Research of Typical Schemes of Conversion of Stations for Speed Passenger Traffic in Comparison with the Variant of the Bypass Construction

N V Kuklev¹, D N Kuklev¹
¹Far Eastern State Transport University, Serysheva str., Khabarovsk city 680021, Russian Federation

E-mail: kukleva.natalya@bk.ru, boblok@mail.ru

Abstract. The development of railway high-speed passenger traffic in Russia under conditions, when the construction of a high-speed line is still at the stage of justification, is an actual and rather difficult task, requiring a thorough feasibility study. This task is sometimes even more complicated than the construction of a new line for the implementation of high-speed traffic, as it requires taking into account a large number of factors, for example, procedure of construction work at a large number of separate points with track development, even small ones, of intermediate stations and divert stations. As a suggestion, the authors review, as an alternative to reconstructive measures, the principle possibility of using detours for the passage of high-speed passenger trains, which in practice are often used for transit traffic organization, more often freight traffic, less frequently – passenger traffic. Previously proposed typical schemes of the conversion of intermediate separate points with track development for high-speed passenger traffic are being analyzed; conclusions about the possibility of using bypass lines instead of reconstruction are being made. The article may be useful to specialists, who make researches in the sphere of high-speed passenger traffic organization from the point of view of preparation of existing highways in general, and railway stations in particular.

1. Introduction
According to the International Union of Railways (UIC), in prospect, till the year 2030 in Russia it is planned to build 762 km of high-speed railways [1]. According to this indicator, having one of the longest railway networks in the world [2], our country, unfortunately, is still significantly behind the world leaders, developing high-speed passenger traffic.

That is why, the development of high-speed railway passenger traffic in Russia in terms when the construction of a high-speed highway is still at the substantiation stage, is an actual task. In search of solutions, the question about reconstructing existing separate points with track development arises, especially about small ones – divert points and intermediate stops, since their number is rather large, and therefore, needed investments are huge. Moreover, because of the variety of possible patterns of track development, resulting from local conditions of geographical, urban planning operational and others, reorganization is often not only very costly, but even impossible, which ultimately does not allow to provide the planned temporary indicators for high-speed trains moving.
2. Problem statement
In order to typify intermediate separate points with track development in the research [3, 4] five possible schemes of their reconstruction are presented, determining the composition and volume of reconstruction works (fig. 1).

Figure 1. Reconstruction schemes of intermediate separate points with track development: a – removal of the station to a new place; b – reconstruction of the station influences all its track development; c – reorganization of the station affects one neck; d – reconstruction works that are not related to changing the plan of the main routes are carried out; e – reorganization of the station is connected with the removal of the passenger platform; ----- reconstructed tracks and structures; — — existing tracks and structures; ----- – disassembly of tracks and structures.
The authors of the following research propose to look at these schemes from the point of view of possible use of bypasses for high-speed passenger traffic instead of reconstruction activities. Such use of bypasses despite the theoretical diversity of their types [5], as well as variants of practical applications both abroad [6, 7, 8, 9, 10], and in Russia [11, 12, 13], has not been considered yet, therefore, in our opinion, is of theoretical interest at least. Thus, the object of this research is a separate point with a path development, located on lines where the possibility of introducing high-speed passenger traffic is being considered, and the subject of the research is the comparison of reconstructive measures with the construction of a bypass, onto which high-speed passenger trains would deviate, excluding reconstruction.

Next, let's consider the conversion schemes.

Scheme No. 1 (see pic. 1, a) – means the removal of an intermediate separate point with track development to a new place when its reorganization is impossible because of local conditions. With this type of conversion, the volume of work and capital investment will be maximum, that is why, the variant with the construction of a bypass along the highway onto which it is proposed to make a separate point, may be preferable.

Scheme No. 2 (see fig. 1, b) – the conversion touches both station necks, which requires complete reorganization of its travel development. In contrast to the first type, the station does not move to a new track, but the volume of work will be close to maximum, also, reconstruction works will be carried out "under the wheels", that means in "gaps", which causes significant violation of the normal operation work mode [14, 15, 16] and respectively, makes the variant with a bypass, as for the first scheme, the most preferable one. It is especially important in those cases, where there is no opportunity to redirect trains on parallel lines, which, for example, do not exist on the Far Eastern Railway [17].

Scheme No. 3 (see fig. 1, c) – the displacement of the main paths exists within the same neck station. With this type of conversion, the volume of work will be significantly less than in the first two types, that is why, the construction of a bypass line will be less possible.

Scheme No. 4 (see fig. 1, d) – the reorganization of the station is not associated with a change in the plan of the main ways, replacement of turnouts with special high-speed ones is required, increase of direct inserts between related turnouts and other works are needed. This scheme probably requires the lower costs, therefore, the construction of a bypass in comparison with others schemes will be the less possible.

Scheme No. 5 (see fig. 1, e) – the removal of the passenger platform from the inter track space and locating it on the side of the main paths is required. It should be noted that the island arrangement of passenger devices can become significant, and sometimes even an insurmountable obstacle to the reconstruction of the station for high-speed traffic. So, for example, when making a decision to increase speeds on the line St. Petersburg – Moscow, it was decided to leave Malaya Vishera station without reconstruction of passenger devices because of great historical cultural significance since it required huge costs with a modest time benefit [18].

To determine the feasibility of constructing a bypass, it is necessary to compare the required capital investments which depend on the level of passenger speed trains, existing infrastructure (number of tracks, turnouts, availability of passenger devices, etc.), while the diagram can look as it is shown in fig. 2.
Figure 2. Dependence of capital investments on the type of reconstruction and maximum speed.

Composition of capital investments for the bypass construction intended for the permit of speed-express trains will be different from the one needed for admission of freight transit trains [19, 20], and needs clarification.

3. Summary

Thus, as the result of conversion schemes analysis, we can make a conclusion that the most unfavorable, from the point of view of reconstruction, are schemes No. 1, 2, and 5 (see fig. 1), requiring maximum in complexity and cost types of works. Respectively, the construction of a bypass for the way of high-speed passenger trains in these cases is the most appropriate. To confirm or deny the gained conclusion, on the next stage it is important to make perform a comparison of capital investments in variants for real stations.

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