World experience analysis in the design of sorting stations

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Abstract. In developed countries, new technologies are being introduced day by day in the transport sector, and in practice these technologies are effectively used. The development of the transport sector in our country, in particular, rail transport, makes it possible to further improve our economic indicators. Through the reliable access of products and cargo to the world market with speed, a significant increase in the economy is achieved, as well as the further strengthening of interstate transport links. A number of operations are carried out in the delivery of goods by rail transport to their destination. Control of the flow of wagons at sorting stations forms the basis of railway work. Keywords: sorting stations, hill locomotives, locomotive brigade, technological processes.

1 Introduction

The arrangement made with an elaborate set of sidings for sorting of wagons at important stations according to traffic requirements, is called marshalling yard. Goods tarins are marshaled so that wagons are placed in the order of the stations at which these are to be detached. Marshalling yards are provided only at important junction stations which act as distributing centre for various destinations. The functions of a marshalling yard can be compared with those of the heart in a human body. The important functions of a marshalling yard are: reception, sorting and departure.The main task of the sorting stations is to effectively organize, manage and build new trains on the lines in the plan to build trains at the minimum time interval from them. In order to implement the train layout plan on time, it is important to spend the least time on the technological processes carried out at the station with recyclable transit and local wagons. In particular, reducing the time spent on transit recyclable wagons will significantly affect the improvement in Station performance and the increase in the speed of wagon flows in rail transport [1,2].

2 Content

Railway stations are considered a complex system and cover a large number of elements. The following factors significantly affect the quality and number indicators of railway operation:

- flow of wagons arriving at the station;
- transfer capacity of station tracks;

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- number of shunting and hill locomotives;
– number of maintenance personnel at the reception and departure Park;
- mechanization and automation of technological processes, etc.

Parking at sorting stations will also depend on the number of sorting parkways not being properly selected. Several scientific researchers have proposed the following formula for determining the number of paths in their works:

$$m = \frac{\alpha \cdot n \cdot t}{24},$$

Where n- the number of trains operated on a register in a qualifying Park;

t- the busy time of the line (this includes the time interval from the moment of receiving the train to the departure);

α- the coefficient of interaction of stations and plots.

The main task of the sorting complexes is the unhindered promotion of the car traffic. The quality of the sorting complex is significantly influenced by internal factors determined by the level of development of the system and the degree of use technology.

An indicator of the operation of any marshalling yard is the average downtime of transit wagons with processing. The time spent by wagons at the station consists of the time spent on performing sequential operations on individual elements of the processing process [3,5,7].

The time spent by a transit wagon with processing at the station consists of the time spent performing technological operations with wagons in various subsystems:

$$t_{s/t} = t_{rp} + t_{cd} + t_{sp} + t_{dp},$$

where t_{rp} – the time the wagon is in the reception park from arrival to disbandment;

t_{cd}– time to disband the squad;

t_{sp}– the time when the car is in the sorting park;

t_{dp}– the time the car is in the departure park from the rearrangement to the departure.

In turn, the time spent by the car in the station parks is divided into elements:

$$t_{rp} = t_{at} + t_{rt} + t_{fc} + t_{ul} + t_{wm} + t_{ti} + t_{rf} + t_{dt},$$

where t_{at}– train acceptance time, h;

t_{rt}– train reception time, h;

t_{fc}– the time of fixing the composition, h;

t_{ul}– the time of uncoupling of a train locomotive, h;

t_{wm}– waiting times for wagon maintenance personnel, h;

t_{ti}– time for technical inspection of wagons, h;

t_{rf}– the time of removing the fastening of the composition, h;

t_{dt}– waiting time for the disbandment of trains, h.

The limited capacity of the sorting park is understood as a restriction on the processing capacity of the park. Insufficient capacity of the sorting park entails an additional volume of re-sorting, which in turn increases the duration of the sorting park [9,10,14].

The clear and well-coordinated operation of the marshalling yard is due to the interaction of the elements and subsystems of the station, according to which two types of interaction: forward and reverse.

Direct interaction manifests itself in a change in the law of distribution the outgoing flow, which will cause changes in the internal processes of the station. For example, if the law of distribution of trains arriving at the marshalling yard is changed, the arrival of trains at the station hill may have significant unevenness, which will lead to a queue for disbandment [12,13,15].

In addition, several other computational methods have been proposed. Nevertheless, the number of roads turns out to be different. The main reason for this is that the average value of the time you take to process one train is taken.

The work of rail transport in many cases is inextricably linked with the effective activities of sorting stations. Sorting stations play an important role in organizing the work of rail transport. Continuous and acceptable use of these increases the efficiency and competitiveness of rail transport. Increasing the processing capacity of the sorting stations is required to prevent the recyclable transit wagons arriving at the station from getting out of time. Several external and internal factors contribute to the increase in the time for recyclable transit cars to stay at the station.

External factors:
- uneven entry of trains into the reception Park;
- decrease in plot speed;
- infrastructure of peregones;
- execution of repair work in peregon;
- do not increase the loads on the wagons in time.

Internal factors:
- lack of sorting parkways at the station;
- lack of coach maintenance personnel;
- changing the mass and length of trains;
- lack of train locomotive and locomotive brigade.

Theoretical and applied research on the development and improvement of the work of sorting stations is carried out in scientific centers, universities and Research Institutes of leading countries, including: Irkutsk State Road Communication University (Russia), Samara State Road Communication University (Russia), University of Baltimore (USA), Technische Universität Berlin (Germany), Swedish National Railway Administration (Sweden), Petersburg State Railway University (Russia), Russian transport University (Russia), Tashkent State transport University (Uzbekistan), etc [4,6,8].

The world's largest scientists in the field of effective implementation of technological processes carried out in the control of the flow of wagons at railway transport stations and the design of Station devices Y.V. Arkhangelsky, V.Y. Bolotny, M.K. Brekhov, E.Z. Broytman, P.S. Gruntov, K.G Guseva, K.M. Dobroselsky, Y.I. Yefimenko, A.M. Kozlov, V.T. Osipova, Y.Y. Lukyanov, I.Y. Savchenko, V.M. Akulinichev, M.L. Zabello A.F. Borodin, A.K. Golovnich, A.T. Asminin, V.A. Persianov, G. Pottgoff, N.V. Pravdin, K.Y. Skalov, Y.M. Tishkin, W.A. Sharov research has been done by et al.

In the literature, the concept of technical stations is interpreted as stations that perform a large number of technical operations with trains, These include precinct and marshalling yards. The schemes of precinct and marshalling yards can be different depending on the size freight and passenger traffic, the number of main tracks on the approaches, the length of the site and local conditions.

The productivity of work performed at sorting stations also depends on how it is designed. The layout of the sorting parkways and the furnishing of freight yards are important in the design of the station. In this regard, V.Y. Bolotny and E.A. Vetukhova In his research work, calculated the optimal design options and the necessary minimum costs for capital reconstruction.

Y.V. Arkhangelsky's in work, it was proposed to redesign the tracks in the sorting Park, taking into account the following: the plan for laying a train on the line, the capacity of the line and the technological operations carried out when building a train at the station. The author studied the average stay Times of transit wagons at the station taking into account each element.

It is important to note the work of L.A Abuladze which provides an example of the location of marshalling yards on a continuous slope. Stations located on a continuous slope provide savings in shunting facilities, but have significant drawbacks: the difference in the marks of the beginning and end of the sorting system (about 25 m) complicates the exit of

trains in the direction opposite to sorting; high costs for equipping the station with carriage retarders; the inability to use variable speed of dissolution and, as a result, lower processing capacity compared to racing stations.

The calculated values of the total wagon traffic of the station play an important role in choosing the type and scheme of the station, as well as in determining the number of tracks, loading of necks, the need to build overpasses, the size of locomotive facilities, cargo facilities, capital costs and operating costs, etc.

When choosing the location of transit parks, the availability of free sites, the size of traffic in directions and their ratio (the number of transit trains and their share), the number of car maintenance points, and the train service system are taken into account locomotives, the location of the locomotive farm (if necessary, the change of locomotives in transit trains). In addition, it is necessary to take into account that transit parks are an operational reserve for the development of transit or receiving parks, parallel to which they are located [13, 15].

P.B. Romanova considered the issues of increasing the efficiency of the export of tanks from filling stations to the nearest marshalling yard. During the study, it was found that at a number of stations of the Kuibyshev railway there are serious difficulties with the removal of train trains to the nearest marshalling yard. One of the options for improving the efficiency of the removal of tanks from filling stations, considered in the work, the goal is to increase the reserve of train locomotives, organize the export of tanks in transfer trains with a number of cars of 30 – 40 tanks.

A.V. Bykadorov considered the ability of sorting stations to process and transfer wagons in the research work. We can see that the time for the distribution of wagons in the sorting Park has decreased when it changes the time it takes to carry out technological work at the station. In addition the author has proposed an optimal methodology for choosing “window” in road maintenance work.

K.A. Berngard in his scientific work, studied the effects of uneven train penetration on the station that caused the wagons to stand and properly distribute the flow of wagons during the day.

I.G. Tikhomirov in his work established that the process accumulation is significantly influenced by the size of the train being sent in wagons. The author has established the factors characterizing the degree of influence the technology of the station's operation affects the process of accumulation of wagons.

Research has established the following: the mass of freight trains will increase with increasing traffic volumes. In practice, only full-fledged trains are required to be sent from the formation stations. The formation of such trains provides cost savings. The authors note that the accumulation of the composition to its norm entails costs associated only with the downtime of wagons under accumulation at the train formation station.

The departure of full-weight and full-composite trains is economically profitable. However, it is necessary to take into account the moments of readiness of the composition for departure, as they depend on the arrival time of the closing group of wagons. It is advisable to send a train without waiting for the size of its composition it will be maximum. This will reduce the idle time of wagons under accumulation, the idle time of the locomotive will decrease while waiting for the train to be ready.

V.T. Osipova in the research work of, the management of the organization of the flow of wagons was considered. The study shows that in intermediate sorting stations, the wagon's arrival time was reduced by transferring it to the wagons without processing.

M.L. Zabello in his research work, considered the assembly of wagons at sorting stations. The author has proposed ways to reduce the time in which wagons remain standing.

In his works, S.V. Duvalyan considered the application of a number of mathematical programming methods to solving problems of planning and accounting, density of cargo movement, schemes of normal directions of cargo flows, determination of monthly plans for

the transfer of empty wagons through junction points of roads, planning the work of locomotive crews with a system of overhead shoulders, a plan for the formation of single-group trains and wagons with containers. The paper presents the calculation of the plan for the formation of single-group trains using the plan improvement method.

L.B. Sushentseva had proposed that the station change the length and mass of the trains to be built by reducing the length of the wagons to stay.

When designing sorting stations based on the results of the analysis, it is necessary to take into account the following:

• in a number of sorting stations, the sorting Park will be located outside the receiving and sending Park. Sometimes it is located between the receiving and shipping Park;

• station main facilities (receiving and sending Park, passenger facilities, freight facilities, sorting facilities, locomotive farm) required transfer capacity, train traffic and manors safety, convenient service to passengers, freight sender and receivers, location in a position that gives the station the possibility of further development and redesign in the future;

• it is necessary that the station occupies as small a square as possible, the rest of its devices (locomotive farm, cargo yard) should be compactly placed with one;

• the possibility of safe passage to the passenger building and platform for passengers;

• convenient location on the residential side of the passenger building at the station;

• convenient location of the freight yard, taking into account the working capacity of the sorting stations, and adjacent to the sorting park of the traction track. In this case, there will be an opportunity to deliver and take the wagons to the freight yard without adjacent to the direction of receiving the trains;

• the location of the Locomotive works and crew on the opposite side of the passenger building allows freight train locomotives not to be crossed along the main line at the time of replacement;

• to reduce the processing time of transit trains, the car maintenance point should be located closer to the central park of the station;

• when the facilities and freight yard of the sorting stations are being redesigned, it is necessary to place the tracks in such a way that they can be extended or added on one side.

A characteristic feature of the precinct stations is the lack of modern sorting devices for processing wagons, insufficient track capacity in the receiving and sorting parks, especially on lines with heavy train traffic, irrational placement of locomotive facilities and freight yards. The unsystematic connection of receiving and sending railway tracks has a negative impact on the technology of operation of precinct stations. Often these connections were carried out from the outside there were freight yards located on the opposite side of the receiving and shipping and sorting tracks. This causes significant hostile sections of the main tracks during shunting maintenance of receiving and sending railway tracks.

It is important to note that the development of schemes of precinct stations of longitudinal and semi-longitudinal type can be carried out with the construction of a combined receiving and sending fleet for both directions of traffic. For to avoid hostility in the necks of the station, the construction of additional main tracks of the enclosing type is required.

Most of the station sites of technical stations are squeezed by urban and industrial buildings. Therefore, the development of such stations is very difficult. It is very problematic to increase the capacity of the ways of sorting and dispatch parks during the construction of additional ones. Therefore, in First of all, the selected option for improving and building a marshalling yard is influenced by the parameters of the station site. The number of parks and devices depends on its size. There are known schemes with a sequential arrangement of the main parks, with a combined the location of the parks (the arrival park sequentially, and the departure and transit parks parallel to the sorting park and vice versa), with the parallel location of all parks (extremely rare).

3 Conclusion

From the analysis of the results of domestic and foreign practices, it can be noted that scientific and practical research work on the development of methods for improving the technological processes of railway transport sorting stations has not been enough for many years. Also, the studies done to reduce the stay time of wagons coming to the station for processing have not been sufficiently studied.

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