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RESEARCH PAPER

Research on the Way to Determine Types and Scales of Bus Stops

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Abstract: The bus stop is a kind of primary facility in bus operation and it is very important as it provides the possibility of passengers' alighting and boarding. In the initial stage of land use and bus development, simple design of stops can meet the needs of the dwelling of buses, and passengers' alighting and boarding, but as land-use and bus system develop, simple design will not meet the needs of buses and passengers on some concentrated lines with passengers crowding the bus stops. In those stops, the dwelling time of buses increases and the level of bus service deteriorates. Therefore, it is necessary to do more research on the types and scales of stops, to ensure the harmonization between capacity and needs. After the discussion of type classification and applicability, stop capacity calculation and bus operational characteristics, a method to determine types and scales of stops is given here. By this method, the types and scales of stops can be determined when the number of buses and passengers is given. Finally, some examples are shown for implemental suggestions.

Key Words: bus stop; type; scale; level of service

1 Introduction

The bus stop is a kind of primary facility set along the roads and bus routes. In stops, buses dwell and provide services for passengers. The bus stops play an important role in bus operation.

The types and scales of bus stops can affect the capacity of buses directly, and then affect the capacity of bus routes and the service level[1]. In the initial stage of land use and bus development, the number of bus routes, vehicles and passengers are not very huge and simple stops on a small scale can meet the needs of buses and passengers. But as land-use and bus system develop, simple stops become the bottleneck of LOS (Lever of Service), especially in some concentrated routes and passenger-crowded sections. In those stops the dwelling time of the buses increases, buses wait in a line like a train and the level of bus service deteriorates. It is highly necessary to do more research on the types and scales of stops to ensure the harmonization between capacity and needs.

2 The types of stops and their applicability

On the basis of researches and practice[2,3], the types of bus stops can be divided into four types: normal stops, bus bays, multi-platform stops, and multi-bay stops which are shown in Fig. 1.

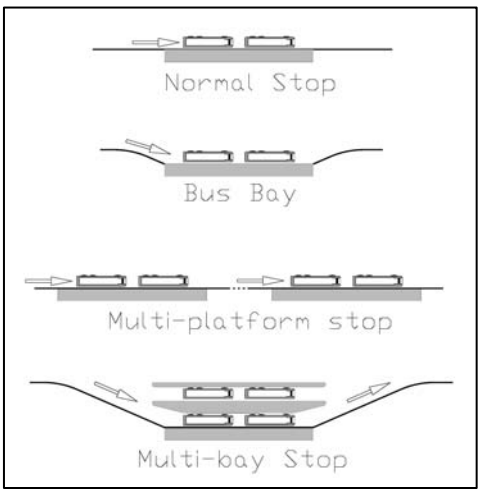

Fig 1 Types of bus stops

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Normal stop is the primary type, which is at the site road section and keeps the original appearance. The only difference from other places is that the shelter and signal board are equipped and the berth drawn. This type of stops can be set quickly and economically. It fits those sections where the number of routes and passengers is not large and traffic pressure is not high.

Bus bay is the type with an extra lane at the stop site where buses can dwell on the extra lane. Because of the lower interfering, other vehicles can run at higher speed, and the service level of buses can be improved. Generally, to get better level of bus services and to create a better situation for other vehicles, all normal stops should be made in this way, if the section permits.

At those concentrated site routes where passengers crowd, interactions among buses and other vehicles become serious and only one extra lane is not enough for the buses and passengers; therefore, it is necessary to set more extra lanes for the dwelling buses. These types of stops with more than two extra lanes can be called as "multi-bay". This type of stop construction needs more lands and funds, and the construction will take more time.

At those concentrated routes with passenger-crowded sites, if there is no possibility to reconstruct a multi-bay, construction of a multi-platform stop is recommended. A multi-platform stop contains two or more separated platforms; therefore, buses and passengers can be divided into two or more groups. Comparing with normal stops or bus bays, using this kind of stop can cut down the length of bus queues sharply and the waiting time of passengers can also be shortened. But still, because of the decentralization of waiting areas, interchanges between routes will be less convenient.

3 Need for effective berths

The capacity of a stop can be shown as the maximum number of buses that can provide service to passengers with a certain level under a certain situation. The capacity can be affected by many factors, such as, passenger number, vehicle characteristic, operation mode, road traffic, stop type, and so on[4,5].

With reference to "Highway Capacity Manual (2000)", the capacity of a bus stop can be shown as the equation below:

$$B_s = N_{eb}B_{bb} = N_{eb}\frac{3600(\frac{g}{C})}{t_c + (\frac{g}{C})t_d + Z_a c_v t_d} \tag{1}$$

Where,

B_s: maximum number of buses in a stop, per hour (veh/h);

N_{eb}: number of effective berths (for a normal stop, if there is only one berth set, the capacity of the stop is equal to the capacity of an "effective berth");

B_{bb}: maximum number of buses per berth per hour (veh/h);

g/C: effective green time per signal cycle (1.0 for a stop not at a signalized intersection);

t_c: clearance time between successive buses (s);

t_d: average dwell time (s);

Z_a: one-tail normal variate corresponding to probability that queues will form behind bus stops. In urban area, the value can be 1.280;

C_v: coefficient of variation of dwelling times; the value can be 0.6 here.

For dwelling time, "Highway Capacity Manual" gave an equation as:

$$t_d = P_a t_a + P_b t_b + t_{oc} \tag{2}$$

Where,

P_a: alighting passengers per bus through the busiest door during peak 15 min (p);

t_a: passenger alighting time (s/p);

P_b: boarding passengers per bus through the busiest door during peak 15 min (p);

t_b: passenger boarding time (s/p);

t_{oc}: door opening and closing time (s).

Now in Guangzhou, China, passengers get on the bus from the front door, and get off from the back door and there is no need to add the two parts as shown in Eq. 2. The modified one should be as in Eq. 3:

$$t_d = \max(P_a t_a, P_b t_b) + t_{oc} \tag{3}$$

Therefore, Eq. 1 should be modified to Eq. 4 as below:

$$B_s = N_{eb}\frac{3600(\frac{g}{C})}{t_c + (\frac{g}{C} + 0.768) \times (\max(P_a t_a, P_b t_b) + t_{oc})} \tag{4}$$

From investigation, some values present in Guangzhou are:

t_a=1.3 s/p; t_b=2.5 s/p; t_{oc}=2 s; t_c=15 s.

So Eq. 4 can be changed to Eq. 5:

$$B_s = N_{eb}\frac{3600(\frac{g}{C})}{15 + (\frac{g}{C} + 0.768) \times (\max(1.3 \times P_a, 2.5 \times P_b) + 2)} \tag{5}$$

To set up a stop properly is to let the capacity of the stop meet the needs of the buses, that is:

$$V_{ND} \le B_s \tag{6}$$

Where V_{ND} means the number of buses needed to pass the stop.

Then the need of effective berths can be drawn from Eq. 7.

$$N_{eb} \ge \frac{V_{ND} \times (15 + (\frac{g}{C} + 0.768) \times (\max(0.6 \times P_a,\ 2.5 \times P_b) + 2))}{3600(\frac{g}{C})} \tag{7}$$

Then, to get the effective berths, investigation and calculation of bus number, alighting and boarding passenger