The micro-climate environment of urban public transport platform in hot summer and cold winter region of China

L. Li¹, M. Tang¹

1 Faculty of architecture and urban planning, Chongqing University, 174, Shazhengjie, Shapingba, Chongqing 400045, China

SUMMARY

The bus station system plays an important role in urban public service facilities, which provide shelters for the users who are waiting for the public vehicles from bad weathers. So there are a large number of bus stations in the city which are frequently used by people. The better the micro-climate environment of the bus stops provide, the more the low carbon travel way people will choose in the city. In this paper, the facilities of the urban public transport platforms are surveyed, the parameters of micro-climatic are measured and the feelings of users are interviewed in Chongqing which is a typical city in the hot-summer and cold-winter area. The result shows that when there are tall buildings or dense vegetation in the surrounding areas, the bus station can use the shadows of the buildings or vegetation to protect users from the direct solar heat, but the wind environment of platforms was greatly influenced by the canyon wind along the street and the tall buildings down-wash effect in this situation, which resulting a poor shelter from rain. Whereas in the low surrounding buildings and lacking of vegetation shades, the wind environment is more regular, but the bubble globe temperature of the station under the direct solar heat was 10°C higher than that in shadows of the vegetation or buildings. While the platform are supposed to shelter users from the hot air and the direct solar heat. What’s more, there was a higher utilization ratio in the middle part of platforms and near the signs. Therefore, it is necessary to combine the situation of different neighborhoods and the behaviors of the users to reasonably optimize the service facilities of the bus stations and improve the capacity of the shelters from rain and direct solar heat.

Themes: Bus station system, Micro-climate environment, Facilities of the bus station improvement

INTRODUCTION

With the development of social economy and urban construction, Requirements about people's living environment quality are getting more and more attention, in recent years, people concerns from the early simple pursuits of the indoor environment comfort turn to the comfort of outdoor environment.

Building and environment gradually become the center of research in China. China has a huge population, and with the acceleration of urbanization process, more and more people choose to live in the cities. The urbanization process has been accelerating constantly in recent decades. High-speed urbanization and a large influx of people come into the city, bring prosperity to the city while also bringing a series of problems, such as urban congestion problems, medical problems, shortage of educational resources, housing problems and so on. In order to alleviate these problems, the Chinese government is trying to take various measures to solve these matters. For example, in urban transport parts, many cities are encouraging people to use public transport to minimize the use of private cars [1].

Public transport facilities help the city becoming more convenient and fast travel, also improving the people's travel efficiency. It can reduce the use of a large number of private cars, which cause the environmental pollution and traffic congestion problems. Many cities in China are creating "public transport cities" with the theme of public transport, which means that more and more people in the future will be preferred to use public transports. So how to design a more convenient and well-used environment of the bus stops has a greater social value.

At present, the status quo of China's public transport design is still in the same state of design, the factory model of the station facilities’ construct process, although the way to adapt to the process of urbanization in the process of high-speed construction needs, but cannot meet the needs of different climatic background users. The basic climatic conditions of different climatic zones are different. The monotonous design cannot meet the demand under different differences. Therefore, after the social development to a certain stage, it is necessary to take into account the development speed and the quality of development. According to the different climatic zones. The specific situation of the corresponding platform design, can better meet the different climatic conditions of the user's actual use needs.

THE QUESTIONS

In real life, we often encounter such problems, in hot summer, while waiting in the public platforms, people need to use the sun umbrellas to reduce the exposure to sun and high temperature; in the rainy season, the current bus stops' shelters are often not practical. Any problem is often inseparable from the surrounding environment, so the study of this topic will mainly focus on the urban bus stops, its surrounding constructions, vegetation and facilities research to understand the urban space configuration on the impact of microclimate.

The specific research questions in this subject are as follows:
1, the user of the main city of Chongqing, the use of the existing bus station evaluation and optimization of the direction and measures of the bus platform.
2, the impact of urban construction, roads and vegetation on the regional microclimate and the effect.
METHODS

1. The field research

The purpose of field research is to fully and accurately grasp the real situation of the outdoor thermal environment in Chongqing bus stops. There are near 1500 bus stops in Chongqing city subdivision. The main forms of the bus stops have three kinds: (1) Just a bus information sign board. (2) A simple shade roof on the platform in the stop. (3) A simple shade ceiling with several seats in the platform (Fig 1).

![Fig.1 three main forms of the bus stops](image)

According to the surrounding space conditions, the platform shelters can be divided into the following types: (A), there are no shelters (trees or buildings) surround the platform, the stop expose to the sun completely. (B), the platform is set up under the tall trees, using of trees to achieve shading itself. (C), the platform perennial in the shadows of tall buildings, the use of architectural shadows to achieve shading itself. (D), the platform in high-rise buildings and multistories building (or vegetation) junction, shade form is not fixed.

Field research found that due to the differences of the building height, building density and other factors, the impact of the buildings in cities are different. As the buildings construct, the natural wind in the street produced a certain degree of change.

In the city, the winds pass along the street between the tall buildings of the city, like the canyons between the mountains, and the winds are stepping up to form a wind canyon effect. Wind Valley canyon effect will affect the city adversely. On the one hand, the city's trees threat. On the other hand, the city traffic and facilities face the hidden dangers. Under the influence of the wind field, the raindrops floating in the wind in the rainy weather, so in the high-rise area, the current bus station is difficult to achieve the purpose of protecting the users from the rain. And in the lower density urban area, the current platform have a limit shade range , and shade time is limited too. So some platform could achieve the morning shading function, but will be exposed to the sun in the afternoon [2].

The current condition of the bus station in Chongqing City can be summarized as follows: single form, outdated facilities, the lack of necessary service facilities to meet the basic needs of the use and cannot make users feel satisfied.

QUESTIONNAIRE

This questionnaire mainly includes the basic knowledge of the status quo of the bus stops, such as the main use population, the age structure, the evaluation of the surrounding building condition, the perception of the greening evaluation, etc. The questionnaire, which from the user's point of view. Aim at surveying the rationality of the status of the space evaluation. In the survey, the current situation of the bus station was estimated, including the main form of the platform (occlusion patterns and methods), the surrounding space status (building height, building density, vegetation richness, shade effect), from the user's evaluation point of view, the users will have a evaluation of these indicators. In the later period, the similarity between human perception and objective physical index evaluation will be understood through the user's real space perception evaluation and actual correlation data measurement and analysis.

Questionnaire survey in Chongqing, a number of bus stations randomly distributed and recovered a total of 103 valid questionnaires, according to age composition, the largest proportion is 20 to 30 years old; followed by 10 to 20 years old; the third is 30 to 60 years of age, the last is over 60 years of age and children under 10 years of age.

Through the age composition we can know that, the main users of bus station in Chongqing are young people, the age of users between20-30 is the largest proportion. So the need of those user should be considered mainly. Through the investigation of the way to travel in Chongqing (walking, subway, public car, bike, private car and others), the proportion of the bus as the primary choice of travel is 41.11% (walk accounting for 52.24%), Accounting for 28.89% of the second way (The subway accounting for 42.86%), accounting for 22% of the third way (The subway accounting for 28.57%). Through the statistics of the first three ways can be aware of the use of bus trips are living in the second choice, this phenomenon is mainly due to Chongqing's special urban environment and traffic network(Fig 2).

Chongqing is a mountain city, the city's special topography determines the urban transport mode to public transport and walking system. Based on the daily needs of the basic activities of people, walking is preferred for a short distance travel. Subway shortage is the limited number of site settings, Apart from the two travel methods, Due to the large number of sites, the bus system become a good choice for short-distance travel in the city. Investigates of the unsatisfied condition of the current bus station, the result reflect that there are many unpleasant aspects in the bus stops in the main city of Chongqing. In the survey, we felt that the first three index are: air quality at the platform was poor (58.25%), the shade effect is poor (56.31%), and the noise (51.46%). The following parts are temporary resting seats (48.54%), no wind (48.54%), no rain (47.57%), Convenient facilities (33.98%). The index of above problems are more than 30%. we can see that these problems on the platform shade, shelter, and other aspects of hot and humid environment, but also on the convenience of facilities, indicating that these problems in the main city of Chongqing The status of the bus station is more prominent, but also the lack of local bus station(Fig 3).

Combined with the form of public platform, it is not difficult to draw the previous article on the bus station is not satisfied with the main problems arising from the reasons. As the existing bus station facilities are relatively simple, mainly based on bus information signs and simple shade roof as the main facilities, it is difficult to achieve shade rain and wind requirements. The survey of the needed facilities in the bus stops can be seen as following: trash cans, seats, sunshades, queues, barrier-free design, etc. This also reflects the lack of the current bus platforms in these areas, these needs are the improve direction.

Through the analysis of several major problems of the questionnaire survey, it can be seen that the Chongqing bus has played an important role in the daily travel to the citizens, mainly using the young people aged 10-60 years, but because of the unique Terrain and other factors, the bus station in the use of reality and cannot make users satisfied, mainly due to
the existing facilities in the bus station behind the form is too simple, the lack of a complete infrastructure and related service facilities. Residents on the use of public homes comfort requirements, mainly reflected in the demand for sun shade capacity (Fig 4).

**MEASUREMENT**

(1) The experiment method

We selected the bus stops of 10 roads around the Three Gorges Square in Chongqing as the object of study. We used the black global temperature, air temperature meter and anemometer to select the weather in the summer, and the data were measured for each of the three stations. The main measurement indicators for the black ball temperature, air temperature and wind speed. The data obtained for each section of the average (Fig 5).

(2) The analysis of the study object

The Three Gorges Square is an important commercial circle in Chongqing. There are 10 major roads around the road. There are differences in the building density and vegetation coverage on both sides of the road. Therefore under the same climatic conditions, there are certain different wind-heat environments in different neighborhoods.

As the research object of the 10 road belongs to the city of Chongqing' mature business section. The main shade trees on both sides of the road are Huang Jue tree and Ficus microcarpa, the basic growth situation is basically the same. So take the average level of tree cover index as the statistics to judge the street shade level [3].

For the statistics on the main building conditions of each street, the ratio D / H of the average street width and the average height of the buildings on both sides is used as the measure of the main building condition.

Through the statistics can be learned, the proportion of trees shade from high to the end are: Xiao Longkang new Street 86.90%, Yu bei Road 78.1%, Han Yu Road 77.3%, sand modulation road 75.7%, Xiao longkan Street 75.4%, Sha Yang Road 74.9 %, Tian Chen Road 63.35%, Station Street 61.75%, Sha Bei Street 52.3%, Shan nan Street 36.8%.Street construction of the D / H from small to large are: Sha South Street 4.455, Han Yu Road / dragons Street, 0.556, Tian Chen Road 0.588, Station Street East 0.625, Sha North Road / Sha zhong Road / Xiao longkankan Street 0.567, Sha Yang Road / Yu Bei Road 0.833.

(3) The experimental results analysis

Through the measurement of these bus station, street D / H value in ascending order to get the relevant parameters of the statistical chart. In order to assess the impact of street microclimate on the existing vegetation and construction teams, the difference between the black ball temperature and the air temperature measured near each street bus station is one of the evaluation indexes [4]. Now use the control scalar method, the temperature difference, D / H, vegetation coverage, wind speed and other four indicators were compared and analyzed as follows:

A. Shayan jing Road and Yu Bei Road, Xiao longkankan Street and Xiao Longkankan Street, the control variable for the street D / H value. After comparison, it can be seen that when the vegetation coverage is increased and the street D / H value is the same, the vegetation coverage increases and the wind speed decreases. The temperature difference has an increasing trend.
B. Sha Nan Street, Han Yu Road, Tin Chen Road. The control variable is the temperature difference. It can be seen that D / H value: Sha Nan Street < Han Yu Road < Tin Chen Road, vegetation coverage: Sha Nan Road < Tin Chen Road < Han Yu Road. At this time there is the street wind speed: Shan Nan Street < Tin Chen Road < Han Yu Road situation.

C. Yu Bei Road and Han Yu Road, Sha Yang Road and Sha Road Road, the two groups of roads through the Three Gorges Square, the coherence of the road, Sha Yang Road and Sha Road Road, the same width, Yu Bei Road and Han Yu Road, Which Shanyang Road and Chongqing Beibei Road to the same line. Can be seen, Sha yang Road to the direction of sand Road, street D / H value decreases (that is, sand on both sides of the building height), vegetation cover green is basically the same, when the wind speed Sha Yang Road, less than sand Road; Road to Han Yu Road direction, street D / H value decreases, vegetation cover green is basically the same, this time the wind speed Yu Bei Road is less than Han Yu Road.

D. The D / H values of the four dragons are basically the same. It is found that the wind speed difference is small, but the vegetation coverage and temperature difference are basically the same; the wind speed of Sha North Street and Xiaolong Kancheng Street is the same, and the vegetation coverage rate is high More; Xiaolongkang New Street and Sha North Street, the temperature difference is basically the same, Xiaogang Kani Street vegetation coverage is relatively high, but the wind is relatively reduced.

From the above analysis we can draw the following conclusions:

A. the street D / H value and vegetation cover have a greater impact on the wind speed of the street. When the D / H value is reduced, that is to say that the buildings on both sides of the road are larger, the streets show the canyons, the street wind speed is often larger; but the higher the vegetation coverage of the street, the wind speed is smaller, indicating that the street vegetation has obvious wind ..

B. vegetation coverage will significantly affect the street temperature changes, and wind speed will not have a greater impact on the temperature. The higher the vegetation coverage rate, the bus stops near the black ball temperature and air temperature difference will be greater, indicating that vegetation cover is an effective means of slowing down solar radiation. The change in street wind speed is difficult to affect the block temperature. (Fig 6~Fig 8)

RESULTS

Through the analysis of the perennial basic meteorological data in Chongqing area and the current situation of the main city bus stops, we can draw the following conclusions:

1. Chongqing main city bus stop’s design needs to take the sun shade and shelter capacity into account. First of all, the unique terrain of Chongqing has resulted in the difference of microclimate in different urban areas. The location of the existing bus stops is mainly based on the basic functional requirements of the relevant laws and regulations (which is the problem of many cities). And not taking the impact of the surrounding environment on the bus platform into account. Second, the design of the site is stereotyped, the lack of regional design for different climate areas. There are differences in the wind-heat conditions in different areas of the city. In some cases, there are some windbreaks in the neighborhood (the height of the buildings on both sides of the street is easy to form the wind valley effect). Some blocks lack the ability to cover the rain (the lack of tall vegetation or buildings, so it cannot achieve shelter function). The current bus platform design cannot meet the needs of different neighborhoods to avoid adverse weather.

2. The bus stop’s design need human’s care. There is a phenomenon in Chinese cities, that is, The main user in the morning and evening peak hours of public travel is middle school workers, and at other times the main middle-aged for the elderly. There are differences in the use and behavior patterns of users at different times. At present, the single function of the platform design is only a meet the needs of the waiting area, which is mainly based on the function, not taking into account the bus station as an important public service facilities, but also in the use of the user feel physically and mentally happy.

3. The building space situation on the wind environment has a significant impact. The ratio of the street width D to the height H of the building on both sides of the block, that is the relationship between D / H, affects the wind environment and shade of the block. When the D / H value is smaller, the street wind speed will increase, making the street ventilation effect increases, the problem to a certain extent to the rainy season bus station shelter problems. But the value does not have a significant impact on the temperature of the street.

4. street vegetation conditions on the district wind heat environment will have an impact. The higher the vegetation coverage rate, the stronger the weakening effect of vegetation on the street winds, and the large area of vegetation in the neighborhood has a good effect on reducing the solar radiation in hot summer months [5].Therefore, the means to achieve a better shade in summer is to combine the bus station with tall trees or green plants designed to be covered with green plants, using the vegetation to achieve the sun shade cooling,

REFERENCES