OPTIMUM STROKE TIME AND TRAIN CONTROL MODE ON THE RAILWAY SECTION

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Annotation: The order is indicated for calculating the travel time of a train along a track and an example of calculating the optimal travel time of a train on separate hauls of a section of a railway is given.

Keywords: optimization, analysis, driving mode, diesel locomotive, running time, selection, haul, section, composition, train.

The present research is a continuation of the work [1] and is devoted to substantiating the efficiency of the transportation work of locomotives by optimizing the running time and mode of driving a train in the real conditions of the organization of railway transportation.

Optimization calculations for a section (direction) include optimizing travel times for all hauls, taking into account the required throughput and choosing the final version of the optimal travel time and train driving mode at the minimum of annual reduced national economic costs.

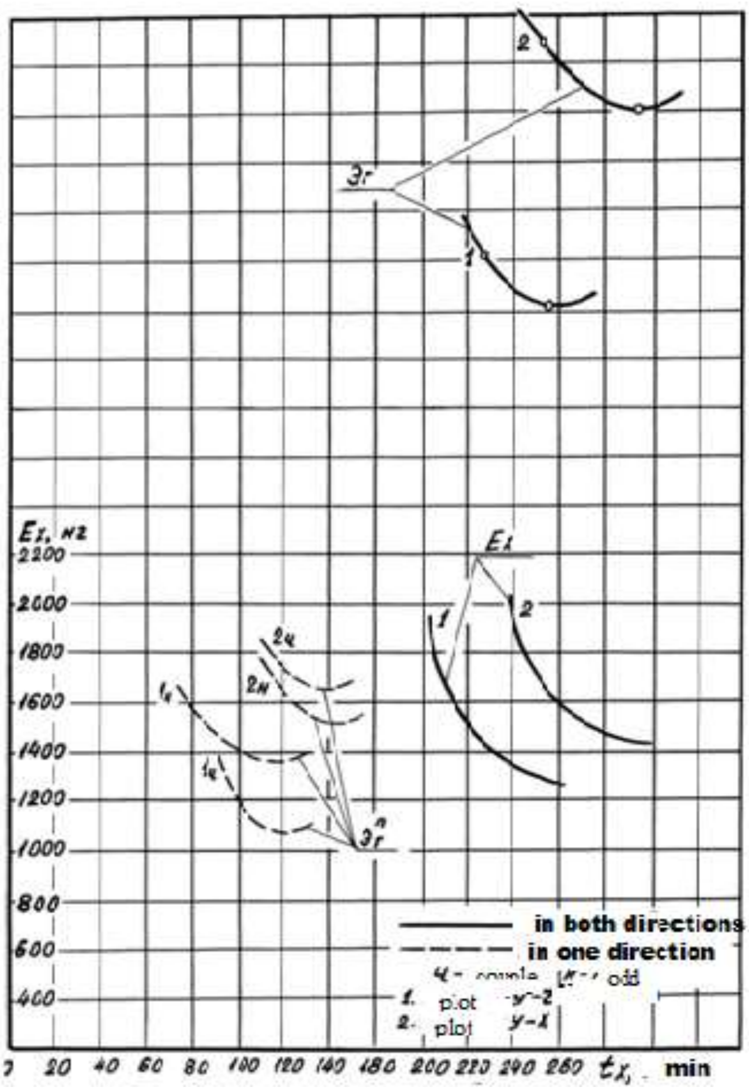
In table. 1 and in fig. Figure 1 shows the calculation results for sections U - Ch and U - X, indicating the expediency of introducing into practice the operation of railways of optimal travel times for hauls. To substantiate what was said by the authors, the following initial data were taken: Diesel locomotive 2TE10M. Odd direction: Γ = 13.6 million net tons/year Qp = 2300 t, mp = 192 axles; direction is even: G = 19 million net tons/year, Qr = 2800 t, mr = 192 axles.

Table 1

The results of optimizing the transportation work of locomotives with the choice of the optimal travel time for hauls in the sections U - C and U - X.

Plots	Direction	Schedule option	The best option	Savings ΔE_g

		t_x, min	$Э_г$, rub/year	t_x, min	$Э_г$, rub/year	rub/year	%
У - Ч	odd	109	2195560	119	2183750	-	-
	couple	103	2050850	118	1820608	-	-
	in both directions	212	4246410	237	4004358	242052	5,7
У - Х	odd	117	2515777	141	2314382	-	-
	couple	115	2617225	136	2476026	-	-
	in both directions	232	5133002	277	4790408	342594	6,7



Rice. 1. Changing the values of E_g, E_g^n and E_x depending on the mode of movement and the time of movement of the train on sections U - C and U - X

The results of the calculations and the above recommendations to some extent contradict the well-known direction in the work of railway transport - the speedy delivery of goods. But this will be the case if we proceed from the payoff parameter B - delivery time.

If, however, we take for the gain parameter B - a generalizing indicator - the annual reduced national economic costs E_g, then it will be appropriate to introduce optimal train travel times. Of course, the use of optimal train driving modes is very important in this case.

An example can be given - for passenger trains of the direction T - A with a diesel locomotive TE3, one section, for Q = 1000t and 10 pairs per day, according to the schedule standards, t^r = 194 min., Fuel consumption at the same time E_g = 630 kg. The calculation of the value of the annual reduced national economic costs E_g for scheduling working conditions gave the value E_g^g = 1126700 rubles. in year.

The calculations carried out with the choice of the optimal travel time and train driving mode made it possible to obtain the total travel time of the train t_x = 198 min., the consumption of full-scale diesel fuel by the diesel locomotive E = 598 kg and, accordingly, the value of E_g^* = 1084400 rubles. per year, that is, less by 3.8 percent.

In sections where there are sections that are difficult in terms of the track profile, taken according to the schedule of an excessively long travel time, it leads to a shift in the values of E_r on these sections "to the right" (see Fig. 1) from the optimal train travel time t_n^*, which confirms the need to identify optimal travel time by calculations with optimization.

These practices, as well as the examples given, show that, as a rule, the driving time of the course is taken for the traffic schedule somewhat longer than the time obtained by traction calculations according to the recommendations [2,3], which is associated with the desire to obtain a lower cost of transportation and ensure a certain reliability of performance. train schedule.

However, these changes in train times are made mainly on the basis of experience without appropriate feasibility studies.

The above methodology allows us to present economically feasible limits for changing the running times of a train for specific conditions that ensure the lowest transportation costs. It is possible to perform traction calculations in the Railway Administration using the most probable determining position n_k^c for each stage with an average train weight Q_p and an average number of axles m_p in the train, which will bring their results closer to real conditions and optimal solutions.

Identification of the determining position of the driver's controller is carried out according to work experience and according to the data of traction and economic calculations carried out on a computer. With $Q \neq Q_r$, it will be possible to complete the given time by changing the positions of the locomotive driver's controller accordingly.

When developing a train schedule, it is possible to set not a rigidly fixed time for the train to run along the hauls, but the limits of its change from the smallest value t_n^min, obtained at the calculated position of the driver's controller, to the optimal train travel time t_n^*. Then the quality of the train schedule will not deteriorate and there will be no difficulties in laying train lines or reducing capacity, that is, the optimal or close to it train time should be used.

This will make it possible to obtain the greatest economic effect by providing a given volume of transportation with the work of locomotives. When scheduling trains, all possibilities should be used to bring the accepted traffic modes closer to their optimal values.

For example, let the estimated travel time of the train along the haul in an even direction is t_п^min=12 min, and the optimal train travel time is t_п^*=16 min. When drawing up a timetable, an arriving train has a stop and must stand for 8 minutes waiting for an oncoming, odd train.In this case, it is advisable to take the travel time of an even train not as calculated, but as optimal, and significant money savings will be obtained without any damage to the quality of the train schedule. The parking time should already take not 8 minutes, but only 4 minutes, which will not cause difficulties in work.The presence of a possible fluctuation of the driving time ranging from the minimum t_p^min to the optimal t_p^* facilitates the construction of a traffic schedule and increases the efficiency of transportation work. It is desirable to carry out appropriate experimental calculations and practical verification of these proposals.

The traction calculations currently being carried out by the road authorities provide for the identification of the maximum carrying capacity of the sections, without reflecting the actual average conditions for the fulfillment of a given freight traffic. The actual organization of the transportation work of locomotives can be reflected in traction calculations, provided that they are carried out according to the average actual prevailing conditions for the transportation work of locomotives in the sections and taking into account the prospects for their improvement.

Carrying out calculations for Q_p, m_p, z_p and n_k^c will allow taking into account specific opportunities for improving them due to the organization and technology of the transportation work of locomotives. It is necessary to separate the calculations related to the carrying capacity on the sections from the calculations related to the identification of the most profitable organization of the transportation work of locomotives, which will significantly increase its efficiency.

To illustrate the above, traction and energy calculations were carried out on one of the sections U-X of the Uzbek railway, the results of which are presented in Table. 2.

Table 2

Indicators of the transportation work of diesel locomotives 2TE10M with different organization and technology of its implementation. L=127.1 km, D=19 million net tons per year

Options Q_r and T_r		$\frac{Q,}{m\text{, axes}}$	t_x, min	E, кg	n_c trains /day	$Э_x$, rub/train participation	$Э_г$, rub/year
not real options	1. Calculated according to PTR [1] ($n_к^p$, $q_0 = 17$т/ось, $\delta = 0,675$)	$\frac{3400}{200}$	112	940	22,8	187,5	200050
	2. Accepted for chart $q_0 = 16,7$, $\delta = 0,67$	$\frac{3200}{192}$	115	910	24,3	186,0	2180225
Real options	3. Average actual conditions $q_0 = 14,55$, $\delta = 0,62$	$\frac{2800}{192}$	115	870	30,1	177,5	2617225
	4. Optimal for medium conditions: $P_т^*$, $t_п^*$, $q_0 = 14,55$, $\delta = 0,62$	$\frac{2800}{192}$	136	770	30,1	155,0	2476026

As can be seen from these data, the first two work options are the most profitable, but at the same time they are practically impracticable. Run all the given freight traffic by trains weighing 3400 tons and 3200 tons is almost impossible.

In practice, this given cargo flow will be carried out by trains with an average weight of 2800 tons, which significantly reduces the efficiency of the transportation work of locomotives (option 3). But this practically possible variant of work can also be optimized by choosing the optimal P_т^* and t_п^* and reduce the cost of funds to fulfill a given cargo flow by almost 6-7 percent.

All of the above confirms the need for calculations with the optimization of the process of transportation work of locomotives and in this regard, studies to study the possibilities of reducing the consumption of fuel and energy resources for train traction through the use of optimal modes of driving a train on sections of railways, including Uzbek ones, are timely and relevant.

These studies should be continued, taking into account the subsequent implementation of their results into the practice of the enterprises of the locomotive complex of railway transport, based on existing and newly developed mathematical methods of optimal control theory.

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