INFLUENCE OF TRAFFIC FLOW SEPARATION DEVICES ON ROAD SAFETY IN BRAZIL’S MULTILANE HIGHWAYS

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1. INTRODUCTION

Projects of multilane highways are primarily based on the level of service required, but the consequences of such designs in road safety are relevant when compared to two-lane highways, for instance, in which there is a unique lane for each direction. If a central reservation is present, with median barrier or not, the possibility of occurrence of certain types of accidents (such as head-on and angle collisions) are drastically reduced because of the existence of a physical distance or a protection device separating traffic traveling in opposite directions.

However, there are specific cases, in Brazil, where the highways possess two lanes in each direction with a continuous cross-section, in which the separation is only visible due to the centerline, although the Average Daily Traffic (ADT) of these roads may be equivalent to the one in divided highways. The main problem is that, because of both lanes in each direction, drivers are naturally encouraged to develop higher velocities. This similarity between divided and undivided highways, with the only difference regarding the absence of separation, provides an unreal feeling of safety, since the chances of the most fatal types of collision are significantly increased and, with high velocities, the consequences may be even worse.

In Brazil, the main document that states the guidelines for the geometric design of roads – the Manual of Geometric Design of Rural Highways (Brazil, 1999) – does not contemplate multilane undivided highways, demanding a median width of at least 3 meters. It also reinforces that, in extreme circumstances, such as tunnels or right-of-way restrictions, the central reservation might be reduced to a single barrier or a guardrail with a marked line just for safety, since it cannot be classified as a shoulder due to the minimum width. Therefore, the single centerline dividing opposing traffic in multilane highways is not regulated, although there are several segments of important Brazilian highways with these features.

Several studies, such as the ones conducted by Pérez (2005) and Russo et al. (2016), investigated safety performance for undivided highways. While the former evaluated the safety impact of road treatments, such as pavement markings, the latter concluded the relevance of geometric variations to the frequency of injuries and fatalities. Also, The Highway Safety Manual considers undivided four-lane roadway segments in its accident prediction models, stating, for example, a proportion of crashes by collision type and severity level (AASHTO, 2010).

The importance of these studies applied to the Brazilian reality is reinforced by the fact that the country presented, in 2014, 23.4 road traffic fatalities per 100,000 people (WHO, 2015). It places Brazil in the 148th position among 182 countries analyzed by the World Health Organization (ONSV, 2014).

Because of the geometric difference between these similar roads in terms of capacity, it’s proposed a study to investigate if the Traffic Flow Separation Devices (TFSD) – physical distance, median barrier
or single centerline – exert a meaningful influence on road safety with respect to typology and frequency.

It’s important to emphasize that the results and conclusions presented in this abstract refer to an ongoing study. Final results and deeper analysis are expected to be available by September. A more accurate treatment of the data, with the usage of statistical hypothesis tests, which can lead to a clear justification of the conclusions shown here, is expected.

2. AIM
To investigate the impact of traffic flow separation devices, such as a physical distance, a median barrier or a single centerline, on road safety in Brazilian multilane highways with equivalent average daily traffic, in terms of typology and frequency.

3. METHOD
The data used for this study was provided by three Brazilian institutions: ANTT (National Ground Transportation Agency), CNT (National Confederation of Transport) and PRF (Federal Highway Police). Their contributions are explained below:

- ANTT: average daily traffic data;
- CNT: traffic flow separation devices data;
- PRF: accident data.

In order to unify the information provided by these institutions, the sample consisted of federal highways operated as a concession which were researched by the CNT, since the latter only studied a limited variety of highways all over the country.

After that, the segments with the most critical type of TFSD (a single centerline) were analyzed and it was verified that approximately 330 km could fit into this category. However, to simplify the comparison to highways with a physical distance or a median barrier, a unique road was selected: BR-040, in the state of Minas Gerais. In its 164.9 km that carried this characteristic, it was observed if, for example, the road was inside the urban perimeter of important cities and, most importantly, the ADT measured in its turnpikes.

Other highways with ADT between 10,000 and 20,000 vehicles per day were selected, but now with different TFSD. The Table 1 summarizes the sample used.

*Table 1: Sample used for the study*

<table>
<thead>
<tr>
<th>Road</th>
<th>State</th>
<th>Traffic flow separation device</th>
<th>Length (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BR-040</td>
<td>MG</td>
<td>Centerline</td>
<td>164.9</td>
</tr>
<tr>
<td>BR-381</td>
<td>MG</td>
<td>Physical Distance</td>
<td>435.2</td>
</tr>
<tr>
<td>BR-040</td>
<td>MG/RJ</td>
<td>Median Barrier</td>
<td>98.9</td>
</tr>
</tbody>
</table>

Descriptive statistics were used to state if the TFSD exert impact on the number of accidents (regarding quantity and typology), victims and deaths. The data applied consisted of a three-year period, including 2013, 2014 and 2015.

Every information collected from the data was divided by the number of kilometers of the corresponding segments. This technique was used to make the comparison possible, since the length for each category of analysis was different.

Further statistics applications are expected to be concluded in the next months. They will try to prove if the usage of a single centerline to separate multilane highways of opposite traffic traveling directions is, in fact, more dangerous to drivers because of the bigger number of mortalities presented.
Additional hypothesis will also be tested, such as the utilization of median barriers as safety measures for roads with severe right-of-way restrictions.

4. RESULTS

Three indexes were used to verify the influence of traffic flow separation devices: number of accidents per kilometer, number of victims per kilometer and number of deaths per kilometer. Therefore, Figure 1, shown below, represents each one of these parameters for a three-year period.

Figure 1: Parameters per Traffic Flow Separation Devices

It is worth mentioning that some other parameters, such as the number of accidents per 100 million vehicles, were not calculated due to the lack of available ADT data for the three-year period studied. However, the three indexes shown below were capable of characterizing the accidentality of Brazilian’s multilane highways according to its correspondent TFSD.

Based on Figure 1, it can be inferred that the median barrier is an effective device for dividing vehicles traveling in opposite directions regarding the reduction of deaths on highways, since the index for this category was significantly smaller when compared to the other types of TFSD.

Concerning typology, two classifications could be highlighted: run-off-road accidents and collisions. Because of that, Figures 2 and 3 show an average of these types of accidents for the three-year period with its standard deviation.
The number of accidents per kilometer on highways separated by a centerline and a physical distance are very close, according to Figure 1a, and this similarity can be justified by the types of accidents occurring in each one of them. Whereas the quantity of collisions per kilometer more likely to happen on two-lane two-way roads, such as head-on, angle and sideswipe, increases in multilane undivided highways (Figure 3), the parameter relative to the number of run-off-road accidents is bigger in roads with a central reservation (Figure 2).

It’s important to state that only one type of collision (the one with a fixed object) did not present its highest number on highways separated by a centerline because of, mainly, the absence of a structure dividing traffic flow. As expected, roads with median barriers came up with the biggest number of accidents in this category.

However, the number of victims on highways separated by a centerline represents the biggest index when compared to the other TFSD categories (Figure 1b), and the situation becomes even more preoccupying when the number of deaths per kilometer is analyzed (Figure 1c), since it’s almost double the number of the runner-up’s parameter (highways separated by a physical distance).
5. **CONCLUSIONS**

Based on the results previously shown, it can be implied that highways with a single centerline dividing opposite traffic directions are significantly dangerous for drivers because of the number of deaths per kilometer presented, approximately double of the quantity on highways separated by a physical distance.

Therefore, the descriptive statistics have shown that the absence of a physical separation (a distance or a barrier) represents a meaningful impact with respect to the mortality on highways, since drivers develop higher velocities, as they are apparently on multilane divided highways, with two lanes for each traffic flow direction. However, the single centerline increases the possibility of, for example, head-on and sideswipe collisions, two of the most fatal kinds of accidents (Figure 2).

The number of accidents, victims and deaths per kilometer on highways divided by a median barrier show that an extremely wide separation in the central reservation, although recommended, is not the only alternative necessary to reduce the parameters presented in this study. The usage of longitudinal barriers produced satisfactory results in road safety, even better than the ones with a physical distance as TFSD, and this can be an outstanding solution if restrictions regarding right-of-way are severe or the existence of properties on the border of the roads prevents their enlargement.

As confirmed for Brazilian multilane highways, the usage of a physical separation is, above all, essential for reducing the number of deaths. And, because of that, the Brazilian’s *Manual of Geometric Design of Rural Highways* is correct, in terms of road safety, when it does not contemplate undivided highways when it comes to projecting highways in the country.

**REFERENCES**


