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Effective installation of an auxiliary lane at sag sections to mitigate motorway traffic congestion

Jian Xing[1*] and Jun Tanaka[2†]
[1]Nippon Expressway Research Institute Co., Ltd. , Tokyo, Japan
[2]Oriental Consultants Co., Ltd, Tokyo, Japan
xing@ri-nexco.co.jp, tanaka-at@oriconsul.co.jp

Abstract
Traffic congestion on motorways on weekends and holidays is not unusual in Japan. To mitigate congestion, installation of an auxiliary lane around the bottleneck in the sag section is used as an alternative and effective countermeasure against congestion to correct overuse of the median lane. However, there are no guidelines on effective installation of an auxiliary lane in the sag section to mitigate motorway traffic congestion. This paper uses a microscopic traffic simulation model to study how best to add an auxiliary lane in the sag section of a dual two-lane motorway to mitigate traffic congestion.

Keywords: Congestion countermeasure, auxiliary lane, microscopic traffic simulation, capacity, bottleneck

1 Introduction

Previous studies have shown that sag and tunnel sections on expressways can become bottlenecks that cause congestion (Koshi, 1986). In these sections, when the traffic volume is high enough, a difference in speed develops between vehicles traveling on the outer and inner lanes and the number of vehicles traveling on the inner lane tends to surge. In a previous study (Oguchi et al., 2001), a scheme to add an auxiliary lane to correct the lane use rate and increase the road capacity to counter traffic congestion was introduced and evaluated.

However, although the auxiliary lane scheme has been introduced, no guidelines have yet been set on how long and where the lanes should be installed. Consequently, the structure of an auxiliary lane is decided more or less subjectively in practice. To even out the number of cars traveling on each lane, the auxiliary lane needs to have a certain length, but over-extending the lane will just increase the cost, thus lowering its cost-effectiveness. The most effective location and length of an auxiliary lane should not

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[†] Created the first draft of this document

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only work to distribute the traffic volume between lanes by a few percent, but also be sufficient to substantially reduce congestion and costs.

In this study, we have sorted existing auxiliary lanes by type and performed microscopic traffic simulations to predict the breakdown flow rate of traffic flow and analyze the effectiveness, to study how to install the auxiliary lanes effectively.

2 Outline of the Study

Figure 1 shows a flowchart of the study. First, the auxiliary lanes in operation were sorted by type and the cases to be studied were selected. Next, road network and traffic data were prepared for the input of a microscopic simulation model used in the study. Various parameters such as the car-following model, lane-changing model, merge/diverge model and so on were calibrated and the simulated traffic flow was examined based on the actual traffic flow observed by vehicle detectors.

Subsequently, simulation runs of each auxiliary lane type were performed to estimate and analyze the traffic flow and study an effective way of installation. A microscopic traffic simulation model was used in this study to estimate the breakdown flow rate of each auxiliary lane type in the sag section.

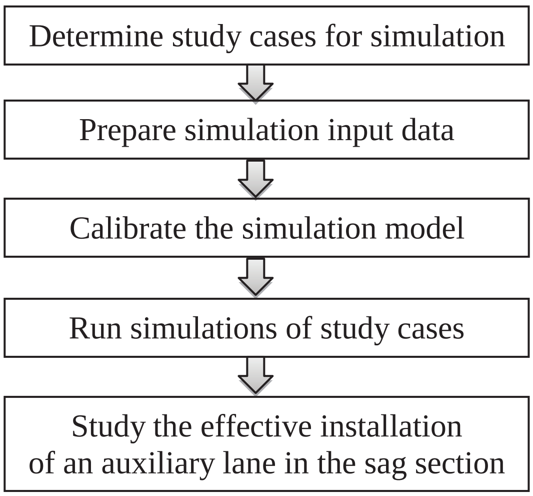

Figure 1: Flowchart of the study

3 Outline of Traffic Simulation Model

The traffic simulation of the study uses a microscopic model of the periodic scanning method. The vehicle movement model mainly comprises a vehicle generation/extinction model, vehicle's longitudinal movement (acceleration and deceleration) model and lateral movement (lane-changing) model. The generation/extinction model creates and erases vehicles. The longitudinal movement model comprises free running, car-following behavior based on car-following theory, stop/go, vehicle driving performance (driving power, running resistance and acceleration), acceleration/ deceleration/ stopping at tollgates and deceleration at horizontal curves. The car-following model used in the study is an improved version of a model originally proposed by Koshi (1986) and Koshi et al. (1992, 1993) and identified by Xing (1992), Ozaki (1994) and Xing et al. (1995). The model was proposed to simulate the occurrence of traffic congestion at sag section of motorways.