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MODEL OF OPTIMIZATION OF TECHNOLOGICAL PROCESS OF OPERATION OF MARSHALLING STATION

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Abstract. The arrival of trains with closing groups of wagons is analyzed in marshalling station. The problem on the determination of the sequence of processing of trains under technological operations is established. Model of optimization of technological process of operation of marshalling station is offered in order to solve the problem. Variants of processing of trains compositions are worked out. Using mathematical model, the optimal sequence of processing of trains compositions is determined.

Keywords: optimal sequence of processing of trains compositions, mathematical model of optimization of technological process of marshalling station.

1. Introduction

One of the elements of the increase of shunting capacity of marshalling station is the reduction of standing time of wagons. It is possible to achieve by the correct planning and management of operation of the marshalling station.

In this article the mathematical model of optimization of technological process of operation of marshalling station is offered.

2. Analysis of arrival of trains with closing groups of wagons

The analysis of statistical data shows that after the train composition, in which have two and more closing groups of wagons, has disbanded from the hump there is the accumulation of several trains compositions in the marshalling yard simultaneously.

Depending on the developing situation the shunting dispatcher has the problem of the determination of the optimal sequence of processing of trains under technological operations (Fig 1).

3. Model of optimization of technological process of operation of marshalling station

Statement of the problem in the general view can be formulated as follows: in the formation system it is necessary to process the trains compositions which have accumulated in the marshalling yard simultaneously. According to the technology of processing of trains compositions there are three technological operations. Each of these operations can be fulfilled only by one processing channel that besides can process only one train composition. Time of processing of each train composition is known. It is necessary to define the optimal sequence of processing of trains compositions so that total standing time of processing of coupling of locomotive at head of train composition was minimal.

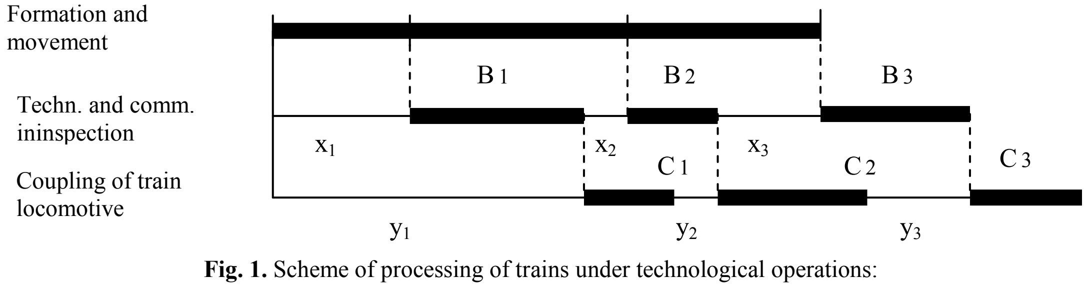

Fig. 1. Scheme of processing of trains under technological operations:
A_i – time of formation and movement of the train composition; B_i – time of technical and commercial inspection of the train composition; C_i – time of coupling of locomotive at head of train composition

Thereby, the optimization task is solved by the mathematical model of optimization of operational planning:

$$F(S\ ) = \sum_{i=1}^{n} C_i + \sum_{i=1}^{n} y_i \rightarrow \min\ , \qquad (1)$$

where $F(S)$ – total standing time of processing of coupling of locomotive at head of train composition depending on the chosen sequence S;

y_i – waiting time prior to the beginning of coupling of locomotive at head of train composition.

$$\sum_{i=1}^{n} y_i = \max_{1 \le u \le v \le n} \left(\sum_{i=1}^{v} B_i - \sum_{i=1}^{v-1} C_i + \sum_{i=1}^{u} A_i - \sum_{i=1}^{u-1} B_i \right). \qquad (2)$$

For the definition of optimal sequence of processing of trains compositions it is necessary:

1. satisfaction of demands: min A_i ≥ max B_i or min C_i ≥ max B_i;
2. definition of the quantity of possible variants of sequence of processing of trains compositions by the combinatory method;
3. determination of the optimal sequence $F(S^{\,opitim})$.

4. Improvement of performance parameters of marshalling station

To make the optimal decision on the organization of operation of the marshalling station, it is necessary to predict beforehand the development of station operation, using the mathematical model of optimization of operational planning (1)–(2).

We determine the optimal sequence of processing of trains compositions at the following values (Table 1).

The quantity of possible variants $N^{var.}$ is calculated:

$$N^{var.} = n! = 3! = 6 \text{ variants.}$$

Table 1

Sequence of processing of trains compositions	Primary variant of processing of trains compositions		
	A_i, min	B_i, min	C_i, min
1	38	31	41
2	27	24	40
3	40	39	58
Total time	105	94	139

For the primary variant (1–3) the total standing time of processing of coupling of locomotive at head of train composition is calculated:

$$\sum_{i=1}^{n} y_i = \max\{94 - 81 + 105 - 55; 55 - 41 + 65 - 31;$$

$$31 - 0 + 38 - 0\} = \max\{63; 48; 69\} = 69 \text{ min;}$$

$$F(S^{1,2,3}) = 139 + 69 = 208 \text{ min.}$$

The operation of each serving channel is presented as follows (Fig 2).

The total waiting time prior to the beginning of coupling of locomotive is shown in Fig 2. $\sum_{i=1}^{3} y_i = y_1 + y_2 + y_3 = 69 + 0 + 0 = 69$ min. It demonstrates that the task is solved is correct.

All received results of calculations are presented in Table 2.

Table 2

Number of the variant	Sequence of processing of trains compositions	Total standing time of processing *F(S)*, min
1	1, 2, 3	208
2	1, 3, 2	215
3	**2, 1, 3**	**202**
4	2, 3, 1	205
5	3, 2, 1	218
6	3, 1, 2	218

Thus, the optimal sequence of processing of trains compositions is achieved by the third variant: $S^{opitim} = (2, 1, 3)$.

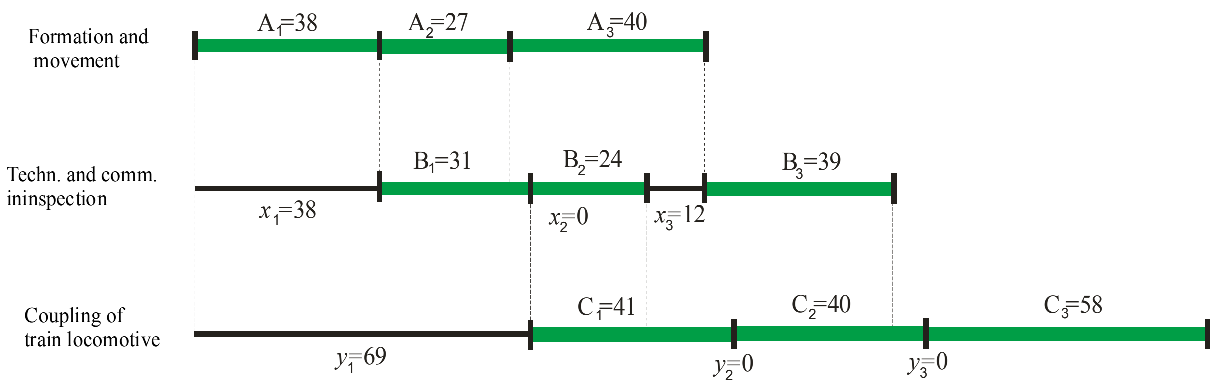

Fig. 2. Scheme of processing of trains compositions in accordance with the first variant

5. Conclusions

Applying the mathematical model of optimization of operational planning at the calculation of formation of trains at the marshalling station, the opportunity to improve the organization of operation of marshalling station and to increase the efficiency of use of technical means is created.

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