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Assessment of Basic Freeway Segments in the German Highway Capacity Manual HBS 2015 and Beyond

Justin Geistefeldt

Institute for Traffic Engineering and Management, Ruhr University Bochum, Germany

justin.geistefeldt@rub.de

Abstract

The second edition of the German Highway Capacity Manual HBS was published in 2015. The paper presents the HBS procedure for the assessment of basic freeway segments and discusses challenges for the future development of the methodology. As in the former edition of the HBS, the volume-to-capacity ratio is used as measure of effectiveness for basic freeway segments. The design capacities and speed-flow diagrams for basic freeway segments were completely revised and supplemented by new design values for segments with four-lane carriageways and segments with hard shoulder running. Besides the provision of specific design capacities, the reduced capacity variance on segments with variable speed limits, which was ascertained in recent investigations, is considered by adjusting the lower threshold value of LOS E. The new edition of the HBS also provides a framework for the use of specific parameters and the application of alternative methods for the assessment of traffic flow quality. Overall, the revised procedure for the analysis of basic freeway segments includes major enhancements and covers a larger number of segment types, but the main concept still follows the tradition of using deterministic capacities and providing rather simple analytical procedures to assess the traffic flow in one specific peak hour. For the future development of the HBS, the application of computer-based simulation models as well as the use of stochastic traffic flow parameters that better represent traffic reliability will increasingly emerge.

Keywords: Quality of service, volume-to-capacity ratio, design capacity

1 Introduction

Comparable to the U.S. HCM (TRB, 2010), the German Highway Capacity Manual HBS (FGSV, 2001, 2015) contains methods for the assessment of traffic flow quality on road facilities based on six levels of service. The second edition of the HBS was released in 2015. It is composed of three different volumes for freeways, rural roads, and urban roads, each containing assessment procedures for basic road segments, intersections and/or interchanges, network links and other specific facilities.

The assessment of traffic flow quality on basic freeway segments is treated in chapter A3 of the HBS 2015. Compared with the first edition of the HBS (FGSV, 2001), the assessment procedure was

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revised and supplemented by design values for additional segment types. The concept of the quality-of-service assessment, which is based on using the volume-to-capacity ratio as measure of effectiveness, was retained. The paper presents the basic concept and the empirical basis of the HBS assessment procedure for basic freeway segments and discusses challenges for the future development of the methodology.

In the HBS, a basic freeway segment is defined as the part of a freeway carriageway between adjacent interchanges (cf. Figure 1), which is further divided into sub-segments if major parameters affecting the capacity change within the segment. The HBS also contains a methodology to evaluate the average travel speed on network links between interchanges connecting freeways of the same functional category according to the German Guidelines for Network Planning RIN (FGSV, 2008).

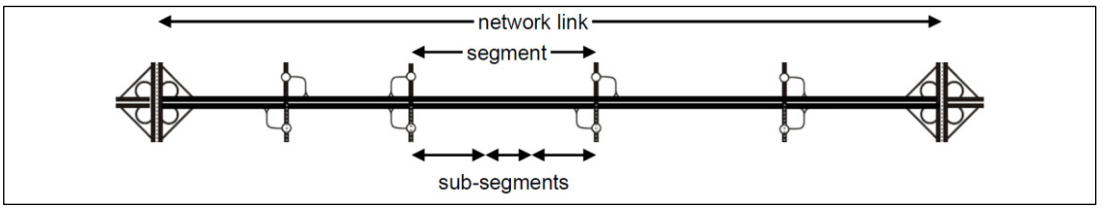

Figure 1: Definition of freeway segments, sub-segments and network links

2 Capacity Estimation

2.1 Empirical Basis

The capacity is the major design value for the assessment of traffic flow quality on basic freeway segments. The capacity depends on the prevailing road, traffic, and control conditions. Furthermore, freeway capacity can vary even under the same external conditions (cf. e.g. Elefteriadou et al., 1995, Minderhoud et al., 1997, Brilon et al., 2005). As the HBS assessment procedures are deterministic, the random capacity variability is not accounted for.

The current design capacities given in the HBS 2015 are mainly based on research by Brilon and Geistefeldt (2007, 2010), in which the design capacities for basic freeways segments were revised and supplemented by values for segments with four-lane carriageways and segments with temporary (dynamic) hard shoulder running. In these studies, capacities of more than 50 freeway segments were empirically estimated by analyzing the speed-flow diagram based on loop detector data. The volume at the apex of the speed-flow relationship was determined by applying van Aerde's (1995) model, which describes the minimum desired distance headway between consecutive vehicles. The corresponding speed-density relationship is:

$$d(v) = \frac{1}{\Delta x} = \frac{1}{c_1 + \frac{c_2}{v_0 - v} + c_3 \cdot v} \tag{1}$$

where:

$d(v)$ = traffic density at speed v
Δx = distance headway between consecutive vehicles
c_1, c_2, c_3, v_0 = model parameters
v = speed