Research on Grasping and Evaluating Road Traffic Conditions to Improve Road Performance

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Road Traffic Department, Road Division

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1. Introduction

In the "Policies for WISENET 2050" that were compiled by the Road Bureau of the Ministry of Land, Infrastructure, Transport and Tourism in October 2023, it is shown that improvement of services for the entire high-standard road network will be realized by implementing measures for bottleneck efficiently and effectively, by means of data-driven performance management of traffic demand and congestion that are unevenly distributed temporally and spatially. In order to improve the performance of a road, it is necessary to utilize its potential to the fullest (Fig.-1).

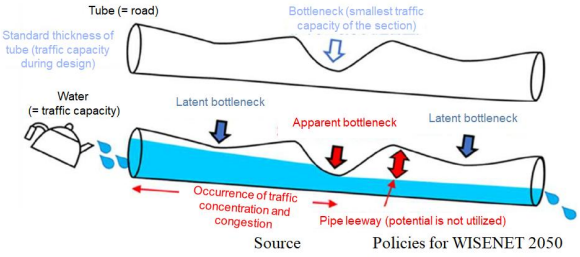

Fig.-1 Conceptual diagram of road performance

An existing research of the NILIM shows, when identifying bottlenecks, the effectiveness of bottleneck points obtained from the frequency of occurrence of congestion for each of the road sections divided equidistantly.

In the planning and design of roads including measures for bottleneck, based on the situations that require response to problems caused by localized insufficient capacity or by traffic volume fluctuations, and in response to autonomous driving and new mobility, as well as new findings such as a decrease in capacity in recent years, it is necessary to consider a review of the conventional methods (including the method for determining the number of lanes).

In this study, in order to contribute to the above consideration, analysis was carried out on the traffic volume fluctuation characteristics and the trends of maximum traffic volume (observed value related to the capacity) in recent years.

2. Analysis of traffic volume fluctuation characteristics

Conventionally, regarding the determination of the number of lanes on a road, a method is used to compare the designed traffic volume (traffic volume expected to pass through the road) with the standard design volume (traffic volume allowed by the road). In Japan, it is specified that the design shall be made based on the 30th highest hourly volume among the 8,760 hours in a year, and in the calculation of the standard design volume, the K-factor (ratio of the 30th highest hourly volume to the annual average daily traffic) is used as the index to represent peak traffic characteristics. This K-factor is set uniformly all over Japan, for each area where roads exist (rural areas, urban areas) or landform (level, mountainous).

In order to analyze the trends of K-factor in recent years and the difference at each spot, we have organized the distribution of the K-factors at the spots according to each situation of areas along the road, by using the constantly observed traffic volume data obtained at 1,046 spots on the national highways under the jurisdiction of the MLIT all over Japan in one single year of FY 2021. Fig.-2 shows the distribution of the K-factors at 182 spots in densely inhabited districts and 253 spots in mountainous areas. Focusing on the average of the K-factors, we can see that the values in mountainous areas are greater than those in the densely inhabited districts, and the differences due to the situation of areas along the road can be identified.

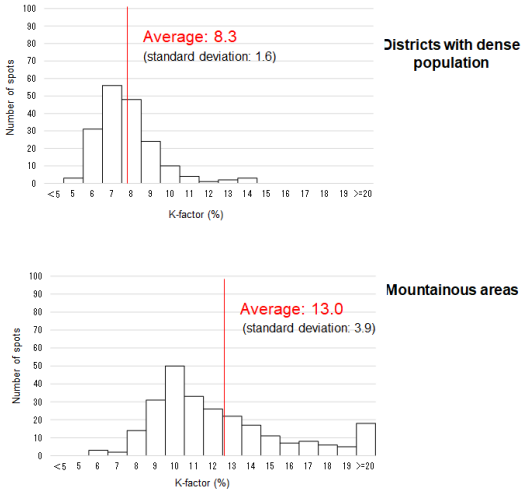

Fig.-2 K-factor distribution

Focusing on the shape of distribution of the K-factors, we can see that the standard deviation is greater in mountainous areas than in densely inhabited districts, and the values at the spots are distributed in a wide range. Therefore, when designing a road in a section in mountainous areas, if the K-factor can be set appropriately from the traffic volume data in the route and in surrounding areas, a design would be possible that is fit for the peak characteristics in the section.

3. Analysis of maximum traffic volume

The basic capacity is used as the capacity that forms the basics when calculating the capacity of a road, and in the publication of the Japan Road Association, "Highway Capacity" (1984), the basic capacity is defined as the maximum number of passenger cars that can be expected to pass through the road when the road conditions and traffic conditions meet basic conditions. In the publication, the basic capacity is defined to be 2,200 pcu/h per lane in the case of multilane roads, which is defined based on the results of observation of the maximum traffic volume in Japan. Note that pcu is the passenger car unit that is used to convert traffic volume into the number of passenger cars.

Table 1 shows values converted into pcu, by using the constantly observed traffic volume data in FY 2023 and extracting the top 5 spots with the maximum traffic volume (actual number of vehicles) on expressways and national highways under the jurisdiction of the MLIT with 2 lanes per direction, and by making corrections by means of the percentage of heavy vehicles , lane width, lateral clearance, and the situation of areas along the road to that the basic conditions will be met in order to make comparison with the basic capacity. The basic capacity in the sections with 2 lanes per direction is 2,200×2＝4,400 pcu/h, and the average at the 5 spots on expressways is about the same level as that of this value, but the values on highways under the jurisdiction of the MLIT are lower than this value. On ordinary roads, there may also be the influence of signalized intersections, but it is considered that a calculation method for capacity will be required that could appropriately consider the site situations including other factors.

Table-2 is an example of year-over-year comparison of maximum traffic volume at the same observation spot, which shows that the volume in FY 2023 is smaller by about 700 vehicles/h. The conditions of roads have improved since 1981 and it is inferred that the mode of utilization of road networks in a wide area is also different, so simple comparison may not be made from the viewpoint of capacity. However, when referring to the values of capacity in the past, it is recommended that attention should be paid to such comparisons. On that basis the values of capacity are required to be reviewed based on the trends in recent years.

Table-1 Maximum traffic volume in sections with 2 lanes per direction

Number of lanes	Observation spot	Direction	Maximum traffic volume generated (pcu/h)	Average maximum traffic volume generated (pcu/h)
2 lanes per direction (expressway)	Ikaw adani - Tamatsu	Upbound	4,841	4,450
	Ebina JCT - Ebina	Upbound	4,784	
	Ichinomiya - Ichinomiya JCT	Downbound	4,283	
	Fushiko - Kariki	Downbound	4,199	
	Funabashi - Hanaw a	Downbound	4,142	
2 lanes per direction (national highways under the jurisdiction of the MLIT)	Kuchi	Upbound	3,894	3,329
	Chikushino	Downbound	3,560	
	Yui	Upbound	3,359	
	Yui	Downbound	3,203	
	Miyamaru	Downbound	2,629	

Table-2 Year-over-year comparison of maximum traffic volume

Route name		E4 Tohoku Expressw ay	E4 Tohoku Expressw ay
Observation spot		Yaita - Nishi-nasuno	Yaita - Yaita-kita
Number of lanes		2 lanes per direction	2 lanes per direction
Observation period		January 1981 - December 1981	April 2023 - March 2024
Realized maximum traffic volume (vehicles/h)	Upbound	3,457	2,794
	Downbound	3,597	2,851
Source		"Traffic Capacity of Rods" (1984)	FY 2023 constantly observed traffic volume data

4. Conclusion

In this paper, the shape of distribution of K-factors has been analyzed, and it has been shown that the peak characteristics of the traffic volume are varied with each spot. Also, in the analysis of maximum traffic volume, the necessity to consider the site situation appropriately has been mentioned in the calculation of capacity using the current basic capacity. In the measures for bottleneck and planning and design of a new road, it is considered that the improvement of road performance can be realized efficiently and effectively, by using the values of traffic demand (peak characteristics, etc.) and capacity that appropriately reflect the situation of the applicable section. We understand that a review of the standard design volume and basic capacity is highly required, based on the differences in traffic characteristics according to the spot and year-over-year changes, and it is necessary to perform data analysis continually.

☞For more detailed information, refer to:
1) 2018 Annual Report of NILIM, p. 125
https://www.nilim.go.jp/lab/bcg/siryou/2018report/ar2018hp083.pdf
2) Kawamoto et al.: Analysis of traffic volume variation using constant observation data in FY 2021, Proceedings of the 44th Conference of Japan Society of Traffic Engineers, pp. 491-496, 2024.
3) Nagashima et al.: Analysis of maximum traffic volume using traffic data in 2023, Proceedings of Infrastructure Planning, Vol.70, 2024.