chassis of the crane

In passenger elevators, the noise that is felt in the cab by passengers is most often derived from the working drive system (winch), wheel-rope system (especially in non-engineered crane) or, in each configuration, from the work of the guide system (fig. 1).

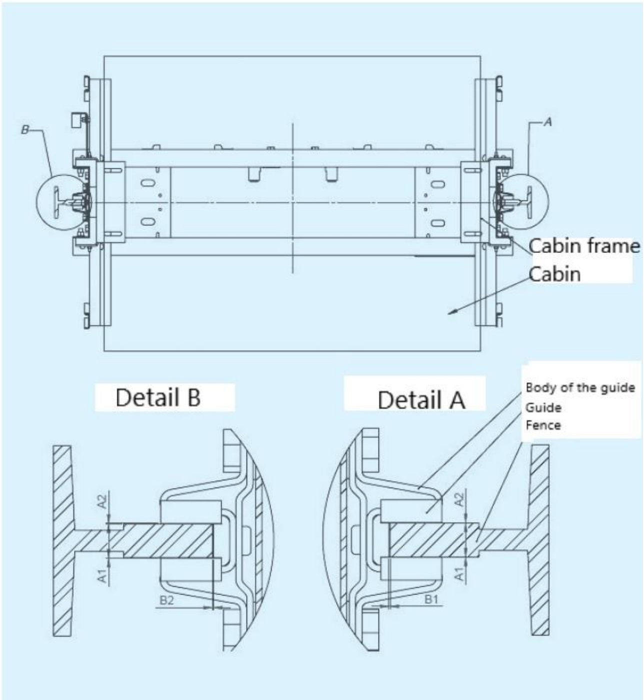

Fig. 1. Personal crane driving system with sliding guides

The slide guide shown in fig. 1 usually consists of a guide body and an insert, which slides together with the fence of the elevator.

To reduce friction, the guide-fence system is lubricated with liquid grease applied to the guide through the grease gun while driving the crane (fig. 2).

Proper selection of the chassis (guides and fences) is especially important, because vibration and noise generated by the chassis is most strongly received by the user due to the direct proximity of the chassis members. You can assume that the more rigid the guide (the rail at which the guide moves), the less vibration it will generate when passing the cabin.

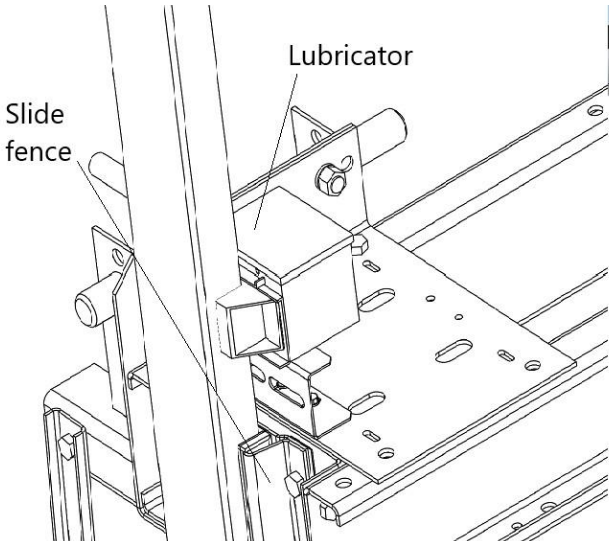

Fig. 2. Typical way of mounting the guide lubricator on the upper part of the cabin frame

Components of the crane in direct contact with the guide are fences which, depending on the design, can be divided into sliding (requiring proper lubrication) and roller (dry working). Proper selection of fences is of great importance for quiet operation of the device. A properly designed slide fence should have a sturdy body and a matching insert to provide an optimal compromise between the hardness that extends its life and elasticity to help suppress the slippage of the guide. This is often achieved by joining materials (hard, with good sliding properties, the insert, which is in direct contact with the guide, is connected to the body by means of a flexible polymer providing cushioning). The slider insert with additional cushioning is shown in fig. 3.

a) b)

Fig. 3. Sliding fence: a) insert with cushioning layer, b) complete fence

Fluid cushioning polymers are also increasingly used on the lateral surfaces of the insert to minimize vibration from the working system to the cab, thereby eliminating the resonance of thin-wall cab elements, reducing the noise generated in the cab. In order to assess the effectiveness of such a solution, it is necessary to perform sound measurements for both traditional solutions and new passive vibration insulators.

Object and study plan

The object was a 5-stop passenger lift with a propulsion system installed in a reinforced concrete pane. The characteristics of the research object are shown in Table I.

TABLE I. Parameters of the research object

Year of installation	2014
Capacity *Q*, kg	750
Speed *V*, m/s	1
The heigh of raising *H*, mm	25 000
Number of stops *N*	9
Cabin depth *A*, mm	1400
Cabin width *B*, mm	1300
Winch type	single speed, adjustable with encoder
Localization of the engine room	in the schaft
Type of guides	sliding
Construction of the cabin walls	panel made of laminated steel

Cranes with such a propulsion location are particularly susceptible to increased vibration and noise in the windscreen, and consequently also in the cabin. The working drive system generates vibrations that are transmitted through the foundation and guides to the fences and the cabin frame, where the cabin is mounted, to the interior.

The test plan included measurements on the cab (inside the windscreen) and inside the cab during the sequence of the journey from the highest stop to the lowest and back to the highest on the cabin inserts without lateral passive vibro-insulation (fig. 4a) and repetition of the sequence after replacing the fences into a three- passive (fig. 4b).

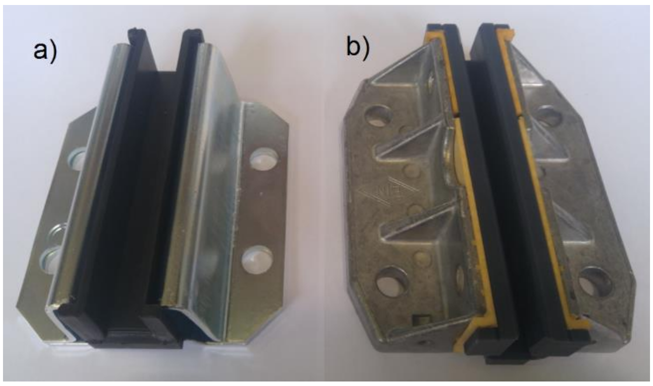

Fig. 4. Slide guide a) with vibro-insulation on one (bottom) plane, b) with passive vibro-insulation on three planes

Comparison of the sound level in the shaft and cab will in both cases allow to check the efficiency of the noise reduction inside the cab using passive vibration insulators.

Research apparatus

Sound level measurements were performed with the Center 390 device. The measuring range of the device ranges from 30 to 130 dB, with the frequency of the measured signal in the range of 20 Hz to 8 kHz. The accuracy of the measurement is ±1.4 dB under reference conditions, i.e. at a sound level of 94 dB and a 1 kHz signal frequency. The device is set to averaging curve (SLOW) (suitable for measuring the average sound level emitted by the source). Measurements were made using the A-weighted curve, which most accurately reflects the particular characteristics of the human ear.

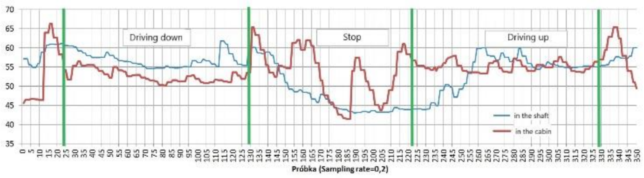

Fig. 5. Sound intensity during crane driving for a passive vibro-insulation guide on three working planes

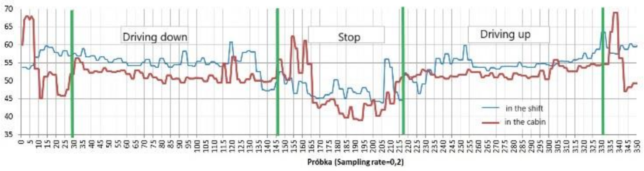

Fig. 6. Sound intensity during crane driving for a passive vibro-insulation guide on one working plane

Results

Data set in Table II graphically illustrated in fig. 5 and 6, conclude that the passive vibration guide work on all application surfaces generates a noise reduction of 1.1 dBA in the shaft and 2 dBA in the cabin.

It is also noted that the difference in sound level in the windshield compared to the values measured in the cab is clearly greater (0.9 dBA) for the vibration-proof fence, which may be due to better isolation of the thin-walled cab from the vibration of the propulsion system carried by the guides. The "smoother" sound waveform shown in fig. 5 shows that the technological clearance on the slides generates smaller sound values during normal crane operation.

TABLE II. Comparing the average sound intensity values during the whole passage in a given direction

	Driving direction	In the shaft *Avg*, dBA	Average for both drives	In the cabin *Avg*, dBA	Average for both drives	Difference, dBA
With vibro-insulation on three working planes	down	56	56,2	51,5	51,8	4,4
	up	56,4		52,2		
With vibro-insulation on one working plane	down	57,1	57,3	52,7	53,8	3,5
	up	57,5		55		

Conclusions

The sound intensity measurements allow to draw the following conclusions:

- the use of passive vibro-insulation fences located on all contact surfaces reduces the sound level measured in the cockpit (by 2 dBA compared to vibration insulators in one plane), which significantly improves the parameters that affect travel comfort,
- the sound level measured in the cabin (in the shaft) is comparable to both types of drive,
- applying the vibration isolation layer in the slide guide inserts allows the cabin to be isolated from vibrations from the propulsion system carried by the guide, thus minimizing the resonance of thin-walled cab elements,
- properly applied vibration isolation of the passive drive system would reduce the vibrations transmitted to the cabin guides.

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