

The Relationship Between on-Street Parking Resource Utilization and Dynamic Transportation

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Abstract

On-street parking is a type of parking that is common in cities. The reasonable and unreasonable setting of on-street parking will directly affect all aspects of dynamic transportation. Therefore, the relationship between on-street parking and dynamic traffic and the changing characteristics of traffic flow during on-street parking are studied, and based on this rational use of on-street parking resources, a series of problems caused by unreasonable parking in the road can be effectively avoided. These problems are the reduced capacity of road sections and intersections, causing serious congestion and delays, and even possible traffic accidents.

Keywords

on-street parking; road capacity; dynamic traffic.

1. Introduction

With the development of social economy, the number of urban motor vehicles in China has increased rapidly. The growth rate has been particularly rapid in recent years. The rapid growth of urban motor vehicles has led to a surge in urban traffic in China, and the problem of "difficult parking" has become increasingly prominent. The management of static traffic is seriously inadequate, and the negative impact on dynamic traffic is increasingly obvious. Urban road traffic has serious road traffic capacity that cannot meet the demand for traffic, and congestion is frequent.

The parking lot can be divided into on-street parking lot and off-street parking lot according to the nature of its land use. On-street parking lot refers to the site designated for parking of motor vehicles within the control area of road red line [1]. On-street parking has certain requirements on the width of the road. It is generally installed on both sides of the roadway, on the side of the non-motor vehicle lane or on the inside of the green belt. It is often used for short-term or nighttime parking. It can be opened at any time without any regularity [2]. On-street parking and off-street parking together form the urban parking system, and on-street parking is an integral part of the parking system. Therefore, on-street parking has become the focus of scholars in related fields at home and abroad.

To understand the relationship between on-street parking and dynamic traffic, based on the advantages of on-street parking, comprehensive consideration of current road capacity, traffic demand, off-road or public parking facilities, traffic control capabilities, to plan on-street parking in urban parking The best configuration, as well as the reasonable settings in the road. This will help to realize the scientific and standardized parking management of urban roads in China, fully improve the parking management efficiency and road capacity, optimize the urban road traffic order, and alleviate the urban traffic congestion degree [3]. This paper takes the on-street parking as the research starting point, summarizes the methods and achievements of the predecessors in this field, and summarizes the relationship between on-street parking and dynamic traffic.

2. Advantage of on-Street Parking

There is still a certain percentage of on-street parking in the current developed countries. Whether it is this reality or the way from the on-street parking to fully utilize the road function and the need for parking, the on-street parking should be an integral part of the urban parking system [4].

2.1. On-Street Parking Lot Has Low Capital Investment and Low Construction Cost

Compared with the off-street parking lot and the public parking lot, the on-street parking lot only needs to build a meter when the parking berth is divided, and the construction cost is small. In addition, the maintenance cost of on-street parking facilities is relatively low, the investment recovery period is short, and the investment risk is low. It is not necessary to open up a large amount of valuable land resources for parking in areas where urban land resources are scarce [1].

On-street parking lot has small technical problems and is highly operable. Social public parking lots generally require the support of modern high-tech. For example, automatic lifting and parking systems require intelligent automatic transmission equipment. Public parking lots often require huge parking information guidance systems and data collection and transmission system support to realize their benefits. At the stage, these systems require high-tech support and are expensive. In contrast, the way in which the on-street parking lot obtains information is simple and straightforward. It only requires the support of technology such as meter technology and mobile payment, which is much simpler than the public parking technology system [5].

2.2. On-Street Parking Lot Is Easy to Rebuild and Has A High Turnover Rate

Social public parking lots should be used for other purposes, and the cost of reconstruction is high. On-street parking can be changed to a parking berth at any time depending on the road traffic conditions, or the parking berth can be changed to a traffic lane in a traffic jam section [6]. According to the survey, on-street parking is mainly based on short-term parking. The parking time is basically 0~2h, while the off-street parking time is mainly 0.5~4h. Therefore, the on-street parking berth turnover rate will be higher [7]. For example, some Western cities have proven to be effective by allowing parking within off-peak sections to maximize the use of road resources and setting different parking usage functions for different berths at different times. Many western cities allow parking in the short-term on-street parking area [6].

2.3. On-Street Parking Lot to Realize the Door-to-Door Service Of Motor Vehicles

On-street parking is still present in various large, medium and small cities because of convenient stop and take. The parking demanders select the corresponding on-street parking spaces according to their destinations, avoid unnecessary walking distance, shorten travel time, and basically realize "door to door" service. If canceling on-street parking, although it can alleviate the problem of dynamic traffic, it also increases the burden on short-term travel demand, greatly increases travel costs, and has a great negative impact on the psychology of travel demanders.

3. Road Parking Planning Constraints

Since the on-street parking behavior occurs in the inner edge of the road, the on-street parking lot is within the red line of the road. The rationality of the on-street parking planning not only involves the parking problem, but also affects the traffic on the road, which will cause serious

Road traffic congestion causes inconvenience to residents' travel and even leads to traffic accidents.

3.1. Road Conditions

According to the function and grade of the road in the urban road system, it can be divided into four categories: expressway, trunk road, secondary trunk road and branch road [3]. Under normal circumstances, on-street parking is mostly installed on the city's secondary trunk roads and urban branch roads; on the urban expressway, traffic safety and road function factors are considered, and on-street parking is prohibited; in principle, urban trunk roads should not be set up for on-street parking. Only in the premise of not affecting the dynamic traffic operation of the main road and ensuring traffic safety, the on-street parking zone should be set on the road section where parking is too tight; some roads with tighter land use should not be set up for on-street parking; when the longitudinal slope of the road is too large, it is not suitable to arrange the road. Internal parking, generally no more than 4% [7].

3.2. Road Environment

It is not advisable to set up on-street parking. In China, no parking is allowed except for sidewalks, bridges and tunnels. At the intersection, vehicle entrances and exits, crosswalks, fire hydrants, parking signs, road signs, bus stops, signal lights, etc. are not allowed to set up on-street parking points within a certain distance. On-street parking is expressly prohibited near the entrances and exits of commercial, medical, and service properties. On-street parking berths are required to be placed within the long section of the plot and it is forbidden to set a parking space when approaching the intersection [8].

3.3. Off-Street Parking Facilities

The setting of on-street parking facilities should not only be combined with current road conditions and road environment, but also the setting of off-street parking lots. There are off-street parking lots or public parking lots in the current area. Considering the current parking demand, if the demand exceeds the supply of off-street parking lots and public parking lots, consider setting a certain number of on-street parking lots and setting corresponding charging standards and Parking time limit.

4. Main Research Results of the Impact of on-Street Parking on Dynamic Traffic

4.1. Impact of on-Street Parking on Road Capacity

In 1973, Jason used computer to simulate the impact of on-street parking on road capacity. Vehicle travel delays [9]; The US Traffic Engineering Manual states that on the same road with the same width and the same traffic conditions, if there is no on-street parking, The traffic volume is large. At this time, the on-street parking has reduced the road capacity by 1/4~1/3; according to the British survey, the effect of on-street parking on the road traffic speed is reduced by 0.1km /h[10].Zou Zhenyuan mentioned in the "Theories and Applications of Urban Static Traffic Management" [11] that the biggest shortcoming of on-street parking lies in the impact on dynamic traffic and the reduction of road capacity leading to traffic congestion. On-street parking takes up road area, reduces the effective width of the road, and reduces the function of road use. In general, allowing on-street parking, road capacity will be reduced by 20-25%, the smaller the road width, the greater the proportion of capacity reduction.Feng Wei [12] through the summary analysis of traffic flow theory research results, modeling based on BPR model. From the three major categories of traffic operation influencing factors, non-traffic operation influencing factors and on-street parking influencing factors, a two-way two-vehicle road segment is taken as a specific research object, and various factors affecting the motor vehicle flow velocity in the road section are analyzed in detail. .On the basis of qualitative

analysis of the influencing factors of the road parking section, the reliability and accuracy of the survey data are guaranteed. By analyzing the sample size, statistical interval, and data processing methods, the minutes are selected as the survey statistical interval, and finally the pair of data sets required for modeling are obtained. According to the survey data, the influence degree and mode of various influencing factors on traffic flow velocity are analyzed. A speed-flow theoretical model of roadside parking zone with two-way two-lane road is established. Based on the survey data, the software is used to model. The nonlinear regression fitting was performed, and the parameters of the regression model were calibrated, and the fitting effect was good. In the case of whether or not an on-street parking zone is set in a two-way two-vehicle road section, the loss of the roadway and non-motor vehicle lane capacity is calculated by taking three possible situations as an example. The results show that the loss of road capacity is linear with the on-street parking and exit frequency, and the loss of traffic capacity is greater when the width of a motorway is reduced due to the placement of the parking zone.

4.2. Influence of on-Street Parking on the Running State of Traffic on the Road Section

The effect of on-street parking on the signalized intersection is related to the location of the parking vehicle from the intersection. In 2005, Chen Jun and others from Southeast University took the secondary roads of inorganic and non-separated cities as the research objects, and established the relationship model between vehicle speed and vehicle saturation before and after the on-street parking belt. They analyzed the impact of the average number of parking times and the average parking time on the speed of the vehicle, and proposed the traffic saturation index of the on-street parking zone under mixed traffic flow conditions. Finally, the roadside parking was entered and exited. The impact on the traffic flow state at the parking point [14]. In 2015, Tian Qiong established an analytical on-street parking location model based on Markov chain in his paper "Markov Chain Based Parking Positioning Model and Simulation". From the perspective of system and driver, the description of the hopping competition queue is carried out. According to its Markov characteristics, the probability density function of parking location distance is derived. It is found that the traditional binomial distribution hypothesis cannot reflect the competition between the vehicles. The behavior of parking spaces reveals that competition among search vehicles is one of the reasons why the theory underestimates the difficulty of parking. Based on the mathematical analysis, the on-street parking simulation model and algorithm of the ring city are proposed. The simulation results verify the conclusion of the theoretical model and find that the continuous occupancy of the parking space is another main reason for underestimating the difficulty of parking [15].

4.3. Influence of on-Street Parking on Travel Delay

At present, the queuing theory and the traffic wave model are used to analyze the delay caused by the vehicle entering and leaving the berth. However, it is found through analysis that there is a big difference between the result calculated by the queuing theory and the actual value. [16]. Yang Xiaofei [17] analyzed and calculated the delay caused by driving a vehicle into and out of a berth on a two-way two-lane road. When the vehicle is driven out of the berth, it is necessary to find the gap and insert it into the traffic flow. The driver will generally drive in when the gap is large enough, and the impact on the traffic flow is not large, especially when the traffic is small, there is almost no impact. For vehicles traveling in the fleet, once there is parking intention, they will enter the berth to park the vehicle, causing the subsequent arriving vehicles to slow down or wait in line, resulting in delays. Delay analysis of free-flow state vehicles and non-free-flow state vehicles.

4.4. Impact of on-Street Parking on Traffic Safety

The University of Tennessee's "Safety Analysis of On-street Parking" researched by FHWA (Federal Highway Administration) is based on a large number of survey data, from different

road grades, different land types, different parking management methods, different parking lot layouts, etc. Based on the factors related to on-street parking, analyze the safety impacts on parked vehicles, vehicles on the road, pedestrians and parking lots, and establish the relationship between them. The study affects the factors of on-street parking and on-street parking. The factors are considered in great detail [18].

5. Relationship Between on-Street Parking and Dynamic Traffic

Through the analysis of the above research results, the impact of on-street parking capacity on road capacity and the frequency of vehicle parking in the road on traffic delay is obtained. A brief analysis was made because there was less research on traffic safety in on-street parking. When the road width is designed to a certain value, the road capacity can reach the theoretical optimal value. At this time, the road capacity is the largest. When the road width is less than the value, the road capacity will be reduced. The clearance loss caused by on-street parking will also cause loss of road capacity. When the lateral clearance is less than a certain value, the driver will feel psychologically unsafe, thus reducing the speed of the vehicle and causing the utilization of the roadside lane to decrease. When the turnover rate of the on-street parking lot is constant, the reduction factor decreases with the increase of the parking lot capacity, and the motorway capacity decreases with the increase of the parking capacity value; when the number of parking spaces in the on-street parking lot is determined, The reduction factor will decrease with the increase of the peak hourly average turnover rate, that is, the increase of the parking turnover rate will lead to further reduction of road capacity.

When the speed of the vehicle is not affected, there will be no delay to the dynamic traffic; when the vehicle has acceleration and deceleration delays, but the delay is small, and the number of vehicles affected by the non-motor vehicle is very small, and can recover or exceed the original Speed, the amount of delay in this case can be ignored. The vehicle has deceleration, heeling and acceleration delays. The amount of delay increases with the increase of the time of the following, and the number of vehicles affected by the non-motor vehicle is more, which may cause the road traffic to flow smoothly and cause congestion.

The factors causing traffic accidents in on-street parking mainly include the entry and exit of parked vehicles, the movement between the driver after parking and the parked vehicles, the distance between the vehicles and the driving distance caused by parking the vehicles, and the use of driving doors; When the road is used as the access vehicle, the parking vehicle often gets caught off guard when driving in and out of the parking space, causing traffic accidents. The parallel parking of the vehicle door is also suddenly opened. The driver and the pedestrian from the parking vehicle and the pedestrian parking room. Suddenly going out will also cause traffic accidents.

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