JOURNAL OF TRANSPORT

ISSUE 3, 2024 vol. 1
ISSN: 2181-2438

RESEARCH, INNOVATION, RESULTS

TOSHKENT DAVLAT TRANSPORT UNIVERSITETI
Tashkent state transport university

JOURNAL OF TRANSPORT

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ISSN 2181-2438

VOLUME 1, ISSUE 3

SEPTEMBER, 2024

jot.tstu.uz

TASHKENT STATE TRANSPORT UNIVERSITY

JOURNAL OF TRANSPORT

SCIENTIFIC-TECHNICAL AND SCIENTIFIC INNOVATION JOURNAL

VOLUME 1, ISSUE 3 SEPTEMBER, 2024

Founder of the scientific and technical journal “Journal of Transport” – Tashkent State Transport University, 100167, Republic of Uzbekistan, Tashkent, Temiryoʻlchilar str., 1, office: 465, e-mail: publication@tstu.uz.

The “Journal of Transport” publishes the most significant results of scientific and applied research carried out in universities of transport profile, as well as other higher educational institutions, research institutes, and centers of the Republic of Uzbekistan and foreign countries.

The journal is published 4 times a year and contains publications in the following main areas:

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Tashkent State Transport University had the opportunity to publish the scientific-technical and scientific innovation publication “Journal of Transport” based on the Certificate No. 1150 of the Information and Mass Communications Agency under the Administration of the President of the Republic of Uzbekistan. Articles in the journal are published in Uzbek, Russian and English languages.

CONTEXT / MUNDARIJA

Checking traffic safety requirements for transportation of oversized cargo in railway transport (on 1520 mm railroad tracks)

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Abstract: The main purpose of the work is to determine and check the levels of undersize of large loads loaded into open traffic. In this article, the analysis of safety conditions in the transportation of goods through undercarriage was carried out. In the study, the possibilities of organization of transportation were considered due to the analysis of the levels of underweight, depending on the geometric dimensions of the transported cargo. In this, the limits of the dimensions of compliance with the gauge levels of large-sized cargo are given, and the calculation of safety requirements for types of cargo outside these limits is performed. Also, based on the research of the operation sequence of the modern type of control frame, the possibility of more accurate and quick determination of the safety of the traffic was considered.
Keywords: Oversized loads, control frame, safety requirements, levels of oversize, movement composition, safety distance, inspection.

1. Introduction

The degree of unevenness of the rolling stock should be taken into account in the straight and curved parts of the railway. If the dimensions of the wagon together with the load exceed the limits specified in the curves, then the loaded wagon cannot pass through these curves. Calculated underweight is determined for oversize loads when the ratio of the length of the load to the length of the rolling stock exceeds 1.41.

Depending on the height of the loaded open rolling stock from the level of the rail head, three main unevenness zones are defined:

- Lower: 480 -1399 mm;
- Side: 1400 - 4000 mm;
- High: 4001 - 5300 mm.

These disparity zones, in turn, are divided into levels depending on the size deviation:

- In the lower minor zone: six degrees;
- In the zone of lateral inferiority: six degrees;
- In the zone of high inferiority: three levels.

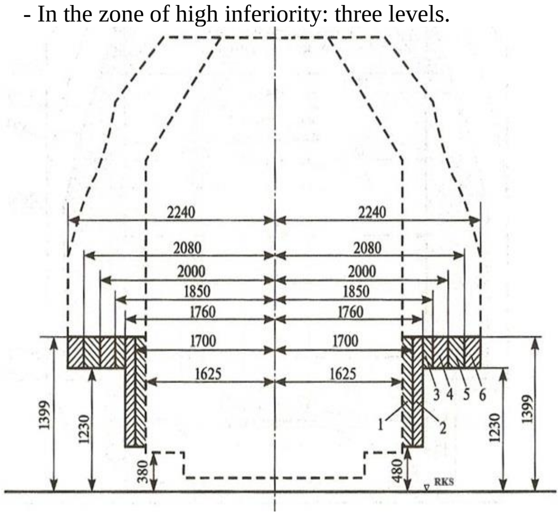

Figure 1. Distribution of degrees of inferiority

The category of oversize cargo includes cargo that horizontally protrudes from the contour of the zones and is higher than 5300 mm above the level of the railway rail head. If the height of the load is more than 5300 mm, then it is called extremely high underweight.

In railway transport, there is an underweight index, and underweight zones and levels of cargo are indicated by five characters. Each symbol of the weight index has a separate meaning and represents the level of weight of the load in a certain zone. The number 8 is used to indicate the extremely high roughness in any zone.

Signs in the Immaturity Index:

Character 1: letter N (oversize);

Character 2: the lower degree of underdevelopment, from 1 to 6;

Character 3: degree of lateral insufficiency, from 1 to 6;

Character 4: high degree of underdevelopment, from 1 to 3;

5th sign: extremely immature, number 8.

If there is no level of inequality in the movement, the index symbol is marked with the number "0". For example, the index N8380 indicates that the load has bottom and top misalignment, and does not have side misalignment of the 3rd degree.

2. Literature analysis and methodology

In order to calculate the underweight levels of cargo delivered for railway transport, shippers must submit loading schemes in three projections, respectively. The coordinates of the turning points are indicated by horizontal distances from the road axis (X) and vertical distances from the level of the rail head (Y), and the load is placed on the platform according to the following conditions:

- The lower support surface of the load must be at the level of the platform base.
- The vertical axis of the transverse contour passing through the center of gravity of the load is combined with

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the vertical axis passing through the center of gravity of the platform.

The coordinates of the turning points of the loaded load are determined along the horizontal and vertical axes, taking into account its location on the platform. These conditions are important in determining the safety of cargo movement and determining the level of underweight.

$X_i=B_i$; $Y_i=h_p+h_i$, (1)

where, B_i - is the distance of the pivot point i (i=1.5), (i=1.5), passing through the center of gravity from its vertical axis along the width of the load, (mm);

h_p — the height of the wagon base from the level of the rail head (mm);

h_i — the height of the turning point of the load from the surface of the cross section (mm).

The calculated imbalance is determined separately for the internal and external parts at the turning points of the load. All parts located on the base of the rolling stock are considered internal parts of the cargo. External parts are parts located outside the base of the rolling stock.

If the ratio of the length of the load to the length of the rolling stock exceeds 1.41, or if the load is transported on combined platforms or on conveyors, it is considered undersized.

Correct calculation of the height of the lower supports is of particular importance in order to correctly place the base of the increased load on the combined platform. The height of the lower supports:

$$h_0 = a_p tg\gamma + h_p + h_x + f_{\text{пр}}, \quad (2)$$

where, a_p - is the distance from the edges of the open rolling stock or the load that can touch it to the axis of the wheel pair of the rolling stock, m:

$$a_p = 0.5(L_{load} - L_b - 1850) \quad (3)$$

where, L_{load}, L_b - is the length of the loading area of the load and moving structure, mm;

$Tg\gamma$ - the value of the tangent of the angle between the longitudinal axes of the load and the combined platform;

h_p – the difference between the levels of the combined platforms; $h_p \leq 100$ mm;

h_x - safety margin, mm;

f_{bur} - value of elastic deflection, mm.

Taking into account the height of the lower supports, the coordinates of the turning points of the load should be measured from the rail level, depending on the type of load placement scheme., Y_{his}:

$$Y_{his} = Y_i + h_p + h_i + h_0 \quad (4)$$

The coordinates of the critical points calculated from the road axis of the loaded wagon can be calculated according to the coordinate axes using the following expressions:

$$X_{his}^{ich} = X_{ich} + \Delta b_{his}^{tash}, \quad (5)$$

$$X_{his}^{tash} = X_{tash} + \Delta b_{his}^{tash}, \quad (6)$$

where, X_{his}^{ich}, X_{his}^{tash} - the distances from the loading axis of the rolling stock to the critical points, located in the inner and outer parts, respectively, are determined in millimeters;

X_{ich}, X_{tash} - the distance from the straight parts of the critical points located on the inner and outer parts, respectively, to the road axis is measured in millimeters;

Δb_{his}^{ich}, Δb_{his}^{tash} - values that take into account the differences in the geometric views of the internal and external parts of the cargo and the conditional calculated curvatures of the traffic structure.

These values depend on the type of rolling stock, the distance, and the following tables or calculation methods can be used to determine them.

When using these values, it is calculated for cases not listed in the tables. If the size of the load does not change in the plane of the platform, then it will be enough to check the coordinates only on the inner and outer parts, which are considered the most dangerous areas.

The values used when loading oversized cargo onto a combined platform or vehicles with a number of axles not exceeding six are taken into account with their permissible value:

$$\Delta b_{his}^{ich} = 1.43(l_b - p_{ich})p_{ich} - 105, \quad (7)$$

$$\Delta b_{his}^{tash} = 1.43(l_b - p_{ich})p_{tash} - 105 + K, \quad (8)$$

where, p_{ich}, p_{tash} – the inner and outer values can be found by calculating as follows:

$$p_{ich} = 0{,}5\ l \quad (9)$$

$$p_{tash} = 0{,}5\ (L_{yuk} - l_b) \quad (10)$$

105 – the exit of the platform at the standard radius of curvature, mm;

K - additional displacement of the load during movement, mm.

The rate of additional displacement is determined depending on the type of vehicle:

In specialized platform types:

$$K = 70\left(\frac{L_{yuk}}{l_b} - 1.41\right); \quad (11)$$

In normal platform types:

$$K = 55\left(\frac{L_{yuk}}{l_b} - 1.41\right); \quad (12)$$

3. Results and discussion

After receiving the necessary information on finding the load imbalance levels and the values needed to determine it, checking these expressions through specific examples is important to gain a more accurate understanding of the load imbalance levels. To make these calculations, an analysis of the position of the load base with a length of 21.72 m on a platform with a length of 9.72 m was carried out. In this case, since the width of the load at the height of the oversize limit of 1400-3850 mm is 3600 mm, this load corresponds to the 2nd level of side undersize. It is enough to determine the internal and external disparity distances, taking into account that the shape of the load is unchanged in terms of width, height and length. These calculations can be calculated using expressions (9) and (10):

p_{ich}=0,5 l = 0,5·9,72 = 4,86 m;

p_{tash}=0,5 (L - l) = 0.5 (21.72 - 9.72) = 6 m;

Differences in geometric deviation can be determined from the technical conditions of loading and fastening.

$\Delta b_{his}^{ich} = f_{ich}$ va $\Delta b_{his}^{tash} = f_{tash}$

According to the technical conditions l = 9,72 and p_{int} = 4,86 m from being f_{int} = 0.

According to the technical conditions l = 9,72 and p_{exte}= 6 m from being f_{exte} = 88 mm.

Through these calculations, expressions (5) and (6) are used and the dimensions of the discrepancy are calculated:

$X_{ich} = X + f_{ich}$ = 1800 + 0 =1800 mm;

$X_{tash} = X + f_{tash}$ = 1800 + 88 =1888 mm;

X_{cal}^{exte} - by comparing the value of 1888 mm with the specified dimensions of oversize, conclusions are drawn that this load corresponds to the 4th level of oversize.

A 16-axle conveyor with a length of 25.17 m and a base of 21.72 m is loaded with a load with a length of 43.25 m, a diameter of 3 m, and a base of 6.03 m. In this case, the load is 1500 mm wide from the road axis and 3600-4500 mm above the level of the rail head at a value of 1230 mm. In this case, the load is considered not to have left the gauge lines.

To determine the oversize, it is necessary to calculate the outermost parts of the load. Since the dimensions of the load do not change, the inner and outer values for the outermost parts are determined by expressions (9) and (10).

$P_{int} = 0{,}5\ l = 0{,}5 \cdot 25{,}17 = 12{,}585$ m;

$P_{exte} = 0{,}5\ (L - l) = 0{,}5\ (43{,}25 - 25{,}17) = 9{,}040$ m.

For levels of underweight: for internal parts of cargo - according to formula (5); for external parts – according to formula (2):

The difference in geometric outputs Δb_{cal}^{int} and Δb_{cal}^{exte}

$\Delta b_{cal}^{int} = f_{int} + f_0$, $\Delta b_{cal}^{exte} = f_{exte} - f_0$

These values are found using specifications:

F_{int} is taken from "Technical conditions for placement and securing of loads", since rolling stock with a base length of 25.17 m is not in the technical conditions, between the values of l = 25 m and l_2= 26 m, f_{int} = 12.585 m ≈ 12.6 m is calculated by determining interpolation: $f_1(l_1$ = 25 m) is 118 mm, f_2 (l_2 = 26 m) is equal to 135 mm.

f_{int}= 118 +(135-118) · (25,17 -25) =118+3=121 mm.

f_{exte} it is also necessary to determine the interpolation from the technical conditions.

l_1 = 25 m and p_{exte} = 9,04 m = 9 m, f_1 = 356 mm;

l_1 = 26 m va p_{exte} = 9,04 m = 9 m, f_2 = 367 mm;

bunda f_{exte}= 356 + (367 - 356) · (25,17 - 25) = 358mm.

The following accounts are determined in the same sequence:

X_{cal}^{int} = 121 + 13 = 134 mm;

X_{cal}^{exte} = 358 - 13 = 345 mm.

Therefore, the values of the degree of inequality will be equal to:

Values at a height of 3600 mm:

X_{cal}^{int}= 1500 + 134= 1634 mm;

X_{cal}^{exte}= 1500 + 345 = 1845 mm;

Values at a height of 4500 mm:

X_{cal}^{int}= 1230 + 134 = 1364 mm;

X_{cal}^{exte}= 1230 + 345 = 1575 mm.

X_{cal}^{int} va X_{cal}^{exte} - comparing the results with the corresponding values of the imbalance levels, it is determined that this load has a level 3 lateral and a level 2 upper imbalance.

The loaded rolling stock has the following oversized dimensions: 1400 - 4050 mm in height and 1650 mm in width; 4050-4250 mm high and 1750 mm wide. The deviations of load sizes on curves are smaller than the deviations of open traffic. If this situation is observed, the requirements of undersize should be determined.

When determining the degree of oversize, according to the technical conditions, it can be determined that 4250 mm in height and 1750 mm half-width is the 3rd level of undersize. To determine the lateral dimension, the largest transverse dimension is taken at a height of 1400-4000 mm and more than 4000 mm. It can be calculated that the largest size is 1750 mm with a height of 4250 mm.

According to the technical conditions, it was determined that the rolling stock has 2nd level of lateral imbalance due to falling into the zone of lateral and upper imbalance. These degrees of disparity can be more clearly understood from Figure 2. The load added to the open traffic structure through the above calculations has the characteristics of 2nd degree lateral and 3rd degree upper imbalance. Irregularity is defined as N023.

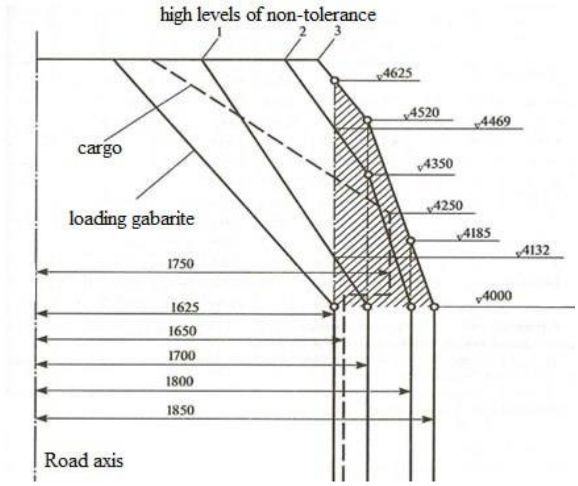

Figure 2. The scheme for determining the degree of lateral imbalance of the load added to the open traffic structure in the upper and side zones

Table 1

Determining levels of inadequacy

Nogabarity levels	Rank number	X and Y are the coordinates of the points, mm							
		1		2		3		4	
		X	Y	X	Y	X	Y	X	Y
bottom	1	1700	380	1700					
	2	1760	380	1760					
	3	1850	1230	1850	1399				
	4	2000	1230	2000					
	5	2080	1230	2080					
	6	2240	1230	2240					
Yeon	1	1700		1700	4000				
	2	1760		1760	4000				
	3	1850	1400	1850	4000				
	4	2000		2000	3700	1850	4000		
	5	2080		2080	3400	2000	3700		
	6	2240		2240	2800	2080	3400		
High	1	1700		1415	4500	880	5300		
	2	1800	4001	1700	4350	1480	4700	1020	5300
	3	1850		1700	4500	1120	5300		

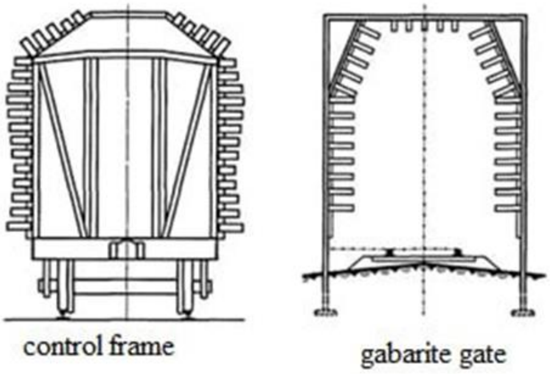

Figure 3. View of the control frame for oversized loads

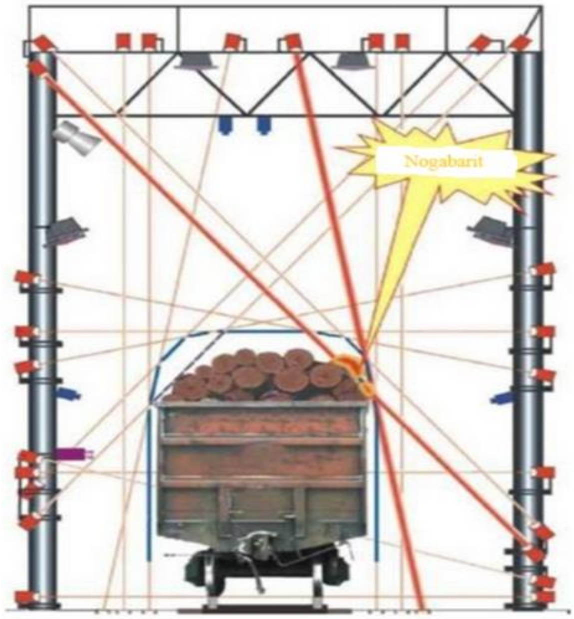

Figure 4. A control frame of modern type

Determining the levels of inadequacy is determined using Table 1 as follows:

1) indicates that the coordinates belong to the 3rd degree of lateral misalignment when X_{cal} = 1850 mm, Y_{cal} = 4000 mm.

2) indicates that the coordinates belong to the 4th degree of lateral misalignment when X_{cal} = 2000 mm, Y_{cal} = 3700 mm.

3) indicates that the coordinates belong to the 5th degree of lateral misalignment when X_{cal} = 2080 mm, Y_{cal} = 3400 mm.

It is passed through the control frame to check the degree of imbalance of the load added to the open movement (Fig. 3). The control frame consists of the main and additional contours.

In addition, there is also a modern control frame. Lasers, surveillance cameras, and sensor-notifiers that detect abnormality are installed in such a control frame (Fig. 4).

In such a system, whether or not the cargo complies with the measurement limits is checked using infrared sensors. Sensors mounted on the frame are placed so that infrared rays fall on the border of the gauge zone. When the infrared light falls on the part of the cargo floor, which is out of bounds, an alarm is sounded and the level of imbalance is displayed. Installation and replacement of control frames is entrusted to road distance workers.

The employee of the railway transport, who monitors the passage of the open rolling stock and the load loaded on it through the control frame, must control the passage of the loaded stock through the curved and straight parts of the track.

In the presence of such loads, the locomotive crew of the train must strictly follow the instructions of the railway transport officer, who monitors the passage of the control frame, in addition to the warnings specified in the documents. In the dark of the day and during the evening movement, the control frame should be illuminated with locomotive lighting. Regardless of the size of the cargo transported with the help of conveyors, these trains must be carried out according to the dispatcher's schedule.

4. Conclusion

In this work, analyzes and calculations on the transportation of large-sized cargoes are carried out, and additional suggestions are made for the determination and verification of the transportation procedure, gauge levels. In the article, the general requirements for acceptance of oversized cargo were considered, such things as oversized and oversized cargo in the wagon, determining the zone and level of oversized cargo, general requirements for transporting oversized cargo were studied. The 21.72 m long load under investigation is loaded on a platform with a base length of 9.72 m. It was determined that the level of the cargo with a width of 3600 mm in the part with a height of 1400 - 3850 mm corresponds to the 2nd level of lateral imbalance. In addition, the modern type of control frame was analyzed, its structure, operation procedure and possibilities were studied. In the future, providing railway stations with this type of control gates will further increase traffic safety and reduce the time spent on checking the compliance of cargo loaded into open traffic conditions.

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