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ANALYSIS OF THE IMPACT OF THE FORMATION PLAN AND THE WEIGHT OF FREIGHT TRAINS ON THE TRACK DEVELOPMENT OF SORTING PARK OF STATIONS

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ABSTRACT

The main purpose of the work is to analyze the plan for the formation of freight trains and the impact of train weight standards on the road network of the Ch sorting station under the management of the "Uzbekistan Railways" JSC. In this case, the Ch station will build a train to several destinations under the freight train plan formation, and the weight norms of trains made from the station in the cross section of June 2021 and January 2022 were analyzed. The results of the analysis found that trains at the station are structured in a significantly lower standard than the established weight standards for certain lines. It was also found that the capacity of the sorting parkways was also not used with a unit.

Keywords: sorting station, track development, track capacity, train handling, sorting park.

INTRODUCTION

According to the plan for the formation of freight trains of "Uzbekistan Railways" JSC, which is approved for 2021-2022, Station Ch trains are formed in the direction of 14 destinations [1-12].

According to the train formation plan, trains formed at the station "Ch" are mainly divided into 4 groups, that is, North, South, Angren and Khodjikent directions. Electric traction is used in the direction and electric locomotives of the 2ВЛ60^{К}, 3ВЛ80^{С} series are used, the new O'ZBEKISTON electric locomotive and 1-2-section locomotives. Table 1 shows the weight of freight trains, according to the standard train schedule approved by JSC "O'TY" [11-20].

Table 1 The weight of freight trains according to the regulatory schedule of 2022.

Appointments	2ВЛ60К		3ВЛ80С		OZB I		OZB II	
	odd.	pair.	odd.	pair.	odd.	pair.	odd.	pair.
	Freight train weight (ton)							
North	3800	4300	3800	4300	2800	3000	3800	4300
South	3800	4300	3800	4300	2800	3000	3800	4300
Bozsu	5000	5000	5500	5500	2300	2800	5300	5300
Angren	3400	2300	4500	3500	3400	2000	4000	2300

Freight trains, according to the formation plan, are formed from wagons of certain purposes and the norm of weight and length of the train set by the schedule [11-16]. Depending on the type and purpose of trains, weight and length standards are established for them: unified – for passing through trains without fractures, weight and length in the direction; parallel (increased or decreased) – for passing without fractures, weight and length of sender routes, accelerated container, refrigerated and for trains of certain purposes; precinct – established by locomotive capacity for this section. Unified and parallel standards for the weight and length of freight trains are established by the railway administration of the state [16-20]. According to the formation plan, in exceptional cases, a deviation from the established norms in the direction of reducing the weight and length of the route by no more than 90 tons or by one physical car is allowed [1, 5-9, 15-20]. In this direction, export, transfer and section trains are formed by weight and length within the minimum and maximum values of the norms established by the order of the Chairman of "Uzbekistan Railways" JSC. Combined trains and dispatching locomotives depart from the initial stations regardless of the number of wagons accumulated based on the established schedule threads.

The standard weight of freight trains is one of the main indicators that largely determine the quantitative aspects of railway operation. The weight of the train determines, first of all, the size of the movement, the required power of the locomotives and the useful length of the station receiving, sorting and exhaust tracks. The weight of the train largely determines the operational requirements for the capacity of the track and artificial structures, the parameters of the technical equipment of railway stations, the design of wagons and locomotives, signaling devices, centralization and blocking [8-16].

The weight of trains is reflected in the operational and economic performance of the rolling stock. The norms of weight and the associated dimensions of train movement determine the technology of operation of stations, especially the duration of maneuvers for the formation, disbandment, rearrangement of trains, the time of accumulation of wagons and processing of trains on departure and arrival, the amount of cargo in the process of transportation, and, consequently, the associated part of working capital in the national economy. That is why the weight of the train is the most important factor determining the organization, technology and economy of the transportation process.

The weight norms of freight trains are determined either by the power of traction means, the steepness of the calculated slope and the specific resistance to movement of wagons and locomotives, or by the useful length of the station receiving and sending tracks and the calculated running load of the rolling stock [5, 8, 9, 13, 17, 20].

The weight norms of freight trains, limited by the capacity of this locomotive, create the best conditions for its effective use, but at the same time the useful length of station tracks may be underused, which is unprofitable primarily due to artificially overestimating the size of traffic and the need to approximate the costs of increasing the capacity of the line with increasing freight flows.

Choosing the weight standards of freight trains in one direction or another is not only a technical task, but also an economic one. From a technical point of view, it requires taking into account the possibilities of passing trains under the conditions of track development and equipping stations, the power of shunting facilities, the best use of the capacity and carrying capacity of lines, the possibility of mastering the resulting traffic sizes, the arrangement of locomotives, including the use of full or partial traction or pushing [7].

RESULTS AND DISCUSSION

The weight of the Q_{total} train is calculated based on the full use of the traction force of the locomotive moving uniformly along the calculated lift with the calculated speed according to the formula:

$$Q_{total} = \frac{F_{kr} - (w_0' + i_p)P}{(w_0'' + i_p)}, t$$

there $F_{cal.tan}$ – the calculated value of the tangential traction force of the locomotive at the design speed, kg/s;

i_{cal} – the value of the calculated lift according to the task;

P – locomotive weight;

w_0', w_0'' – the main specific resistance to movement, respectively, of the locomotive in traction mode and wagons at the design speed, kg/s

In freight traffic on adjacent sections of the research object, it is used according to the regulatory schedules of 2ВЛ60^К, 3ВЛ80^С, O‘ZB, 2 O‘ZB electric locomotives, Table. 2.

Characteristics of locomotives of the object under study

Name of electric locomotives	$F_{КР}$, кгс	V_P, km/h	P, т	L, m
2ВЛ60^К	36800	43,5	138	42
3ВЛ80^С	49000	44,2	184	99
OZB	45000	53	138	28
2OZB	45000	53	138	56

The main specific resistance to the movement of electric locomotives can be determined according to the “Rules of traction calculations” (PTF) by the formula:

$$w'_0 = 1{,}9 + 0{,}01 \cdot \vartheta_{\text{p}} + 0{,}0003 \cdot \vartheta_{es}^2, kg/t;$$

there ϑ_{es} – the estimated speed of the locomotive, km/h.

$$w'_0 = 1{,}9 + 0{,}01 * 43{,}5 + 0{,}0003 * (43{,}5)^2 = 2{,}903\ kgs/t;$$
$$w'_0 = 1{,}9 + 0{,}01 * 44{,}2 + 0{,}0003 * (44{,}2)^2 = 2{,}928\ kgs/t;$$
$$w'_0 = 1{,}9 + 0{,}01 * 53 + 0{,}0003 * (53)^2 = 3{,}273\ kgs/t;$$

According to the PTF , the main specific resistance to the movement of freight wagons can be determined by the formula:

$$w'_{04} = 0{,}7 + \frac{3 + 0{,}1 * V_p + 0{,}0025 * V_p{}^2}{q_{04}}\ kgs/t;$$

there q_{04} - the load from the axle of the wagon on the rail, respectively, of four-axle wagons. (q_{04} = 85,5/4 = 21,4 t/ax)

$$w''_{04} = 0{,}7 + \frac{3 + 0{,}1 * 43{,}5 + 0{,}0025 * (43{,}5)^2}{21{,}4} = 1{,}265\ kgs/t;$$
$$w''_{04} = 0{,}7 + \frac{3+0{,}1*44{,}2+0{,}0025*(44{,}2)^2}{21{,}4} = 1{,}275\ kgs/t;$$
$$w''_{04} = 0{,}7 + \frac{3 + 0{,}1 * 53 + 0{,}0025 * (53)^2}{21{,}4} = 1{,}416\ kgs/t.$$

The norm of the weight of a freight train in the directions is determined by:

To the North:

ВЛ60К $Q_{total} = \frac{36800-(2{,}903+5{,}4)*138}{1{,}265+5{,}4} = 5197 \approx 5200\ t;$

ВЛ80С $Q_{total} = \frac{49000-(2{,}928+5{,}4)*184}{1{,}275+5{,}4} = 7111 \approx 7150\ t;$

OZB $Q_{total} = \frac{45000-(3{,}273+5{,}4)*138}{1{,}416+5{,}4} = 6427 \approx 6500\ t.$

To the South:

ВЛ60К $Q_{total} = \frac{36800-(2{,}903+6{,}4)*138}{1{,}265+6{,}4} = 4634 \approx 4650\ t;$

ВЛ80С $Q_{total} = \frac{49000-(2{,}928+6{,}4)*184}{1{,}275+6{,}4} = 6161 \approx 6200\ t;$

OZB $Q_{total} = \frac{45000-(3{,}273+6{,}4)*138}{1{,}416+6{,}4} = 5586 \approx 5600\ t.$

On the side of Angren:

ВЛ60К $Q_{total} = \frac{36800-(2{,}903+5{,}9)*138}{1{,}265+5{,}9} = 4967 \approx 5000\ t;$

ВЛ80С $Q_{total} = \frac{49000-(2{,}928+5{,}9)*184}{1{,}275+5{,}9} = 6603 \approx 6600\ t;$

OZB $Q_{total} = \frac{45000-(3{,}273+5{,}9)*138}{1{,}416+5{,}9} = 5978 \approx 6000\ t.$

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On the side of Hodjikent:

ВЛ60[К] $Q_{total} = \frac{36800-(2,903+5,3)*138}{1,265+5,3} = 5433 \approx 5450\ t;$

ВЛ80[С] $Q_{total} = \frac{49000-(2,928+5,3)*184}{1,275+5,3} = 7222 \approx 7250\ t;$

OZB $Q_{total} = \frac{45000-(3,273+5,3)*138}{1,416+5,3} = 6524 \approx 6550\ t.$

Despite the fact that the schedule of movement in each direction provides for a certain norm of train weights, the actual weights deviate from this norm in a fairly wide range. This is explained by the fact that the calculated weight standards are set most often based on the power of traction means and the profile of the track on the site or direction, in fact, the trains are also limited by the useful length of the station receiving and sending tracks. The linear load of individual wagon streams is very different and therefore some trains have a calculated mass at a length less than the maximum possible, while others do not reach the established weight norm at the maximum possible length. In the first case, trains are considered full–fledged, in the second - full-composite.

Deviations of the actual weight of a freight train from the norm established by the schedule in the larger direction are often associated with the use of partial multiple traction. When the actual weight of freight trains deviates from the norm, there is often an underutilization of the power of traction means [12, 17].

As you know, the power of traction means can be used either to increase the weight or to increase the running speed of the train. With very different actual weights of trains and the same type of locomotives, their power can be used in full, corresponding to its mass and power of the locomotive. Practically, however, such use of traction power is also impossible: in the timetable, all trains, regardless of their weight and traction means, are laid with the same estimated running speed. It is determined by the lowest specific traction power – the amount of horsepower per 1 ton of weight of a train with a locomotive. If the actual specific traction power of certain trains is higher than the calculated one, then the power of the locomotives is underutilized. If individual categories (the weight of the train is greater than the calculated one), then a multiple thrust is required [17-20].

The actual weight of freight trains performed according to sample statistics adjacent to the station "Ch" is distributed as shown in table 3.

Table **3 Distribution of the weight of freight trains on departure from the sorting station Ch.**

Train weight	Departure June 2021				Departure January 2022			
	North	South	Angren	Bozsu	North	South	Angren	Bozsu
0 – 1000	0	11	3	1	1	9	1	0
1000 – 1500	50	13	2	0	34	9	6	0
1500 – 2000	32	13	8	15	48	13	12	9
2000 – 2500	22	8	20	13	24	22	13	8
2500 – 3000	26	13	9	7	9	32	8	9

3000 – 3500	10	9	5	5	6	24	10	10
3500 – 4000	4	19	7	2	4	12	6	4
4000 – 4500	2	31	1	2	2	23	3	3
4500 – 5000	0	26	0	0	0	9	1	0
5000 – 5500	0	9	0	0	0	4	0	0
5500 – 6000	0	1	0	0	0	0	0	0

As can be seen from table 3, the actual weight of trains to the North, South, Bozsu and Angren was distributed very widely, in the range from 1000÷5500 tons or more. In the North 1000 3500 t, in the South 2000 5000 t, in Bozsu 1500 3500 t and in Angren 2000 4000 t. The average actual weight of trains in this direction is 1500 tons or more to the North, 3000 tons or more to the South, 2000 tons or more to the Bossu and 2500 tons or more to the Angren.

The study of the actual distributions of all these indicators is important when choosing rational norms for the weight of freight trains and their traction service system, as well as the capacity of the tracks of the station parks.

The distribution of the weights of freight trains departing from the sorting station “Ch” is given in table 3. The analysis of the data and calculations performed is given in Table 4.

Table 4 The weight of freight trains of the object under study

Appointment	Weight of freight trains									
	According to the regulatory schedule			According to the traction force of the locomotive calculation			Actually completed			
	2ВЛ60к	3ВЛ80с	OZB I/II	2ВЛ60к	3ВЛ80с	OZB	June 2021		January 2022	
							min	max	min	max
North	3800	3800	2800/3800	5200	7150	6500	50 (1000-1500) 26 (2500-3000) 10 (3000-3500)	4 (3500-4000) 2 (4000-4500)	34 (1000-1500) 48 (1500-2000) 24 (2000-2500) 9 (2500-3000) 6 (3000-3500)	4 (3500-4000) 2 (4000-4500)
South	4300	4300	3000/4300	4650	6200	5600	11 (0-1000)	31 (4000	9 (0-1000)	23 (4000-4500)

							13 (1000-1500) 13 (1500-2000) 8 (2000-2500) 13 (2500-3000) 9(3000-3500) 19 (3500-4000)	-4500) 26 (4500-5000) 9 (5000-5500)	9 (1000-1500) 13 (1500-2000) 22 (2000-2500) 32 (2500-3000) 24 (3000-3500) 12 (3500-4000)	9 (4500-5000) 4 (5000-5500)
Bozsu	5000	5500	2800/5300	5450	7250	6550	15 (1500-2000) 13 (2000-2500) 7 (2500-3000)	5 (3000-3500) 2 (3500-4000) 2 (4000-4500)	9 (1500-2000) 8 (2000-2500) 9 (2500-3000)	10 0(3000-3500) 4 (3500-4000) 3 (4000-4500)
Angren	2300	3500	2000/2300	5000	6600	6000	3 (0-1000) 2 (1000-1500) 8 (1500-2000) 20 (2000-2500)	9 (2500-3000) 5 (3000-3500) 7 (3500-4000)	6 (1000-1500) 12 (1500-2000) 13 (2000-2500)	8 (2500-3000) 10 (3000-3500) 6 (3500-4000) 3 (4000-4500)

CONCLUSION

The analysis of the data in Tables 3 and 4 for the main purposes shows that freight trains are formed below the norm. Also, the higher the tractive effort of the locomotives used in the sorting process, the more positive it will directly affect the increase in the processing performance of the wagons it can be seen.

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