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The Comparison Research of Capacity and Saturation Flow Between Chima and UK

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Abstract: In order to ease ever-worsening transportation problems and to improve the utilization of road, this paper takes Chinese traffic capacity and saturation flow to compare with that of UK by collecting video data of 3 intersections of UK and 10 of Beijing China and analyzes the difference and reasons between China and UK. On this basis, we quantitatively analyze the green time lost and quantitatively analyze the capacity and saturation flow of signalized intersections influenced by no-power-driven vehicle. Finally, we put forward several comprehensive resolutions for improving the utilization rate of road and provide suggestions for the authorities.

Key words: Intelligent transportation system, traffic parameters, factors, comparison

INTRODUCTION

With the rapid development of cities, the amount of vehicle increase dramatically which make almost all big cities in the world have encountered transportation problem, such as traffic congestion, disorder, accidents and environmental pollution. And with development the modern science and technology or as the limitation of land resource, Countries in the world have transferred from mainly depending on expanding road network to meet the increasing traffic requirement to using new technologies to reconstruct the existing road traffic system and its management systems, so as to improve the capacity and quality of service of the transportation network. Using the modern management methods and means, organization traffic scientific, regulation traffic flow and high efficiency of road network are the important measures to mitigate the contradiction between traffic supply and requirement.

Traffic problem and service are forcing Beijing city authorities to find innovative transportation solutions. While new road construction is no longer seen as the reasonable approach, due to financial constraints, lack of space and environmental pressures. There is an increasing need for improved techniques for assessing traffic state and for regional traffic organization. In this study, we compare the traffic capacity and flow between China and UK to find the difference and analyze the effect factors. Then obtain good solutions and scheme for the city authorities.

RELATED WORK

The capacity defined in Highway Capacity Manual (2000) is the maximum number of vehicles passes the profile (section) of a lane (road) in a period time under certain road, traffic, environment and controlled conditions. In the case of certain external conditions, the capacity is usually regarded as a constant. While current capacity computation and prediction model almost belong to deterministic methods. Such as America, Canada, Sweden, Australia etc. These representative capacity manual or guidebook is processed capacity as a constant (Highway Capacity Manual, 2000; Richardson and Teply, 1995). Current intersection capacity is mathematical expectation obtained by analytical method based regression analysis prediction or probability statistics (Akcelik, 1981). However, under most cases, these methods are just a rough estimate of capacity, it is not precise value. Due to randomness of drivers' behavior and difference of traffic flow component, even under the same external conditions, capacity is also a random variable fluctuating in a certain range (Rouphail and Eads, 1997; Brilon *et al*., 2008). Pedestrian and non-power-driven vehicle have great influence on vehicle running at signalized intersection.

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Too many factors influence the capacity of signalized intersection, because the system characteristics are multi-dimension, nonlinear and randomness, it is hard to cover all of its properties using theoretical derivation to describe capacity. Therefore, comparing capacity of signalized intersections between China and UK, we can quantitatively analyze many factors influencing capacity of signalized intersection of China and can compensate the shortcomings of certainty capacity calculation. Thus, provide theoretical basis for intersection planning and design, management and decision-making under mixed traffic conditions, thereby promote the rational use of intersection resources and improve the utilization of road resources. Furthermore, intersection is the bottleneck of urban road, the research of capacity of signalized intersections will be the basis for capacity study of road network under mixed traffic conditions.

Capacity of road network is both related to road space and traffic control software and hardware, road use, vehicle organization and management. Because very different results of service will be produced under different traffic component, different ratio of traffic direction and different management. And different traffic status will be produced by different distribution patterns under the same traffic flow. Therefore, there is a best use problem for road and for traffic management authorities, for optimal use of road, they must prescribe usage mode for road and optimize and organize different vehicles by a variety of management measures and means. Management and operation of road based the results of traffic organization and optimization and design will make rational use of road and avoid waste and ease congestion. Pedestrian and non-power-driven vehicle influence capacity of signalized intersection of UK less than that of China under mixed traffic conditions and theoretical calculation is no longer applicable to mixed traffic conditions in China. So, this paper compares capacity and saturation flow between China and UK, qualitatively and quantitatively analyzes the factors influenced capacity of signalized intersection of China and then modified capacity calculation model to apply to China.

DATA COLLECTION

Different traffic information collects by different methods, it is necessary to select traffic information detection techniques and to determine traffic parameters to be detected under a clear demand of information. And we use video camera to collect traffic data of junctions and then process the video data to obtain traffic flow. In this paper, we collect traffic data of 3 junctions for UK and 10 junctions for China during morning and evening peak. Field data for UK is shown as Fig. 1.

VIDEO DATA PROCESSING AND ANALYSIS

Process the collected video data and then calculate real flow, saturation flow and capacity for each junction. The results of Burgess-Avenue Junction of UK are shown in Table 1.

We divide the signalized intersection into four-leg junction and T-intersection; the results are shown in Table 2 and 3.

The capacity comparison between China and UK are shown in Table 4 and 5.

Real flow and capacity of intersection comparison between China and UK and the results are shown in Table 6 and 7.

Fig. 1: Field data collection for junction of UK

Table 1: Real flow, saturation flow and capacity of Burgess-Avenue junction

	East		South		West			North	
	L1	L2	L3	L4	L5	L6	L7	L8	L9
R	1434	1046	517	1516	694	1608	1496	1486	1556
S	1549	1409	0	1632	0	1704	1619	1619	1848
SR	2480	2727	3077	3042					
SS	3039	1632	3463	3467					
C	3039	3264	3463	3467					

R: Real flow, S: Saturation flow, SR: Sum of real flow, SS: Sum of saturation flow, C: Capacity and L1 to L9: Lane

Table 2: Saturation flow of intersection (pcu)

	Through	Left turning
China	1326	1177
UK	1691	1548

Table 3: Saturation of T-intersection (pcu)

	Through	Left turning
China	1465	1380
UK	1575	1758

Table 4: Capacity of intersection (average lane)

	East	South	West	North
China	1386	1326	1221	1327
UK	1514	1616	1701	1753

Table 5: Capacity of T-intersection (average lane)

	East	South	West	North
China	1465	1465	1380	-
UK	1761	1756	1462	-

QUANTITATIVELY ANALYZES FACTORS INFLUENCED CAPACITY OF SIGNALIZED INTERSECTION OF CHINA

Data processing and statistical results show that the differences between China and UK are as follows:

- Signalized junction utilization is lower than that of UK
- Capacity of lane is lower than that of UK
- Saturation ratio of T-intersection is higher than that of UK
- The traffic flow distribution of intersection is not balance in China

The reason is as following:

- The effect of non-power-driven vehicle is great
- The effect of pedestrian is great
- Left-turning vehicle influence great
- Some signal timing is not reasonable
- Quantitative analysis of some factors

Statistics the delay affected by non-power-driven vehicle: A case study of Guanyuan Bridge, the relation between green time lost and cycle is shown in Fig. 2. And the green time lost is shown in Table 8. In Table 8, we denote intersection as Capital character (Baishi Bridge-A, Fuchengmen and Xisi north street-B, Guanyuan Bridge-C, Xisi north street and Picaihutong-D, Xinjiekou and Xizhimen street-E, Yuetan south street and Nanlishi road-F, Zhanlanguan road and Fuchengmen street-G, Zhanlanguan Road and Fuchengmenwai Street-G). By analyzing, the green time lost is between 7.6~40.37%, average green time lost is 5~10 sec.

Table 6: Difference s comparison of intersection

	East	South	West	North
Real flow of China	1123	1055	979	964
Capacity of China	1386	1326	1221	1327
Difference	263 (19%)	271 (20%)	242 (20%)	363 (27%)
Real flow of UK	1312	1358	1428	1559
Capacity of UK	1514	1616	1701	1753
Difference	202 (13%)	258 (16%)	273 (16%)	194 (11%)

Table 7: Differences of real flow and capacity comparison of T-intersection

	Through 1	T	Through 2
Real flow of China	1133	1037	998
Capacity of China	1465	1465	1380
Difference	332 (23%)	430 (29%)	382 (28%)
Real flow of UK	1266	637	884
Capacity of UK	1761	1756	1462
Difference	495 (28%)	1119 (64%)	578 (40%)

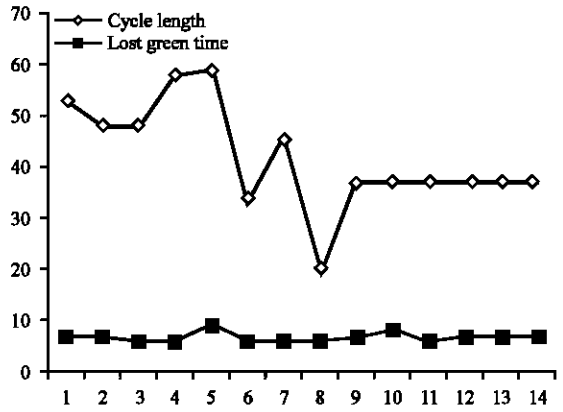

Fig. 2: The relation between green time lost and cycle of Guanyuan bridge

Table 8: Green time lost of intersection

	E (%)		S (%)		W (%)		N (%)	
	Through	Left turning	Through	Left turning	Through	Left turning	Through	Left turning
A	20.60				18.96		32.34	
B	8.15		9.10		7.56		9.45	
C	18.21	10.78	18.50	15.45	16.18	15.10	17.98	16.61
D	18.46		13.09		25.89	40.37	11.71	
E			8.83		13.35		7.60	
F	10.43	22.71	9.22		9.93	20.79	10.09	
G	17.61	23.58	15.09	23.21	15.72	23.58	12.865	24.41
H	18.55		26.90		24.53		19.59	

CONCLUSION

By analyzing the signalized intersection comparison between China and UK, we can get the conclusions that the real flow is high, saturation rate is low, the capacity is low and road utilization is to be improved. Although, the road condition is not better than China, the capacity is high and road utilization is high. However, in city of UK, the effect of non-power-driven vehicle is small and the influences of capacity are vehicle by vehicle, signal setting, road condition, climate and so on. While in Beijing city, the traffic flow is high, pedestrian and non-power-driven vehicle affect greatly which leading to poor capacity. Therefore, the comparison of traffic flow and capacity between China and UK is meaningful to find ameliorative measures to improve traffic condition and relieve congestion. By analyzing the differences and factors between China and UK, we can provide useful suggestion for Beijing city authorities.

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