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# Pedestrian Flow Characteristic of Metro Station along with the Mall

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## Abstract

When metro station is connected with shopping mall the pedestrian flow is huge. Passenger from the mall who carries luggage brings large fire load into the metro station. In this thesis three typical metro stations are chosen to measure the moving data of pedestrian by observation, and the relation between moving speed and person information, such as age, gender, luggage, shoes and accompanying is analyzed.

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*Keywords:* metro station; pedestrain flow; velocity distribution; moving speed

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## Nomenclature

$S$	walk distance (m)
$T$	record time(s)
$V$	speed (m/s)

## 1. Introduction

Statistics show that more than 90 percent of large shopping malls are along with the metro route in Guangzhou [1]. From the metro stations it can directly walk to the connected commercial buildings. In the earliest opening and operation of the Guangzhou Metro Line 1 which has 16 stations, and a total of 11 stations and 27 underground mall entrances are connected with the mall. These means that stations along with mall are accounted for 68%. Currently, the pedestrian flow of the shopping mall exit is several times the pedestrian flow of normal exit of metro station. Tian [2] set observation video at four metro exits of one station to get the passenger distribution and obtain the basic characteristic parameters of passengers, also the workday and weekend has been comparison, here the pedestrian flow characteristic in metro station along with the mall cause the attention in this article.

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## 2. Observation measurement

### 2.1. Parameter measurement

There are usually two general ways to obtain data: one is Observation and Survey Method, and the other is Test Method [3]. The data obtained by the Test Method often contains the subjective factors which is not suit for the actual subway people movement. Therefore, the Video Observation Method was chosen to get the basic moving parameters [2].

The selected time is from 17:00PM-19:00PM at workday which was the rush hour in Guangzhou metro. The software Corel Video Studio Pro X6 (the time resolution is 0.04 seconds) is used to analysis the catching video. The required time is measured when passenger moved in specified distance  $S$ . The required time is recorder and named  $T$ , according to the formula  $V=S/T$ , so the corresponding speed of each person is  $V$ .

### 2.2 Characteristic recording

The moving speed is related with gender and age, while in the subway and other public places, the speed is also related with the environment and personal state [4]. In this observation experiment, not only the moving speed is recorded, but also the personnel characteristic is recorded which is including: gender, age, luggage, shoes and accompany or not. In order to obtain more accurate movement speed, 106 target objects are selected as shown in Table 1.

Table 1 Statistical parameters of the target of personnel

No.	Gender	Age	Luggage	Shoes	Accompany	Speed m/s
1	Female	Young adults	Small	Flats	Single	0.923
2	Male	Young adults	Small	Flats	Single	0.984
3	Female	Young adults	Small	Flats	Single	1.176
4	Female	Young adults	Small	High-heels	Single	1.017
5	Female	Children	none	Slippers	Single	1.034
...						

Consider the proportion distribution of the different speed ranges, personnel speed distribution is normal distribution, as shown in Figure 2-11. When the evacuation simulation software, the movement of personnel to set different types of parameters, the set speed of the column is usually given a range of values instead of just a single given speed value [5]. Left researchers who move distribution data obtained in other metro stations, the right is the moving speed of the target group in this article 106 of the distribution, in line with normal trend, and the correlation coefficient is 0.87

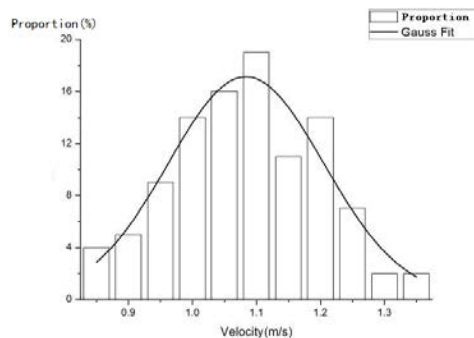


Fig.1. Distribution of pedestrian moving speed

### 3. Parameters affecting speed

#### 3.1. Gender and age

The selected 106 targets are relatively centralized data; the arithmetic mean method is used for statistical data processing. Table 2 represents the speed profile of four groups of people, namely young women, young men, elderly and children. In general, the young men have the fastest speed and the children have the slowest speed. These data can be applied to study the evacuation of metro station in china.

Table 2 The classification and speed of passengers

Category	Young women	Young men	Elderly	Children
Proportion	48.1%	39.6%	6%	6.3%
Speed (m/s)	1.05~1.35	1.14~1.40	1.00~1.28	0.96~1.23

It can be seen that the proportion of young adults account for 87.74% of all. The speed varies with age and gender. The statistical results show the average speed of the male is 1.135m / s, and the mean speed of the female is 1.076m / s which is 5% slower than that of male.

#### 3.2. Luggage

In the station connected with the shopping mall, there are many pedestrians carrying shopping bags or luggage, these shopping bags or luggage affects not only the self-speed, but may also affects the speed of peripheral pedestrian cause the luggage occupying a considerable space in such crowd station. Classification features are shown in Figure 2, for passengers carrying other luggage (may be bigger) not only affect his (her) own velocity but also may affect the speed of pedestrians nearby.



Fig. 2. Passenger with luggage

Table 3 The classification and the corresponding speed (luggage)

Category	Proportion %	Speed m/s
None	34.9	1.123
Small	49.1	1.130
Other luggage	16	1.011

Through the statistics of Table 3, no luggage passenger is accounted for 34.9%, carrying the shopping bags handbags and other small pieces of luggage at most, accounted for 49.1%, and respectively 16% carrying medium and large luggage. Analysis of four kinds of personnel speed, found no luggage and moving speed of carrying small pretty, even the overall pace of mobile small pieces of luggage to be a little faster. As shown in Table 3.

### 3.3. shoes

Figure. 3. represents that pedestrian wear different shoes in metro, especially women may also wear high-heeled shoes, so the wearing condition is divided into: the high-heeled shoes, slippers, flat shoes. Statistics is shown in Table 4 that the pedestrian with the high-heeled shoes has the slowest moving speed, and the moving speed of slippers is relatively the fastest. This means that wearing shoes have obvious influence on pedestrian's movement.



Fig. 3. Pedestrians wear different shoes

Table 4 The classification and the corresponding speed(shoes)

Category	Proportion %	Speed m/s
Flat shoes	59.4	1.097
High-heeled shoes	19.8	1.066
Slippers	20.8	1.158

### 3.4. Accompany

In the observation video such as Figure. 4., the phenomenon of accompanying is common in metro station and mall, so the accompanied persons can be seen as one target in statistics which has a consistent speed. Generally, there is one fast one slow phenomenon in accompanied persons, and then they need to coordinate with each other. In the fire and other emergency situations, a small group of accompanied persons will inform each and have joint action.

Table 5 indicates that the accompanying phenomenon is an important factor to influence the pedestrian moving speed, but at here the difference was not significant, it may be because in metro most pedestrians are the youth groups who have the equivalent moving level.



Fig. 4. Pedestrians with accompany

Table 5 The classification and the corresponding speed(accompany)

Category	Proportion %	Speed m/s
Accompany	40.3	1.098
single	59.7%	1.108

Based on the above analysis, through the pedestrian observation of Guangzhou Metro, the influence of gender, age, luggage, shoes and group accompanied on personnel movement is analyzed. These actual data provide a basis for the study of metro station evacuation in china.

#### 4. Conclusion

The behaviour of pedestrian in metro stations along with shopping mall is lack of data in china, so pedestrian movement characteristic of this type is observed and measured, and the main conclusion is as follow:

- (1) Velocity distribution of passengers conform to normal distribution, the moving speed range of elderly, children, young men and younger women is recorded;
- (2) Influence of gender, age, luggage, shoes and group accompanied on personnel movement is analyzed, the impact of large luggage on the movement is the most obvious by comparison, and the following is the shoes.

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