



# Journal of Applied Sciences

ISSN 1812-5654

**science**  
alert

**ANSI***net*  
an open access publisher  
<http://ansinet.com>

## Research on the Transportation Characteristics of Residential Quarter in Suzhou

Li Xinyu, Zhu Yujiao and Li Chaoyang

School of Naval Architecture, Ocean and Civil Engineering, Shanghai Jiao Tong University,  
Shanghai, 200240, China

---

**Abstract:** Studying on the transportation characteristics of residential quarter is the basis of traffic forecasting, traffic design and people-oriented traffic environment. Taking the typical “private car city” – Suzhou as an example, this study introduces several survey methods and analyzes the transportation characteristics of persons and vehicles. This study also focuses on discovering some relations between transportation characteristics and floor area, with the purpose of providing some illuminating ideas in the sustainable development of the residential quarters in China.

**Key words:** Residential quarter, trip generation rate, traffic behavior, suzhou

---

### INTRODUCTION

With the booming development of society and economy in China, the requirements of both quality and quantity of residential quarter raise unceasingly as the remarkable improvements of living standard. At the same time, supporting facilities of transportation and facilities supply become the critical elements for residents because of the motorization of the society and the rapid popularization of private cars in ordinary families. Therefore, this study aims to research on the transportation characteristics of residential quarter, which is the key to update the traffic design concept as well as to build people-oriented traffic environment in residential quarters.

Suzhou, as the geographical center of Yangtze River Delta city circle, is an important transportation hub near Shanghai, Wuxi and Nanjing. It is the state-level historical and cultural city and world-class tourist city as well. Since reform and opening up, social and economic undertakings in Suzhou have made a great progress with the help of its export-oriented economy policy, proving by the fact that its economic aggregate has been in the first place of Jiangsu province. Moreover, the modernization level of Suzhou has increased and its motorization has rapidly developed, which result in the continuously enhancement of its comprehensive competitiveness. So this study takes Suzhou as an example to study the transportation characteristics of residential quarter and furthermore to provide some significant advice and reference to other cities in China.

### SURVEY

A scientific, rational and effective survey is the basis of this research. So first of all, this study determines the targets, contents and methods of the survey according to the demands of transportation development in Suzhou and some similar research experience home and abroad. Secondly, after the survey, this study analyzes the survey data by computer software-Foxpro to summarize the transportation characteristics of residential quarter in Suzhou, which helps to provide some key parameters and decision supports for traffic design of residential quarters in the future.

**Survey area and objects:** Most large-scale residential quarters are distributed over the east, west and mid-south of Suzhou, basically located in the area with perfect infrastructures, high standard of road facilities, moderate population density and good location. This survey selects 16 residential quarters in old town district, new developed district of high and innovative technology, new industrial district of sino-singapore and Xiangcheng district of Suzhou as survey objects, including 14 ordinary residential quarters and 2 high-class villas.

**Survey targets:** When framing the Urban Transportation Planning and Urban Mass Transit Planning of Suzhou, the local government has conducted several rounds of household survey, which helps to realize the characteristics such as trip purpose, times, method, period and consumption of time. However, these surveys tell

little about the destination of the trip or the origin-destination of elastic trips, especially the use characteristics of different kinds of buildings and traffic behavior. Therefore, this survey aims to find out the use characteristics of buildings, demand of site traffic and trip rate of site traffic.

**Survey contents and methods:** According to the survey targets, there are three main survey contents: General survey of residential quarters, volume of persons and vehicles of site traffic as well as the number of persons in the vehicle. This survey includes two stages as follows. The first stage is to finish the general survey of residential quarters and the other one is to count the volume of persons and vehicles of site traffic and the number of persons in the vehicle (ITE, 2004).

- **General survey of residential quarters:** First of all, the survey team went to Urban Planning Bureau of Suzhou City several times to discuss the probationary samples with local experts and marked them on the map. Additionally, the survey team visited the probationary samples one by one in order to get their techno-economic indicators by filling the questionnaires. Finally, the determinate samples were selected from the probationary ones and were drawn accurately on the sketch map of the general layout
- **Volume of persons and vehicles of site traffic:** The survey team explored the samples and discussed repeatedly to determine the number of team members and survey sites rationally. During the survey, researchers must complete the task in due time. ‘Persons’ in the questionnaire were those who arrived at or left the survey site on foot recorded by the researchers. Actually, they may walk to the site after stepping out of public transits or taxis. However, these vehicles were neglected by the researcher, which means that researchers only counted persons they saw regardless of whatever public transit they took before (Mehra and Keller, 1985). So, the counted volume of vehicles and bicycles in this survey is relatively smaller than the actual volume and it is hard to reflect the mass transit
- **Number of persons in the vehicle:** Researchers wrote down the number of persons they saw loading or uploading the vehicle in the questionnaire. For private cars and taxis, at least 15 samples must be taken to guarantee the accuracy of the survey

**Survey time periods:** Generally, such survey can be completed in three parts: all day, morning and afternoon (ITE, 1991). Time periods for all day survey are 7:30 am-6:30 pm, for morning survey are 7:30-11:30 am and for afternoon survey are 3:30-6:30 p.m. If holiday is in force, the survey time periods will be changed to 10:30 a.m.-1:20 pm. According to the experience of similar surveys, the difference between morning and afternoon cone period is extremely large, because volume of both persons and vehicles in morning cone period is larger than those in noon or afternoon cone period (TRB, 2000). So, all day and morning were selected to be the survey time periods and the survey was carried out in January, 2010.

### GENERAL TRANSPORTATION CHARACTERISTICS

The characteristics of a residential quarter include several aspects. For example, the general characteristics is about name, location, land area, floor area, etc., characteristics of time focus on the time at which residents or visitors arrive and leave; characteristics of vehicle imply vehicles possessing capacity, including private cars, motorcycles (electric bicycles), bicycles, etc. And the last characteristic analyzed in this chapter is the quantity of parking facility in a residential quarter.

**General characteristics:** A residential quarter is a concentration area that people live in. In this survey, the land area of selected samples are mostly more than 10000 square meters, some of which are over 100000 Sq.m. The average floor area of these samples is over 80000 Sq.m and the Floor Area Ratio (FAR) is 1.4.

The population, in most cases, is less than 500 and on an average of 2240. The average occupancy ratio is 85%. In addition, there has a strong relativity between population and floor area, as shown in Fig. 1.

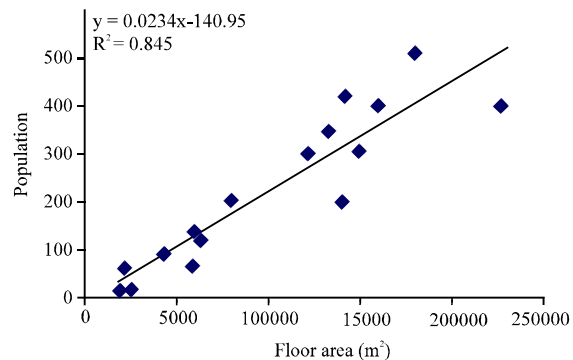


Fig. 1: The relation between floor area and population

**Characteristics of time:** Most residents leave their residential quarter around 7:00-8:30 a.m., some will leave at 9:00 a.m. or even later. The cone periods for going back in general are 5:00-6:30 p.m., earlier or later individually.

However, visitors arrive averagely in a year, without significant seasonal or monthly variation. So it is in weekdays, but least at weekends.

**Characteristics of vehicle:** According to the survey, the quantity of private cars, motorcycles (electric bicycles) and bicycles that per 100 residents own in a residential quarter is 58.1, 56.7 and 58.5 respectively, which are very close to each other.

**Characteristics of parking facility:** Parking facilities of residential quarters in Suzhou are mainly ground parking lots, accounting for 72% of the total, while underground parking lots are with the percentage of 27%. In addition, there is almost no parking lot near by and a very few even inside. The parking space per square meters of floor area is less than 1 and the average value is merely 0.28 because of the significant difference between each residential quarter.

**DEMAND OF SITE TRAFFIC**

After researching on the general information of 16 selected residential quarters, this study further studies the demand of site traffic. In this chapter, the survey objects are reduced to 14, including 13 ordinary residential quarters and 1 high-class villa. The research was made in all day and the morning of ordinary workdays. Through the studies of peaking characteristics, peak hour trips prediction model as well as the number of persons in the vehicle, this chapter aims to analyze the demand of site traffic in residential quarters.

**Peaking characteristics:** This survey researches the volume of persons, vehicles and bicycles in order to get the peaking characteristics, such as rush hour and peak hour.

- **Volume of persons:** According to Fig. 2, the rush hour for persons in an ordinary residential quarter is generally 7:30-9:00 a.m. in the morning and 5:00-6:00 p.m. in the afternoon, while the peak hour is 8:00-9:00 a.m. of weekdays. In terms of high-class villa, the rush hour is 8:30-9:30 a.m. and 2:30-4:30 p.m., shown in Fig. 3
- **Volume of vehicles:** For vehicles, the rush hour of trip generation rates in an ordinary residential

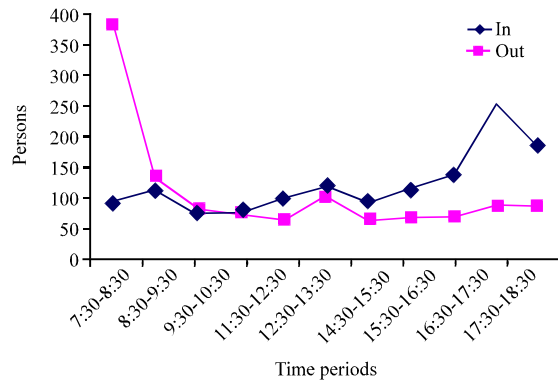


Fig. 2: All day volume of persons in an ordinary residential quarter

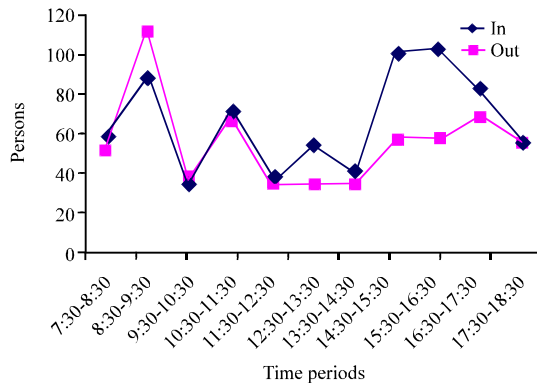


Fig. 3: All day volume of persons in a high-class villa

quarter is 7:30-9:00 a.m. and 5:00-6:00 p.m. while the peak hour is 8:00-9:00 a.m., which is similar to the volume of persons. However, the rush hour of trip generation rates in a high-class villa is 8:30-9:30 a.m. while other hours are almost the same

- **Volume of bicycles:** For bicycles, the rush hour of trip generation rates in an ordinary residential quarter is 7:30-9:00 a.m. while the peak hour is 8:00-9:00 a.m. However, the rush hour of trip generation rates in a high-class villa is 4:00-5:30 p.m.

**Peak hour trip prediction model:** The peak hour trip prediction model is made through the relationship of peak hour trip to both land area and floor area. In this part, the prediction model only focuses on ordinary residential quarters.

By regression with land area and floor area respectively, it is concluded that peak hour trip has a good relativity with both of them, as shown in the above Fig. 4 and 5.

**Number of persons in the vehicle:** In order to get the actual using efficiency of different vehicles, this study also studies the number of persons in the vehicle, for example, private cars and taxis.

- **Private cars:** According to Table 1, the average number of persons in a private car is 1.4, which mean square deviation is 0.6 and the coefficient of variation (CV) is 0.44
- **Taxis:** According to Table 2, the average number of persons in a taxi is 1.6, which mean square deviation is 0.8 and the coefficient of variation (CV) is 0.5

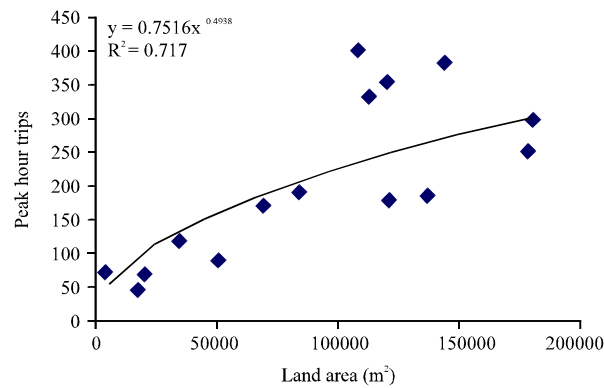


Fig. 4: The relation between peak hour trip and land area

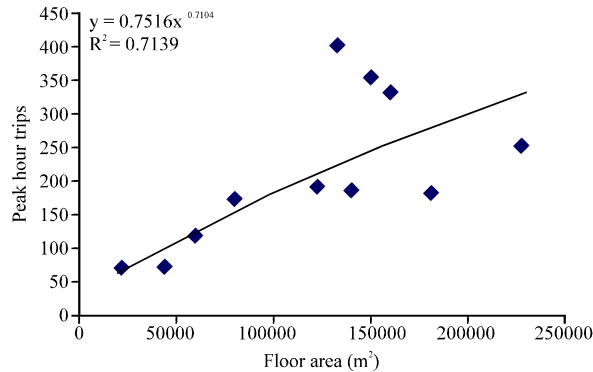


Fig. 5: The relation between peak hour trip and floor area

Residential quarters	Total persons	Total private cars	Mean value
	1070	787	1.4
	Mean square deviation		CV
	0.6		0.44

Residential quarters	Total persons	Total taxis	Mean value
	198	123	1.6
	Mean square deviation		CV
	0.8		0.5

**TRIP RATE OF SITE TRAFFIC**

One of the most critical elements of site impact studies is to estimate the amount of traffic to be generated by a proposed residential development (Stover and Koepke, 2002). This is usually done by using trip generation rates. Rates are commonly expressed in trips per hundred square meters of floor area of development. And trips are defined as a single or one-directional travel movement with either the origin or destination of the trip inside the study site (ITE, 2010). The trip rates discussed in this chapter is collected during the peak hour (8:00-9:00 a.m.).

**Volume of persons:** According to the trip rate of persons in an ordinary residential quarter listed in Table 3, the related coefficient of trip rate of persons-per hundred square meters of floor area regression curve is only 0.5, while CV of trip rate is 0.46 and the mean value is only for reference.

The trip rate of persons in a high-class villa is listed in Table 4.

**Volume of vehicles:** Trip rate of vehicles is calculated by trip generation because it may reflect the reality more accurately. According to the survey, the trip rate of vehicles in an ordinary residential quarter is listed in Table 5.

The related coefficient of trip rate of vehicles-per hundred square meters of floor area regression curve is only 0.5, while CV of trip rate is 0.5 and the mean value is only for reference.

Table 3: Trip rate of persons in an ordinary residential quarter (person/hundred square meters)

Parameters	Average inbound rate	Average outbound rate	Average trip generation rate
Rate	0.37	0.58	0.95
Mean square deviation	0.04	0.08	0.19
Minimum value	0.15	0.34	0.51
Maximum value	0.60	1.30	1.88

Table 4: Trip rate of persons in a high-class villa (person/hundred square meters)

Parameters	Average inbound rate	Average outbound rate	Average trip generation rate
Rate	0.35	0.45	0.8

Table 5: Trip rate of vehicles in an ordinary residential quarter (passenger car equivalents /hundred square meters)

Parameters	Average inbound rate	Average outbound rate	Average trip generation rate
Rate	0.08	0.12	0.20
Mean square deviation	0.00	0.00	0.01
Minimum value	0.02	0.07	0.10
Maximum value	0.18	0.19	0.32

Table 6: Trip rate of vehicles in a high-class villa (passenger car equivalents/hundred square meters)

Parameters	Average inbound rate	Average outbound rate	Average trip generation rate
Rate	0.1	0.12	0.22

Table 7: Trip rate of bicycle in an ordinary residential quarter (bicycle equivalents/hundred square meters)

Parameters	Average inbound rate	Average outbound rate	Average trip generation rate
Rate	0.22	0.35	0.52
Mean square deviation	0.02	0.05	0.10
Minimum value	0.03	0.11	0.14
Maximum value	0.51	0.79	0.97

Table 8: Trip rate of bicycles in a high-class villa (bicycle equivalents/hundred square meters)

Average			
Parameters	Inbound rate	Outbound rate	Trip generation rate
Rate	0.12	0.03	0.15

The trip rate of vehicles in a high-class villa is listed in Table 6.

**Volume of bicycles:** The trip rate of bicycles in an ordinary residential quarter is listed in Table 7.

There is no relativity in the trip rate of bicycles-per hundred square meters of floor area regression curve, but CV of trip rate is 0.6 and the mean value is only for reference.

The trip rate of bicycles in a high-class villa is listed in Table 8.

### CONCLUSION

This study researches on the transportation characteristics, such as volume of persons and vehicles as well as its relation between land area and floor area, so as to get the relevant parameters and trip prediction model

of site traffic. In addition, this study provides some scientific survey data and methods not only to give reference to residential development in the future, but also to help in updating the transportation design concept, making a safe and efficient traffic environment as well as creating a harmonious city for both persons and vehicles.

### ACKNOWLEDGMENT

This study was supported by Urban Planning Bureau of Suzhou City.

### REFERENCES

- ITE, 1991. Traffic access and impact studies for site development. Institute of Transportation Engineers, USA.
- ITE, 2004. Trip Generation Handbook: An ITE-Recommended Practice. 2nd Edn., Institute of Transportation Engineers, USA., ISBN: 9780935403862, Pages: 154.
- ITE, 2010. Transportation Impact Analyses for Site Development: An ITE Recommended Practice. Institute of Transportation Engineers, USA., ISBN: 9781933452562, Pages: 128.
- Mehra, J. and C.R. Keller, 1985. Development and application of trip generation rates. Report No. FHWA/PL/85/003, Kellerco, INC., Federal Highway Administration, Final Report, January 1985.
- Stover, V.G. and F.J. Koepke, 2002. Transportation and Land Development. 2nd Edn., Institute of Transportation Engineers, USA.
- TRB, 2000. Highway Capacity Manual. 3rd Edn., Transportation Research Board, National Research Council, USA.