10th International Congress on Civil Engineering, 5-7 May 2015
University of Tabriz, Tabriz, Iran

New Methods for Determining Capacity of Bottlenecks on Freeways

Rahim F. Benekohal[1], Hani Ramezani[2]
1- Professor of Civil and Environmental Engineering
rbenekoh@illinois.edu
2- Graduate Research Assistant
hrameza2@illinois.edu

University of Illinois at Urbana-Champaign
205 N. Mathews Ave
Urbana, Illinois, USA

Abstract

Accurate determination of capacity of bottlenecks is essential for proper traffic management in and around bottlenecks. Restrictions in roadway geometry or traffic composition, or implementation of new operational policies may create a chock-point on a freeway. Regardless of the cause of bottleneck, the effects are often congestion, queue, and increase in travel time. Bottlenecks may also create unsafe driving conditions and may increase the chance of rear-end collisions. This paper presents two new methodologies for finding bottleneck (i.e. work zone) capacity and operating speed: Four-Regime Models (FRM) and Updated Highway Capacity Manual (UHCM). The paper briefly discusses the factors affecting speed and capacity, and then compares the values estimated by the two methods for four different real-world work zone scenarios. The scenarios cover different speed limits, presence of flagger, and work activity levels. The results showed that FRM estimated values for speed and capacity represent the conditions more accurately than UHCM results because the FRM directly considers the presence of flagger and work activity, but UHCM does not.

Keywords: freeway, bottleneck, work zone, capacity, four-regime speed flow, congestion, queue

1. INTRODUCTION

Construction zones, though required for infrastructure maintenance, often create bottlenecks and congestion on most highway systems. The bottleneck may create potentially unsafe driving conditions as the approaching motorists encounter an unexpected queue of slow moving or stopped vehicles. Managing the growth and shrinkage of the congestion and queue within and around the bottleneck could improve traffic safety and operational efficiency.

A critical element for an effective congestion management is determining accurately the bottleneck capacity. There are various factors affecting capacity in work zones such as geometric conditions, lane configuration, work intensity, presence of a flagger and a police, and implementation of Intelligent Transportation Systems (ITS). Different researchers (1-7) have developed different models to estimate speed and capacity in work zones. The capacity relationships are shown in different forms: look-up tables (1), additive or multiplicative models (2-4), and speed-flow models (5-7). The speed-flow models have the advantage of providing not only the capacity values, but also the operating speed at a given volume.

This paper presents two new methodologies for finding work zone (bottleneck) capacity and operating speed: 1) the Four-Regime Models (FRM) proposed by Benekohal et al. (6), and 2) the Updated Highway Capacity Manual (UHCM). The paper illustrates how to construct each model and briefly discusses the factors affecting speed and capacity. In particular, it contrasts the two methods in terms of factors incorporated and then compares the values estimated by the two methods for four different real-world work zone scenarios to achieve a better understanding of capabilities and limitations of the models.