



Functionally Hierarchical Road Classification Considering the Area Characteristics for the Performance-oriented Road Planning

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Abstract

This study aims to find out the necessary target travel speeds of roads in functionally hierarchical network which can achieve the target travel times for connecting centers with five different functions, considering the distribution of centers in the subjective area. In this paper, hierarchical road classification scenarios which consists of target travel speeds and road spacings are developed for differentiating road functions. Then travel times under the certain scenario are numerically calculated by an approximate method. Here, the calculation is based on a combination of hypothetical grid network and the actual motorway network. Finally, an application study of Tokaido region in Japan and southwest region in Germany demonstrated the impact of hierarchical road classification scenario on the achievement of the target travel time between centers in different categories.

Keywords: road network planning, target performance, functional hierarchy

1 Introduction

1.1 Background

Functionally hierarchical road network is the network where individual roads are classified into several levels and operated based on the priority for mobility, access or residential functions. This principle has been widely introduced since long ago with recognizing advantages in both mobility and safety. In order to make a road network “functionally hierarchical”, it is necessary to provide satisfactory performance at each hierarchical road level so that different kinds of movements (e.g. passing-through, accessing roadsides and parking) as well as users (e.g. automobiles, pedestrians and cyclists) can be spontaneously segregated into appropriate road levels. Therefore, performance evaluation is quite important at every stage of road planning, design and operation. It can improve not

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only a single road element such as link, intersection or segment, but also a whole network in terms of quality of road traffic.

However in Japan, highways and streets have been planned, designed and operated usually based on traffic demand and capacity only, and performance is still not commonly evaluated in practice particularly at the planning stage. Although there is a road categorization by Road Structure Ordinance (Japan Road Association, 2015), it does not mention the target performance which should be achieved in each category. Thus, on one hand, signalized intersections are densely placed and roadside access is not properly controlled on urban arterial roads which should prioritize mobility function. On the other hand, many residential areas suffer a problem of passing-through traffic which deteriorates safety and calm, since traffic calming devices are seldom equipped on minor local road which should prioritize residential function. As a result, most of highways and streets except motorways are not well distinguished in terms of their operational performance. According to the Road Traffic Census conducted in 2010, average travel speeds on highways in congested peak hour are about 35km/h regardless of their road categories, and significantly lower than the average travel speed on motorways that is about 80km/h (Shimokawa, et al., 2012).

In such a situation, reorganization of functionally hierarchical road network is one of the crucial tasks in Japan. Therefore, Japan Society of Traffic Engineers (JSTE) proposed a framework of “performance-oriented road planning, design and operation” (Research Group on Highway Capacity and Quality of Service, JSTE, 2015). In this framework, performance of a road segment is evaluated by comparing with the “target performance” which is defined according to the hierarchical road classification, and its geometrical structure and/or traffic control policy are/is reconsidered and improved so that the gap between the actual/expected performance and the target one can be minimized. However, there is still missing the concrete hierarchical classification which presents the necessary number of road levels and the target performance of each level.

1.2 Objective

This study aims to provide the target performances for functionally hierarchical classification at road planning stage. As a primary approach, “travel speed” is adopted as a performance measure of each road level by focusing on automobiles’ mobility function only. The main research questions are how many levels are necessary and how to determine the target travel speed of each level.

Then, the objective of this paper is to find out appropriate scenarios of hierarchical road classification as illustrated in Figure 1 for achieving the “target travel time” between representative places defined as “centers” (Details of a concept of “center” and target travel time are explained in Section 2). Under a certain classification scenario, “target travel speed profile” is determined by “target travel speeds” of individual road levels as well as “access distances” from a center to them. Since whether the scenario can achieve target travel time or not depends on the distance between centers and which varies by area and terrain, evaluation of classification scenarios is conducted in several areas with different characteristics.

1.3 Literature Review and Scope of the Study

(i) Guidelines with hierarchical road classification

Since the performance-oriented road planning, design and operation are already common in several developed countries, target performance under functionally hierarchical classification is available in some existing guidelines. For example, “appropriate level of service” is provided for four road levels (i.e. freeway, arterial, collector and local) under specific area and terrain type (i.e. rural level, rural rolling, rural mountainous and urban and suburban) in the United States (AASHTO, 2011), and ranges of speed for ten road levels are stated as one of the performance criteria named “traffic speed environment” in Queensland, Australia (Eppel, et al., 2001). These settings can distinguish performances of different hierarchical road levels; but these do not consider a relationship to their

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