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Overview Paper

Estimating capacity and traffic delay in work zones: An overview

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ABSTRACT

This paper presents a review of the approaches to estimating the work zone operational issues: capacity and traffic delay in work zones. It first explores the factors affecting work zone capacity and then critically reviews three types of approaches including parametric, non-parametric and simulation approaches to estimating work zone capacity. Subsequently, a detailed critical review of the three types of approaches for traffic delay estimation in work zones is presented. Finally, it provides some directions and recommendations for the future research.

1. Introduction

For any country, the road system is an important part of its infrastructure which can affect economic development. An efficient road system can promote economic development because it enhances the performance of local transportation. A good level of service for a road system requires implementation of work zone projects to maintain it. Therefore, various work zone activities, such as pothole patching, crack sealing and pavement resurfacing, are regularly carried out by land transport authorities. Hereafter, a work zone is referred to as a segment of road in which maintenance or construction operations impinge on one or more lanes available to traffic, or affect the operational characteristics of traffic flow through the segment. In general, a work zone comprises four components including the advance warning area, the transition area, the activity area and the termination area, shown in Fig. 1.

However, work zone activities could cause several problems because work zones usually close one or more of the lanes available for traffic, as shown in Fig. 1. The lane closure in work zone might be owing to the following two reasons. First, it is impossible to implement some types of work zone activities such as resurfacing pavements without interrupting traffic. Second, the lane closure could protect workers' safety. However, lane reductions could cause a disturbance to normal traffic flow and speed reductions, further resulting in a reduction of road capacity and an increase of traffic delay. Since vehicles in the closed lanes have to merge into the adjacent available lanes, it may increase the number of traffic conflicts and cause severe traffic safety problems.

In order to increase capacity and mitigate traffic delay in work zones, a few advanced traffic control systems, such as dynamic lane merge traffic control systems, have been proposed in the past. For example, Tarko and Venugopal (2001) devel-

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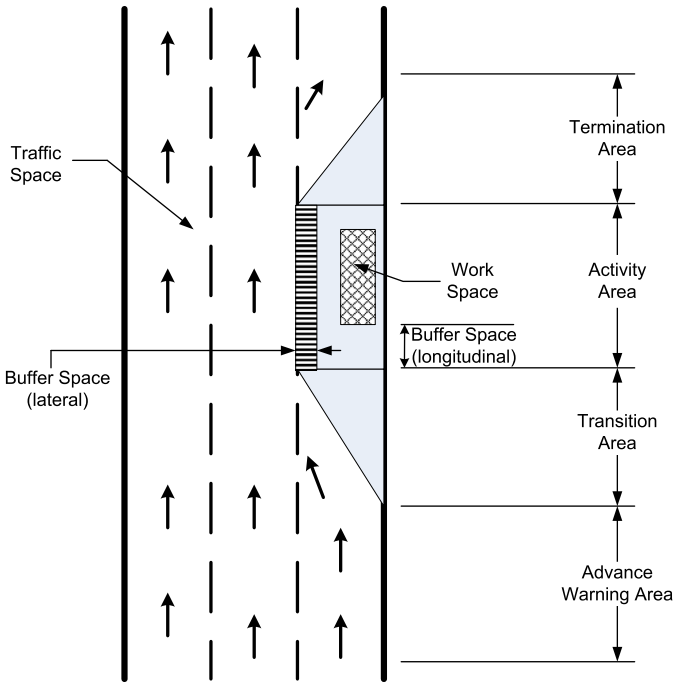

Fig. 1. Component parts of a work zone (MUTCD, 2003).

oped the Indiana Lane Merge System, comprising a series of dynamic "Do Not Pass/When Flashing" signs to smooth the merge operations. Schattler and Datta (2003) implemented the dynamic early merge traffic control system (EMTCS) in work zones which cause lane closures in Michigan. The EMTCS was found to significantly reduce forced lane merges and aggressive driver behavior. To increase the traffic throughput in work zones, Grillo et al. (2008) used the dynamic late lane merge system (DLLMS) to specify a definite merge point in freeway construction work zones. The DLLMS was found to greatly reduce queue lengths in travel lanes. Recently, Shaaban et al. (2011) proposed two Simplified Dynamic Lane Merging Systems (SDLMS) (early merge and late merge) for 3–2 lane short-term work zones in Florida.

It should be noted that work zone capacity estimate is an essential component in planning work zone traffic control systems. In addition, work zone capacity and traffic delay are the two critical indices to determine whether the effectiveness of traffic control systems is acceptable or not. Hence, the accurate estimation of capacity and traffic delay in work zones is of utmost importance and thus there is a need to review the estimation approaches. However, the existing literature on the overview of approaches to estimating work zone capacity and traffic delay is rather limited and incomplete (e.g., Kayani and Bham, 2010). Therefore, this paper aims to provide a thoroughly critical review on the approaches to estimating work zone capacity and traffic delay in work zones. The potential gaps and limitations of these approaches will be identified in this paper. It will also provide some directions and recommendations for future research.

This literature review was conducted using a computerized literature search method. With an access to the digital library of the Beijing Jiaotong University, which includes hundreds of journals as well as conference proceedings, the search is able to cover most published research works worldwide. First, the databases of Scopus, the ScienceDirect®, and the ISI Web of Knowledge were searched using the following key words: "work zone", "capacity", "traffic delay" and "methodology". Beside of these databases, we also used the Google Scholar as a second channel and browsed the personal websites of researchers who are active within traffic operations. Furthermore, we retrieved studies by tracking the references cited in papers we had already found. Finally, we identified 42 papers which relate to the methods and techniques for estimating work zone capacity and traffic delay.

This paper is organized as follows. Section 2 reviews the existing approaches for estimating work zone capacity. The strength and drawbacks of these approaches are also illustrated. Section 3 discusses the available approaches to estimating traffic delay. Future research recommendations and concluding marks are given in Section 4.

2. Work zone capacity

2.1. Factors affecting work zone capacity

There are many factors that could affect work zone capacity. Weng and Meng (2012) concluded 16 important factors which could significantly affect work zone capacity, shown in Fig. 2. These factors are grouped into five categorizes and in detail elaborated below.