CETRA[2018]

5th International Conference on Road and Rail Infrastructure

17–19 May 2018, Zadar, Croatia

Road and Rail Infrastructure V

Stjepan Lakušić – EDITOR

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APPLICATION OF PASSING SIGHT DISTANCE IN ROAD DESIGN

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Abstract

The regulations determine the minimum length of passing sight distance as the function of design speed. Researches have confirmed that passing sight distance has a positive impact on capacity for relatively low traffic volume. Recent researches show that the definition of passing capabilities as percentage of zones with forbidden passing (no passing zone) does not describe sufficiently well the real state. In this paper are presented the results of the research on the section of the main road (V_r = 80 km/h), which show that the minimum lengths of passing zones (passing sight distances) have very little effect evan at very low traffic flow rate. The basic parameter of the capacity analysis is PTSF (percent time spent following). By increasing the length of the passing distances, the positive impact increases significantly to a certain limit (optimum length). A further increase loses meaning (does not give a significant effect). The obtained results indicate that additional research could provide design guidance on optimum lengths of passing zone as the function of speed and traffic flow rate.

Keywords: passing sight distance, optimal length, capacity analyses, PTSF

1 Introduction

The regulations determine the minimum length of passing sight distance as the function of design speed. The impact of passing sight distance on capacity decreases by increasing the traffic volume. The design regulations in the countries of the region ([1-3]) similarly define minimum passing sight distance. It is defined by the length required by the vehicle to pass the slower vehicle and to return to its lane. It is assumed that the speed difference between the vehicles is $\triangle V$ = 15 km/h and the passing duration is 10 seconds. The passing sight distance of two-way roads also includes the length that the vehicle crosses from the opposite direction at that time. The minimum length of passing sight distances according to regulations allow passing for most vehicles only in the case when there are no vehicles in the opposite direction. Comparison of minimum lengths of passing sight distances according to several rules ([1-5]) are shown in Figure 1. These regulations specifie almost the same minimum percentage of road that ensure passing. Usually it is 25 % for roads of higher rank and 15 % for other roads. Serbian regulations [3] specifies 20 % for all roads with speed from 40 to 100 km/h. The main feature that distinguishes two-way rural roads from all the other functional elements of the uninterrupted traffic flow are that passing maneuvers run on a lane for the opposite direction. Therefore, apart from the described geometric (physically required minimum lengths), it is necessary to have a sufficiently long time headway in the opposite direction so that passing maneuver could really happen. As the traffic volume increases (and the need for passing at the same time), the passing potential is at the same time reduced. This causes the platoons in the traffic flow and there is additional delay due to the inability to pass slower vehicles.

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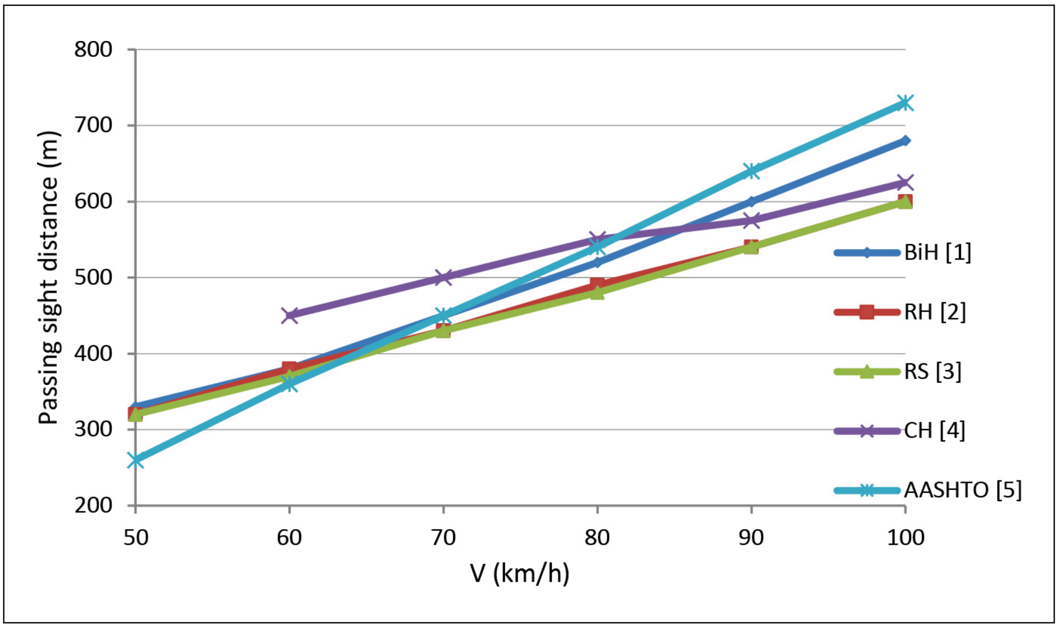

Figure 1 Comparison of minimum lengths of passing sight distances according to different regulations

As passing possibilities decreases as traffic demand increases, two-way roads have a unique feature: the quality of traffic flows often drops as demand increases, and maneuvers can become "unacceptable" at relatively low volumes and capacity ratios. For this reason, operating conditions on two-way highway almost never approach capacity, or in most cases, lower quality of traffic flow leads to their improvement or reconstruction much before capacity is reached. From the above mentioned it can be concluded that besides the determination of minimum passing sight distance, at the same time, it is necessary to establish the functional relation of the traffic volume and the optimum length of passing zone.

2 Impact of the length of passing distance on level of service

According to the American Highway Capacity Manual [6] methodology, the impact of the passing length is taken through the percentage of no passing zone PNPZ. The greatest impact is achieved at low volumes. According to this methodology, there are two parameters based on which level of service is defined: average travel speed ATS and percent time spent following PTSF. The largest impact of the no passing zones according to both parameters is at flow of 400 pc/h in both directions while the capacity for ideal conditions is estimated at 3200 pc/h. Figure 2 shows graph of traffic volume impact on PTSF. As the flow increases, the passing capacity decreases and at reaching the level of service D it is almost zero.
For segments with PNPZ over 70 %, HCM gives very close PTSF value (level of service).That is the problem of HCM application in B&H because almost all roads have these values of the PNPZ and show different quality of traffic flow conditions. German HBS 2001 [7], which should be more appropriate to our prevailing conditions (due to a similar fleet), gives significant differences in approach. The capacity analysis of two-way roads is also determined according to percentage of no passing zones. It is defined as the combined impact of the curvature and the passing for the determination of 4 curvature classes. A percentage of no passing zones has more significant impact and hence greater impact on the speed of the passenger car, the density, or level of service (Figure 3).
The graphs in Figure 3 show significant impacts of longitudinal grades (shown in gradient of grades 1 in the first and 5 in the second column) and corresponding gradient curve classes. Looking at a relatively law traffic flow of 500 pc/h for both directions, with 10 % of heavy vehicles for the highest class of grades, it is noticeable that the class of curvature (combined impact curve and percentage of no passing) reduces the speed of 90 km/h at about 50 km/h.

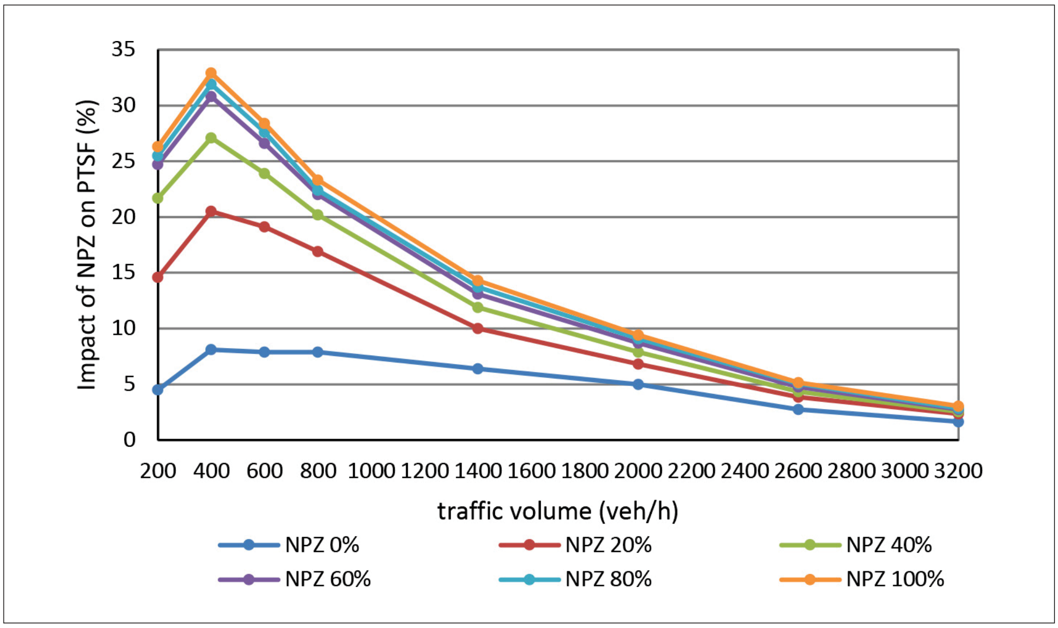

Figure 2 Impact of percentage of no passing zones on PTSF, distribution 50/50 (HCM 2010 [6])

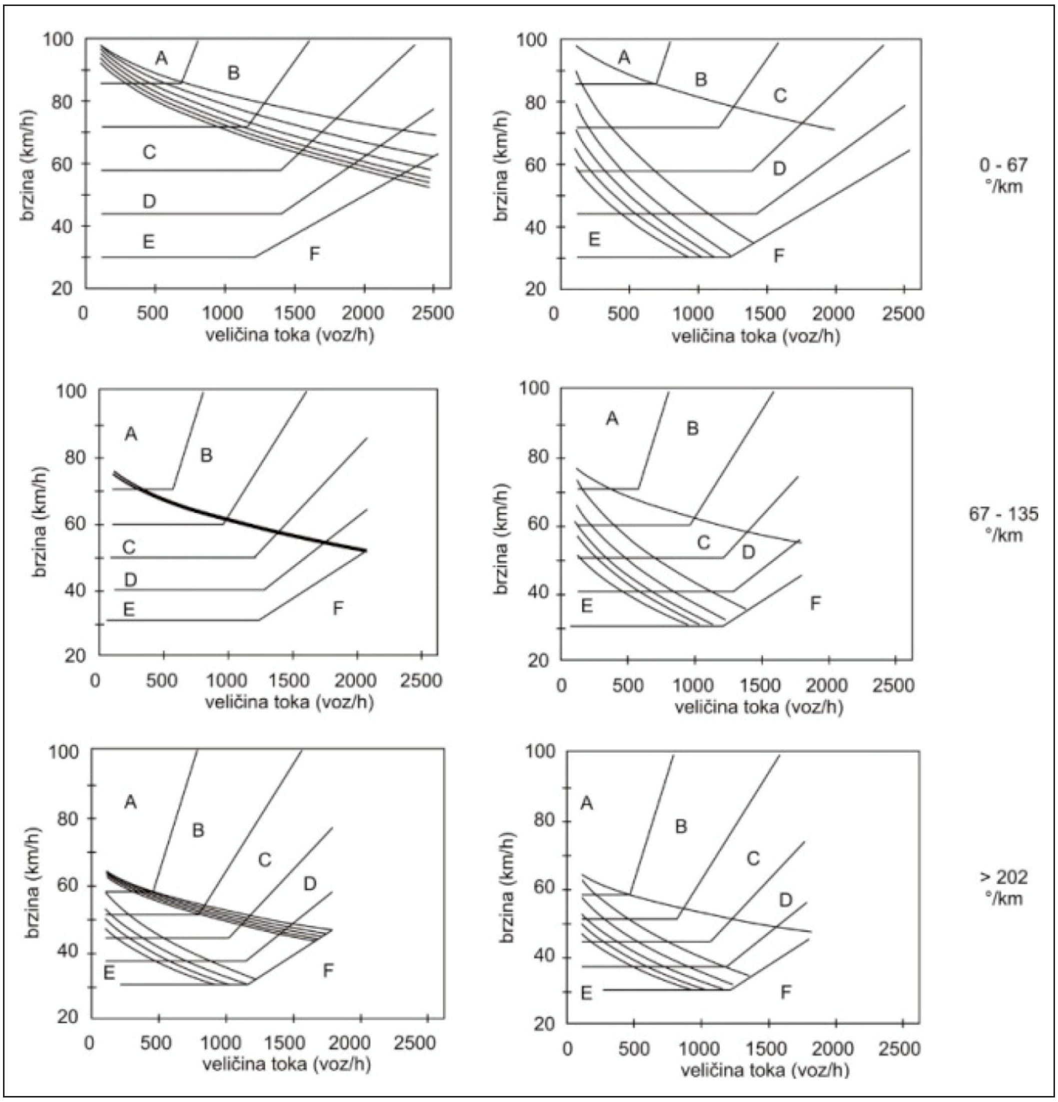

Figure 3 Example of speed-flow diagram for combinations of geometries (heavy vehicles from 0 % to 25 %) [7]

Big changes are introduced by the new HBS 2015 manual [8], which has a new concept of capacity analysis. It is divided into three parts: (i) motorways, (ii) rural road network and (iii) urban road network. In the analysis of the rural roads, the capacity analysis for the “2+1” road was introduced, and methodology for two-lane roads is changed. The impact of passing is completely neglected in the analyzes.

3 Recent researches

Studies in Spain have given interesting results regarding the impact of the passing zone lengths. Moreno et all (2016) [9] conducted a large field measurements and analyzed the impact of passing on ATS and PTSF. ATS and PTSF are defined as the sum of basic values as well as the impact of no passing zones NPZ:

$$ATS = ATS_{base} + ATS_{npz} \tag{1}$$

$$PTSF = PTSF_{base} + PTSF_{npz} \tag{2}$$

Analyzes were made for two-way roads with a speed limit of 100 km/h and for evenly distributed passing zones, level terrain and good road condition. They also analyzed the length of the passing zones, not just the total percentage (for 0 %, 50 % and 100 %) of the no passing zones. Figure 4 shows the analyzed lengths and distribution of zones.

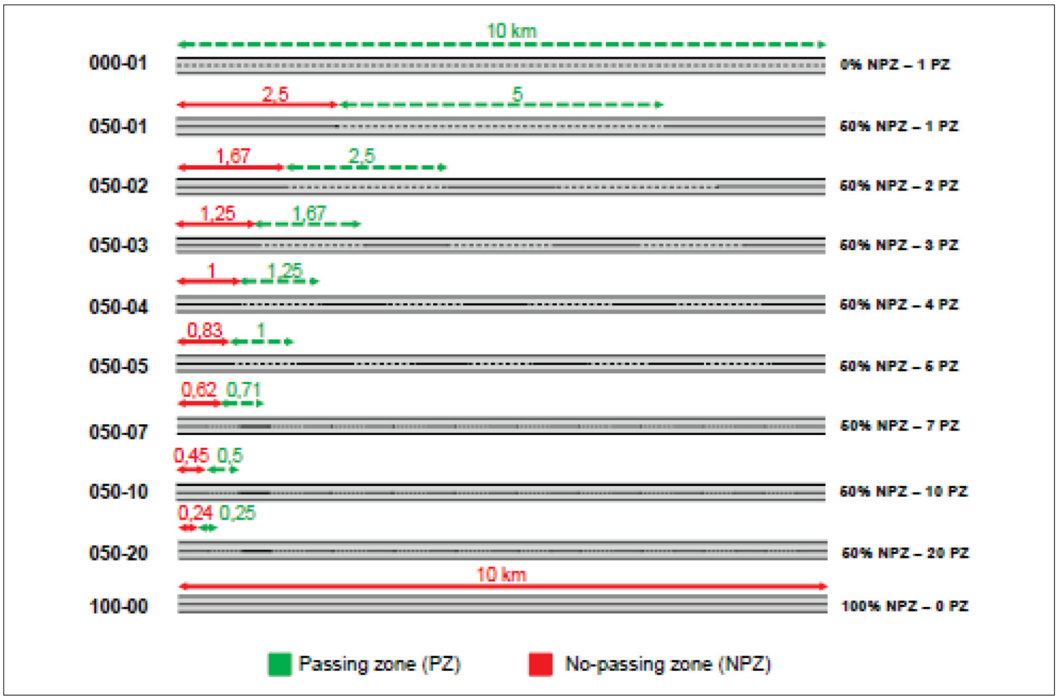

Figure 4 Analyzed lengths and positions of passing zones [7]

The basic expressions for ATS and PTSF according to the HCM also added the impact of the passing zone length PZL and received the following expressions:

$$ATS = ATS_{base} + ATS_{npz} + ATS_{pzl} \tag{3}$$

$$PTSF = PTSF_{base} + PTSF_{npz} + PTSF_{pzl} \tag{4}$$

Where:

$PTSF_{pzl}$ – correction factor for the average length of the passing zones for PTSF (%);

ATS_{pzl} – correction factor for the average length of the passing zones for ATS (km/h).

Comparison of results with HCM was done in the case of 50 % no passing zones NPZ depending on the directional split and length of passing zones PZL. Concluding considerations have been taken [9]:

- “Distribution by directions has a significant effect on traffic quality, and therefore the analysis by directions has the advantage.
- Impact of PZL is greater when there is a chance of passing, which occurs when it is distributed over 60/40 by directions or at low traffic flows. For distributions below 40/60, the changes are in the flow function in the analyzed direction, while in the case over 60/40 only in the PZL function.
- The impact of PZL on PTSF is significantly higher than the impact on ATS. The average difference is up to 23 % in the case of short lengths of passing zones.
- There are four groups of PZL with similar behavior: very short passing zones (250 m), short passing zones (500 and 714 m), mean passing zones (1000, 1250, 1670 m) and long passing zones (2500 and 5000 m). Very short zones do not at all contribute to the operational efficiency of the segment. Central zones have a certain impact (reduction of ATS for 2km/h and increase of PTSF by 5 %). Long zones give close results for different lengths, which means stabilizing results after lengths greater than 2500 m.
- PTSF results show that there is a negligible error in the HCM 2010 methodology under well-balanced directional distribution and long passing zones (longer than 1670 m). For distribution below 40/60 HCM gives lower PTSF results with a error of up to 19 % for all PZL lengths, while errors go up to 22 % for distribution over 60/40. The biggest errors occur in the conditions of flow size in the analyzed direction less than 400 veh/h.”

The research results conducted in B&H for the purpose of this paper show significant differences in the impact of certain lengths of passing zones. High-speed road (80 km/h) was performed on two sections, with a length of passing zones 450 m and 900 m. The PTSF difference (based on the headway of 3 sec) was measured both before and after the zone in both directions. In this way, the impact of these zones on PTSF has been gained. Figure 5 shows the results of dependence of PTSF change for the analyzed direction (V_d on the abscissa), while the opposite direction is shown cumulatively (average value for all volumes).

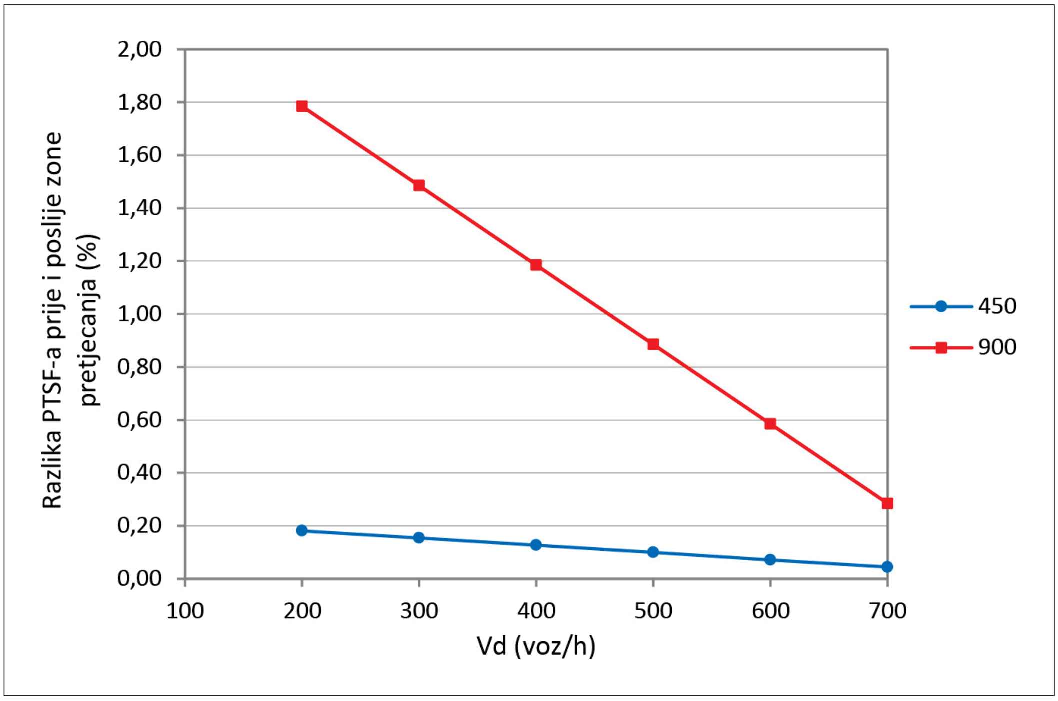

Figure 5 The impact of length of passing zones 450 m and 900 m on PTSF

From the results of the graph of the figure 5 it can be seen that the impact of PTSF significantly decreases by increasing the directional flow rate V_d. The difference in PTSF (impact of the zone length) is as much as nine times higher in the 900 m long passing zone than at 450 m, although the length difference is only two times higher. As in Spanish research, the importance of length of the passing zone length is confirmed.

4 Conclusions

Concerning the results of the above-mentioned methodologies for the two-way road, it can be concluded that different countries approach differently to the problem of passing on the two-lane roads. The approach of defining only through the percentage of no passing zones does not adequately describe the impact of passing, especially in our prevailing conditions. Studies show that minimum passing lengths have very little positive effect on good geometric roads while increasing the passing zone length to a certain value increases its positive impact. The number and length of zone for passing is a more precise and better measure of efficiency in the capacity analysis than the percentage of no passing zones.
From the point of view of design, the rule of a certain passing sight distance (minimum length) is necessary but not a sufficient input. Number of headways and their distribution in the opposing flow are very important variables. By introducing interdependence between the length of passing zone, traffic demand in both directions and level of service, the optimum length can be achieved that will then really allow the passing maneuvers.

References

[1] Pravilnik o osnovnim uvjetima koje javne ceste, njihovi elementi i objekti na njima moraju ispunjavati s aspekta sigurnosti, “Službeni glasnik BiH”, broj 6/06, sarajevo 2007.

[2] Pravilnik o osnovnim uvjetima kojima javne ceste izvan naselja i njihovi elementi i objekti moraju udovoljavati sa stajališta sigurnosti prometa, Zagreb, 2001.

[3] Priručnik za projektovanje puteva u Republici Srbiji, Beograd 2012.

[4] Vereinigung Schweizerischer Strassenfacmänner (VSS): Linienführung, Quergefällsänderung (SNV 640 140) Zürich, 1991, 2001.

[5] American Association of State Highway and Transportation Officials, A Policy on Geometric Design of Highways and Streets, Washington, DC., 2011.

[6] Transportation Research Board. Highway Capacity Manual. Fifth Edition, TRB, National Research Council, Washington, D. C., 2010.

[7] FGSV: Handbuch fuer die Bemessung von Strassen (German Highway Capacity Manual) HBS 2001, FGSV, Cologne, edition 2005.

[8] FGSV: Handbuch fuer die Bemessung von Strassen (German Highway Capacity Manual) HBS 2015, FGSV, Cologne, edition 2015.

[9] Moreno, A.T., Lorca, C., Washburn, S., Bessa, J.E.J., Garcia, A.: Effect of Average Passing Zone Length on Spanish Two-Lane Highways Traffic Performance, Transportation Research Board 95th Annual Meeting,. Transportation Research Board, Washington, D.C., 2016.