



Prevention of overtaking accidents on rural roads

Compact accident research

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Preliminary remarks

9% of the people killed on roads outside of built-up areas are the victims of overtaking accidents. These accidents are thus among the accidents with the most serious consequences on roads outside of built-up areas.

The purpose of this now completed UDV research project was to ascertain the infrastructure-related, traffic-control and traffic-related factors influencing overtaking behavior and overtaking accidents in order to be able to identify suitable measures to prevent these severe accidents.

500 sections of road in five different German federal states that were found to have the highest numbers of accidents served as the basis for this study. It was ascertained where overtaking was prohibited (by means of road markings and signs) and what speed limits were imposed. On 100 of these sections of road, the sight distances at the accident locations were ascertained and included in the analysis of the accidents. In a detailed investigation, overtaking maneuvers were recorded on video and analyzed.

This compact accident research report summarizes the findings of this study. You can obtain more detailed information from research report no. 24, entitled „Untersuchung von Maßnahmen zur Prävention von Überholunfällen auf einbahnigen Landstraßen“ (a study of measures designed to prevent overtaking accidents on single-carriageway roads outside of built-up areas). You can download this report free of charge at www.udv.de.

Introduction

Around 75,000 accidents involving injury on roads outside of built-up areas were reported to the police in 2012. 2,151 people were killed in them, and a further 25,766 people were seriously injured. Around 6% of these accidents and 9% of the fatalities occurred as a result of an overtaking maneuver. Overtaking accidents are thus particularly serious.

The UDV therefore carried out a scientific investigation to find out how, where and why overtaking accidents happen on single-carriageway roads outside of built-up areas, and whether these accidents happen despite the fact that overtaking is prohibited or in areas in which overtaking is permitted [1]. Above all, the aim was also to ascertain what can be done to prevent these accidents.

Methodology

The basis of the study was a comprehensive analysis of sections of road outside of built-up areas where a disproportionate number of overtaking accidents in five selected German federal states occurred. The road information databases and accident databases were prepared and combined with this purpose in mind. Based on the calculation of the accident indicators, 500 sections of road were identified in the area covered by the study that were most affected by overtaking accidents. A survey vehicle was driven along these sections of road. The sections where overtaking was prohibited (by means of road markings and signs) and speed limits were set up were ascertained. The overtaking accidents were assigned to these different sections of road. In addition, for the 100 sections of road with the most conspicuously high numbers of accidents, the axes were redesigned both in

horizontal and vertical plan, and the sight distances were ascertained, in order to analyze any effect they might have on the accident occurrence. Finally, in a total of 50 selected stretches of road with conspicuously high numbers of accidents, a microscopic detailed analysis of overtaking behavior was carried out by means of video observations.

Accident occurrence

The analysis of the accident occurrence consisted of a nationwide analysis of the structure and consequences of overtaking accidents on roads outside of built-up areas in 2009 and a detailed analysis of the accident occurrence in five federal states from 2007 to 2009. On 58,269 kilometers of single-carriageway roads outside of built-up areas, there were 85,345 accidents involving injury and serious property damage (category 1 to 4), including around 6,200 overtaking accidents.

The results can be summarized as follows:

- Two-thirds of the overtaking accidents involving injury were accidents in longitudinal traffic, a further 21% were turning-off accidents, and the remaining 10% were driving accidents (i.e. the driver lost control of the vehicle).
- In half of the overtaking accidents the driver overtook despite the fact that there was oncoming traffic or the traffic situation was unclear. 24% of the overtaking accidents involving injury were frontal collisions, a further 24% were side-on collisions with vehicles traveling in the same direction, 14% were rear-end collisions with the vehicle in front, and 11% were accidents with vehicles turning into or crossing a road.
- 76% of the people involved in the accidents who were partially responsible for the accident were driving passenger cars, 16% were riding motorcycles, and 8% were driving trucks.

Effect of prohibiting overtaking and setting up a speed limit

Effect of prohibiting overtaking and setting up a speed limit

As a result of further filtering, 500 sections of road outside of built-up areas with a conspicuously high number of accidents and a total length of 2,235 kilometers were identified, on which a total of 1,557 overtaking accidents had occurred. These 500 stretches of road were driven in order to ascertain whether the accidents occurred on sections where overtaking was prohibited.

On average, overtaking was prohibited on 31% of the stretches of road driven. If overtaking was prohibited in both directions, this was generally indicated by a broken middle marking line (in 56% of cases) or by traffic signs (in 22% of cases). However, the combination of a broken middle marking line and the traffic sign, which is actually not permissible, was also frequently found (in 22% of cases). On around a third of the sections of road included in the study, there was a speed limit of less than 100 km/h.

The accidents that occurred in these sections were analyzed, and the following results were obtained:

- 74% of the overtaking accidents occurred in sections where overtaking was not prohibited.
- 72% of the overtaking accidents occurred in sections with a speed limit of 100 km/h.
- There was a lower risk of accidents occurring on stretches of road where overtaking was prohibited, and the accidents were less serious (lower accident rate and accident cost rate).
- There was an even lower risk of accidents and lower accident severity on stretches of road with speed limits of less than 100 km/h (Figure 1).

Overtaking regulation	Risk and consequences of overtaking accidents on two-lane rural roads by speed limit			
			   	
	Accident rate [A/(10 ⁶ ·veh·km)]	Accident cost rate [€/1000·veh·km]	Accident rate [U/(10 ⁶ ·veh·km)]	Accident cost rate [€/1000·veh·km]
	0.12	19.0	0.09	14.5
	0.09	15.8	0.06	8.9
 ¹⁾	0.10	12.0	0.07	9.4
	0.07	13.9	0.07	9.7

¹⁾ partly removal slow vehicles

Figure 1: Accident rate and accident cost rate depending on overtaking regulations and speed limits

Effect of bends, cambers and sight distances

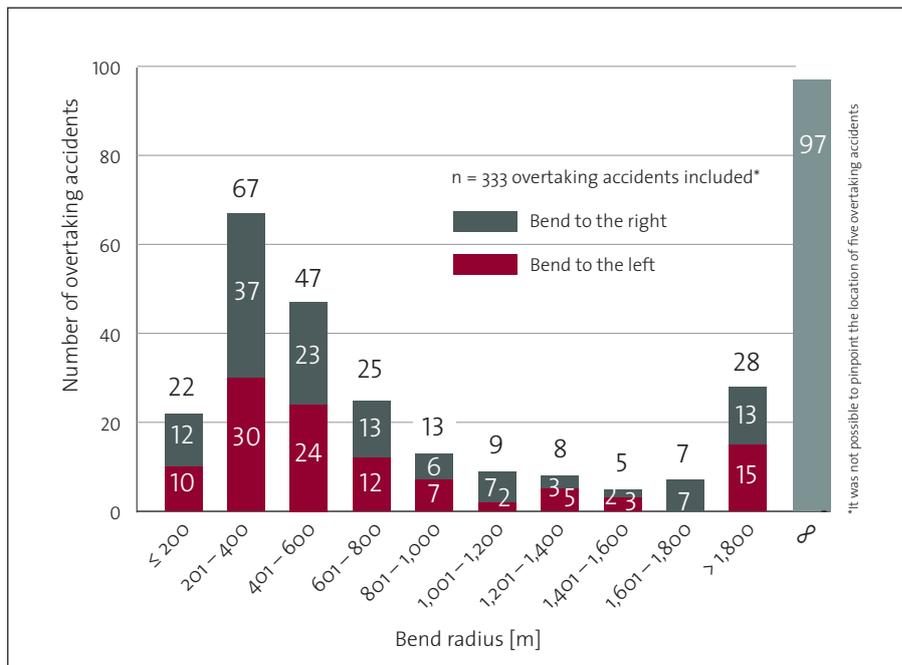


Figure 2: Overtaking accidents by bend radius and direction of bend

Effect of bends, cambers and sight distances

The axes of the 100 stretches of road with the most conspicuously high numbers of accidents were redesigned for this detailed analysis. It was possible to pinpoint the locations of 333 overtaking accidents over a total road length of 350 km. In addition, on the basis of the redesign the sight distances around the accident location were ascertained.

Around 71% of the accidents occurred within the sphere of influence of bends. The tighter the bends, the more overtaking accidents were found (Figure 2). Moreover, overtaking was not prohibited at around 73% of the bends at which conspicuously high number of accidents occurred.

Around 38% of the overtaking accidents happened in the direct vicinity of cambers, and overtaking was not prohibi-

ted at over two-thirds (71%) of all cambers at which a conspicuously high number of accidents occurred (Figure 3).

Figure 3 shows whether signs and what kind of road markings were in place at typical accident locations on roads outside of built-up areas. Overtaking accidents also occurred at intersections, and overtaking was not prohibited in around half of these cases.

Around 70% of the overtaking accidents occurred in locations where the sight distances were shorter than those stipulated for safe overtaking in the guidelines for the design of roads outside of built-up areas [2]. Moreover, 24% of these accident locations had shorter sight distances than the limit values stipulated in the guidelines for the road markings [3].

Figure 4 essentially shows two trends. First, both the number and severity of overtaking accidents are lower where sight distances are shorter. Second, in general fewer accidents occur on stretches of road where overtaking is prohibited than on stretches that have broken middle marking lines. However, there are two exceptions

Effect of bends, cambers and sight distances

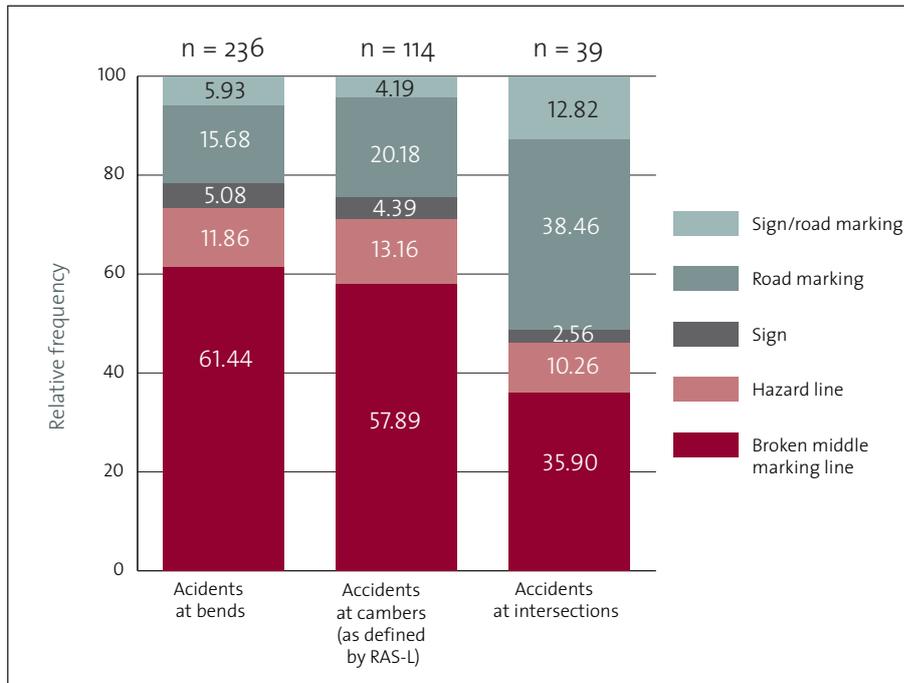
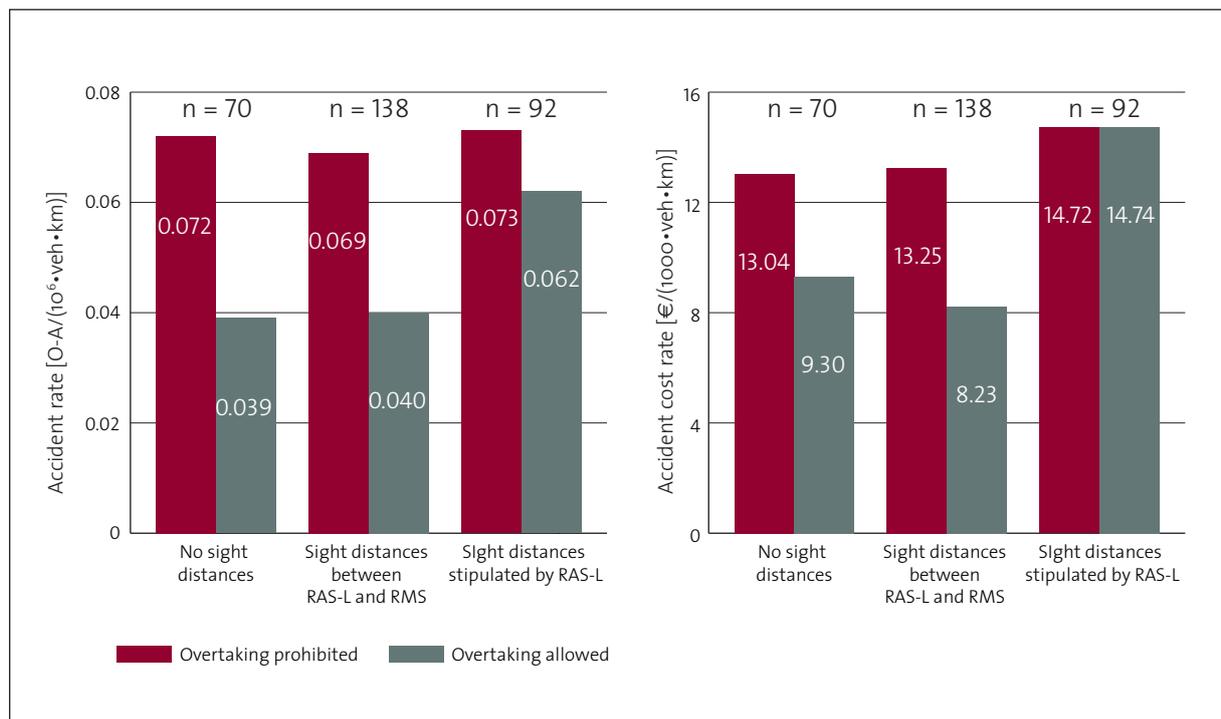


Figure 3: Signing and marking at typical accident locations

Figure 4: Accident indicators by sight distance ranges and overtaking regulation



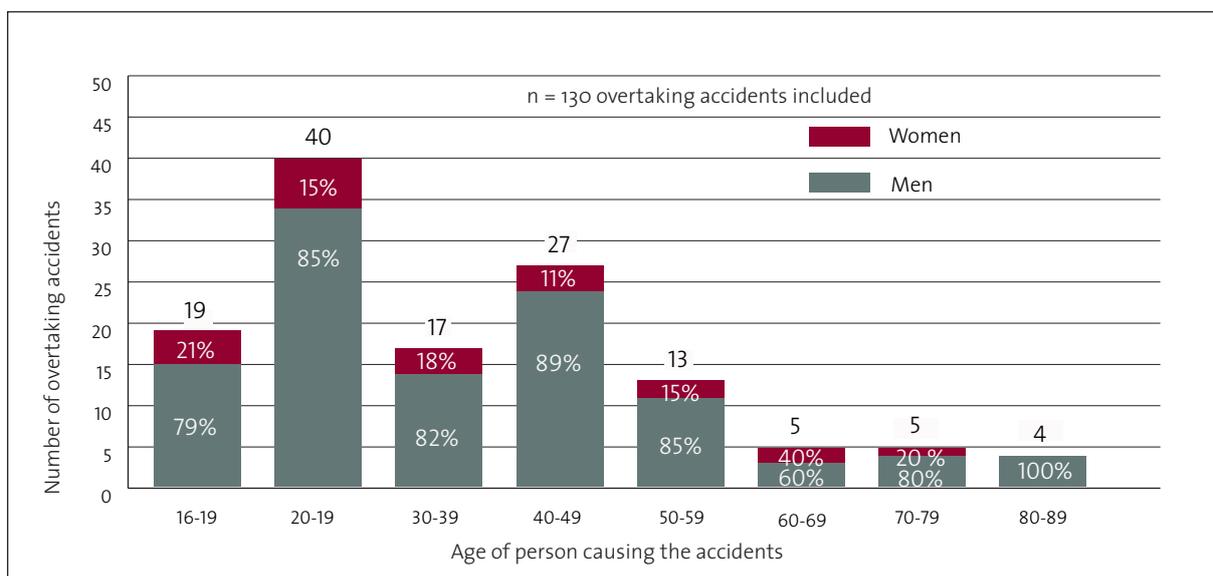
to the general conclusions. The accident risk, as measured by the accident rate, is very similar for all three sight distance ranges for the sections of road where overtaking is allowed. Where overtaking is prohibited, on the other hand, the accident risk decreases with shorter sight distances, in line with the general trend. Considering the accident severity measured by accident cost rates and accident cost density on sections of road with adequate sight distances there are no differences between sections of road where overtaking is allowed and sections where overtaking is prohibited. Although the accident risk is lower where overtaking is prohibited, when accidents do happen, they are similar in terms of severity to accidents on sections of road where overtaking is allowed.

Detailed analysis of the accident occurrence

A detailed analysis of the accidents that occurred was carried out for 43 sections of road on which there were 166 overtaking accidents during the period studied (2007 to 2009). The key findings were as follows:

- The overtaker was generally responsible for causing the accident (in 97% of the cases).
- The accidents were predominantly caused by car drivers (82%).
- One in five overtaking accidents occurred at intersections or junctions with agricultural roads.
- In 31% of cases more than one vehicle was overtaken.
- 48% of the overtaking accidents occurred during the overtaking maneuver, 27% when pulling out and 19% when pulling in again.
- Inexperienced drivers were at particular risk of causing these accidents. Around half (46%) of the people responsible for causing overtaking accidents were younger than 30 (Figure 5).
- 85% of the people primarily responsible for causing overtaking accidents were men (Figure 5).

Figure 5:
People primarily responsible for causing overtaking accidents by age and gender



Detailed analysis of overtaking behavior

- Overall, the most important causes of accidents were problems with assessing sight distances, distances and speeds; failure to recognize a driver's intention to turn off; loss of control; a poor sense of orientation with regard to following vehicles and conflicts on pulling out and back in; and failure to maintain adequate safety clearances.

Detailed analysis of overtaking behavior

In the detailed analysis, a total of 15,173 overtaking maneuvers were investigated using video recordings (Table 1). Around a third of these involved cars overtaking other cars, 37% involved cars overtaking trucks, 17% involved cars overtaking light motorcycles or other vehicles, and 7% involved motorcycles overtaking cars.

The longer the sight distances, the more overtaking maneuvers took place. However, many overtaking maneuvers also took place where sight distances were poor or inadequate.

The analysis of overtaking accidents (Figure 6) shows that the accident risk on sections of road outside of built-up areas with shorter sight distances than stipulated in the guidelines for road markings (RMS) [3] was five times

Table 1: Overtaking maneuvers investigated

Overtaking vehicle	Vehicle overtaken				
	Car	Truck	Light motorcycle	Motorcycle	Other vehicles
Car	5,143	5,560	1,490	111	1,127
Truck	35	62	94	2	96
Light motorcycle	9	5	2	0	5
Motorcycle	1,099	294	19	2	11
Other vehicles	4	1	2	0	0
Total number of overtaking maneuvers = 15,173					

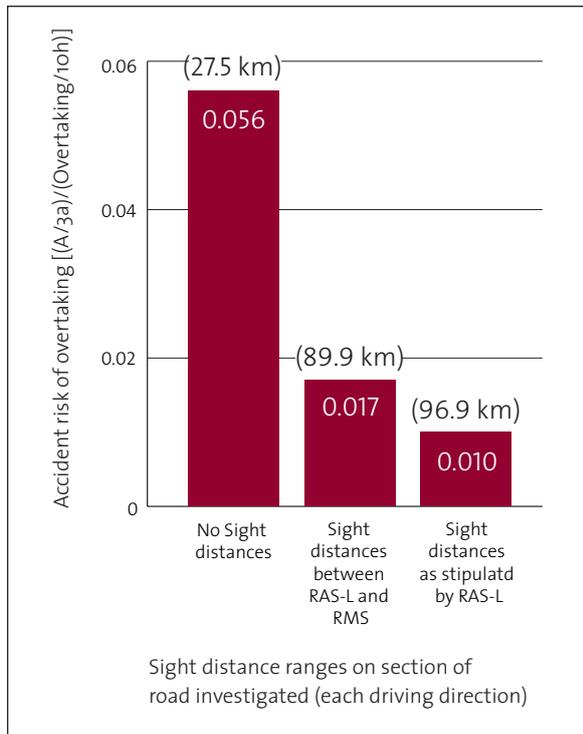


Fig. 6: Accident risk of overtaking maneuvers in different sight distance ranges

higher than on sections of road with good sight distances, as stipulated in the guidelines for the design of roads (RAS-L) [2].

Where overtaking was prohibited, the number of overtaking maneuvers on roads outside of built-up areas was lower, but they were not eliminated. On sections of road with speed limits of less than 100 km/h, significantly lower overtaking rates were recorded.

Summary and recommendations

Overtaking accidents are generally particularly serious. They occur predominantly in locations where overtaking is permitted. However, the analyses show that the majority of these accidents take place in locations where drivers cannot see far enough ahead. Drivers are evidently not always able to recognize whether the free stretch of road ahead is long enough to overtake safely. The following recommendations are therefore made:

- The level of risk is high when overtaking. On sections of road where sight distances are inadequate or of medium length, overtaking should therefore be prohibited in order to prevent driving errors.
- Prohibiting overtaking reduces the accident risk and accident severity.
- A speed limit further reduces the risk and severity of overtaking accidents.
- Overtaking must be clearly and effectively prohibited near intersections.

In addition, the provision of an alternating central overtaking lane for both directions (2+1 roads) reduces the pressure to overtake. Lower speeds also have the effect of reducing the pressure to overtake. The development of suitable driver assistance systems could also make overtaking safer in future.

The dangers of overtaking and the correct overtaking behavior (practice) should be emphasized during driver training and in targeted safety campaigns, because overtaking in locations where it is prohibited is not a minor offense.

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Imprint

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Layout:
pensiero KG; www.pensiero.eu

Photo references: Cover photo: Fotolia, UDV

Published: 01/2016



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