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ANALYSIS OF LANE-BASED SERVICE LEVEL FOR BASIC SECTION OF URBAN HIGHWAY

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ABSTRACT

A service level of highway is evaluated by average density or traffic flow rate of all lanes of relevant section.But when the service level of the road is lower, traffic flow rate by lane and traffic share rate by lane are different each other which results in lack of representativeness and thus analysis of service level by lane in consideration of actual traffic flow characteristics is required. Evaluation of service level of highway indicated in highway capacity manual uses the density as the effect scale without considering the number of lane. But the service level measured on a 2-lane or a wider highway cannot represent the traffic situation of relevant section because of different function of each lane as well as the difference in density by function of each lane when the traffic not reaches to the level of a full capacity.

For such reason, it's hard or impossible to evaluate the service quality by lane and provide the accurate information when using the evaluation method indicated in current road capacity manual. In this study, analysis was conducted on highway in Seoul area and as a result, traffic share by lane was found different each other, which means the need for improving the highway service level analysis methodology and more effective traffic management is expected when the traffic is smooth.

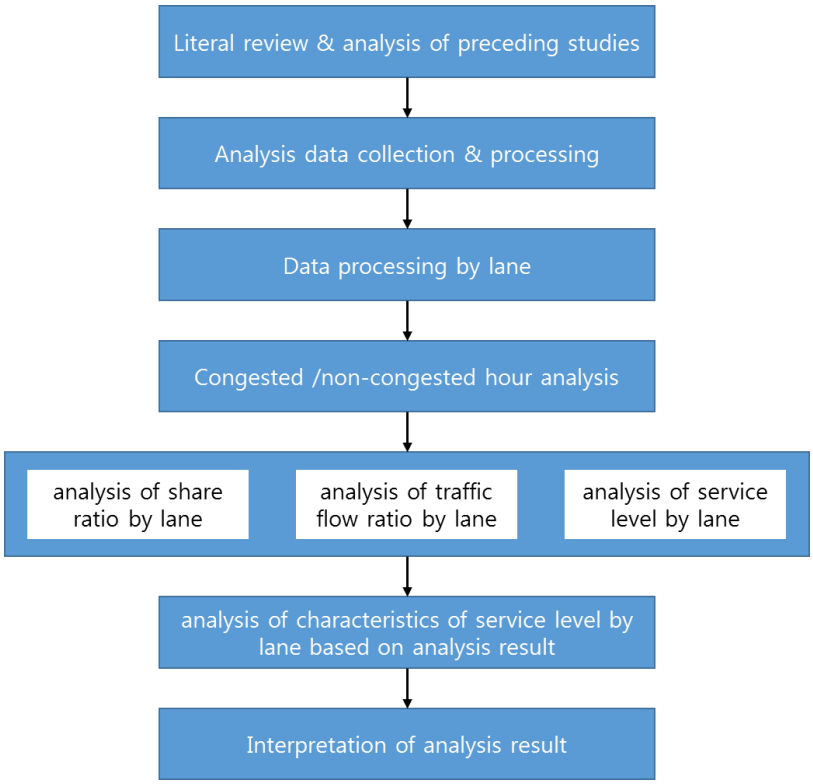
Key Words: Level of Service, Urban Highway, Basic Section, Lane-based

Introduction

Evaluation of service level of basic section of highway is conducted using average density or traffic flow rate on all lanes. But because of different traffic flow rate or traffic share by lane, service level evaluation method according to the current way using average value of all lanes may lack the representativeness. Thus, it's necessary to analyze the service level by lane in consideration of actual traffic flow characteristics. Evaluation method of highwayservice level suggested in road capacity manual uses the density as effect scale without considering the number of lane. But such analysis results in difference in utilization ratio by lane as well as the density by function of lane when not reaching to the full capacity. For such reason, it's impossible to evaluate the service quality by lane and provide the accurate information when using the evaluation method indicated in current road capacity manual.

This study is intended to evaluate the service level by lane in consideration of characteristics of basic section and actual traffic situation.

In this study, data was collected separately for peak time/ non-peak time using vehicle detection data. Traffic volume under normal traffic condition only without accident or other factors that may affect the traffic such as geometric constraint was calculated and service level was determined according to the service level depending on design speed. Analysis result was compared with the service level of all lanes on relevant section so as to evaluate the service level analysis. Work process is as <Fig 1>



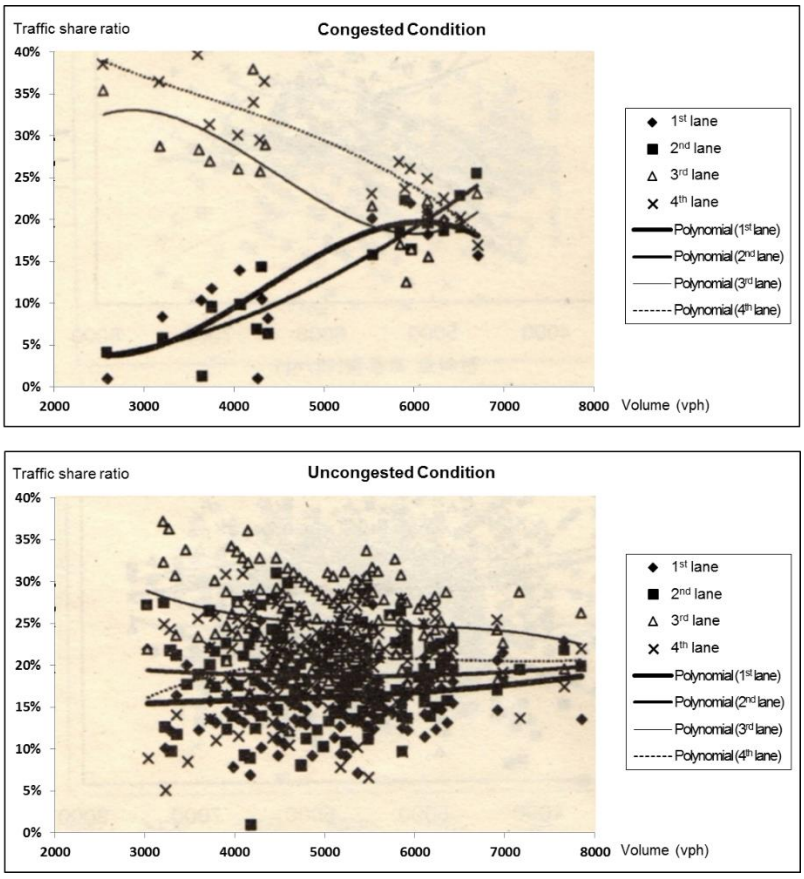
<Fig 1>Work process

Ⅱ. Review of previous studies

Lee, Seung-joon (2006) developed the service level evaluation methodology using highway traffic analysis and a resulting single evaluation standard, which focused on identifying the cause of congestion on highway and classifying the bottleneck and congestion mechanism that enabled the researcher to analyze the congested flow depending on traffic volume. The study by Lee, Seung-joon (2006) evaluated the service level focusing on congestion on the contrary to this study.

Son, Bongsoo (1997) pointed that 3rd and 4th lane or outer lanes have higher share ratio comparing to 1st and 2nd lane or inner lanes when the traffic is not congested. Traffic share ratio

of all lanes is about 20~30%, which is evenly distributed to all lanes when the traffic reached to the full capacity. But in congested traffic, traffic share by 1st and 2nd lane is far lower than the 3rd or 4th lane and in line with increase in traffic, share ratio of 3rd and 4th lane is decreased while the ratio of 1st and 2nd lane is increased, indicating that traffic share ratio of all lanes is almost equal in terms of the capacity.



<Fig 1>Traffic share ratio by lane at basic section of Olympic highway.

According to reviewing the mean travel speed variation, mean travel speed at uncongested traffic condition was in inverse proportion to traffic share ratio. That is, the higher the traffic share ratio the lower the mean travel speed. But generally, mean travel speed on 1st lane and 2nd lane was equal and the speed on each lane was maintained at a certain level, irrespective of traffic volume. At congested condition, it's generally in proportion to traffic share ratio, which indicates, the higher the traffic share ratio the higher the mean travel speed. Then the 1st lane indicates the similar pattern with the 2nd lane and the 3rd lane with the 4th lane in terms ofvariation in mean travel speed depending on variable traffic volume and the increase on the 1st and 2nd lane is greater than 3rd and 4th lane.<Fig 1> shows the analysis result of traffic share ratio at peak hour and non-peak hour on upper stream of Hangang Bridge on Olympic Highway, indicating significant difference in traffic share ratio by lane at peak hour.

Ⅲ. Data analysis

1. Data collection and basic data processing

The source data at 30 sec-cycle collected by video detectors installed along the Gangbyeon highway and Olympic highway within Seoul Transportation Management Center was used in this study.

Video detectors are installed at 500m interval along the Gangbyeon highway and Olympic highway to collect the traffic flow data by lane at 30 sec-interval and the data collected includes speed, traffic volume, traffic share ratio, density and kind of vehicle and in this study, data processing was made based on speed and traffic volume.

For data collection purpose, three 4-lane sections on Gangbyeon highway and Olympic highwaywere designated.

The data for 3 sunny days when road surface was dry was used. Source data collected was processed to a 15-minute cycle data and data with the speed 0 or traffic flow 0 was excluded from the analysis.

<Table 2>shows the conversion process from source data to a 15-minute cycle data. Based on a 15-minute cycle data, an hour traffic flow rate data was produced and the speed was processed to the mean speed value with weighted value on traffic volume. Analysis of service level by lane was estimated based on a 15-minute mean speed by lane.

For analysis, data was classified using Microsoft Excel 2010 and each data analyzed was processed to a 15-minute cycle data. A process to a 15-minute cycle traffic flow data was made because a 15-minute interval is optimal in representing the traffic flow characteristics and variation and the peak hour factor(PHF) for processing the data in an hour unit is the 15-minute interval which means the 4 times of 15-min of peak hour factor when it comes to traffic flow rate. Thus it's processed at 15-minute interval. After classifying a 30-sec cycle data into a 15-minute unit data, the sum of all traffic within a unit time was used as a 15-minute cycle data. When it comes to the speed, the speed with weighted traffic, instead of a simple mean value, was estimated so as to minimize the error that might occur when using a simple mean value by such method.

<Table 1>Data collection

Category	Description
Detector point	- 900m ahead of Banghwa Bridge to the way to Hanam on Olympic Highway - 1,000m ahead of Dongjak Bridge to the way to Guri on Gangbywon Highway
Road condition	- Design speed: 100km/h (Limit 80km/h) - Lane width: 3.5m or more - Marginal width: 1.5m or more - Number of lane: 4 main lanes - Topography: Level

PCU	- Small (Truck less than 2.5t, Bus with less than 16seats) : 1.0 - Medium (Truck 2.5t or more, Bus with 16 seats or more) : 1.5 - Large (Semi-truck or full trailer): 2.0

<Table2>Data processing method

Time	**Traffic**	**Speed**	**Speed × Traffic**	**Converted time**	**Traffic for 15 min**	**pcphpl**	**Mean speed during 15 min**
60000	6	94.66	567.96	060000 - 061430	209	836	90.33
60030	5	100.6	503				
60100	11	92.09	1012.99				
. . .	. . .	. . .	. . .		Sum of the traffic for 15 minutes	Converted traffic flow rate for 15 minutes	Mean speed with weighted traffic volume
61130	3	83.33	249.99				
61200	12	81.58	978.96				
61230	14	94	1316				

2. Analysis method

The data used for determining the service level by lane was traffic volume. The standard to determine the service level of highway in highway capacity manual is as <Table 3> Service level analysis of basic section in highway capacity manual is based on traffic volume on all lanes at the section and in this study, service level by lane and for all lanes was analyzed based on traffic volume by lane and on all lanes.

Average density of the section and by lane was estimated using traffic flow rate by lane and then the service level was analyzed based on average density of all lanes and by lane. Based on such dada, service level by lane and average service level of all lanes were analyzed so as to identify the problem with service level analysis method for basic section of highway.

<Table 3>The standard to determine the service level of basic section of highway

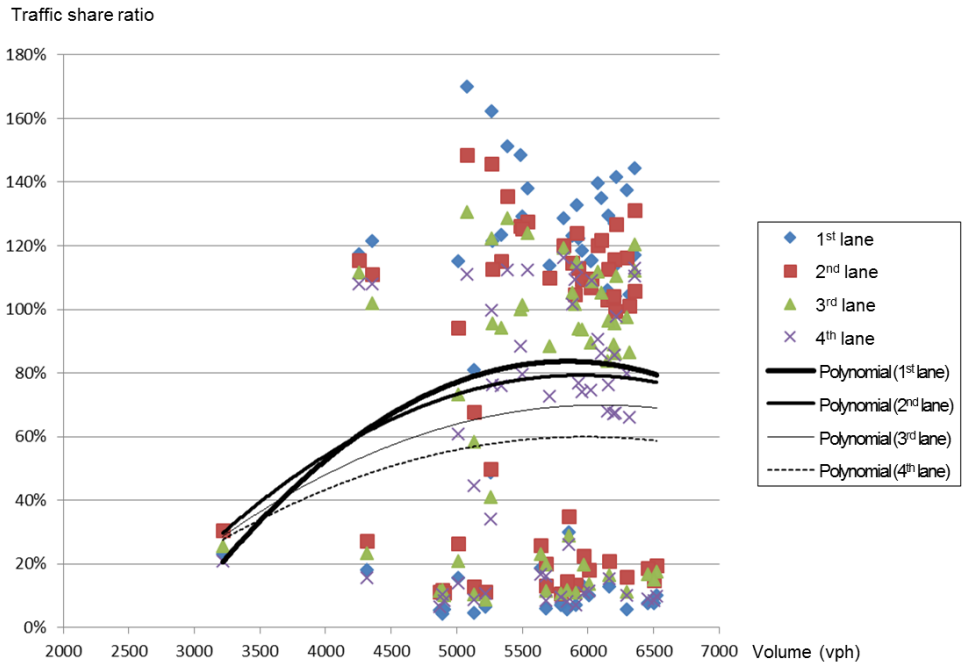
Level of Service	**Density (pcpkmpl)**	**Design speed 100kph**	
		Volume (pcphpl)	**V/C Ratio**
A	≤ 6	≤ 600	≤ 0.27
B	≤ 10	≤ 1,000	≤ 0.45
C	≤ 14	≤ 1,350	≤ 0.61
D	≤ 19	≤ 1,750	≤ 0.8
E	≤ 28	≤ 2,200	≤ 1.00
R	> 28	-	-

3 Analysis of traffic share ratio by lane

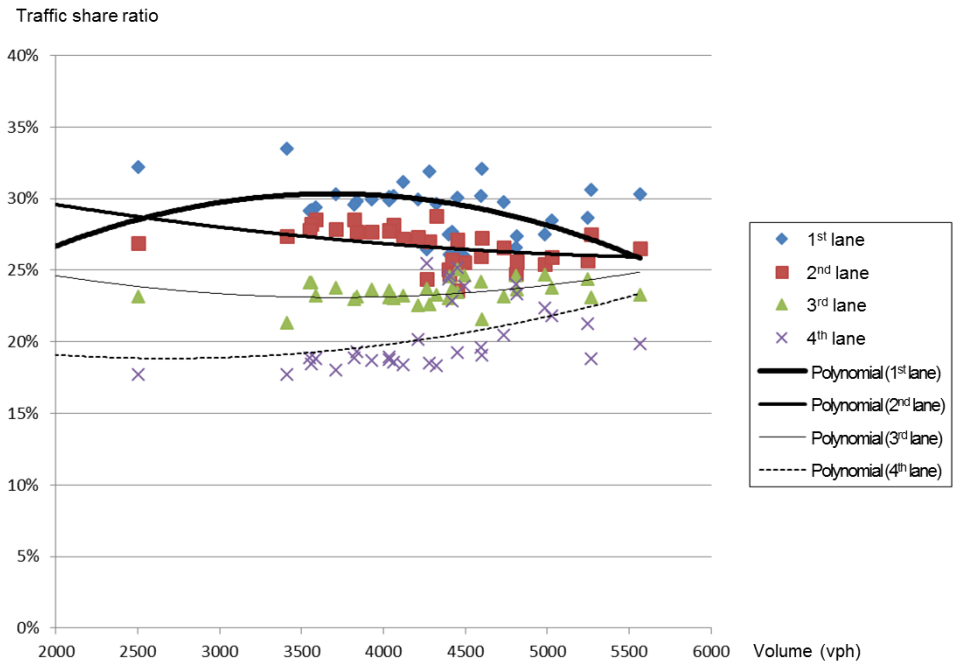
Traffic share ratio by lane was estimated based on traffic volume by lane. As indicated in analysis of <Table 4>, traffic share ratio was different by lane. At peak time 07:00 ~ 07:30, traffic share ratio of the 2nd and 3rd lane was high as much as 30% or more.

<Table4> Example of traffic share ratio by lane at 900m ahead of Banghwa Bridge in the way to Hanam on Olympic highway.

Hour	1st lane	2nd lane	3rd lane	4th lane
70000	18%	34%	31%	17%
71500	14%	36%	32%	17%
73000	17%	32%	33%	18%
123000	31%	27%	23%	19%
124500	30%	27%	23%	20%



<Fig 2>Traffic share ratio by lane at 900m ahead of Banghwa Bridge in a way to Hanam on Olympic highway



<Fig 3>>Traffic share ratio by lane at 1,000m ahead of Dongjak Bridge in a way to Guri on Gangbyeon highway

At peak hour, traffic share ratio of the 2nd and 3rd lane where lane change is easier was higher. For such reason, service level by lane may be indicated differently and the service level determined by mean speed or traffic volume and density as indicated in highway capacity manual has a low representativeness.

When it comes to non-peak hour, 12:30 ~ 13:00, traffic share ratio by lane was similar to average value, 25%. As a wide distance among the vehicles is maintained, the vehicles are distributed over entire road by changing the lane.

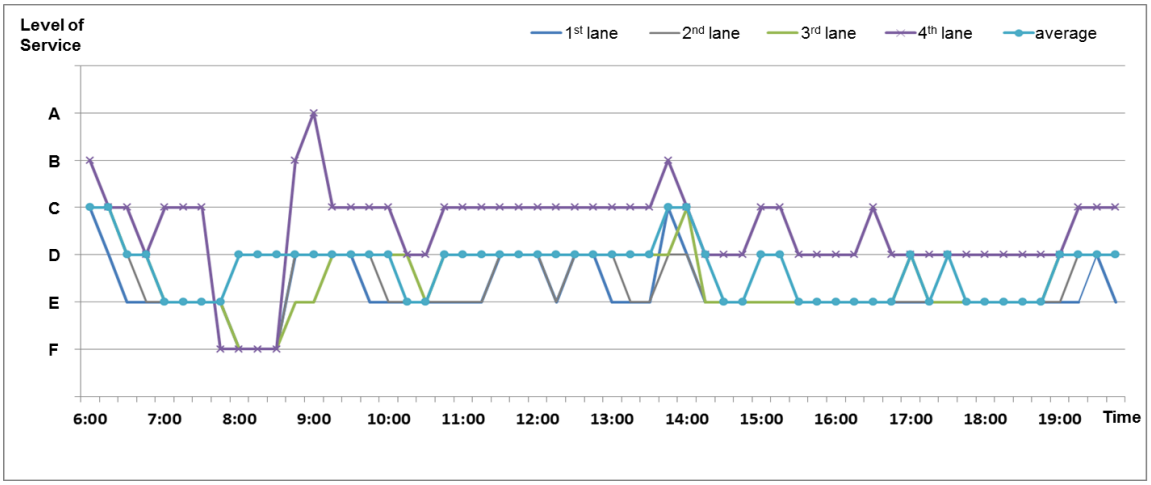
4. Analysis of service level by lane

As a result of analyzing the service level by lane, service level determined according to highway capacity manual was all D as shown in <Table 5> by the service level by lane was divers from B to E.
Service level was different due to difference in average speed and traffic flow rate by lane.

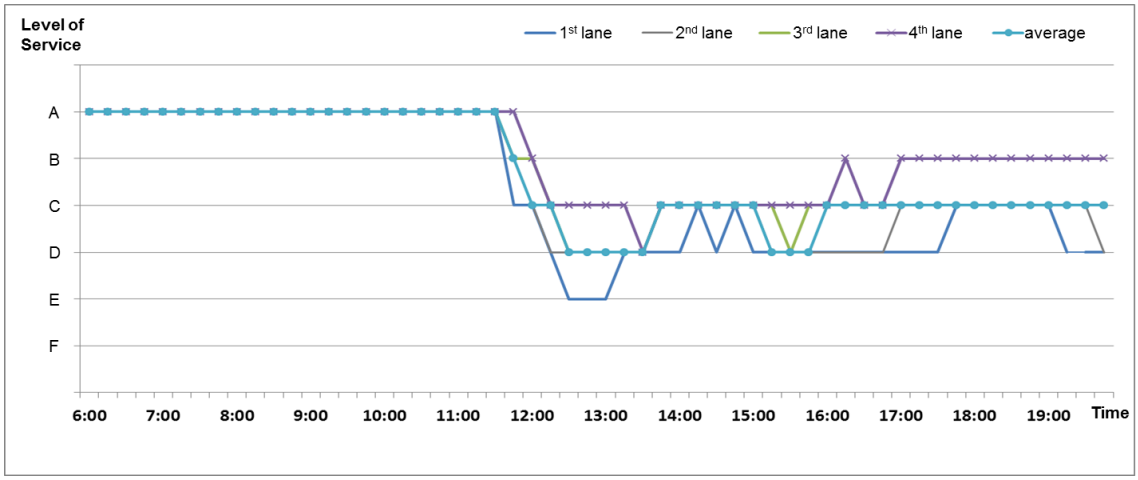
As <Fig 4> and <Fig 5>, variation of service level by lane at the investigation point over 24 hours was analyzed. According to the analysis of service level of all lanes and by lane, in case of service level of all lanes, D, E and F, service level of all lanes and service level by lane were similar but in case of A, B and C, service level of all lanes and service level by lane were different in some cases.

<Table 5>LOS by lane at 1,000m ahead of Dongjak Bridge to Guro on Gangbyeon highway

Hour	1st lane	2nd lane	3rd lane	4th lane	All lanes
90000	D	D	E	B	D
91500	D	D	D	C	D
93000	D	D	D	C	D
94500	E	D	D	C	D
10000	E	E	D	C	D



<Fig 4>LOS by lane at 900m ahead of Banghwa Bridge in a way to Hanam on Olympic highway



<Fig 5>LOS at 1,000m ahead of Dongjak Bridge in a way to Guri on Gangbyeon highway

Ⅳ. Conclusion

The outcome of this study is similar with the study by Son, Bongsoo (1997)

This study is intended to verify the difference in traffic share ratio by lane in previous studies as well as the need for improving current service level analysis method because of the difference in service level by lane.

When the road traffic flow is good except the design goal in service level D or E (road service level A, B, C), analysis of service level by lane would result in more meaningful outcome.

This study is aimed at analyzing the service level by lane in consideration of the characteristics of basic section of urban highway and actual traffic condition. Based on this study and applying to Lane Control System (LCS) and advanced technologies would lead to more smooth traffic through effective use of highway.

Acknowledgments

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