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The effects of road geometrics and traffic regulations on driver-preferred speeds in northern Italy. An exploratory analysis

Marco Bassani [a,*], Davide Dalmazzo [a,1], Giuseppe Marinelli [a,2], Cinzia Cirillo [b,3]

[a] Politecnico di Torino, Department of Environment, Land and Infrastructures Engineering (DIATI), 24, corso Duca degli Abruzzi, 10129 Torino, Italy
[b] University of Maryland, Department of Civil and Environmental Engineering, 3250 Kim Building, 20742 College Park, MD, United States

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ABSTRACT

Speeds are affected by several variables such as driver characteristics, vehicle performance, road geometrics, environmental conditions and driving regulations. It is therefore important to study the relationships between speed and such variables in order to facilitate conscious speed management on existing and planned roads, and to induce drivers to select a speed consistent with the posted limit. This relationship is of great interest to those who wish to achieve roadway functionality and improve overall road safety.

A small number of studies have focused on this objective; however, few of them concern urban roads and they are limited to specific road types and recently built-up areas. These studies often refer to the 85th percentile of the speed distribution and are relevant to locations which are homogeneous in terms of geometry, environment, driving regulations and vehicle type.

This paper presents results obtained from a study carried out on urban arterials and collectors characterized by dissimilar geometric features which facilitated the inclusion of a fully representative range of variables. A general model able to predict operating speed for a generic percentile was calibrated using three different strategies: (a) a simple multiple regression analysis in which the variables were selected using the Bayesian Information Criterion (BIC); (b) the analysis of covariance method including random effects on the same set of variables as in (a); and, finally, (c) the analysis of covariance method with random effects and a new selection of variables (again using BIC). The analysis shows a dramatic variation in results depending on the method selected. In particular, when random effects are considered, almost all the variables are found to be statistically significant.

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1. Introduction

Urban roads are characterized by an elevated accident risk factor, which is mainly due to high traffic volumes, the coexistence of multiple categories of road users moving at different speeds, and the number of daily activities along the roadsides

* Corresponding author. Tel.: +39 011 5645635.
E-mail addresses: marco.bassani@polito.it (M. Bassani), davide.dalmazzo@polito.it (D. Dalmazzo), giuseppe.marinelli@polito.it (G. Marinelli), ccirillo@umd.edu (C. Cirillo).
[1] Tel.: +39 011 5645622.
[2] Tel.: +39 011 5645625.
[3] Tel.: +1 301 405 6864; fax +1 301 405 2585.

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(Committee for Guidance on Setting, 1998). In 2010, in Italy, the number of road accidents on urban roads was 150,602 which represented more than 71% of the total crashes, while the number of fatalities was 1744 equal to 45% of the total fatalities recorded on the national road network (Ministero delle Infrastrutture e dei Trasporti, 2011). More than 20% of urban fatalities involved vulnerable road users like pedestrians and cyclists who are prone to accidents with fast passenger cars or light duty vehicles. As a consequence, speed management remains crucial for creating a safe road system and for achieving the EU imposed target of a further 50% reduction in road fatalities in the decade 2011–2020 (European Transport Safety Council, 2012).

There is a general consensus that if speeds on a specific road section decrease, then accidents will be less severe, and therefore fewer crashes will be reported (Global Road Safety Partnership, 2008; Hauer, 2009). Garber and Gadiraju (1989) found that the crash severity is linked to the average speed, while the speed variance has a bearing on the number of crashes. Hauer (2009) stressed that speed data from flow speed observations and crash scene investigations are not estimated with a uniform degree of accuracy, so any results from research into the effects of speed variations are inconclusive and inadequate. Similar conclusions were drawn by Aarts and van Schagen (2006).

Studying the relationship between driver speed and the variables affecting driver behaviour is important for conscious speed management on existing and planned roads and also helpful to those seeking ways to encourage drivers to select a speed consistent with the posted speed limit (PSL) and traffic conditions.

High unsafe speeds occur mainly under free-flow conditions when low-density streams are mostly composed of isolated vehicles. In urban road networks, free-flow speeds are difficult to observe given the level of traffic and the influence of traffic signals and other traffic control devices. According to the Highway Capacity Manual (Transportation Research Board, 2010), in the case of urban roads, free-flow speeds occur at off-peak hours in the central part of urban street segments where traffic control systems do not affect driver speed choice.

The research presented here aims to generate new relationships between geometric variables and speed for urban roads. This has been accomplished by using an approach capable of identifying the most significant variables affecting average speed and by also taking into account the dispersion of the collected data.

The study builds on a previous observational investigation (Bassani & Sacchi, 2012) performed on a limited dataset, which has been enriched with new free-flow speed data. All the observations were conducted within the municipality of Torino (Italy) on urban arterials and collector streets that were selected in order to include a wide range of fully representative variables. Speed measurements were recorded during the times of day in which free-flow traffic conditions prevailed. Different models have been constructed taking into account the hierarchical structure of collected data, thus distinguishing the set to which each speed belongs (lane, section and road).

2. Background to operating speed

2.1. Driver behaviour on urban roads

In contrast to rural roads, urban roads have more operating functions. In fact, designers have to provide a harmonious and comfortable driving environment in which longitudinal and transversal movements coexist, and where other roadway users, such as cyclists and pedestrians, have to be safely accommodated. However, on too many occasions the operating speeds exceed the PSL (European Transport Safety Council, 2011).

In Fig. 1, each line represents the percentage of drivers that exceeded the PSL during an observational study on selected urban roads in a representative sample of European cities during the decade 2000–2009. Observations reveal that in some countries the percentage of aggressive drivers is constantly high (in Austria, 70% of vehicles exceed the 30 km/h limit in residential zones and 51% exceed the 50 km/h limit), in other cases the percentage is relatively low (roads in Switzerland and

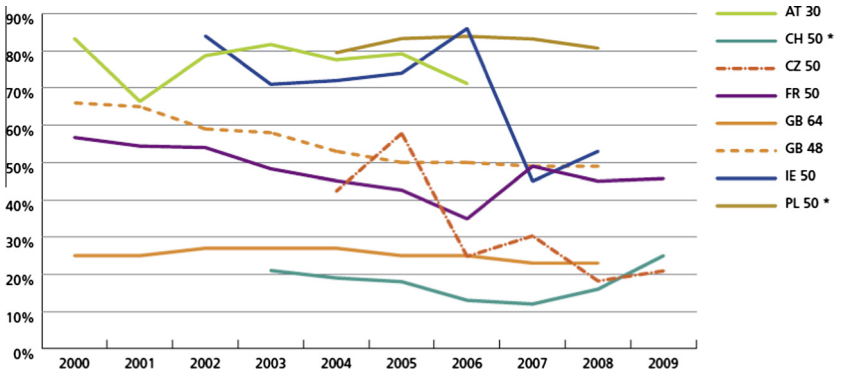

Fig. 1. Percentage of cars and vans exceeding the posted speed limits (PSL) on European urban roads in the period 2000–2009 (the labels indicate the country and the PSL of considered roads) (European Transport Safety Council, 2011).

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