Study on night transportation organization of high-speed rail express products

Mingyao Ma*, Peng Zhao and Ke Qiao
School of Traffic and Transportation, Beijing Jiaotong University, Beijing, China

*Corresponding author e-mail: 805470181@qq.com

Abstract. Along with the rapid development of high-speed railway, high-speed railway express products gradually mature, the electronic commerce industry of high-speed rise in demand for goods, the implementation of the high-speed rail freight trains is imperative, but freight trains operation organization faces new challenges at night. In this paper, we study the freight trains, different types of high-speed rail transportation express product process, the purpose is to effectively reduce skylight influence on train operation organization and freight trains for passenger train interference, and improve transportation efficiency, increase freight trains, operation specification, create a good environment for the emu operation. Based on the characteristics of different types of high-speed rail express products, this paper puts forward suggestions on rationalizing the transport process of freight emu, so as to give full play to the transport capacity advantages of freight emu, which is conducive to the high-quality development of freight emu.

1. Introduction

With the rapid development of the e-commerce industry, the number of logistics services has risen sharply, opening up new space for high-speed rail express. During the "Double Eleven" E-commerce Golden Week in 2018, China Railway Express Co., Ltd. used the remaining space such as oversized luggage compartments and seat gaps of 700 high-speed rail passenger EMUs to send high-speed rail courier daily to 132 passenger EMUs. A non-ticketing carriage is reserved on the board to load some cargoes, and at the same time, 20 trains of high-speed rail are used to confirm the delivery [1]. High-speed rail delivery and express trains often need to withstand large restrictions on transport capacity and train speed. Relying on high-speed rail express trains operated by passenger trains, it is common to follow high-speed trains for express delivery. The restrictions are also relatively large, and they are easily affected by changes and fluctuations in railway passenger flow. It is difficult to ensure the safety and regularity of freight transportation. These factors have severely limited the development of China's high-speed rail express. In order to further enhance the capacity of high-speed railway freight, CRRC released freight sports vehicles with a speed of more than 250 kilometers per hour, which provided the possibility for high-speed freight trains. Reasonable high-speed freight trains can increase the development scale and economic benefits of railway freight transportation, can effectively utilize idle transportation capacity, and provide customers and businesses with fast and convenient freight distribution services.

Based on the above background, freight trains will definitely become the main force of the high-speed rail express, but the difficulties in the organization of freight trains will follow. At present, the operation map of daytime passenger trains is tightly packed. If the cargo sports cars are operated
during the day, it will cause great interference to the operation of the passenger sports cars. If the cargo sports cars are operated at night, it can reduce the interference to the passenger sports cars. In addition, the number of passenger sports trains running at night is small, which can provide a good environment for freight sports trains to run at night. Therefore, this article analyzes the feasibility of freight cars at night, and proposes the driving organization of high-speed freight cars during the comprehensive maintenance of the sunroof at night. Based on this, combining the characteristics of different high-speed rail express products, a complete plan of night operation organization of the freight emu is proposed.

2. Feasibility of night operation of high-speed freight trains

Due to the high traffic density of the high-speed passenger train during the day, if the high-speed freight train operates during the day, it will take up the passing capacity of the high-speed railway line, so the train operation chart needs to be adjusted significantly. However, there are few high-speed passenger trains running at night, and high-speed freight trains running at night not only avoid occupying effective high-speed rail line passing capacity due to daytime operation, but also match with the demand of their target cargo, which has certain beneficial impact on their application prospects.

Most high-speed railways operate passenger trains at night with a small demand, and comprehensive maintenance skylights are mainly set at night, with a length of 4-5 hours, and the setting time is between 0 a.m. and 5 a.m. (the skylights are set from 0 a.m. to 4 a.m. On most high-speed railways in China). Due to the need to carry out line and traction power supply system maintenance operation, maintenance skylight in the time period of different driving organization may cause partial through capacity loss. At present, China's Beijing-Shanghai, Beijing-Guangzhou and other high-speed railway sleeper trains are organized by night time, and the main idea of their operation is to adjust the time of skylight and the way of skylight setting, indicating that high-speed railway is feasible to operate at night.

At night, most of the passenger emu trains return section, which provides the space and time conditions for the high-speed freight emu trains. China's high-speed freight emu trains at night can refer to the train organization mode of the sleeper train, the skylight time and the skylight setting mode are adjusted; At the same time, we can also learn from the operation mode of "mixed passenger and cargo transportation, time-sharing and co-line operation" of Germany's high-speed railway, that is, the freight train runs from 30min after the end of high-speed passenger train operation to 30min before the start of high-speed passenger train operation the next day. To sum up, it is feasible to operate the freight train group at night.

3. Suggestion on the organization mode of night operation of high-speed freight train

The key of high-speed cargo sports car driving at night is to adopt a reasonable driving organization method during the period of comprehensive maintenance sunroof to reduce the loss of passing capacity during the period of integrated sunroof. At present, the driving organization methods adopted by the high-speed rail in the comprehensive maintenance sunroof are "isoline", "first-line maintenance and first-line traffic", "adjusting the sunroof", and "changing lines". The number of high-speed freight trains operating at night is large, and it is necessary to ensure recurrence. Generally, it is not appropriate to use "first-line traffic and first-line maintenance" and "periodic organization based on passenger flow demand laws". It is necessary to consider its different requirements for transportation time, comprehensively choose the organization methods such as "adjusting the sunroof", "isoline", and " changing lines ".

As for the high-speed express direct train, since the train runs fast and there is no cargo operation in the intermediate station, its operation mode should mainly refer to the high-speed emu sleeper train with similar characteristics and adopt the "adjustment sunroof" scheme. High-speed emu trains can operate in the night time period created by the adjustment of skylight time and setting mode. The sleeper trains of high-speed emu trains with the same running speed can be considered to form the train operation group together to minimize the impact on the maintenance skylight. If the line itself has
night emu sleeper trains running, this scheme basically generates lower additional costs, the best use effect.

As for the intermediate operation train of high-speed railway express, it is difficult to keep up with the sleeper train of emus due to the cargo operation in the middle, so it is more appropriate to adopt the operation organization method of "isoline" and "transition" respectively according to the requirements of transportation time. When the distance between the "OD" points of the freight emu trains is close and the transportation time is relatively abundant, the "isoline" method can be adopted when the "isoline" will not affect the arrival of the goods at the terminal station as required. The "isoline" time can be combined with the transit and loading operation to reduce part of the loss. When the distance between the OD points of the freight emu trains is far away or there are many transit operations, and the transportation time is relatively tight, and the "equal line" may cause them to fail to reach the destination as required, the "transfer line" method is adopted. The premise is that there are tie lines and other "transfer line" conditions between the high-speed line and the universal speed line.

In addition, the possibility of reducing the skylight maintenance time for high-speed railways can also be considered. High-speed railways around the world have adopted maintenance methods mainly based on state maintenance and supplemented by regular maintenance, and maintenance and repair are gradually mechanized, automated, and systematic. The maintenance and repair methods of ordinary speed line equipment in China are mainly preventive maintenance, followed by the combination of maintenance and maintenance, prevention and rectification. Affected by factors such as mixed passenger and cargo transportation, equipment level, and detection methods, the status repair assumptions proposed in recent years have not been implemented, and regular scheduled repairs have been adopted. China’s railway infrastructure and facilities management level and comprehensive detection technology are gradually improved, which provides good conditions for the implementation of condition repair. After the implementation of condition repair, the efficiency of maintenance can be improved and the number of skylights can be reduced. In terms of the setting time of the sunroof, ballastless tracks are laid on the entire line, which avoids changes in the height of the rail surface caused by line hoisting, screening, tamping, and pillow replacement. The maintenance and maintenance workload and costs are greatly reduced, and the maintenance speed is greatly improved. With reference to relevant domestic and foreign practical experience, the sunroof time can be controlled at about 2 hours.

4. Cargo organization of different high-speed rail express products at night

4.1. Features of different high-speed rail express products

At present, China railway express co., LTD is the leading and main enterprise of China's high-speed railway express. Its main high-speed railway express service products include "same-day delivery", "second-morning delivery" and "next-day delivery" [2].

| Service type               | Stop order time | Delivery time | First weight (RMB/kg) | Continued weight (RMB/kg) |
|----------------------------|-----------------|---------------|------------------------|--------------------------|
| same-day delivery          | 456             | 456           | 123                    | 123                      |
| second-morning delivery    | 789             | 213           | 644                    | 644                      |
| next-day delivery          | 213             | 654           | 649                    | 649                      |

Table 1. Express rates for high-speed rail.

There are two main methods: high-speed railway "confirmation car" transport and high-speed railway passenger train transport. The main purpose of the "confirmation vehicle" operation is to confirm the normal operation of high-speed railway line equipment, which generally does not need to carry passengers, but can make full use of the seat, aisle and other space to transport express packages. The main disadvantage of this method is that it can only be applied to the stations at both ends of the high-speed railway line, and can only run in the early morning. As a result, the transportation volume is limited, which has relatively large limitations on the transportation time and coverage area. At
present, high-speed railway passenger trains carry products in the form of "high-speed express". The disadvantages of this mode of transportation are that the freight volume that each train can carry is not high, the efficiency of transportation is difficult to be guaranteed, and the capacity of passenger flow peak is insufficient, which is greatly affected by the fluctuation of passenger demand.

4.2. "Same-day" high-speed cargo sports car night transport organization

At present, the "same-day delivery" accounts for about 8%, "next-morning delivery" for about 6%, and "next-day delivery" for about 76% [3]. "Same-day" high-speed rail express products are high-speed rail express products delivered before 22:00 on the same day and before 12:00 noon on the same day. "On the day of" high-speed rail express way for the payment of goods: the first 130 RMB, 25 RMB/KG, the price is relatively high, suitable for sensitive factors of shipping time but is not sensitive to price of the goods, such as certificates, urgent documents, etc., weight and number of this kind of goods is less, could be far short of operation of the high-speed rail freight train transportation demand during the day. At present, the "same-day arrival" cargo is mainly transported by using the free space of the passenger train. First, the cargo is directly loaded into the special boxes of high-speed rail express, and then the special boxes are placed in the large luggage area of the passenger train and other special positions. This approach can make flexible use of existing train resources, but it takes up part of the space originally used for passenger service, which may affect passenger experience.

Considering that "same-day delivery" goods must be delivered before 22:00 p.m. on the same day, and such goods are generally small in size and quantity. Same-day delivery is an important characteristic service item of high-speed railway express. Although the price is high, it also well meets the differentiated demand of some high-speed railway express customers. Ordinary express companies do not open such express items. To ensure timeliness, transportation should follow the principle of "first come, first served". The operation process is as follows:

i. When the order is due at 12:00 noon every day, the staff shall load the goods and give priority to the delivery of such goods to the distribution center;

ii. In order to ensure timely delivery at 22:00 on the same day, medium and long distance (800-1200 km) and long distance (1200 km or more) goods should be transported with the train. Since the number of such goods is small, passenger train stopping time can be used to load the goods in a short time. Such trains can be delivered to their destinations before skylight operations begin;

iii. The number of passenger trains will be reduced after 18:00, and a few cargo trains will be opened at 18:00. Intermediate (400-800 km) and short-distance (within 400 km) goods can be transported to the destination in about 3 hours, so freight emu trains can be selected for transport to reduce the impact on passenger trains. Load special express boxes before 18:00 and such trains can be delivered to the destination before the skylight operation begin;

iv. The goods will arrive at the distribution center before 22:00, and will be processed and given priority to delivery.

As shown in figure 1, "same-day delivery" goods can be delivered before 22:00 on the same day, which can not only alleviate the interference of passenger trains, but also complete the delivery before the arrival of the skylight, so as to avoid the situation that the delivery time is prolonged due to the skylight and the delivery cannot be delivered on time.

![Figure 1. Schematic diagram of the running process of "same-day delivery" freight train.](image-url)
4.3. "Second morning arrival" high speed freight train group night transport organization

The order deadline for "next morning delivery" is 12:00 noon and the delivery time is before 11:00 am the next day. Freight demand is less than "same-day delivery", and the transport time is more generous. But compared with other ordinary express delivery, the delivery speed is fast, can meet the time requirements of some customers, and the first cost is about a quarter of the "same-day delivery", in terms of price advantages.

The cut-off time of "second morning arrival" products is the same as that of "day arrival" products. For such products, the following way of driving organization can be adopted:

i. For intermediate and short-distance goods, high-speed rail freight trains shall be used instead of emus to confirm the train. High-speed rail freight trains shall start from 4 am to 6 am according to the confirmed train, and after 6 am according to the normal train;

ii. For medium and long-distance goods, we can learn from the organization mode of "time-sharing collinear operation of passenger and cargo" of German high-speed freight train. We can adopt the mode of sectional vertical skylight. The high-speed freight emu trains will leave at around 20:00 and arrive at the destination station in the early morning of the next day, as shown in figure 2.

![Figure 2. Schematic diagram of the running process of "next morning arrival" cargo freight train.](image)

4.4. Night transportation organization of "next day arrival" high speed freight train group

The number of "next-day delivery" goods accounts for about 76% of high-speed rail express, and is the most important component of high-speed rail express. The cut-off time of goods order is 18:00 every day and the delivery time is before 18:00 the next day. Compared with other modes of transport, road transport cannot guarantee the timeliness of medium and long-distance express. Air transport is greatly affected by the weather, and the price is relatively high. High-speed rail "next day arrival" can not only guarantee the goods to be delivered to customers on time, but also enjoy nice prices and high cost performance. Due to the large number of "next-day delivery" express, the high-speed railway has confirmed that the car can no longer meet the freight capacity demand of "next-day delivery", so more freight capacity needs to be provided. Thus, it is imperative that high-speed freight trains be used to deliver "next day" products. For such products, the relevant organization methods are as follows:

i. The cut-off time of the goods is 18:00, the relevant personnel will collect the goods and transport them to the distribution center, and then load them into special express boxes. Since the "next-day delivery" products will be delivered at 18:00 the next day, the "same-day delivery" products and "next-morning delivery" products can be processed in priority because of the relatively ample time;

ii. The special express box will be loaded on the freight train before 20:00, and the train will depart at 20:00. For medium and long-distance cargo, you can reach the destination before the sunroof, as shown in Figure 3. For long-distance goods, consider appropriately adjusting the sunroof time according to the demand for short-distance goods. For example, during the peak period of shopping festivals such as "618" and "Double Eleven", you can use the segmented vertical rectangular sunroof. Mode to reduce the sunroof time to two and a half hours, and to a certain extent, maintain the sunroof workload. During the non-shopping festival, trains can use "isoline" and "transition lines" to organize traffic according to different line equipment conditions, as shown in Figure 3.
5. Conclusion

With the rapid development of e-commerce, the current high-speed rail express is far from meeting transportation needs. This paper proposes a plan to operate a freight train at night, and analyzes the feasibility of shipping a train at night. On this basis, suggestions are provided for the organization of traffic in the sunroof for comprehensive maintenance of high-speed rail freight trains at night. For high-speed rail express trains, the “adjusting sunroof” scheme can be adopted. Requirements, can use "isoline", "transition line" driving organization method. Finally, the characteristics of three high-speed rail express products, namely, "same day delivery", "next morning delivery" and "next morning delivery" are analyzed, and the night transportation organization plan of the three types of freight trains is given.

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