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Nesterenko G. I.
Chibisov Yu. V.

c. Dnepropetrovsk

OPTIMAL ROUTE SELECTION WHEN DISTRIBUTING THE FREIGHT TRAINFLOW IN THE RAILWAY JUNCTION WITH THE CONSIDERATION OF THE LEVEL OF THE TRAFFIC CAPACITY SATURATION

There were determined the expenditures of time, mechanical work and cost of the running trains with different mass that pass Dnepropetrovsk railway junction. There was researched the influence of the railway line load onto the main indexes of the train running. The value of the rational load of the main trespass of Dnepropetrovsk railway junction was determined.

Key words: railway junction, trainflow parameters, rational routes of the train advancing.

Problem statement. The problem of the forming the effective way of decision making, directed towards the rational usage of the means of transport and energy resources, is becoming urgent under the conditions of the market economy. Choosing the criteria of decision making is a very complicated task. The solution of this task can provide a great advantage in front of the other means of transport. It will also help railway transport to become more competitive and attractive. Optimal route selection is a complicated and multicriterion task that has not been solved yet. As a rule, dispatchers and managing stuff are facing this problem every day, but unfortunately, they do not possess the precise algorithm to use when choosing the optimal route of the train passing.

The analysis of the recent researches and studies showed that the task of the defining the optimal routes of the train running has not a complete decision yet. When researching the railway line [1–2] a lot of factors are being ignored, such as the interconnection between the arrival and departing intensity under the conditions of the instant increase of the railway line saturation.

When simulating the operation of the railway line [1] a train is regarded as single unit, which means that the influence of the ahead and behind running trains is being ignored. Actually, the running regimes depend on the intensity of the trainflow, which means the indexes of the train running may differ. That is why the research should be made with the help of the simulating model, which allows simulating running the flow of the trains [3–5].

Target setting. The task of this research is to determine the optimal route of the trains in the railway junction with the help of the mathematical algorithm which considers two factors simultaneously [1]. Some of the following criteria may be chosen for defining the optimal route of the trains: route length, time of the train running, mechanical work losses, the costs of the train running, signal facilities, traffic capacity, railway line load and others. In order to solve the task of the determining the optimal route of the trains there were chosen the following criteria of optimality: time of the train running and mechanical work losses [8]. This chose is based on the following consideration: time of the train running determines the duration of the freight delivery, which should be useful for the clients; mechanical work losses provide necessary information when calculating the cost of delivery. Thereby, in order to attain this priority task of determining the optimal route of the trains passing, it is necessary to define the time of the train running and mechanical work losses of the trains with different mass that are running through the railway junction.

Research results. The research was made on the example of Dnepropetrovsk railway junction. In order to define the optimal routes of the trains in this junction it was necessary to calculate the time of the train running and mechanical work losses in the junction, as it was stated before. The research was made with the use of the simulating model that allows considering the speed of the running trains [6], mechanical work losses, resistance force losses, retarding regimes and electric power losses. The relation between the time of the train running and the length of the railway line is shown on the fig. 1.

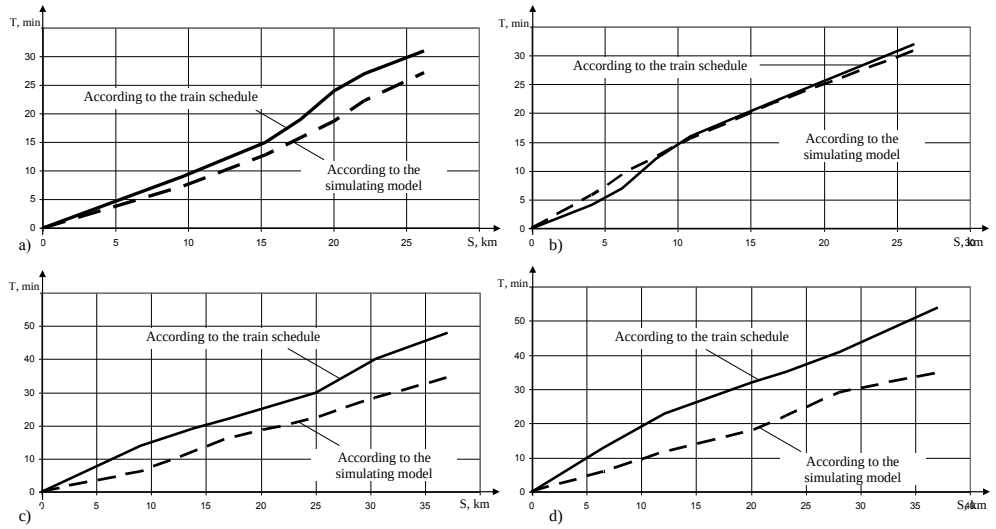

Fig. 1 – Dependence between the time of the train running and the length of the railway line
a) even direction of the main line; b) odd direction of the main line;
c) even direction of the parallel line; d) odd direction of the parallel line

The analysis of the obtained dependences shows that the time of the train running according to a schedule is overrated, especially on the parallel line of the railway junction. That is why it is possible to concede that the actual time of the train running might be 15 minutes less compared to the time in the train schedule. That means that the time of the train running on the main line has a very little difference compared to the one on the parallel line (34,8 min and 30,8 min). Taking into account that the length difference of the main and parallel line is approximately 11 km, the time difference of 4 min could be ignored.

On the basis of the simulating results there was also obtained the dependence between the mechanical work losses and the length of the railway line. This dependence is shown on the fig. 2.

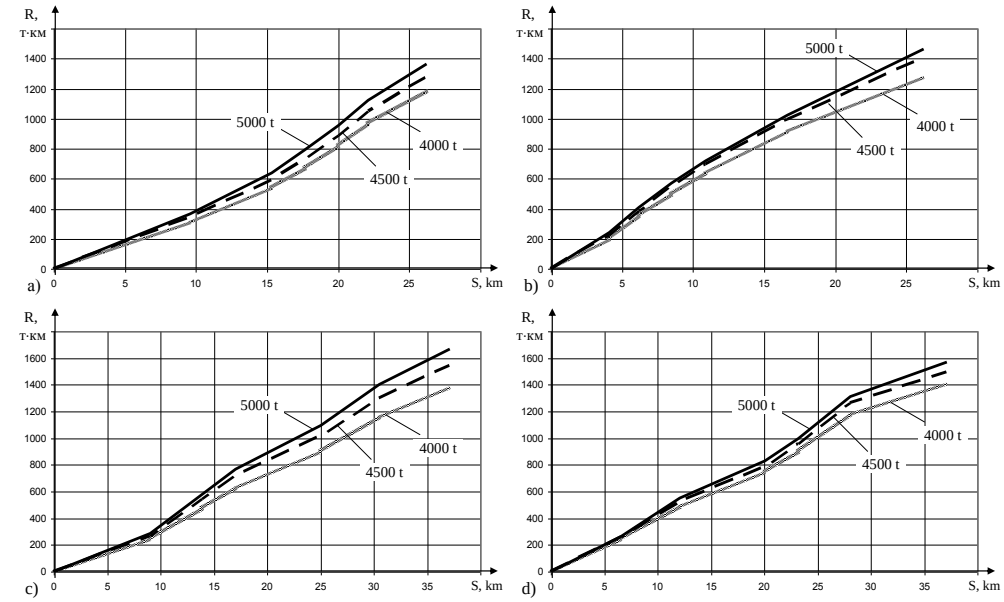

Fig. 2 – Dependence between mechanical work losses and the length of the railway line
a) even direction of the main line; b) odd direction of the main line;
c) even direction of the parallel line; d) odd direction of the parallel line

The analysis of the obtained dependences shows that the more the mass of the train, the more scatter of the speed. In order to estimate the economic indexes [7] of the train running there obtained the functional dependences between the cost of the train running and the length of the railway line in correspondence to the mass of the train which is shown on the fig. 3.

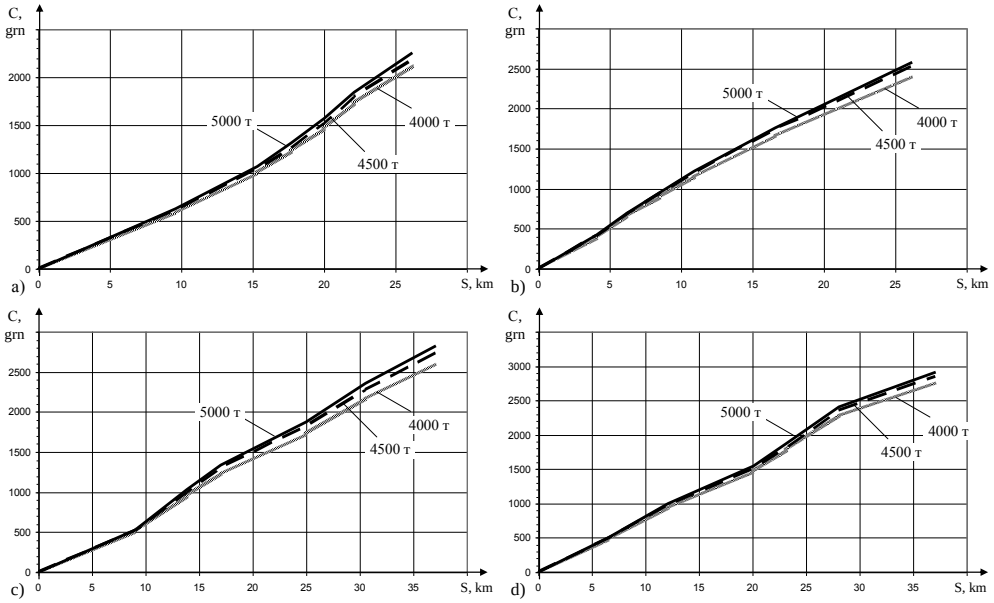

Fig. 3 – Dependence between the cost of the train running and the length of the railway line in correspondence to the mass of the train

a) even direction of the main line; b) odd direction of the main line;
c) even direction of the parallel line; d) odd direction of the parallel line

It is necessary to stress that the difference in cost of running the train on the main and the parallel line of the railway junction is about 60..220 grn on each train. This information may be useful when choosing the route for particular train. In addition, the cost of running the 5000 tonn train on odd direction of the main line has a little difference compared to the cost of running the 4000 tonn train on the parallel line.

When simulating the operation of the railway line, a train is regarded as single unit, which means that the influence of the ahead and behind running trains is being ignored. In this occasion, the research should be made on a simulating model that allows simulating running the flow of the trains. The model of this type was used for researching the operation of the Dnepropetrovsk railway junction.

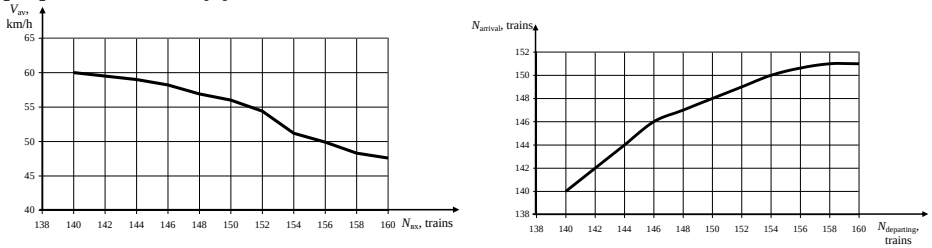

Fig. 4 – reaction of the railway line onto the increasing the arrival intensity

a) dependence between the average speed of the train running and the arrival intensity
b) interconnection between the arrival and departing intensity

A number of experiments were made with a help of this simulating model. The arrival intensity varied from 140 to 160 trains per 24 hours. The speed of the trains was executed with an accuracy 5 %, which allowed considering the so-called “human-factor”. There was figured out that increasing the quantity of the trains in the arrival intensity causes the dramatic decrease of the speed of the running trains (fig. 4a). In addition, when the saturation point of the traffic

capacity is reached, any further increasing the arrival intensity causes decreasing the quantity of departed trains (fig. 4b). This circumstance is cased by the following: the more trains are on the railway line the less is the distance between them, which causes that the trains face the yellow and red traffic lights more often.

The optimization part of the research concerns defining the necessary quantity of the trains, which provides minimum of the time running (t) and minimum of the mechanical work losses (R) simultaneously, under the conditions of the traffic capacity guaranty [10–11]. Taking into account that the indexes of the train operation depend on the level of the traffic capacity usage, it is necessary to analyze the tendency of their changes. In order to estimate the distribution of the trains on the lines of the railway junction the following figure is shown.

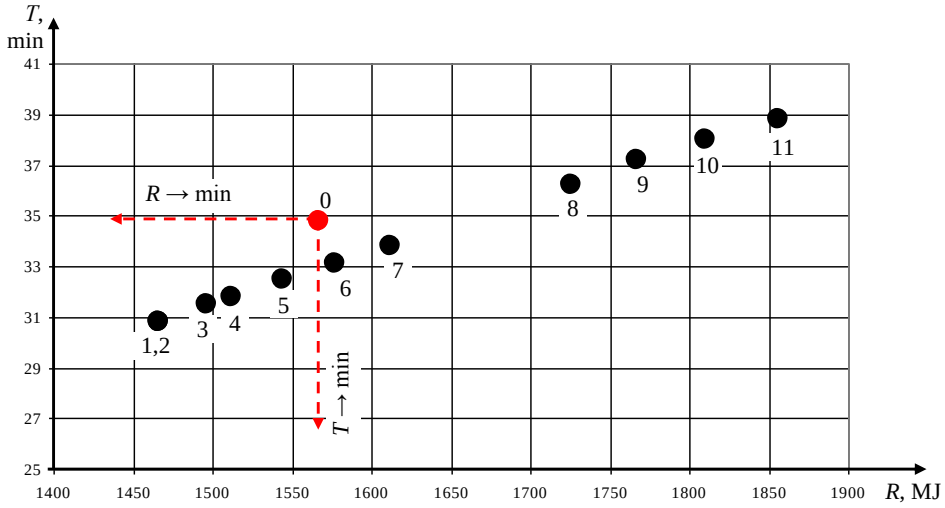

Fig. 5 – Comparative analysis of the train distribution in the railway junction

Each variant of the trains' distribution corresponds to its own parameters of time and mechanic work losses. Thus, variant 1 corresponds to 140 trains running on the main line in the odd direction; variant 2 – 142 trains and on. Variant "0" corresponds to appropriate time and work losses when directing the train in the odd direction of the parallel line. It is obvious that variants 6–11 are "worse" than variant "0". That means if the quantity of the trains in the arrival stream is more than 148 trains per 24 hours, it becoming more rational to transfer part of the trains to the parallel line, that has a reserve of the traffic capacity.

Conclusion. There were determined the value of the time of running the trains and mechanic work losses of running the trains of the different mass in Dnepropetrovsk railway junction. The analysis of the obtained dependences shows that the time of the train running according to a schedule is overrated, especially on the parallel line of the railway junction.

There were determined the dependence between the cost of the train running and the length of the railway line in correspondence to the mass of the train. It was figured out that the cost of running the 5000 tonn train on odd direction of the main line has a little difference compared to the cost of running the 4000 tonn train on the parallel line.

There was researched the influence of the railway line load onto the main indexes of the train running. There was figured out that increasing the quantity of the trains in the arrival intensity causes the dramatic decrease of the speed of the running trains. That means it is important to define the rational quantity of the trains on each railway line; every extra train on the line causes an increase of the time and work losses. So, it is necessary to consider different variants of directing the trains in the railway junction when reaching the saturation point of the traffic capacity.

The value of the rational load of the main trespass of Dnepropetrovsk railway junction was determined. It equals 148 trains per 24 hours.

The results obtained in this research may be useful when choosing the rote of directing the trainflow in the railway junction, railway direction or railway network on the whole at the time of the summer schedule, increasing the arrival intensity of the trains or at the time when

one track of the railway direction is closed. In terms of the economic point of view the described method of distributing the trains in the railway junction will help to decrease maintenance costs connected with the transferring the trains on the routes of the railway network.

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Нестеренко Г. І., Чибісов Ю. В. **Вибір оптимальних маршрутів при розподілі вантажного поїздопотоку у залізничному вузлі з урахуванням рівня насиченості пропускної спроможності.** Визначено витрати часу, витрати механічної роботи та вартість пропуску вантажних поїздів різної маси по ділянках Дніпропетровського залізничного вузла. Виконано дослідження впливу завантаженості ділянок вузла на основні показники руху поїздів. Встановлено величину раціонального заповнення головного ходу Дніпропетровського залізничного вузла.

Нестеренко Г. И., Чибисов Ю. В. **Выбор оптимальных маршрутов при распределении грузового поездопотока в железнодорожном узле с учетом уровня насыщенности пропускной способности.** Определены затраты времени, механической работы и стоимость пропуска грузовых поездов разной массы по участкам Днепропетровского железнодорожного узла. Выполнены исследования влияния загрузки участков узла на основные показатели движения поездов. Определена величина рационального заполнения главного хода Днепропетровского железнодорожного узла.

Ключові слова: залізничний вузол, параметри поїздопотоків, раціональні маршрути пропуску поїздів

Ключевые слова: железнодорожный узел, параметры поездопотоков, рациональные маршруты пропуску поездов

Нестеренко Галина Іванівна

К.т.н., доцент, завідувач кафедри «Управління експлуатаційною роботою», декан факультету «Управління процесами перевезень» Дніпропетровського національного університету залізничного транспорту імені академіка В. Лазаряна. вул. Лазаряна, 2, м. Дніпропетровськ, Україна, 49010.

Чибісов Юрій Віталійович

Асистент кафедри «Станції та вузли» факультету «Управління процесами перевезень» Дніпропетровського національного університету залізничного транспорту імені академіка В. Лазаряна. вул. Лазаряна, 2, м. Дніпропетровськ, Україна, 49010.

Тел. (робочий): (056) 373-15-20; тел. (мобільний): 0662928973; e-mail: Chibisoff_yuriy@mail.ru

Рецензент: д.т.н., професор Бобровський В. І.

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