Research on determination of the scale of parking space on High Speed Rail Station, using East Ji'nan Station as an example

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Abstract: With the rapid growth of High-Speed Railway network in China, more and more stations has been designed. Based on the work of planning practice, this article has analyzed the influencing factors of proper supplement of parking space in High-Speed Railway Stations with analogy and parking turnover method, and taking East Ji'nan High-Speed Railway Station as an example to give recommended values.

1 Research Background

With the rapid growth of China's high-speed railway network, more and more cities began to operate/planning or construction of high-speed rail hub. As a gateway to the city, high-speed railway hub has high volume of demand, multiple transport modes and the transport system in quite complicated. In order to distribute the high volume of demand in traffic of high-speed railway hub, it is necessary to take the large capacity public transport tools to carry the major volume of transportation. However, with car ownership growth and the high-speed rail travel passengers are mostly carrying the size of luggage, private car still occupies an important position in the the distribution of passengers in high-speed rail hub. From the actual situation of a number of high-speed rail hub in operation, the private car parking demand has grown rapidly, there have been parking spaces tense or inadequate phenomenon, and some of the hubs even has been carried out to consider conduct the expansion of the parking lots.

Taking the Hongqiao hub as an example, after the hub has been put in use, the parking demand of the parking lot has grown rapidly, and the daily parking traffic flow has increased from 1,304 in 2010 to 10008 in 2014 (as of July), an increase of 2.29 times. The growth rate of more than 40%. Currently, the underground parking spaces of both east and west plaza have been basically saturated, a new expansion study has been carried to find proper solution to meet the demand.

Based on the above background, this paper intends to combine the planning practice of Jinan East passenger station, and discuss the size of the private car parking space needed for high-speed railway hub.

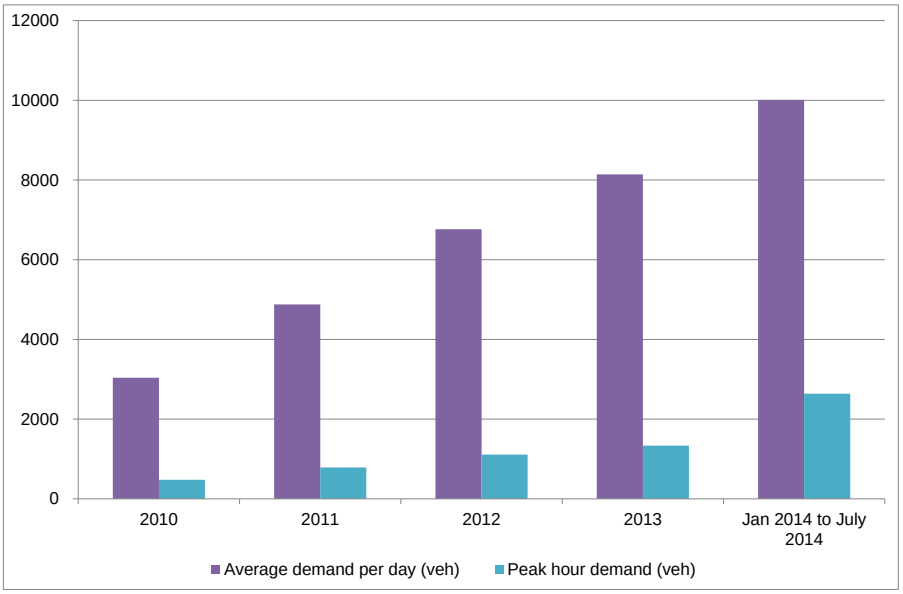

Fig.1. Parking demand of private car on Hongqiao Railway Station

2 Factors Affecting the No. of Private Car Parking Space in High - speed Rail Station

The size of the parking spaces of the hub is mainly affected by the main factors such as the parking demand of the private car, the average number of passengers per car, the average parking dwell time and the parking demand management policy, details as follows:

2.1 Volume of private car

The size of social car traffic is the primary factor affecting the size of private car parking spaces. It is the total passenger flow of hub and the proportion of private car together to decide. The size of the total passenger flow is basically determined in the preliminary planning and relatively stable (the basic demonstration is basically stable after the comprehensive demonstration), but the proportion of the selection of different travel modes is a competitive process. It would be determined by the supplement of transport facilities and the level of service of road network, public transport, parking and slow movement and so on together.

2.2 Average No. of passengers per car

The average number of passengers in a private car is usually related to the purpose of the trip. For example, the average number of commuter traffic is lower than leisure and other travel. The average number of passenger cars in the hubs is usually higher than that of ordinary commuters. This is because the passengers of the high-speed rail hub traveled together more frequently. According to the survey data, the average number of private car in the hubs is usually around 1.5.

2.3 Average dwell time

Usually parking requirements can be divided into three categories: (a) pick-off needs. The average parking time for this type of demand is relatively short, usually about half an hour before the train arrives, leaving for a short stay; (b) the demand for passengers driving to high-speed rail hubs. Such passengers will park at high-speed rail station to travel with the high-speed rail, and then drive away after coming back. This type of passenger has a long parking dwell time and most of them parking overnight. Appropriate fees and other policy measures should be used to adjust this part of the demand to reduce the long-term occupation of parking resources; (c) the surrounding area of commuter traffic parking demand. As the high-speed rail hub has a relatively easy accessibility to the subway, bus and other large transport facilities, this will attract part of the surrounding area commuter traffic to park and transfer (P+R). For this part of the demand, because the hub itself has relatively tight resources, in

principle, should try to use reasonable measures to adjust and avoid this demand. The average parking dwell time difference between different stations is large. For example, the average parking dwell time of Hongqiao Railway Station is about 4.5 hours, and the average parking dwell time of Jinan West Railway Station is 16 hours.

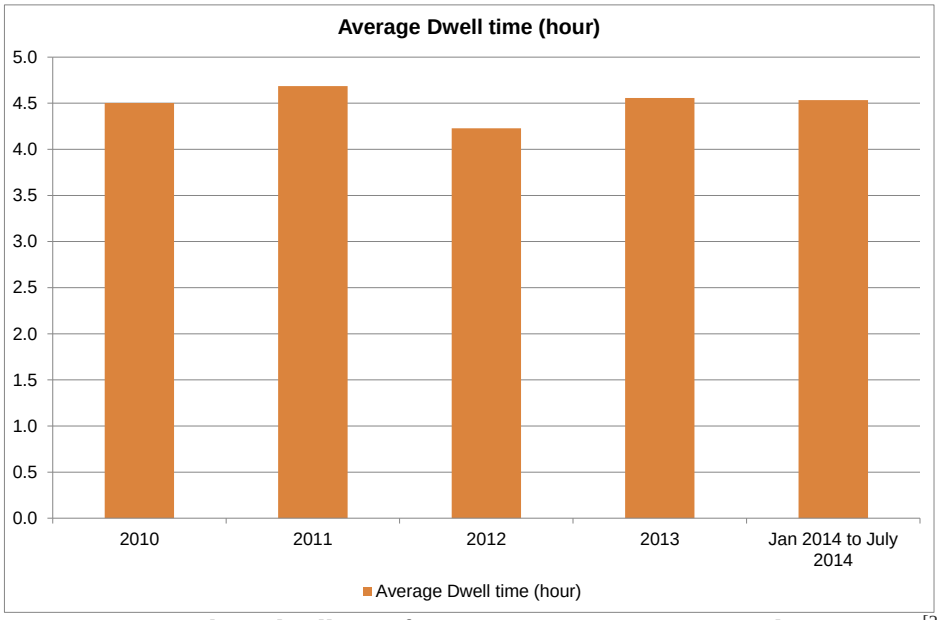

Fig.2. Average parking dwell time for private car on Hongqiao Railway Station[2]

2.4 Parking demand management policy

The average parking dwell time of private car in the high-speed rail hub has also largely related to demand management policy. Among them, the charge rate is one of the decisive factors. The use of a differentiated charging policy for different needs can effectively adjust the composition of the parking demand. At the same time, the level of parking fees can effectively adjust the overall parking needs. When Shanghai Hongqiao station opened in 2010 , when it implemented a higher fee rate (cap 80 yuan / day), the average utilization of parking spaces was only 19.46%; then, the operator decide to adjust the charge rate (adjusted to the cap 50 Yuan / day), as a result, overnight traffic has increased. In 2011, the average utilization of parking spaces increased to 32.51%, with the further growth of passenger flow in 2014, the average utilization rate of 64.52%.

3 The Calculation Method of Private car Parking Space in High - speed Rail Station

At present, the most frequently used calculation method of No. of parking space in high-speed railway station can be divided into two categories: the analogy and parking turnover rate method.

3.1 Analogy

Analogy is based on the relevant cases to compare, which need to choose cases of high comparability. Key indicators to be considered in the selection of cases include: planning the number of annual passenger shipments, the number of high-speed railway station stations and the number of lines, planning the size of public transport facilities (subway lines, BRT, conventional bus, etc.) and so on. Since analogy between the various types of analogy between the factors has a big difference, so this method can only determine the approximate proportion of parking scale, can not accurately predict the number of specific parking berths.

3.2 Parking turnover method

The parking turnover rate is based on the size of the private car demand and the average parking dwell

time to calculate the required size of the private car parking spaces, the formula is:

No. of private car parking space = private car demand / average number of passengers / parking turnover rate

Among them: parking turnover = 24 / average parking dwell time (hours)

4 Calculation of No. of private car parking spaces of Jinan East Railway Station

Jinan East Railway Station is one of the three main passenger and railway stations in Jinan. It is a comprehensive transportation hub integrating multiple transportation, such as Shiji Railway, Jiqing Railway, intercity railway, urban rail transit and Jinan metropolitan area. Planning 2030 passenger traffic amounted to 16.86 million passengers. In 2040, the number of passengers estimated will reach 22.4 million. In addition, the hub also set up a coach station, planning 2040 design passenger daily delivery volume of about 23,000 people / day.

	Passengers per year (ten thousands)	
	2030	2040
Ji'nan-Qin dao High Speed Rail	538	680
Shijiazhuang-Ji'nan High Speed Rail	1148	1560
Intercity Rail (Binzhou, Taian)		
Total	1686	2240

Table.1. Planning Annual demand of Ji'nan to Qingdao High-Speed Rail[1]

Combined with the total amount of passenger flow, using analogy and parking turnover method respectively to calculate the No. of parking spaces required in Jinan East Railway Station

4.1 Using analogy method

According to the scale and positioning of Jinan East station, select the similar high-speed rail hub to collect the following data:

	Category of Station	Forecast Demand (ten thousands)	No. of platforms	No. of tracks	Planned No. of metro lines	Planned No. of pricate car parking spaces
Heifei South Station	Principal station	3160	12	26	3	1720
Zhengzhou East Staion	Principal station	3200	16	32	3	1980
Changsha South Station	Principal station	2500	13	28	4	2000
Ji'nan West Station	Principal station	2807	8	17	3	2987

Table.2. Data of High-Speed Rail Stations of similar scales in China

According to the above data, the planning annual passenger volume Jinan station is 22.4 million, with 13 platforms and 27 lines. Subway R3 line and M1 line planning station in the East Railway Station. Based on analogy, Jinan East passenger station should be configured 1700 to 3000 parking spaces.

It should be noted that since the Jinan West Railway Station is currently one of the main passenger railway hub, the reference to the project is more meaningful. According to the current operating data of Jinan West Railway Station, the amount of passenger traffic has not yet reached the planned traffic demad, but the planned parking lot parking rate is close to saturation. Moreover, Jinan East passenger station platform scale is 50% more than Jinan West Railway Station. As a result, Jinan East Railway Station need to be equipped with more than 1,800 parking spaces.

4.2 Using the parking turnover method

Parking turnover is mainly dependent on the average length of parking, according to parking charges data of Jinan West Station in 2015, the average dwell time for private car is more than 16 hours (see table below). This shows that the average dwell time of Jinan West Railway Station is long, which is

mainly caused by two reasons: (a) Jinan West Railway Station parking fee is relatively low, a day and night is only 29 yuan (8 am to 8 pm) ; (b) Jinan West Railway Station is located in the west of Jinan City, close to the west freeway of the city, relatively far from the city center, taxi costs is higher and there is no subway and public transport Service level is relatively weak.

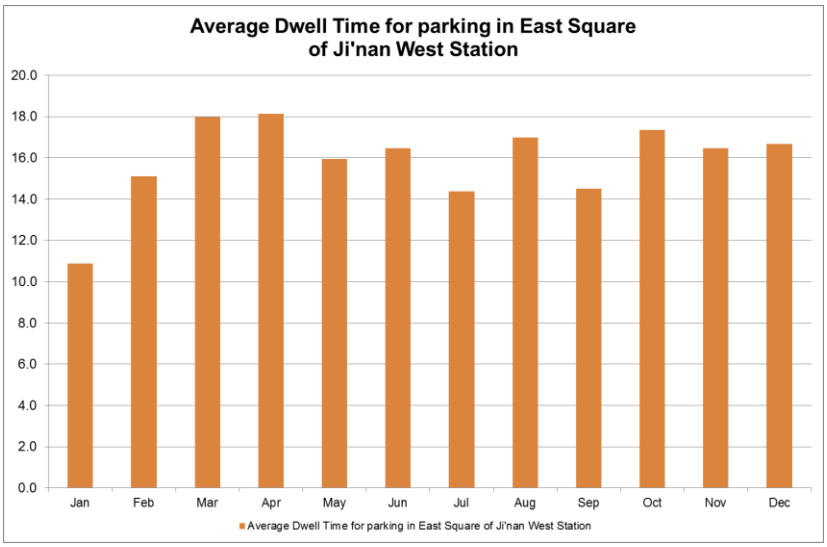

Fig.3. Average parking time for private car on East Square of West Ji'nan Railway Station[3]

According to the forecast data of Jinan East station hub, the railway 2040 design day delivery volume of 74000 people, which 13% of them uses the private car. In addition, the coach station design day delivery of about 23,000 people, of which the use of private car accounted for 9%. As a result, the daily demand for private car is 11,640 person / day. According to the survey data of Hongqiao Railway Station and Jinan West Railway Station, we use the average parking dwell time of 6 hours, which would give an average turnover rate of 4 times / day.

No. of private car parking spaces = 11640 / 1.5 / 4 = 1940.

With the combination of two methods, it recommends to provide private car spaces of not less than 1940.

5 Conclusion

Based on the analysis of the influencing factors of the no. of the private car parking lot in the high-speed railway hub, taking the planning practice of Jinan East passenger station as an example, this article has calculated the scale of the private car parking lot of the high-speed railway hub by the analogy method and the parking turnover rate method and given the recommended value.

Reference:

[1] Shanghai Municipal Engineering Design Institute (Group) Co. LTD , Ji'nan East Station Comprehensive Transport Planning Report. 2016.11.
[2] Shanghai Municipal Engineering Design Institute (Group) Co. LTD , Hongqiao Hub West Transport Square Parking Space Expansion Study Report. 2016.01.
[3] Huayun City Transport Infrastructure LTD, 2015 Parking Operation Data Report. 2016.03