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Pedestrian Facilities Planning on Tianjin New Area program

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Abstract

Nowadays the principle of "human-oriented" has been implemented in the transportation planning, but the implementation is always opposite. The phenomenon of "car-oriented" is becoming seriously. As an important part of urban traffic, pedestrian traffic cannot be ignored equally. By comparing the research on pedestrian crossing facilities spacing and pedestrian traffic characteristics at domestic and foreign, this paper propose the reasonable calculation methods of interchange pedestrian crossing facilities spacing .Integrating with the traffic characteristics and urban land development layout of Binhai New Area, this paper calculates reasonable pedestrian crossing facilities intervals by the discriminatory idea of sub-regional and hierarchical method, and puts forward the reasonable interchange pedestrian crossing facilities planning program.

Key words: Tianjin New Area; Pedestrian crossing; Pedestrian crossing spacing;

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1. Introduction

As an important part of urban traffic, pedestrian traffic is often been list the last considering object in urban planning. For example, the setting of the road cross section and land layout about pedestrian traffic space is reduced to the minimum. The rate of the road traffic accidents caused by pedestrian illegal crossing the road, accounts a large proportion over the years. The security of pedestrian is gradually concerned by the community and the planning scholars. Pedestrian crossing facilities allocates the road rights of pedestrians and motor vehicles in space and time ,which will reduce traffic accidents by reducing pedestrian and motor vehicle conflicts. Through the consideration of the crossing facilities spacing and analyzing the influencing factors of crossing facilities, this paper puts forward to the crossing facilities spacing by in different regions at different levels, as a reference of pedestrian facilities planning.

2. Pedestrian Crossing Analysis

2.1. Day walking distance

The survey of residents travel displayed that most of pedestrian walking distance is in range of 400-500 meters, which is within certain limits. Residents prefer to choose other modes to travel beyond the walking distance limit. The analysis of the residents travel survey from 8 cities showed that one person's walking trip time all-day is in 20 minutes or less, that is about 1.5 kilometers.

Figure 1 The residents' walking trip time all-day

2.2. Acceptable bypassing distance

The acceptable bypassing distance of pedestrian crossing is affected by the factors of road network, traffic, the characteristics of the traveler, the socio-cultural, and climate and so on, that has not yet arrived a consistent conclusion in china.

Table 1. The city resident acceptable bypassing distance

City	Acceptable bypassing distance(meters)

USA	Usual neighborhoods	45
	Walking-oriented neighborhoods	76
Japan		20
BeiJing		200
ShenZhen		100

In the United States, pedestrian crossing can accept 45 meters of a maximum distance and the more appropriate bypassing distance is 76meters in walk-oriented neighborhoods, especially apartments, commercial center and front of the school. In Japan, the acceptable distance is only 20 meters according to survey study. In Beijing the bypassing distance of which more than 200 meters accounted for 1.5% only, 50 to 200meters accounted for more than 98.5%,among in less than 50 meters accounted for 37.6% . The Shenzhen research found that 100% of the people willing to accept within 100 meters for security purposes, 69.4% of people can accept 150 meters, 54.4% of the people can accept 200 meters, and 27.5% of people can accept more than 200 meters.

In summary it can be seen that pedestrian acceptable bypassing distance of domestic is longer than the foreign.

2.3. Pedestrian crossing spacing

By contrasting the pedestrian crossing spacing of the domestic and foreign, the average crossing spacing of Beijing's Chang' an Avenue is 3.1 times the Champs-Elysees and 3.2 times the Western Highway; East Bridge Road is 1.8 times First Avenue, and 2 times Keiyo Avenue. That is to say, the bypassing distance of residents crossing in Beijing is about 2 to 3 times Paris and Tokyo. The crossing spacing on the arterial road which is more than 200 meters is rare in foreign, but most appear in domestic cities.

Table 2 The crossing spacing of CBD arterial road

CBD	arterial road name	Average spacing（m）	Maximum spacing（m）	CBD	arterial road name	Average spacing（m）	Maximum spacing（m）
Tokyo's Ginza	Tokyo Speedway	133	315	Shanghai Lujiazui	Century Boulevard	293	623
	316 Line Road	91	265		East Rift	230	648
	50 Line Road	101	180		Lujiazui Ring	249	424
	473 Line Road	95	180	BeiJing Outward	East Bridge Road	278	561
	304 Line Road	96	285		Chang'an Avenue	261	912
Paris	Champs-Elysees	84	274	TianJin	Freeway inner ring		961
New York	First Avenue	156	460		Weiguodao		745
Manhattan	Western highway	81	178		Dagu South Road		638
Tsim Sha Tsui,HongKong	Plus Gascoigne Road	148	332		Jiefang South Road		650
	Jordan Road	159	295		Weijinnan Road		1233
	Nathan	109	335		Fukang Road		2000
cetral HongKong	Connaught Road Central	217	286		West Green Road		1320

	Des Voeux Road	161	349		The Jingjin to Red Bridge North Avenue		764

Data sources:《The Slow topic of the Binhai New Area CBD》

2.4. Pedestrian crossing facilities applicability

Pedestrian crossing facilities have been divided into the form of crosswalk and grade-separated pedestrian crossing, crosswalk facilities include without control and signal-control, grade-separated pedestrian crossings facilities contain overpass and underpass.

The pedestrian crosswalk has often been applied to the branch road and arterial road, with low traffic flow and short intersection distance of less than 400 meters; the grade-separated pedestrian crossing usually sets on the expressway and long intersection distance of more than 400 meters. The unreasonable setting of grade-separated pedestrian crossing which has low utilization of the facilities leads to the waste of high investment cost. Aiming at this point, this paper mainly studies the way of setting grade-separated pedestrian crossing.

3. Influence factor of grade-separated facility spacing

3.1. Pedestrian crossing demand

Buildings are the origin points of traffic production and attraction, which distribute along both sides of the road. A school always attracts more people than a small print store, which means more pedestrian crossing demand. Therefore, the pedestrian crossing demand is the most important thing in the location of grade-separated pedestrian crossing facility.

Pedestrian attraction domain is decided by a comfortable walking distance, which is one of important factors influencing the location of grade-separated pedestrian crossing facility. According to resident trip survey from many cities in china, the walking distance of 400-500 meters is acceptable.

Pedestrian attraction rate means the proportion of the amount of building attracting pedestrian to GFA[4], which reflects how much the buildings along both sides of the road attract walking people. Pedestrian attraction rate is different with the change of building properties. Table 3 shows some pedestrian attraction rates of buildings along both sides of road according to traffic survey in Beijing, which shows that school, shopping mall and bus station attract more people.

Table 3 Beijing trip rate index

	Residence	School	mall	bus	shop	Hotel	Office	Hospital
Beijing	0.014	0.105	0.313	1.455	0.086	0.091	0.014	0.109

Data sources:《trip rate index in Beijing》

3.2. Attraction Domain of Grade-Separated Pedestrian Crossing Facility

Grade-separated pedestrian crossing facility serves to walking people, which serves the same scale range with pedestrian attraction domain of buildings. According to overseas research, bus or subway station always attracts a range of 400~500 meters walking distance. We define attraction domain of grade-separated pedestrian crossing facility is 400 meters, and people will choose pedestrian crosswalk instead when over 400 meters.

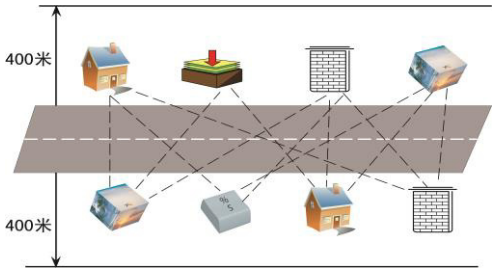

Figure 2 The attracting range of the road on both side

4. The locating model of grade-separated crossing facility

4.1. Model Introduction

This paper need make some assumptions before the analysis of modeling

- Assume that there is only one grade-separated crossing facility on the target section.
- There is no crosswalk and other crossing facilities, all the pedestrians pass through the road with overpass.
- Assuming the pedestrian flow of across the street is proportional to the attract range of building, that is increased with increase of building attracting.

In the region of high- density road network, the pedestrian cross the road with shortest time by crosswalk in condition of the short distance between intersection; on the contrary, the pedestrian need overpass crossing the road in the long distance between intersections.

On the road of central- isolated hurdle, the grade-separated crossing facility should set around the people concentration for the convenience of the pedestrian, which can give play to the greatest benefit. The figure 3 shows that the building attracting is from the both sides of road and the street-centerline is seen as axis. The flow of the building attracting is to be regarded as the force perpendicularly to the axis[2] .The distance from the point to the reference point is to be viewed as moment, the force both the side is consistent with the principle of leveraged balance. so the study can calculate the specific location through solving the distance of the balance point to the reference.

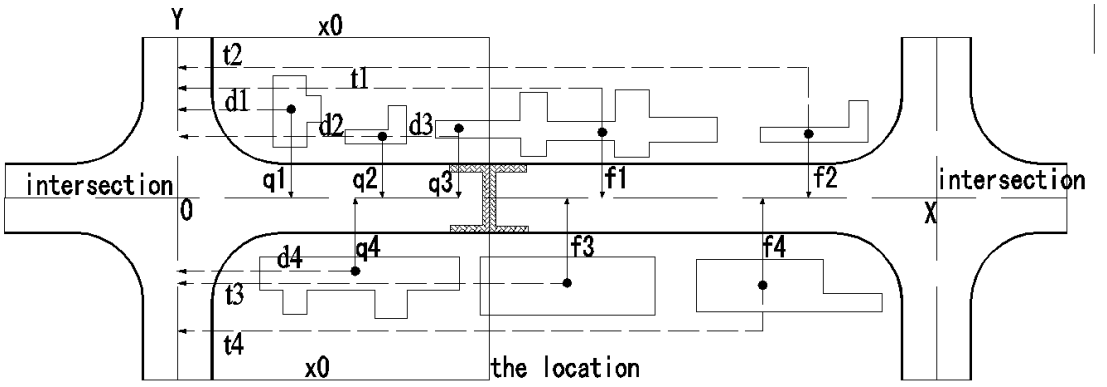

Figure 3 The schematic diagram of the model

The model treat all the crossing person as using the grade-separated crossing facility, the model forms follows

$$\sum q_i \times (x_0 - d_i) = \sum f_i \times (t_i - x_0) \quad (i=1, 2, \cdots 11) \tag{1}$$

$$x_0 = \frac{\sum f_i \times t_i + \sum q_i \times d_i}{\sum q_i + \sum f_i} \tag{2}$$

Where q_i is the number that building i along the road attract people and f_i is the number that the building i along the other road attract people.

Where d_i is the distance that the point of the attracting building i along the road perpendicularly to the axis is to the reference point. t_i is the distance that the point of the attracting building i along the other road perpendicularly to the axis is to the reference point.

x_0 is the distance that the location of the grade-separated crossing facility is to the reference, which shows the gravity of the road attracting ability. Obviously, it will be give play to the greatest benefit if the overpass/underpass is set on the center of gravity, this is the basic idea of the model.

If it will be set not only one crossing facilities on the long street blocks, which need to be divided into several section on the basis of average attracting ability or the distance range of 400-500 meters accepted by the residents, then the center of gravity of each section is calculated.

Figure 4 Land character of both sides

4.2. Simple example

As a example of the certain section of Tianjin Binhai New Area, the distance is 470 meters on certain road section, there are 11 attracting sources on the segment of 470 meters between intersection, numbered 1, 2, … 11; which is on both sides respectively, the relative coordinate system is established as figure 4.

Table 4 The attracting of the building both sides

number	Land character	attracting（f,q）	relative coordinate（d,t）	number	Land character	attracting（f,q）	relative coordinate（d,t）
1	residence	1235	379	7	residence	253	89
2	School	1172	379	8	business	3444	175
3	residence	330	230	9	residence	2156	318

4	residence	751	230	10	residence	480	424
5	business	2121	230	11	residence	705	247
6	residence	271	136				

It can calculate the relative coordinate by placing the attracting value of the table 4:

$$x_0 = \frac{\sum f_i \times t_i + \sum q_i \times d_i}{\sum q_i + \sum f_i} = \frac{1125 \times 379 + \ldots + 705 \times 247}{1235 + \ldots + 705} = 261 \tag{3}$$

The solution of 261 is the site of the grade separate pedestrian crossing facility to the reference point, which indicated by dashed line in the chart.

5. Application and conclusion

5.1. The Binhai New Area planning

As the differences on the land layout, public facilities and the location in Binhai New Area, the planning adopt the differential treatment thought based on regional separation and level-division.

In scope of the study in Binhai New Area, it is divided into the central city and the core area. The pedestrian crossing demand of the two area are showed different increasing, and the distribution form is showed punctate and line map mainly according to the pattern of urban development.

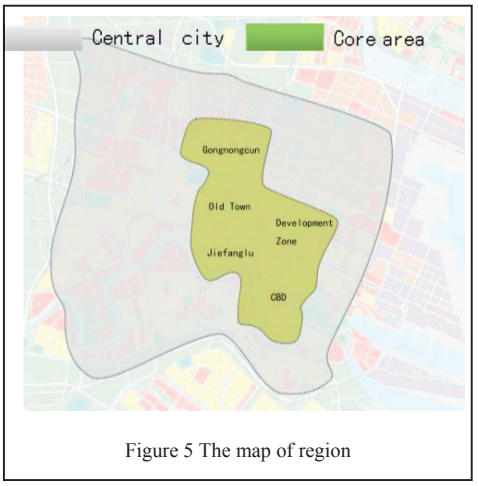

Figure 5 The map of region

Table 5 The demand of different region

area	Demand of crossing	Key consideration of the crossing	Distribution form
Central city		The arterial road or the attracting range	Punctuate map
Core area		Commercial district or pedestrian street	Line map
remark：Paying attention to the effective link of the levels，meanwhile forming effective transfer with the external traffic system			

The planning divided the long road into several segments based on the method of the regional separation and level-division, according to 700 meters stage on central city and 400 meters stage on core area. Through the analysis of the model, the appropriate site of the grade-separate pedestrian crossing facilities is calculated separately per segment.

In 2020, there are 59 grade-separate crossing facilities in the core area of the Binhai New Area, among them there are 14 cases of maintaining and 45 cases of adding newly. There are adding newly 24 cases on express road and 21 cases on the arterial road.

5.2. Conclusion

In this paper, the location model of grade separated pedestrian facility was funded based on pedestrian distribution and character of pedestrian crossing behavior, which was described by quantitative analysis method. The conclusion of this paper is scientific and authentic.

However, the model was based on the assumption that the proportion of street crossing is the same as the ratio of between the building attracting pedestrian, which is not accurately accordance with the actual case, And supposed that only one crossing facility was set up in every 400 meters, which does not apply the situation that the demand of crossing people is more than the capacity of crossing facility. We should optimize the problems in our follow-up study.

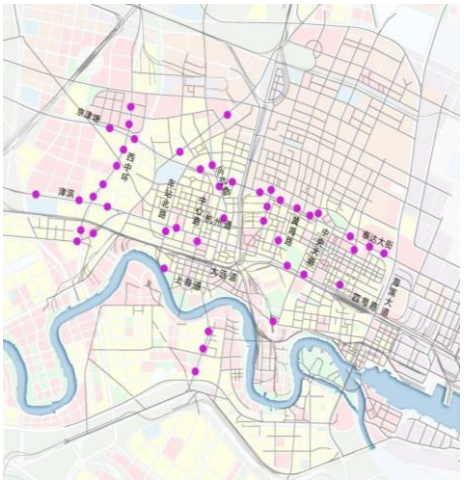

Figure 6 Layout of the planning

5.3. Prospect

The paper assumes that the proportion of street crossing is the same as the ratio of between the buildings attracting pedestrian, the actual passenger distribution is usually different from the theory, and therefore the model needs to be improved in the next step.

On the long street blocks, it divided into many segments, which depending on the attracting ability of the entire street block based on the capacity of the grade-separated pedestrian crossing facility or the consideration of the convenience of the pedestrians accepting distance. It needs to need to discuss in the next step.

In practical applications, the specific location of the overpass should be based on the land granting and the location of theoretical calculating to revise partially, so that it can put the facilities in place.

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