The priority of international freight expresses in the overlapping section of RFC 7 and RFC 9 Kolín - Česká Třebová

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Abstract

This article deals with the railway traffic control and railway traffic equipment in terms of implementation of TSI. The main goal is to research the optimal priority of international freight expresses, especially in the overlapping sections, which represent critical line sections of European freight corridors. This article shows this problem in the context in the overlapping section of RFC 7 and RFC 9 Kolín – Česká Třebová. There are mentioned possibilities of using of ETCS and implementation of automatic train paths.

Keywords

Capacity, freight expresses, freight corridors, overlapping section, periodic timetable, traffic control.

1 Introduction

One of the aims of European transport policy is to redirect capacity of road freight traffic to other modes of transport, where rail transport is an interesting and environmentally friendly alternative, especially in terms of speed, availability and amount of transported cargo. On the other hand, by customers is required delivery time is guaranteed by carriers, what is unfortunately not always possible, especially due to high utilization of European rail infrastructure. The solution is the construction of new lines, increasing the capacity of existing lines through construction and reconstruction measures or through operational measures. Among the operational measures may be included alternative routing of trains as well as changing priorities of a particular type of train, e.g. train category Fex (freight express).

2 Aims

The aim of this article is to find the optimal priority of international freight expresses to satisfy the customers required delivery times due to optimization of railway traffic control. Unfortunately, in the Czech Republic is very problematic to buy up structural land for extension of railway infrastructure, e. g. for construction of another track line. The railway infrastructure of the overlapping section of RFC 7 and RFC 9 Kolín – Česká Třebová is equipped with the new modern signalling system with ETCS Level 2. The possibility to improve the signalling system is only implementation ETCS Level 3 or implementation of automatic train paths. However, the easiest variant is to change the priority of freight expresses and observe the passenger transport impact.

3 Materials and methods

There are mentioned some information about European freight corridors RFC, leaflet UIC 406, deadline cargo mode and the simulation method with using of simulation tool SimuT (average delay increment (ADI) calculation).

3.1 Rail Freight Corridors (RFC)

On the basis of the European Parliament and the EU Council no. 913/2010 for competitive freight and no. 1316/2013, which is created the Connecting Europe Facility (CEF), is the gradual establishment of rail freight corridors RFC (Rail Freight Corridors). The main aim of the operation of these corridors is to strengthen the competitiveness of railways synergies between rail systems and harmonization of allocation interstate freight routes by national infrastructure managers [1].

Czech Republic, respectively Czech Railway Infrastructure Administration (CRIA), as the infrastructure manager and allocator of capacity, is a member of RFC 5 (Baltic - Adriatic), RFC 7 (Orient / East-Mediterranean), RFC 8 (North Sea - Baltic) and RFC 9 (Czechoslovak corridor). Each corridor is operated on the basis of the Corridor information document (CID); each corridor has a single point of contact (C OSS) and allows carriers to apply international prearranged train paths facilitated freight via C-OSS. The request must be filed by information system RNE PCS and must include the cross-border section. This paper deals with the model study of common section of RFC 7 and RFC 9 Kolín - Česká Třebová.

3.1.1 RFC 7

RFC 7 - the Orient corridor runs from Central Europe to Eastern- and Southern-Europe connecting 7 member states - Czech Republic, Austria, Slovak Republic, Hungary, Romania, Bulgaria and Greece. The total length of main lines is approx. 3 900 km and the length of alternative and connecting lines is almost 2 500 km altogether. Most limiting factors of RFC 7 are low capacity, speed limit, limited length of trains, limited axle load, not electrified sections and lack of adequate safety equipment (signalling track circuits with 25 Hz frequency, ETCS, GSM-R, etc.). The railway infrastructure managers and capacity allocation companies responsible for establishing and running RFC7 are committed to offer reliable, high-quality, competitive transport services in order to increase the market demand, to operate the infrastructure cost-effectively on the long run through harmonization of technical and procedural conditions and to facilitate the environmentally sustainable development of the European economy and the achievement of a better quality of life for its people [2]. In capacity analysis, published in Implementation plan of RFC7 [2], there are found lines with capacity utilization higher than 90 %. The longest sections with this high capacity utilization are situated in the Czech Republic, concretely sections Poříčany - Pardubice (65 km) and Choceň - Česká Třebová (25 km). The whole second section is in the model study, which results are published in this paper, included. The first section is included, too, without the section Kolín - Poříčany (20 km).

3.1.2 RFC 9

RFC 9 - the Czech-Slovak Rail Freight Corridor (CS CORRIDOR) runs from Prague to Čierna nad Tisou (Slovak-Ukrainian border) connecting 2 member states - Czech Republic and Slovak Republic. The total length of main lines is 972 km and the length of alternative and connecting lines is 276 km altogether. Most limiting factors of RFC 9 are the same as in RFC 7. In capacity analysis, published in Implementation plan of RFC9 [3], there are found lines with capacity utilization higher than 90 %.

3.2 The UIC 406 leaflet

The UIC 406 leaflet, completely overhauled in June 2013, is one of the most important documents about the capacity calculation. There is published the approach to calculate capacity consumption by compressing a timetable and to evaluate the number of possible train path to a node, line or corridor. The compression method consists of five steps – defining infrastructure and timetable boundaries, defining section for evaluation, calculation capacity consumption, evaluating capacity consumption and evaluation available capacity. Corridor is in the UIC 406 defined as the main international and national connection and thus usually stretches over several hundred kilometres. Corridors may overlap with one another - overlapping section is illustrated on the Figure 1 [4].

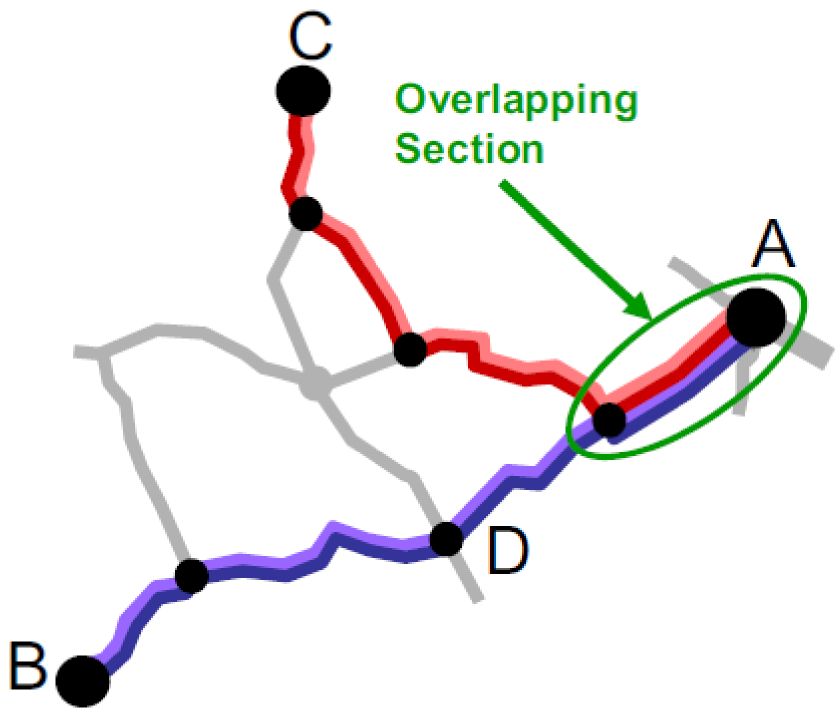

Figure 1: Overlapping train path line sections [4]

3.3 The deadline cargo mode

Periodic schedules are in rail passenger commonplace. In order to satisfy also the end users of rail freight and ensure its full competitiveness, it is necessary to trace freight trains in the fixed periodic routes, which would have removed one of the main rail transport disadvantages against road transport. To increase the transport speed and reduce the overall delivery time is also desirable international freight train paths were carried out accurately under deadline cargo - for this purpose it may be necessary to change the current train priority so that international freight expresses (Fex) weren´t in their paths delayed by stop passenger trains. This measure in addition to increasing the speed of transport and reducing the overall delivery time also contributes to reducing the overall energy efficiency of rail freight, which will no longer need to waste power electricity due to start heavy freight trains.

3.4 The simulation method

In this part is said something about the simulation method in context of the transit of international freight express trains (Fex) in the deadline cargo mode in the overlapping section of RFC 7 and RFC 9 Kolín - Česká Třebová.

In this section there are a total amount of 14 railway stations, in which it is possible overtaking trains (double track line). Interstation sections are divided by an automatic block into track sections; all crossing safety devices are equipped with gates. For simulation was used simulation tool SimuT, developed by Pavel Krýže, PhD. from CRIA.

The simulation tool SimuT is developed in Visual Basic, therefore it can run on every PC with Microsoft Office. It has to be input the option of a simulation, then railway stations and their shortcuts, station tracks for each railway station, line tracks, connection of station and line tracks, length of interstation departments and amount of line departments, type of train for priority, type of train for each number of a train and the path of each train. The simulation program SimuT can put new paths in a daily timetable with the solution for arisen path conflicts.

It was created the daily timetable, which included the amount of 384 trains, concretely 160 express trains, 34 speed-up passenger trains, 46 stop passenger trains and 144 Fex trains. The passenger transport trains were concentrated especially from 6 am to 23 pm. All trains were conducted in periodic timetable.

Within the simulation program was established the average delay increment (ADI). The average delay increment was calculated by dividing the difference between total output and total input delay and the total number of trains. This indicator was calculated as an ongoing basis for each simulation run, so the total for the entire graph (all simulation runs). The indicator was also calculated for different types of transport, i.e. for long-distance passenger transport, regional passenger transport and freight transport. In order to achieve measurable results of transiting Fex within RFC in the deadline cargo mode, the freight transport segment was narrowed to only those trains, for which it was created recurring schedule, counting 3 pairs of trains every hour (the period 20 min) on the prescribed speed of 100 km/h (total amount of 144 trains). In the real operation the other freight trains shouldn’t delay the trains of Fex category.

Three variants were created, reflecting the priority of Fex. The first variant corresponded more or less simultaneous the operation in the Czech Republic, when international freight trains of the Fex category were delayed by all passenger trains including stop passenger trains. In the second variant there was set priority of trains, corresponding to the Transport prescription D1 of CRIA [5], when the Fex trains overtook stop passenger trains. And in last, the third variant, received international freight trains of the Fex category the second highest priority, not just for passenger trains category Ex (Expresses).

As part of the simulation was set for all simulation runs random entry delay based on the exponential probability distribution. There were solved conflicts of station tracks, freight trains were allowed to ride before their schedule time (in the case of free capacity). For each variant was made a total of 365 runs of simulation (for a daily timetable) [6].

4 Results and Discussion

Depending on the other train categories (multicriteria decision model – stop passenger train has got coefficient 1) it was set low priority of Fex trains (0,5), priority of trains by Transport prescription D1 made by CRIA (1,7) and high priority of Fex trains (1,9) - results are displayed in Table 1.

Table 1: ADI for different variants of priority of Fex trains

Variant	ADI			
	Long distance passenger transport	Regional passenger transport	Fex	Total
Low priority	5,40	10,17	5,12	5,87
D1 priority	7,22	19,35	-5,63	4,03
High priority	7,67	18,57	-8,49	3,14

Source: Author

For each run of simulation had to be done 34 500 solutions by simulation program SimuT, it meant in total to count for 365 runs of simulation 12 592 500 solutions for each variant - for three different variants had to be counted 37 777 500 solutions of daily timetable with random entry delay based on the exponential probability distribution.

The most important is the total average delay increment - this indicator is getting lower with the increasing priority of Fex trains. In this research we are getting back to the beginning of railways in the territory of Czech Republic - to years, when cargo transport was preferred. In the growing amount of Fex trains, which are operated on RFC, it seems quite logical to overtake some passenger transport trains by Fex trains to balance the railway transport. For CRIA is this model convenient because of higher fee payed for using of the railway infrastructure (which is generated by Fex trains). And especially the high priority of Fex trains fulfil at most the terms of deadline cargo mode, which is preferred by customers. The results from Table are illustrated on Figure 2.

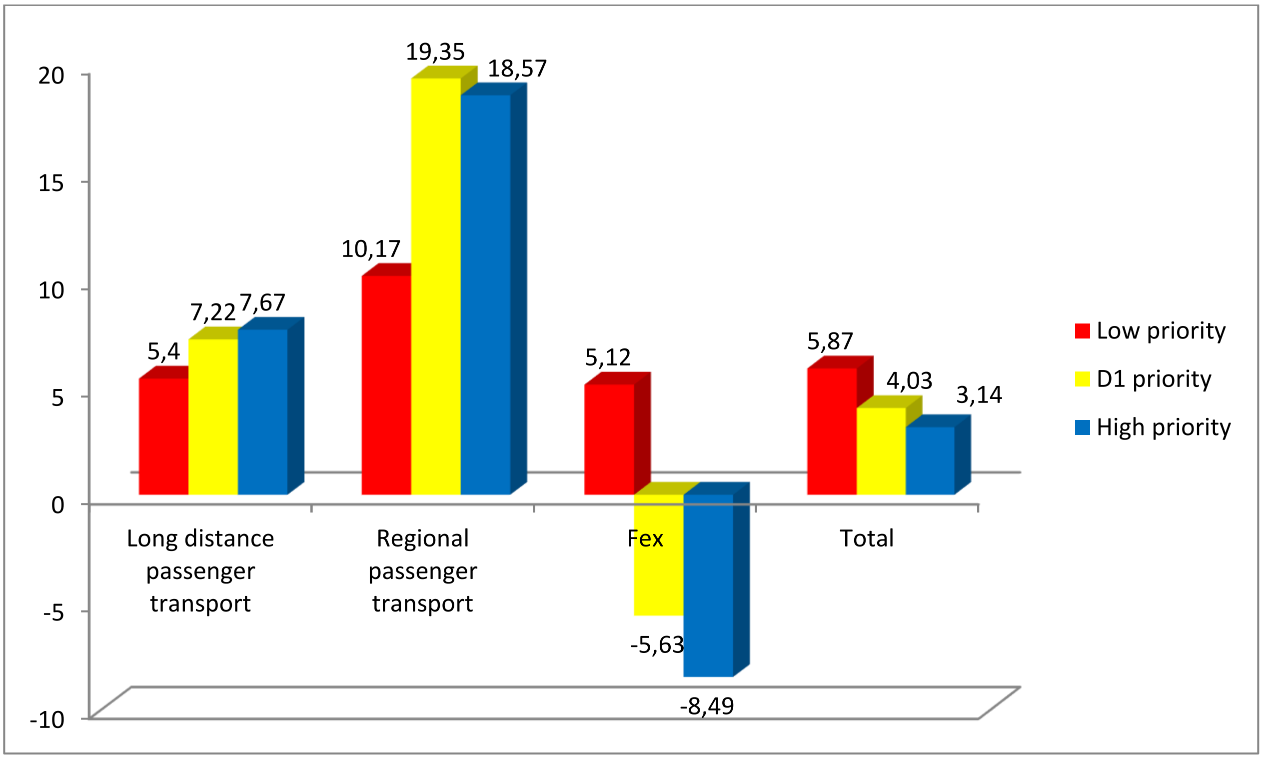

Figure 2: Average delay increment for different variants of Fex train priority

To explain more the results presented on the Figure 2, it must be said the ADI is for Fex trains negative (D1 and high priority) due to allowing of riding before their schedule time. The schedule was created and new paths were included on the basis of simultaneous operation (low priority). Therefore, if the Fex train could overtake in other variants the train of another category, it did it and then the average delay increment of Fex was negative, on the other hand the ADI of the other train category increased.

From the Table 1 is apparent, too, all train categories couldn't be conducted in the overlapping section of RFC 7 and RFC 9 Kolín - Česká Třebová in periodic timetable. If will be possible to conduct in periodic timetable the Fex trains, it is inappropriate to conduct the same way the other train categories due to increasing ADI. The solution could be to adjust paths of stop passenger trains - e .g. incorporate some deviation of periodic timetable. In long distance passenger transport the operation could be solved by consolidation of expresses, because nowadays short passenger expresses (locomotive + 3 wagons) often cause the stopping of heavy Fex trains due to overtaking. If the passenger express will have more wagons and to final directions will be divided in intermediate station, it resists more capacity for Fex and stop passenger trains. In the section Kolín - Česká Třebová is this rule very good applicable - present expresses could go together in one longer express train from Prague to Česká Třebová, where will be divided to directions Brno and Ostrava.

In the context of implementation of TSI-TAF in the overlapping section, it means operation of ETCS Level 2 with full-functional GSM-R, it is offered the extension to ETCS Level 3 or the implementation of automatic train paths on ETCS Level 2. Both variants enable to improve the railway traffic control technology and to reduce the amount of human interventions to do the railway traffic safer and well-timed.

5 Conclusions

To boost the attractiveness of railway freight transport it has to be kept customers required delivery times. To keep the customers required delivery times railway freight transport has to be operated in deadline cargo mode. To operate the railway freight transport in deadline cargo mode it has to be guaranteed train path stability. To guarantee the train path stability for freight trains it has to be increased priority of freight trains (expresses).

In the overlapping section of RFC 7 and RFC 9 Kolín - Česká Třebová there could be generated free capacity due to expresses consolidation (passenger transport), too.

6 Acknowledgements

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