Study on Development of Pedestrian Spaces to Respond to Diversification of Pedestrian Attributes

(Period of Study: From FY 2014 to FY 2016)

SHINGAI Hiroyasu, Head   **YOSHIDA** Jundo, Senior Researcher

Urban Facilities Division, Urban Planning Department

Keywords: Pedestrian flow, pedestrian walking speed and pedestrian density, sidewalk design, large-scale development, pedestrian attributes

1.   Foreword

Regarding pedestrian flow, pedestrian walking speeds and pedestrian densities for each surrounding environment have been expressed in a certain relational expression in past studies, etc.[2] As traffic volume is determined by pedestrian walking speed and pedestrian density, this relational expression has been utilized for designing sideway capacities.

On the other hand, pedestrian traffic frequently observed recently in the areas surrounding large-scale redevelopment areas in large cities is substantially different from pedestrian traffic during the rapid economic growth period, when the above relational expression was established. This is primarily due to changes in the composition ratio of pedestrian attributes in line with the aging population, a variety of pedestrians moving for different purposes, and an increase in pedestrians with large personal effects (such as carry bags and strollers), among other things.

As such, in this study, we collected fresh data on pedestrian walking speeds and pedestrian densities in various areas of central Tokyo in order to analyze a unique pedestrian flow currently observed there, and then analyzed the pedestrian flow data, focusing on the dispersion of pedestrian walking speeds as values that represent flexibility in the choice of walking speeds. In this paper, we would like to present the results of our traffic flow observations in the vicinity of Kachidoki Station as a preliminary report of the FY 2016 survey results.

2.   Survey Overview and Results

Traffic flow observations (to collect data on pedestrian walking speeds and pedestrian densities) were performed on sideways along Harumi-dori Street in the vicinity of Kachidoki Station during 8:00 to 9:00 a.m. on weekdays, and we analyzed pedestrian traffic data during 8:35 to 8:40 a.m. when the spot traffic volume peaked. In the surrounding areas of Kachidoki Station, which have been developed at a rapid pace in recent years, there is a strong flow of pedestrians commuting to work during morning rush hours. As shown in Table 1, the average pedestrian walking speed is as high as 1.5 meters per second, but differences in walking speeds due to pedestrian attributes are small, representing the typical characteristics of pedestrian flow during commuting hours.

Looking at pedestrian walking speeds by the level of pedestrian densities, as shown in Table 2, the standard deviation of pedestrian walking speeds is around 0.25 meters per second when the pedestrian density is 0.6 persons per square meter or above, but it is as high as 0.30 meters per second or above when the pedestrian density is less than 0.3 persons per square meter. As shown in the figure, it can be seen that, when the pedestrian density is less than 0.3 persons per square meter, there is a greater flexibility in the choice of pedestrian walking speeds, with some pedestrians actually running.

Table 1. Pedestrian walking speed by pedestrian attribute

Group	Non-elderly		Elderly		Total
	Male	Female	Male	Female	
Solo	1.52(n=1480)	1.50(n=1198)	1.49(n=15)	1.51(n=6)	1.51
Two people	1.27(n=9)	1.40(n=23)	1.36(n=2)	1.32(n=1)	1.36
Total	1.52	1.50	1.47	1.48	1.51(n=2734)
	1.51		1.48		

Table 2. Pedestrian walking speed by the level of pedestrian density

Density rate (person/m²)	k<0.1	0.1≤k<0.2	0.2≤k<0.3	0.3≤k<0.4	0.4≤k<0.5	0.5≤k<0.6	0.6≤k<0.7	0.7≤k<0.8	0.8≤k<0.9	0.9≤k<0.10	1.0≤k<0.11
Frequency (person)	16	48	114	221	165	191	132	119	197	244	407
Walking speed (m/s) Average	2.53	1.91	1.69	1.66	1.60	1.62	1.52	1.58	1.46	1.42	1.36
Standard deviation	0.69	0.72	0.39	0.32	0.29	0.32	0.27	0.28	0.26	0.25	0.25

Density rate (person/m²)	1.1≤k<0.12	1.2≤k<0.13	1.3≤k<0.14	1.4≤k<0.15	1.5≤k<0.16	1.6≤k<0.17	1.7≤k<0.18	1.8≤k<0.19	1.9≤k<0.20	2.0≤k	Total
Frequency (person)	147	144	105	136	85	58	17	13	0	14	2573
Walking speed (m/s) Average	1.41	1.43	1.51	1.45	1.48	1.42	1.22	1.29		1.21	1.50
Standard deviation	0.22	0.25	0.28	0.24	0.27	0.19	0.13	0.24		0.09	0.33

①Density : 0.2person/m²   ②Density : 2.0person/m²
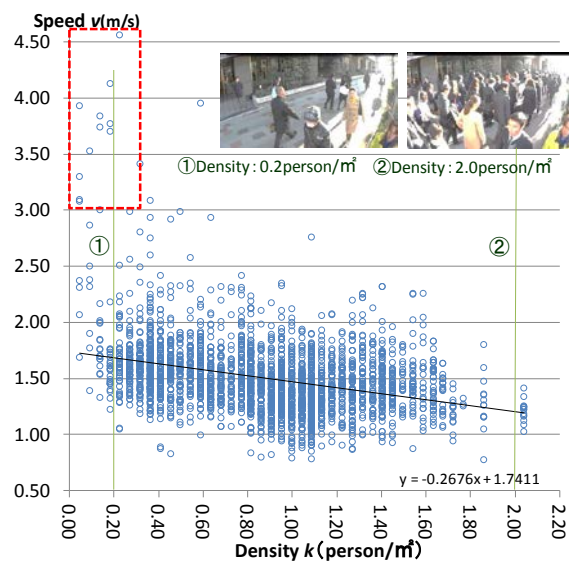
$$y = -0.2676x + 1.7411$$

Figure. Relationships between pedestrian walking speeds and pedestrian densities in surrounding areas

3.   Next Step

In this paper, we presented the results of our traffic flow survey in the vicinity of Kachidoki Station where there are pedestrian spaces with relatively uniform traffic flows at high pedestrian densities. We conducted the same pedestrian traffic flow survey in other areas as well, including in the vicinities of Sugamo Station, where there are a greater number of elderly people, and Ueno Station, where there are many tourists and shoppers. Going forward, we will study the desired future state of pedestrian spaces that are appropriate for the composition of pedestrian attributes (corresponding to the surrounding environment) by analyzing the survey results in these areas and relationships between pedestrian walking speeds and pedestrian densities, among other things.

☞**For further information, please refer to the following:**

1) Collection of papers for 32nd traffic engineering workshop No. 24

Reference

2) *Traffic Engineering Handbook* (2014 edition)