

Greenway design for electric bicycles in Asia: A Beijing Case Study

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Introduction

The cases studied here are two greenways that have been complied recently in Wanshoulu community of Beijing, China. This paper examines allows the use of electric bicycles in community greenways, and how to be better for electric bicycle passage in the community greenway design. The two community greenways are both along the north and south sides of the Jingou River, and there are totally 8 residential districts connected to 2 bus stations and 1 subway station in the surrounding (Figure 1).

Background

In high density cities in Asia, the number of electric bicycles is increasing. Up to December 2014, China's electric bicycle ownership is more than 200 million, and it is still growing. Moreover, there is a trend to use electric bicycle to replace the bicycle. Due to the following reasons, the electric bicycle will play an important role in the daily commute of China and other Asian high density cities: (1) Energy saving, environmental protection, emission free. The energy consumption of electric bicycle is only about the 1/10 of the car, and discharges no pollution in the process of using. (2)The travel distance of electric bicycle is much longer than normal bicycle, it can meet most of the travel requirements of residents. At present, the electric bicycle, in a full power condition, can travel mileage of about 40~70km. Beijing Academy of Social Sciences reported that 44% of the daily travel distance of the residents of Beijing is less than 5km(Guo Jifu et al., 2011). (3) With the properties of small size, no traffic jam can prevent electric bicycle from reaching the destination on time. (4) Electric bicycle is easy to park and easy to use. Even in the most cold season, some of the wind prevent design of the electric bicycle can still suitable for winter travel, and the winter is not too long in most of the high density cities of Asian. (5) Road is occupied less. The road area occupied by the electric bicycle is only about the equivalent of the 1/5 of the motor vehicle. (6) The price of electric bicycle is low, which is only 1/50~1/100 equivalent of the car.

At present, because of its numerous users of electric bicycles, this traffic tools also cause a certain degree of troubles for urban motor transport and non-motorized traffic: (1) Because the speed of the electric bicycle is higher than that of the bicycle and lower than that of the motor vehicle, so it is difficult for

electric bicycle to share the lanes with the other two. (2) No matter we like it or not, many electric bicycle has appeared in a variety of greenways, running in the line with pedestrians (Zhu Jiang and Lai Shouhua 2012). (3) It is very difficult to limit the entry of the small size electric bicycle into the greenways. If we can actively guide the electric bicycle instead of restrict its access to the greenways, and combine greenways construction with electric bicycle, we can improve the present situation greatly. Greenways have a variety of functions such as commuting, recreation, leisure and so on. In the community greenways, the commuting function is foundation. It should be met firstly. And the construction of the greenways in the high density city in Asia should conform to the trend of the growth of electric bicycle. The planning and design of community greenways should be combined with the traffic and parking of electric bicycle.



Figure 1. Beijing Jingou River Waterfront greenway plan (Figure RS for residential district, GW for green road, PA for park, SW for subway, BS for bus station)

Goals and objectives

The goal of building a community greenway should include the use of electric bicycles. This is the fact that must be accepted for the construction of a community greenway in the high density cities of Asia. From this case, electric bicycle is more popular in the spring, summer and autumn seasons within residential district. Combined with the use of electric bicycle, when we build community greenways in the high density cities, we should connect the greenways and residential district with the bus stations, supermarkets and subway stations. What's more, we should also provide battery charging, the

electric bicycle rental, parking and other services in the greenway for electric bicycle. Besides, the electric bicycle, bicycle and pedestrians requirements should all be considered in the process of design.

Method(s) and Discussion

Facilitate the using of residents, the residential districts, public transportation and subway should be linked up

At present, the community greenways service 8 residential districts around the Jingou River. When the residents want go to nearby bus stations, subway stations, as well as supermarkets, schools, etc. if they go through these greenways, it requires 10~20mins by walk, but only 5~8mins by electric bicycle. So it is not strange that in the spring, summer and fall, the electric bicycle becomes the first choice for many families in the nearby residential district.



Figure 2. Wangshou Road Community Lane (left) and the Green Road after the reconstruction (right)

In this case, the main challenge for electric bicycles is the risk of mixed traffic with motor vehicle (Wang Jie et al., 2014). The risk performance in 2 aspects: (1) The electric bicycle occupies the motor vehicle lane sometimes, which is easy to lead a traffic accident. For example, in the community in the south of the 5~8 residential district, before the reconstruction, the residents from various residential districts who want to take subway line 1 and line 10 had to take up the inside of the motor vehicle lane, since non-motorized vehicles lane along the way are often occupied by motor vehicles, electric bicycles and so on. (2) There is a mixture of electric bicycle and bicycle in the outside lane of the road. In the motor vehicle lane on the south side of the Jingou River, the electric bicycle and the bicycle are mixed on the outside lane of the road. Because of the difference of speeds is quiet large, especially for some shuttle children vehicles, they often occur the dangers of traffic accident.

With the use of electric bicycle, the construction of community greenway can conveniently connect residential districts and city public transportation, subways, supermarkets, schools and other service facilities together. In the seventh residential district, there are about 80 electric bicycles. Before the reconstruction, these electric bicycles are all go through the Jingou River Road to the bus stations and the subway stations. Pedestrians and cars are mixed in the same road, it is not only dangerous but also often blocked. After the reconstruction, most of the electric bicycles go through the community green road leading to the bus stations, supermarkets, schools and subway stations, it become more convenient and safe.

Appropriate bending of the greenway shape

In order to meet the needs of electric bicycle travel, let electric bicycle travel more convenient, the community greenway should take a curving shape. (1) The road with bending shape can reduce the speed of electric bicycle and the bicycle to a more safe degree. In the community greenway, there is a certain degree of mixing among the electric bicycle, the bicycle and the pedestrian. To take the curving shape could reduce the speed and the risk of the traffic danger. (2) Taking curving shape can provide a rich landscape visual (Wu Junyu and Xu Jianxin 2015). Community greenway's scale isn't very large generally, take the bend of the road shape can produce different walking scene and small landscape effect. It is very important for both pedestrian and bicycle. (3) It provides the residents with larger area to carry out all kind of community activities. Community greenways should provide residents with a large number of fitness, communication, leisure places, which takes 20~25% of the total area of the greenway. Taking the curving shape greenway and pushing the greenway to one side of site land can also increase the area of square for residents. (Figure 3).



Figure 3. Wanshou Road community Greenway, the same angle view comparison before (left) and after (right) reconstruction

Pedestrian and electric bicycle

Compared the situation of traffic before and after reconstruction in this case, we will find that combined with the electric bicycle traffic, community greenway should appropriately increase its width, if the width of the greenway is enough, the electric bicycle way should be separated from the motor road. (1) To appropriate increase the width of the main road of the community greenway, so that it can meet the requirements of the electric vehicle and pedestrian at the same time. The main road should be more than 4m wide, both sides set the 0.9m width sidewalk, and 2.2m for non-motorized bicycle, and electric bicycle using road in the middle. (2) If the green road is wide enough, we can set up a special road for pedestrians and electric bicycles. (WANG Hongyan and WANG Shudong 2014). In this case, the special road for the electric bicycle and the bicycle are respectively arranged in the community greenways of both side of the JINGOU River. In the north entrance of No. 5 residential district, entrance and exit of both bicycle, pedestrian and electric bicycle are separately set. Electric bicycle and bicycle rely on the right side of the road to enter the road, and pedestrian road is set at the left. The turning radius of the electric bicycle lane is much larger than bicycle, and the distance is longer. The pedestrian road is more curved and the distance is shorter. The road forms conform to the two traffic habits, so that the two naturally separated, which reduce the contradiction between cars and pedestrians (Figure 4).



Figure 4. Comparison between the pedestrian and the electric bicycle in the Wangshou Road community

Set the bus stations in the community greenway



Figure 5. Greenway pedestrian road before and after the reconstruction

If the length of the community greenway is larger, we can set bus stations or subway stations as well in the central. We can set the electric bicycle parking place nearby the bus station, so that it can have a convenient connection between residential district and public transport (Xiao Ma et al., 2014). (1) In the community greenway, bus station can be set to reduce the contradiction between the bus and the private car. In this case, two community Greenways is about 1.5km from the East to the West. At present, the bus station is located at the entrance and exit of each residential district. However, contradictions often occur between private cars and the bus station. If the bus station has been set in the community greenway, residents of these communities would be able to reach the bus station through the greenway, so this contradiction could be eliminated probably. (Lv Yang et al., 2014). (2) If we set the bus stations in the community green road, then we can let the residents ride electric bicycle to reach the bus stations, and it is also convenient to transfer with the bus and subway. In this case, because the bus station is usually set in the community at both ends of the greenway, when residents take the electric bicycle to the bus station, subway, etc., they always meet the parking problem. Therefore, if the bus stations, subway stations and other facilities have been set in the community greenway, it would be more convenient for residents to use the community greenways (Figure 5).

Conclusion

(1) To facilitate residents, greenway should be designed with electric bicycle so as to increase the neighbourhood and reduce the city traffic congestion. The community greenway construction in high density city in Asia should combine with the use and maintenance of electric bicycle.

(2) To improve the connection between the residential district, the bus station and subway, curve shape road, pedestrians and electric bicycle separation, as well as set the bus stations in the community greenway and other strategies should be used in greenway design.

(3) Combined with the use of electric bicycle for community greenway construction, we should not only pay attention to the electric bicycle parking, rental, but also we should avoid the interference of the electric bicycle to the open space of the community greenway.

Acknowledgement

This research is supported by the National Natural Science Foundation of China, No. 51378018

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