ANALYZING SPEEDING BEHAVIOR IN TWO-LANE RURAL ROADS

Pérez-Zuriaga, Ana María
PhD
Highway Engineering Research Group, Universitat Politècnica de València
Camino de Vera sn, 46071 Valencia (Spain)
anpezu@tra.upv.es, +34 963877374, +34 963877379

Camacho-Torregrosa, Francisco Javier
PhD Candidate
Highway Engineering Research Group, Universitat Politècnica de València
Camino de Vera sn, 46071 Valencia (Spain)
fracator@tra.upv.es, +34 963877374, +34 963877379

García, Alfredo
Professor
Highway Engineering Research Group, Universitat Politècnica de València
Camino de Vera sn, 46071 Valencia (Spain)
agarciag@tra.upv.es, +34 963877374, +34 963877379

Llorca-García, Carlos
PhD Candidate
Highway Engineering Research Group, Universitat Politècnica de València
Camino de Vera sn, 46071 Valencia (Spain)
carlloga@cam.upv.es, +34 963877374, +34 963877379

Moreno-Chou, Ana Tsui
PhD Candidate
Highway Engineering Research Group, Universitat Politècnica de València
Camino de Vera sn, 46071 Valencia (Spain)
anmoch@cam.upv.es, +34 963877374, +34 963877379

Pérez-Zuriaga A.M., Camacho-Torregrosa F.J., García A., Llorca-García C., Moreno-Chou A.T
ABSTRACT

Speeding is one of the most significant contributing factors to traffic crashes, especially to crash severity and traffic fatalities. It reduces driver’s ability to safely negotiate curves or skip objects on the road, and it increases the necessary stopping distance.

The main objective of this research is to identify and to characterize the factors that might contribute to the propensity for certain drivers to speed, not only when drivers travel under free-flow conditions, but also when they pass another vehicle. The analyzed factors were: drivers’ characteristics; characteristics of the trip; and vehicle type.

In the free-flow conditions study, speeders were characterized from two points of view: comparing drivers’ individual speed profiles to the posted speed, the posted speed plus 10 km/h and the posted speed plus 20 km/h; and comparing drivers’ individual speed profiles to the 85th and 95th percentiles of the speed distribution of the road segment they were driving through. Speeding appeared to be associated with younger age, male gender and passenger cars and SUV.

In the passing maneuvers study, the developed average speed during maneuver was compared to the posted speed limit for speeders identification. Speeding appeared to be associated with younger age, without influence of the driver gender.

Keywords: speeding, free-flow driving, passing maneuvers, drivers’ behavior.

INTRODUCTION

Speeding is one of the most significant contributing factors to road crashes, directly linked to severity. It reduces driver’s ability to negotiate curves or skip objects on the road and increases the stopping sight distance. Thus, in order to improve road safety, it is important to identify the predisposing (knowledge, beliefs, values, attitudes), enabling (availability, accessibility, laws, driving skills), and reinforcing factors (family, peers, teachers, employers, community leaders, decision makers) that influence drivers’ speeding behavior (Gabany et al., 1997).

Most research on speeding behavior focus on self-reported speeding behavior and attitudes (Gabany et al., 1997; Blincoe et al., 2006; Fleiter et al., 2006; Stradling, 2007; Paris et al., 2008; Mannering, F., 2009). Large amount of data can be collected and analyzed in a short period of time and at a low cost in questionnaire-based studies.

Gabany et al. (1997) highlighted the possible inverse relationship between age and the perception of risk-taking as a predisposing factor to speed, and the possible relationship between age and perceptions of time pressures. They also found that males considered ego-gratification as a predisposing factor to speed more than females, while they pointed to time pressures, disdain of driving, and inattention. In the same way, Fleiter et al. (2006) found some subjective factors that were significantly related to the frequency of speeding, including: exposure to role models who speed; favorable attitudes to speeding; experiences of punishment avoidance; and the perceived certainty of punishment for speeding.

Despite the cited advantages of questionnaires, some researchers have doubts about using them as a measurement instrument of speed choice. Self-reports are always more open to socially desirable responding than unobtrusive observations. In fact, there are several research focused on the comparison between self-reported speed and observed speed.
One example is the study carried out by Fildes et al. (1991). They reported correlations from 0.12 to 0.52 between self-reported and observed speed. According to rural results, slow drivers estimated accurately their own speed, compared to excessive speed drivers’ responses which presented more dispersion. In the same way, Haglund and Aberg (2000) compared unobtrusively video recorded vehicle speeds with drivers’ responses to questions concerning their speed choice. In that study, a strong relationship was found between the observed and reported speed when travelling, although both parameters differed substantially.

Only a few studies that analyzed speeding behavior were based on collected speed data. The study carried out by Wsielewski (1984) analyzed the speeds that were measured by radar on Long Lake Road (Michigan) driving at free-flow conditions. They did not characterized speeders but studied the relationships between independent variables (the driver, vehicle, and trip characteristics) and the speed. Higher speeds were observed for younger drivers, drivers with prior accidents and convictions, newer cars, heavier cars and cars with no passengers. Similar results were obtained by Preusser et al. (1988).

Fildes et al. (1991) carried out an overall analysis studying the relationship between the drivers and their vehicle’s characteristics and the observed speed. The results showed that young drivers, people who were alone, and those who drove newer cars were likely to be excessive speeders. Harrison et al. (1998) carried out a similar study in order to investigate the changes in speed behavior since then. In this study the relationship between observed speed and driver’s age was not found to be significant. However, it was found a significant relationship between observed speed and gender of the driver, with males overrepresented in the fastest group.

Haglund and Aberg (2000) studied the correlation between observed speed and an attitude scale. The results indicated that high-speed drivers held more positive attitudes toward speeding than low-speeders. In that study, high-speed drivers, more often than low-speed ones, reported passengers, other road users and police officers affected their choice of speed.

Williams et al. (2006) collected speed measurements of free-flowing vehicles on thirteen locations on Virginia roads. Their results showed that speeders were younger, more likely to drive newer or sport utility vehicles (SUV), and less likely to drive minivans. All those studies were based on spot speed data, which might produce biased results. Speed collected in only one location may not be representative of driver behavior. In order to avoid that, Richard et al. (2012) developed a naturalistic field study in which volunteer drivers agreed to have a GPS unit installed in their vehicles. Data collected included 1 Hz recordings of vehicle position and speed, and also responses to a battery of a personal inventory questionnaires, and daily driving logs that captured trip-specific situational factors. The GPS data were used to compare the drivers’ speeds to the posted speed limits associated with the roads they were driving along, identifying speeders. They tried to identify the reasons why drivers speed, model the relative roles of situational, demographic, and personality factors in predicting travel speeds and classify speeders. They concluded that speeding was a complex behavior strongly influenced by several factors, such as situational factors, demographic factors, and driver’s personality.

The main critical issue of those studies is the definition of speeding behavior and how to apply it using the available data set. Fildes et al. (1991) and Harrison et al. (1998) identified the drivers traveling at excessive speeds as those who traveled at a speed within the highest 15% of the free speed distribution. Haglund and Aberg (2000) split the drivers sample into three groups according to observed speed: under 90 km/h (speed limit), 90.0 to 99.9 km/h and 100.0 km/h and over.
Williams et al. (2006) identified a driver as a speeder if the vehicle was traveling 15 mph or more above the posted speed limit and was also traveling 5 mph faster than at least three of the four surrounding vehicles. Thus, speeders were not only driving much faster than the speed limit but also traveling relatively faster than nearby vehicles.

The most complex definition has been developed by Richard et al. (2012). They identified four different behavior types that correspond to different speed bands relative to the posted speed. However, the speeding of interest in that study was defined to be Type 3 speeding (driving 10-20 mph above the posted speed) and Type 4 speeding (driving over 20 mph above the posted speed). They also considered the way to estimate overall exposure by using a new variable named “percentage time speeding”. It consisted on speeding time divided by free-flow time. Moreover, they studied driver speeding patterns using two different speeding measures, including the percent of trips with any speeding, and the average speeding per trip. The combination of both measures led four driver speeding patterns: incidental speeding, situational speeding, regular/casual speeding, and habitual speeding.

Finally, it should be noted that in both type of studies data has been obtained in one particular area and a certain time period, so the results do not necessarily generalize to other roads and time periods.

OBJECTIVES

Considering that previous studies about speeding behavior have been focused in particular areas, the main objective of this research is to identify and to characterize the factors that might contribute to the tendency of drivers to speed in Spain. This study has not only analyzed speeding behavior during traveling along a two-lane rural road segment, but also during passing maneuvers. Thus, it was necessary to develop two kinds of data collection methodologies.

In the first case, drivers’ individual free-flow speed profiles have been evaluated in order to identify speeding situations. These results have been correlated with several factors: drivers’ characteristics, characteristics of the trip and vehicle type.

In the case of passing maneuvers, the passing vehicle speed has been compared to posted speed for speeding identification. Speeders have been characterized by their gender, age, their vehicle type and the presence or not of passengers. Therefore, data collection methodologies should allow to obtain not only speed data but also data about the variables mentioned above. Besides, data collection should not be the cause of drivers’ behavioral change.

METHODOLOGY

This section describes the application of the developed data collection methodologies for both types of studies.

Free-Flow Data Collection

Continuous data collection was performed by means of GPS devices placed on the vehicles of actual drivers (Pérez-Zuriaga et al., 2010). After data filtering and reduction, the coordinates were used for composing the horizontal alignment of the road (Camacho-Torregrosa et al.,
2010), while the speed data were used for obtaining the individual speed profiles. Besides, those data were combined with drivers’ questionnaires.

Data collection process consisted on limit a road segment by means of two checkpoints, separated by several kilometers. Drivers entering the road segment were asked to participate in the project. A 1 Hz GPS device was placed on the vehicle and the vehicle was released in order to get to the other checkpoint. Drivers were also told that the collected data was going to be used for researching purposes, not for enforcement, and thus they were encouraged to drive as they usually do. The device was later removed at the second checkpoint.

After drivers’ agreement, they were asked about some questions about their driving experience, previous knowledge of the road segment and the purpose and length of the trip. Another member of the group wrote down some data, such as the number of passengers or the type of vehicle.

To ensure drivers’ unbiasedness due to data collection, it was necessary to check whether the operating speed differed significantly during the test and at normal conditions. Therefore, at three road segments, two spot speed measurements were taken, during the test and a few days before. Those speed measurements were obtained by means of video recording, far away from drivers’ line of sight. Results showed that drivers were not biased by the presence of GPS devices (Pérez-Zuriaga et al., 2010; Pérez-Zuriaga et al., 2013).

Data collection campaigns were carried out from February 2008 to July 2008 during periods between 8:30 a.m. and 2:00 p.m., in working day and under dry weather conditions. Data was obtained from ten two-lane rural road segments, with no main intersections and with a high lateral clearance. All road segments presented a low to medium traffic volume in order to reduce the impact on traffic conditions, as well as ensuring a significant sample size. Heavy traffic volume was also low. Longitudinal grades ranged from -6.3% to +5.7%. Lane widths varied from 3.4 m to 3.65 m and shoulder widths from 0.15 m to 1.5 m. The posted speed limits varied from 40 km/h to 90 km/h. The posted speed limits profile for each road segment was characterized. The general road segments characteristics are summarized in Table 1.

Table 1 Summary of road segment characteristics (free-flow data collection)

<table>
<thead>
<tr>
<th>ID</th>
<th>Road segment</th>
<th>Road segment length [km]</th>
<th>Estimated AADT [vpd]</th>
<th>Lowest posted speed 1/direction 2 [km/h]</th>
<th>Highest posted speed 1/direction 2 [km/h]</th>
<th>Observations direction 1/direction 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CV-35</td>
<td>13.40</td>
<td>860</td>
<td>40/40</td>
<td>90/90</td>
<td>70/90</td>
</tr>
<tr>
<td>2</td>
<td>CV-35</td>
<td>8.20</td>
<td>2257</td>
<td>50/50</td>
<td>90/90</td>
<td>121/120</td>
</tr>
<tr>
<td>3</td>
<td>CV-333</td>
<td>5.10</td>
<td>2419</td>
<td>70/70</td>
<td>90/90</td>
<td>101/109</td>
</tr>
<tr>
<td>4</td>
<td>CV-50</td>
<td>5.70</td>
<td>4852</td>
<td>90/70</td>
<td>90/90</td>
<td>116/116</td>
</tr>
<tr>
<td>5</td>
<td>CV-372</td>
<td>4.50</td>
<td>4149</td>
<td>50/50</td>
<td>80/80</td>
<td>77/77</td>
</tr>
<tr>
<td>6</td>
<td>CV-305</td>
<td>4.40</td>
<td>6086</td>
<td>50/50</td>
<td>90/80</td>
<td>112/112</td>
</tr>
<tr>
<td>7</td>
<td>CV-370</td>
<td>8.30</td>
<td>2523</td>
<td>90/90</td>
<td>90/90</td>
<td>61/61</td>
</tr>
<tr>
<td>8</td>
<td>CV-401</td>
<td>6.00</td>
<td>5292</td>
<td>40/40</td>
<td>90/90</td>
<td>102/102</td>
</tr>
<tr>
<td>9</td>
<td>CV-376</td>
<td>6.70</td>
<td>2656</td>
<td>60/60</td>
<td>90/90</td>
<td>58/58</td>
</tr>
<tr>
<td>10</td>
<td>CV-310</td>
<td>4.70</td>
<td>6809</td>
<td>60/60</td>
<td>80/80</td>
<td>74/74</td>
</tr>
</tbody>
</table>

Passing Data Collection

The methodology for data collection during passing maneuvers was based on an instrumented vehicle, developed by the Highway Engineering Research Group (HERG) of the Universitat Politècnica de València (Spain). The new instrumented vehicle was driven along eight two-lane

Pérez-Zuriaga A.M., Camacho-Torregrosa F.J., García A., Llorca-García C., Moreno-Chou A.T
rural road segments at different constant speeds, lower than the operating speed, in order to be passed by faster vehicles (Llorca et al., 2012).

This methodology provided a combination of video data, distances to other vehicles and positioning data. Video data was provided by four small digital cameras installed into the car. Since they covered the rear, left and front areas, the whole trajectory of every passing vehicle was observed. Relative distances between passing vehicle and the instrumented vehicle before and after performing a passing maneuver were collected by two laser rangefinders installed on rear and front bumpers. The position of the instrumented vehicle was registered by a 10 Hz GPS. As size of equipment was very small, it was not visible by other drivers, avoiding changes on drivers’ behavior.

Additional information, such as vehicle type, number of passengers and gender and age estimation of passing drivers was registered by the co-driver of the instrumented vehicle.

Data collection campaigns were performed in eight two-lane rural road segments located in the surroundings of Valencia (Spain). All the road segments presented similar traffic volume and cross-section. The number of allowed passing zones varied from 2 to 22, and their length from 135 m to 1855 m. The general road segments characteristics are summarized in Table 2.

<table>
<thead>
<tr>
<th>ID</th>
<th>Road segment</th>
<th>Number of allowed passing zones</th>
<th>Length of allowed passing zones [m]</th>
<th>Estimated AADT [vpd]</th>
<th>Posted speed limit [km/h]</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CV-35</td>
<td>10</td>
<td>435-1855</td>
<td>5797</td>
<td>100</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>CV-50</td>
<td>2</td>
<td>660-845</td>
<td>4517</td>
<td>100</td>
<td>32</td>
</tr>
<tr>
<td>3</td>
<td>CV-50</td>
<td>12</td>
<td>230-1127</td>
<td>5091</td>
<td>100</td>
<td>34</td>
</tr>
<tr>
<td>4</td>
<td>N-225</td>
<td>17</td>
<td>265-1280</td>
<td>5925</td>
<td>100</td>
<td>52</td>
</tr>
<tr>
<td>5</td>
<td>CV-415</td>
<td>18</td>
<td>135-1250</td>
<td>5465</td>
<td>60-90</td>
<td>37</td>
</tr>
<tr>
<td>6</td>
<td>CV-415</td>
<td>18</td>
<td>135-1250</td>
<td>5465</td>
<td>60-90</td>
<td>28</td>
</tr>
<tr>
<td>7</td>
<td>CV-50</td>
<td>11</td>
<td>270-1150</td>
<td>4517</td>
<td>100</td>
<td>48</td>
</tr>
<tr>
<td>8</td>
<td>CV-405</td>
<td>22</td>
<td>140-905</td>
<td>15342</td>
<td>80</td>
<td>61</td>
</tr>
</tbody>
</table>

**ANALYSIS**

A descriptive analysis was carried out in order to study the influence of different variables on speeding phenomenon, studying not only vehicles driving under free-flow conditions but also vehicles during a passing maneuver.

For the first study, involved vehicles were supposed to drive under free-flow conditions. Those conditions were defined as those of isolated vehicles with a minimum headway of at least 5 s. It was assumed that vehicles with shorter headways might be constrained by a lead vehicle. Applying the methodology developed by Pérez-Zuriaga et al. (2013) at each individual speed profile, the sections where the driver was constrained were removed from the study.

**Speeding Definition**

The most critical issue in this kind of studies is the definition of speeding and how to implement this definition. Considering the differences between vehicles driving under free-flow conditions and vehicles during a passing maneuver, speeding was defined differently for each phenomenon.

Pérez-Zuriaga A.M., Camacho-Torregrosa F.J., García A., Llorca-García C., Moreno-Chou A.T
Free-Flow Conditions Speeding Definition

In this case, speeders were characterized considering two points of view: the relationship to speed limits and their relationship to other vehicles.

In order to characterize speeders according to speed limits four speed thresholds were considered:

- $V < PS$: driver’s speed was lower than the posted speed limit
- $PS < V < PS+10$: driver’s speed varied between the posted speed limit and the posted speed limit plus 10 km/h
- $PS+10 < V < PS+20$: driver’s speed varied from the posted speed limit plus 10 km/h and the posted speed limit plus 20 km/h
- $V > PS+20$: driver’s speed is higher than the posted speed limit plus 20 km/h

However, usually drivers don’t pay attention to posted speed limits. Besides, several guidelines (Forbes et al., 2012) recommend setting the speed limit at or near the 85th percentile speed of free-flow traffic ($V_{85}$). This is why speeders were characterized in this study also considering the following speed thresholds:

- $V < V_{85}$: driver’s speed was lower than the $V_{85}$
- $V_{85} < V < V_{95}$: driver’s speed varied from $V_{85}$ and the 95th percentile of the speed distribution ($V_{95}$)
- $V > V_{95}$: driver’s speed is higher than $V_{95}$

The definition of these speed thresholds was not considered enough for the complete definition of the speeding phenomenon. Considering that continuous individual speed profile for each driver was available from data collection, a new variable was implemented. The new variable was named speeding and was defined as Equation 1. It was defined for each speed band as the quotient between the length where the driver’s speed varied inside that speed band ($speed\_length_{speed\_band}$) and the road segment length where driver was traveling under free-flow conditions ($free\_flow\_length$). The speeding variable represents the portion of road segment where drivers speed.

$$speeding_{speed\_band} = \frac{speed\_length_{speed\_band}}{free\_flow\_length} \quad (1)$$

Applying Equation 1, four different behaviors can be considered according to posted speed limits:

- No speeding (PS_NS): situation where the driver’s speed was lower than the posted speed limit
- Speeding 1 (PS_S1): situation where driver’s speed varied between the posted speed limit and the posted speed limit plus 10 km/h
- Speeding 2 (PS_S2): situation where driver’s speed varied from the posted speed limit plus 10 km/h and the posted speed limit plus 20 km/h
- Speeding 3 (PS_S3): situation where driver’s speed is higher than the posted speed limit plus 20 km/h

In the same way, applying Equation 1, three behaviors can be considered according to $V_{85}$:

- No speeding ($V_{85}\_NS$): situation where driver’s speed was lower than the $V_{85}$
• Speeding 1 (V85_S1): situation where driver’s speed varied from $V_{85}$ and the 95th percentile of the speed distribution ($V_{95}$)

- Speeding 2 (V85_S2): situation where driver’s speed is higher than $V_{95}$

The value of \textit{speeding} variable must be higher than 10\% in order to take it into account in the analysis. Otherwise, it was considered that the shown behavior was incidental and that result was removed from the analysis.

It is worthy to highlight that the same driver can show the four behaviors in the case of posted speed characterization or the three behaviors in the case of $V_{85}$ characterization.

Passing Maneuver Speeding Definition

Studying passing maneuver phenomenon, there was not available a continuous speed profile for each passing driver, but the average speed of the vehicle during passing maneuver. Therefore, it was not necessary to implement a variable similar to \textit{speeding}.

For the speeding during passing maneuvers analysis, four behaviors were considered:

- No speeding (PM_NS): driver’s average speed during passing maneuver was lower than the posted speed limit of the road segment
- Speeding 1 (PM_S1): driver’s average speed during passing maneuver varied between the posted speed limit and the posted speed limit plus 10 km/h
- Speeding 2 (PM_S2): driver’s average speed during passing maneuver varied from the posted speed limit plus 10 km/h and the posted speed limit plus 20 km/h
- Speeding 3 (PM_S3): driver’s average speed during passing maneuver is higher than the posted speed limit plus 20 km/h

Studied Variables

Since the data collection methodology was different for each study and the speeding phenomenon is also different, the studied variables in order to characterize the speeders were considered separately.

Variables for Free-Flow Conditions Speeding Study

As a result of data collection and treatment, individual continuous free-flow speed was available for each vehicle and for each road segment. Besides, the different questions included in the questionnaires allowed the characterization of some variables, such as: driver’s characteristics (age, gender, driving experience); characteristics of the trip (distance, regular or not, number and type of passengers); and vehicle type.

The analysis about the influence of those variables over the developed speed by drivers were performed in a previous research (Pérez-Zuriaga et al., 2013), so that, in the current study, only the observed significant variables were considered. Those variables are:

- Driver age: this variable was divided into 5 intervals considering the results of Pérez-Zuriaga et al. (2013). These intervals were: 18-20 years old, 21-25 years old, 26-55 years old, 56-75 years old, and older than 76 years old.
- Driver gender: it was divided into male and female.
- Driver experience: it measured the amount of kilometers driven in the last year.
Passenger: it considered the presence of passengers inside the vehicle, taking into account if they were children, adult or elderly people.

Trip frequency: it identified whether the trip was regular or not.

Trip length: the trip length was classified into short, medium and long distance trip. It was also included if the trip was a professional route.

Vehicle type: the considered vehicles were: light truck, van, minivan, SUV and passenger car.

Table 3 shows the number of subjects as a function of these variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
</tr>
<tr>
<td>18-20</td>
<td>44</td>
</tr>
<tr>
<td>21-25</td>
<td>95</td>
</tr>
<tr>
<td>26-55</td>
<td>104</td>
</tr>
<tr>
<td>56-75</td>
<td>294</td>
</tr>
<tr>
<td>&gt; 76</td>
<td>20</td>
</tr>
<tr>
<td>Gender</td>
<td>Male/Female</td>
</tr>
<tr>
<td></td>
<td>1225/371</td>
</tr>
<tr>
<td>Experience</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>486</td>
</tr>
<tr>
<td>Medium</td>
<td>707</td>
</tr>
<tr>
<td>Low</td>
<td>100</td>
</tr>
<tr>
<td>Passengers</td>
<td></td>
</tr>
<tr>
<td>Children</td>
<td>55</td>
</tr>
<tr>
<td>Adult</td>
<td>421</td>
</tr>
<tr>
<td>Elderly</td>
<td>72</td>
</tr>
<tr>
<td>None</td>
<td>1066</td>
</tr>
<tr>
<td>Trip Frequency</td>
<td>Non-regular/Regular</td>
</tr>
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<td></td>
<td>348/1169</td>
</tr>
<tr>
<td>Trip Length</td>
<td></td>
</tr>
<tr>
<td>Short</td>
<td>551</td>
</tr>
<tr>
<td>Medium</td>
<td>489</td>
</tr>
<tr>
<td>Long</td>
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<td>Route</td>
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<td>Vehicle Type</td>
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<td>Light truck</td>
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<td>Van</td>
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<td>Minivan</td>
<td>40</td>
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<tr>
<td>Passenger car</td>
<td>621</td>
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<tr>
<td>SUV</td>
<td>61</td>
</tr>
</tbody>
</table>

Variables for Passing Maneuver Speeding Study

After the data collection campaigns based on the instrumented vehicle, the available data included the average speed data of the passing vehicle during the passing maneuver, driver’s characteristics (age, gender); and presence of passengers.

According to the results of previous research (Llorca-García et al., 2013) the characterization of these variables was:

- Driver age: two groups were considered: young drivers (under 30 years old) and old drivers (over 30 years old).
- Driver gender: male or female.
- Presence of passengers: it considered whether the driver traveled alone or not.
Table 4 shows the number of subjects as a function of these variables.

Table 4  Sample characterization (passing maneuver study)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Young/Old</td>
</tr>
<tr>
<td>Gender</td>
<td>Male/Female</td>
</tr>
<tr>
<td>Passengers</td>
<td>Yes/None</td>
</tr>
</tbody>
</table>

Analysis of the Speeding Phenomenon

A descriptive analysis was carried out in order to characterize the speeding phenomenon during two driving conditions: during free-flow traveling, and during passing maneuvers.

Free-Flow Conditions Speeding Analysis

The analysis of the speeding phenomenon of drivers traveling under free-flow conditions were developed from two points of view. The first one was based on the definition of speeding situations focused on the comparison between drivers’ speed and posted speed, posted speed plus 10 km/h and posted speed plus 20 km/h. In the second one, this definition was based on the comparison between drivers’ speed and the speed corresponding to the 85th and 95th percentile of the speed distribution of the road segment they were driving through.

For each driver the value of the variable speeding was calculated for each speed band. These results allowed the drivers’ behavior identification, considering the behaviors’ definitions cited above. Figure 1 shows the percentage of drivers that were driving according to the different behaviors or combination of behaviors.

![Figure 1](distribution_of_drivers_behaviors_free_flow_conditions.png)

Figure 1  Distribution of drivers’ behaviors. Free-flow conditions

Despite the usually accepted hypothesis related to the fact that a driver who speed traveling along a road segment behaves in the same way along other road segment, the current study results showed that a high percentage of drivers combined different behaviors. This conclusion might question the studies that analyze speeding behavior based on speed data recorded in only one location.
Another important conclusion that was extracted from this analysis is that the main percentage of drivers usually drives slower than the $V_{85}$, and, considering the posted speed limit, most drivers travel below the posted speed limit plus 10 km/h.

Besides the overall study, specifics studies were carried out considering the variables listed above. Figure 2 shows the distribution of drivers’ behavior depending on their gender and age. Men, and especially young men, tend to concentrate more on driving behaviors associated to speeding than women do, especially the older ones.

![Figure 2](image-url)

Figure 2  Distribution of drivers’ behaviors (age and gender). Free-flow conditions

The same analysis was carried out taking into account the driving experience of the different drivers, but the distribution resulted similar for the three levels of driving experience defined above.

In the case of the frequency of the trip the results were similar. The distribution of the percentages of drivers was similar for regular trip and non-regular trip. Although it was also almost similar for short, medium, long and route trip, drivers traveling along a short or route trip showed a slight tendency to speed more than the others. The same situation was shown in the study of the percentage distribution considering the differences between traveling alone or not.
The study of the differences in speeding behavior driving different types of vehicles produced some expected results. They indicated that drivers with passenger cars or SUV tend to show speeding behaviors (Figure 3).

Figure 3 Distribution of drivers’ behaviors (vehicle type). Free-flow conditions

Passing Maneuver Speeding Analysis

The analysis of the speeding phenomenon during a passing maneuver were developed comparing the average speed of the passing driver to the posted speed limit of the road segment. Hence, they were classified according to the behavior types cited above.

For the descriptive analysis, the distribution of percentages of drivers belonging to each behavior depending on their age and gender and the presence of passengers was carried out.

In the case of the gender of the driver, no significant differences were observed. However, differences were found considering the age of the driver: young people tend to show the highest speeding behaviors more frequently than adult drivers do (Figure 4).

Figure 4 Distribution of drivers’ behaviors (vehicle type). Passing maneuver
The sample of drivers traveling alone was too small, so the analysis taking into account the presence of passengers was not significant.

**CONCLUSIONS**

The current research is based on the analysis and characterization of speeding behavior, not only related to drivers traveling under free-flow conditions, but also to drivers passing slower vehicles. This kind of behavior was evaluated considering drivers’ characteristics; characteristics of the trip; and vehicle type. In order to obtain drivers’ speeds and those characteristics two different data collection methodologies were developed. Speeders were characterized comparing drivers’ individual speed profiles to the posted speed, the posted speed plus 10 km/h and the posted speed plus 20 km/h, for the free-flow conditions study. Their individual speed profiles were also compared to the 85th and 95th percentiles of the speed distribution of the road segment they were driving through. These comparisons were done considering continuous individual speed profiles thanks to the implementation of a new variable. The new variable was named *speeding*. It was defined for each speed band as the quotient between the length where the driver’s speed varied inside that speed band and the road segment length where driver was traveling under free-flow conditions. According to this variable, several driving behavior types were defined.

The main conclusions regarding the analysis of speeding phenomenon during free-flow conditions in the current sample of drivers were:

- A high percentage of drivers tend to combine different behaviors when driving. The studies based on speed spot data measurement might not be accurate enough for speeding characterization.
- The main percentage of drivers usually drives slower than the V_{85}, and, considering the posted speed limit, most drivers travel below the posted speed limit plus 10 km/h.
- Speeding behavior appears to be associated with younger male driver with a passenger car or a SUV.
- The driving experience, the frequency and length of the trip and the presence of passengers were not found significant variables for speeding characterization.

In the case of the study of passing maneuver phenomenon, the average speed of the vehicle during passing maneuver was the only one available variable. The variable *speeding* was not necessary. The average speed during passing maneuver was compared to the posted speed limit for speeders identification. Speeding during passing maneuvers appeared to be associated with younger age, without influence of the driver gender variable.

These research findings may have important policy implications, particularly relating to educational campaigns and enforcement tolerances.

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