
# Measures designed to reduce streetcar accidents

## Compact accident research

Unfallforschung der Versicherer
GDV

# Contents

## Preliminary remarks

There are streetcars in 60 large German cities. If a traffic accident involving a streetcar occurs, it tends to receive a lot of media attention due to its severity. The number of these accidents has stagnated, while the total number of fatalities and cases of serious injury on roads in built-up areas is falling.

Bauhaus Universität Weimar was commissioned by the UDV (German Insurers Accident Research) to carry out a comprehensive study of the accident statistics for the first time in Germany, based on around 4,100 streetcar accidents in 58 German cities in the period from 2009 to 2011. It is therefore not far short of a study of all streetcar accidents in Germany. The aim of the research was to find out how, where and when the various road-user groups are involved in accidents with streetcars, the consequences of these accidents and what measures can be taken to improve the situation.

This brochure summarizes the key results of the study of the UDV. You can obtain more detailed information from research report no. 37, entitled "Maßnahmen zur Reduzierung von Straßenbahnunfällen" (Measures designed to reduce streetcar accidents). You can download this report free of charge at www.udv.de.

## Introduction and methodology

The numbers of accidents on roads in built-up areas in Germany and, in particular, the numbers of fatalities and cases of serious injuries have been falling for years. However, this positive trend in the accident occurrence is not reflected in the statistics for accidents involving streetcars.

The absolute number of fatalities and cases of serious injury in accidents with streetcars is relatively low compared to those involved in all road accidents, but if these accident statistics are considered in relation to the distance covered and compared with other means of transport (e.g. buses and cars), streetcar traffic has a relatively high accident risk.

The aim of this research was to obtain conclusive findings on the basis of comprehensive accident data as to whether, and by means of which measures, the number or severity of streetcar accidents can be reduced.

Two methodological approaches were combined to carry out the research. In an initial step, a statistical analysis of the accident statistics was carried out for 58 German cities with streetcars. Only accidents involving injury and streetcars were taken into account. To this end, the accident data for the years 2009, 2010 and 2011 were obtained from the relevant authorities. This accident data was complemented by standardized, road space-related characteristics to enable the statistical analysis to include these standardized characteristics.

The second step in this research project was an in-depth analysis of intersections and stretches of road that featured strongly in the accident statistics in order to ascertain characteristic safety shortcomings.

In addition, a safety assessment of entire streetcar networks in selected cities was carried out on the basis of different road types.

## Safety of streetcars – nationwide analysis

Within the framework of a comparative assessment of road safety, the numbers and severity of accidents involving cars, buses and streetcars were compared. In addition, important accident parameters were compared with each other in relation to the distance covered and the number of people transported.

*Table 1: Summarized input parameters of the comparison on means of transport*

| Indicator | Unit | Involving cars (built-up areas) | Involving buses (built-up areas) | Involving streetcars |
|---|---|---|---|---|
| **Accidents** | **Number p.a.** | **215,979** | **5,397** | **1,814** |
| • with fatalities | Number p.a. | 690 | 27 | 36 |
| • with serious injury | Number p.a. | 23,558 | 706 | 340 |
| • with minor injury | Number p.a. | 142,386 | 4,026 | 1,054 |
| • with serious property damage | Number p.a. | 49,346 | 638 | 385 |
| **Casualties** | **Number p.a.** | **205,928** | **7,286** | **1,463** |
| • Fatalities | Number p.a. | 719 | 29 | 41 |
| • Seriously injured | Number p.a. | 25,394 | 784 | 210 |
| • Minor injured | Number p.a. | 179,815 | 6,473 | 1,212 |
| **Accident costs** | **Euros (in m)** | **7,611** | **224** | **99** |
| **Distance covered** | **Vehicle-km (in bn)** | **182.32** | **1.08** | **0.30** |
| **People transported** | **Passenger-km (in bn)** | **272.61** | **18.53** | **16.48** |

Source: [Destatis] and Ifeu

**Safety of streetcars – nationwide analysis**

Based on absolute accident numbers (Table 1), it is clear that accidents involving streetcars are relatively rare. The number of casualties in streetcar accidents is also relatively low in absolute terms. However, there are more fatalities involved in streetcar accidents than in accidents involving buses, although streetcars are only in operation in a relatively small number of German cities. The severity of streetcar accidents is also significantly higher overall than that of accidents involving cars and buses (Figure 1). The average economic costs per accident in built-up areas are used as the measure of accident severity. In accidents involving injury, the severity of streetcar accidents is around 50 percent higher than for car accidents and around 30 percent higher than for accidents involving buses.

As far as the distance covered is concerned, streetcars have a significantly lower total distance covered than cars and even buses. The associated lower accident probability is thus indicated by the calculation of the accident rate, and the consequences of these accidents are indicated by the accident cost rate. The inclusion of the number of people transported takes into account that, without streetcars, a large number of additional journeys would have to be made by buses and an even greater number by cars.

It is clear from the findings that, on the basis of the number kilometers traveled, streetcars are a comparatively unsafe means of transport (Figure 2a and Figure 2b). The accident cost rate for streetcars is eight times

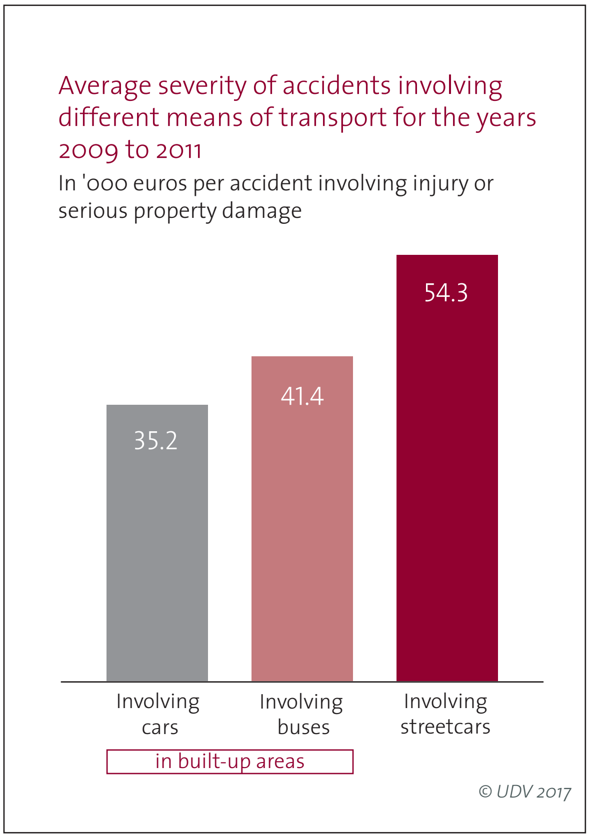



*Figure 1: Comparison of means of transport by accident severity*

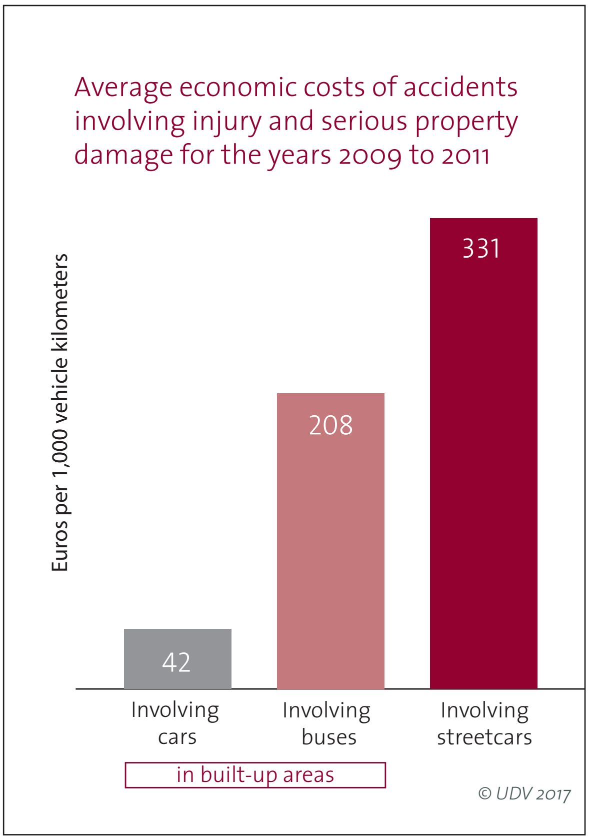



*Figure 2a) Comparison of different means of transport by distance covered*

higher than that for cars. If only the accidents involving fatalities are considered, the risk increases by a factor of around 35. In terms of the number of people transported, however, streetcars are a comparatively safe means of transport. The accident cost risk (accident costs per 1,000 passenger kilometers) for streetcars overall is only around 20 percent of that for cars. If only accidents involving fatalities are considered, however, streetcars, buses and cars have a similarly high accident risk in relation to the number of people transported.

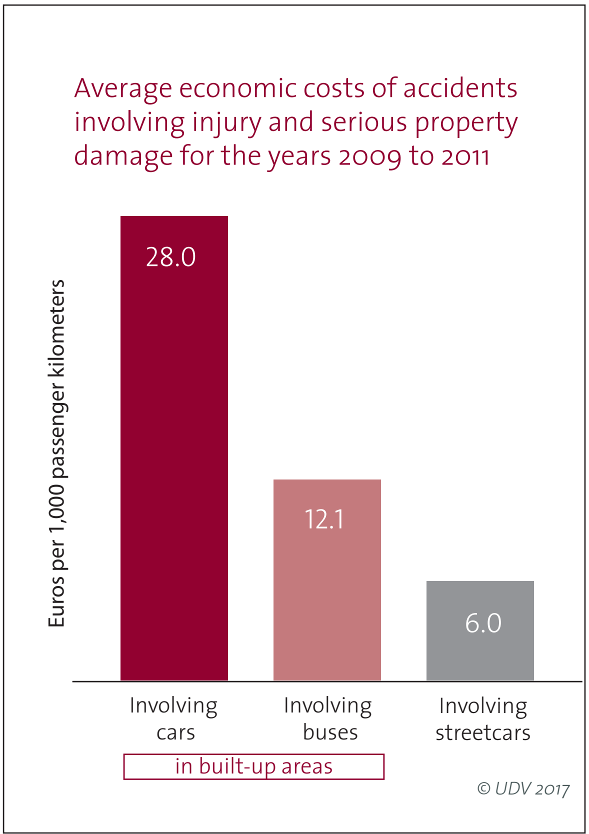



*Figure 2b): Comparison of different means of transport by number of people transported*

## Structure and consequences of the accidents

### Underlying data and data preparation

The accident data of the accidents recorded by the police in the years 2009 to 2011 involving injury and streetcars in 58 cities was available for analysis (Table 2). It represents almost all the streetcar accidents in German over the period of these three years. Table 2 and Table 3 provide an overview of the number and structure of the casualties by type of road user and accident severity (accident category).

*Table 2: Analyzed police accident data (2009 to 2011, 58 cities)*

| | | Casualties by accident severity | | |
|---|---|---|---|---|
| **Accident categories** | **Number accidents** | **Number fatalities** | **Number seriously injured** | **Number minor injured** |
| **Accident with fatalities** | 100 | 100 | 6 | 58 |
| **Accident with serious injury** | 956 | - | 997 | 497 |
| **Accident with minor injury** | 3,043 | - | - | 3,913 |
| **Total number of accidents** | **4,099** | **100** | **1,003** | **4,468** |
| | | **5,571** | | |

*Table 3: Overview of the casualties in streetcar accidents (2009 to 2011, 58 cities)*

| Accident category | | Accident with fatalities | Accident with seriously injured | Accident with minor injured | Total |
|---|---|---|---|---|---|
| Number of accidents where the consequences are known by type of road user* | | 93 | 864 | 2,693 | 3,650 |
| Fatalities by type of road user | Pedestrians | 70 | - | - | 70 |
| | Cyclists | 15 | - | - | 15 |
| | Car occupants | 7 | - | - | 7 |
| | Streetcar occupants | 1 | - | - | 1 |
| | Other road users | 0 | - | - | 0 |
| | Total number of fatalities | 93 | - | - | 93 |
| Cases of serious injury by type of road user | Pedestrians | 2 | 333 | - | 335 |
| | Cyclists | 0 | 134 | - | 134 |
| | Car occupants | 2 | 248 | - | 250 |
| | Streetcar occupants | 0 | 130 | - | 130 |
| | Other road users | 0 | 46 | - | 46 |
| | Total number of seriously injured | 4 | 891 | - | 895 |
| Cases of minor injury by type of road user | Pedestrians | 0 | 8 | 513 | 521 |
| | Cyclists | 0 | 3 | 206 | 209 |
| | Car occupants | 3 | 74 | 1,176 | 1,253 |
| | Streetcar occupants | 53 | 276 | 1,298 | 1,627 |
| | Other road users | 0 | 9 | 174 | 183 |
| | Total number of minor injured | 56 | 370 | 3,367 | 3,793 |

*Note: For 449 accidents, the accident consequences by types of road user were not available.

For analyses based on streetcar accident parameters in connection with distance covered, the accidents were examined in relation to streetcar traffic volume, which was obtained from the timetable data, taking road cross-sections into account.

In addition to the characteristics of the accident data recorded by the police, further traffic-related and road space-related characteristics were assigned to the localized accidents for the subsequent assessment of the road infrastructure. This was essentially done using aerial photographs and street view images of well-known map services.

The additional information obtained includes characteristics such as the design situation, the road crosssection type, the form taken by the streetcar stops, the intersection characteristics (spacing, form, number of access roads and lanes, cross-section types of the access roads) and the crossing facility characteristics (spacing, crossing facility type).

## Results of the accident analysis

Over 4,000 accidents involving injury and streetcars were analyzed in detail. The key results are presented below.

Pedestrians make up by far the largest share of fatalities and cases of serious injury (Figure 3). Cyclists also feature disproportionately strongly in accidents involving serious injury. On the other hand, the occupants of streetcars and cars dominate when it comes to cases of minor injury.

When the fatalities and cases of serious injury are examined on the basis of where they occur in the network (Figure 4), it becomes clear that pedestrians suffer serious accidents disproportionately often on stretches of road and at streetcar stops. In absolute terms, the largest number of accidents causing serious injuries to pedestrians occurs at intersections.

Casualties by type of road user and accident consequence

Casualties in accidents involving injury A(I)

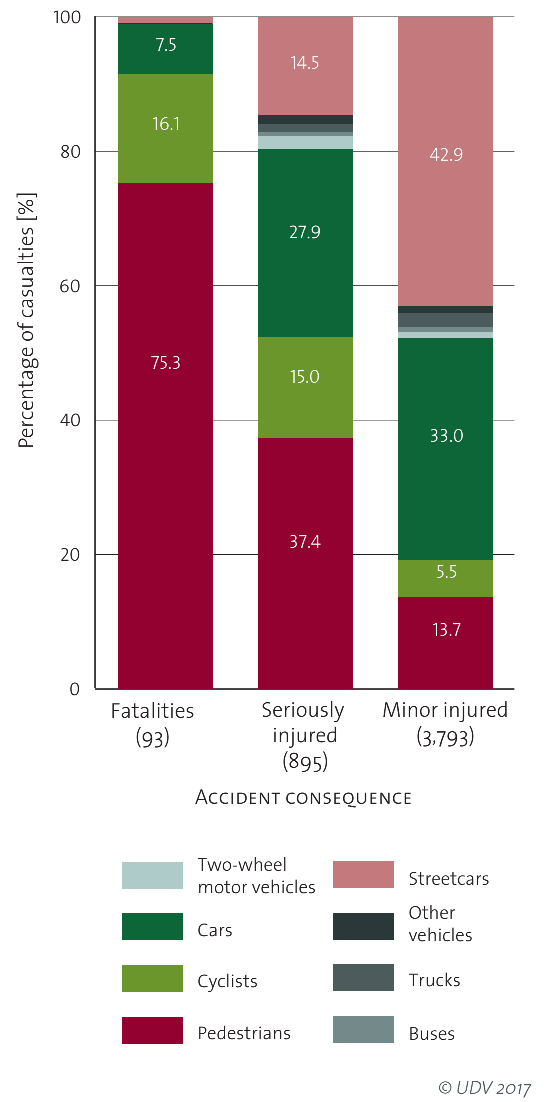
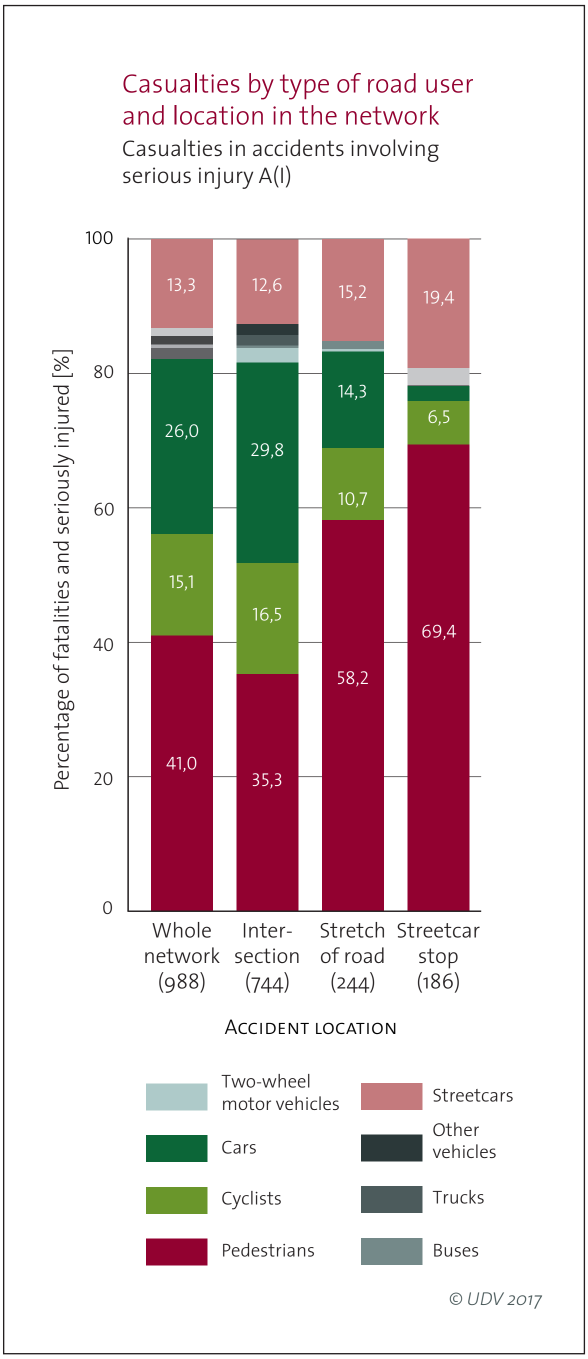



*Figure 3: Casualties by accident consequence and type of road user*

**Results of the accident analysis**




When you examine the main causers of all streetcar accidents involving injury, you discover that streetcars themselves are the main causer in only a few cases (15.7 percent of them). Around a third of these cases are single-vehicle accidents.

Due to the variation in the casualty structure and distribution of the main causers of streetcar accidents, in the detailed examination of the accidents researched, distinctions were drawn based on the type of road user and the accident locations.

Serious accidents occur, in particular, at signal-controlled intersections and on three- or four-lane roads with a separate streetcar track bed in the middle (Figure 5 and Figure 6). Pedestrians are the main causers of these accidents in a particularly high number of cases.

*Figure 4:*
*Fatalities and seriously injured by location in the network and type of road user*

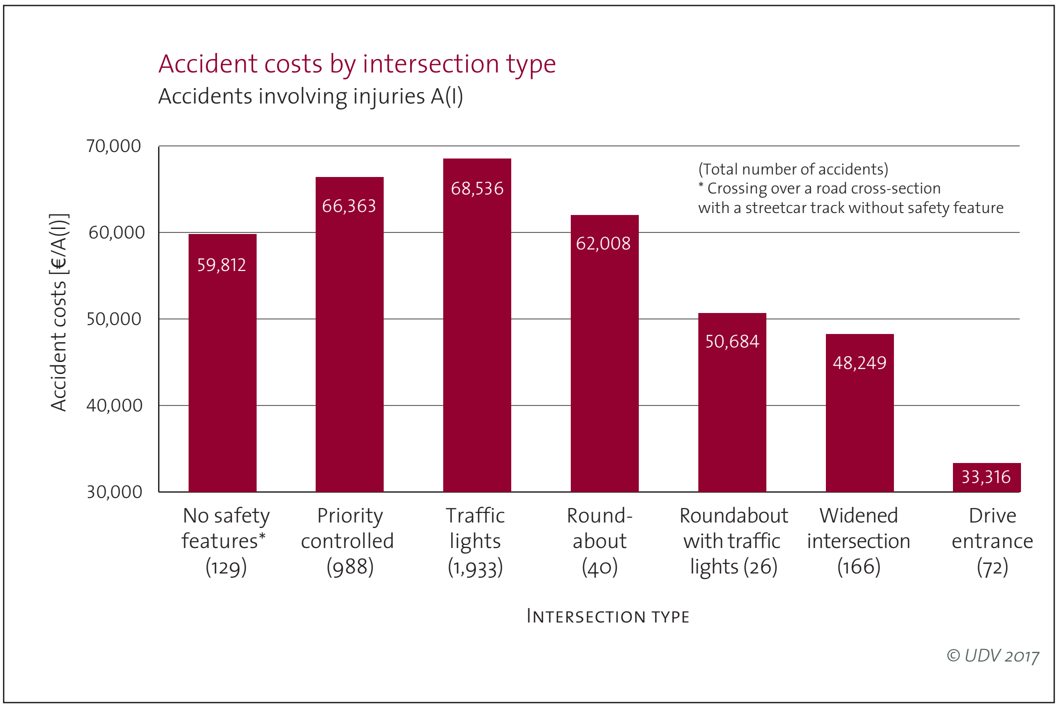



*Figure 5: Accident severity by intersection type*

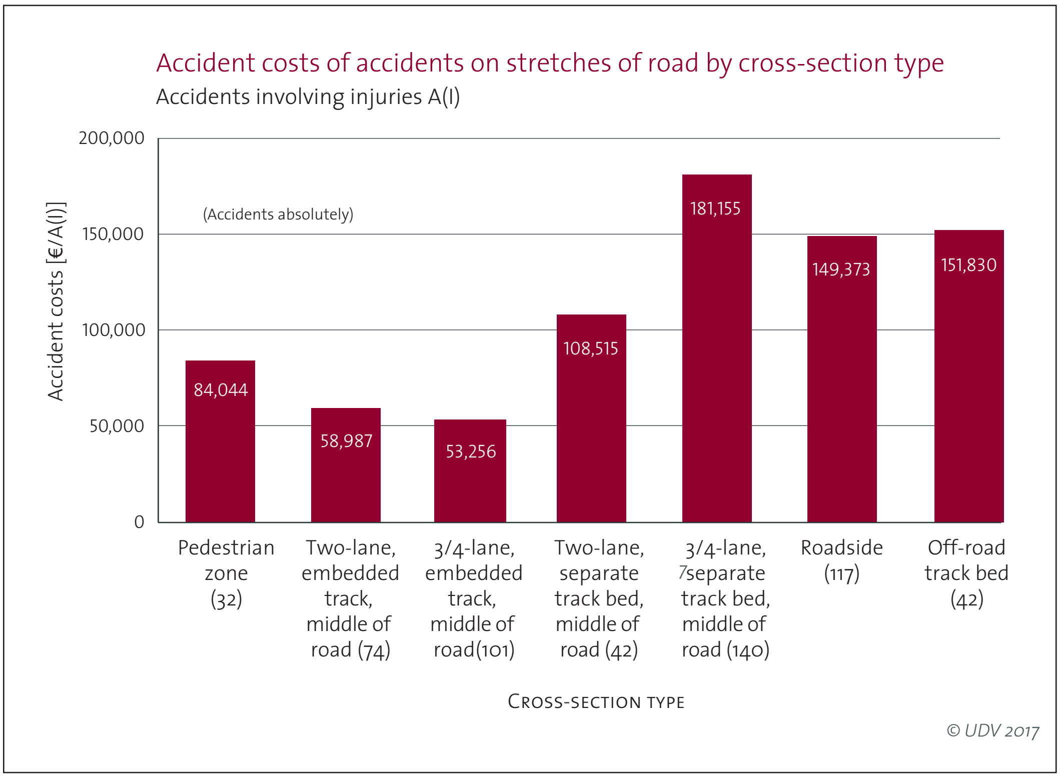



*Figure 6: Accident severity by cross-section type*

Results of the accident analysis

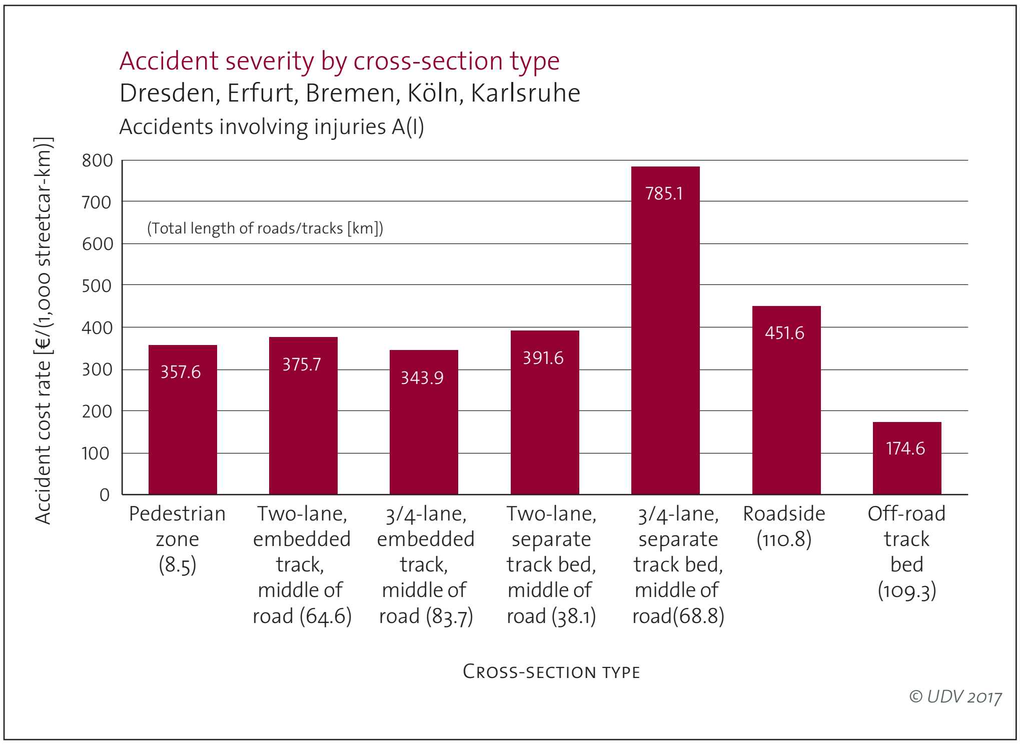



*Figure 7: Accident cost rate by cross-section type for all $A_{Streetcar}(I)$*

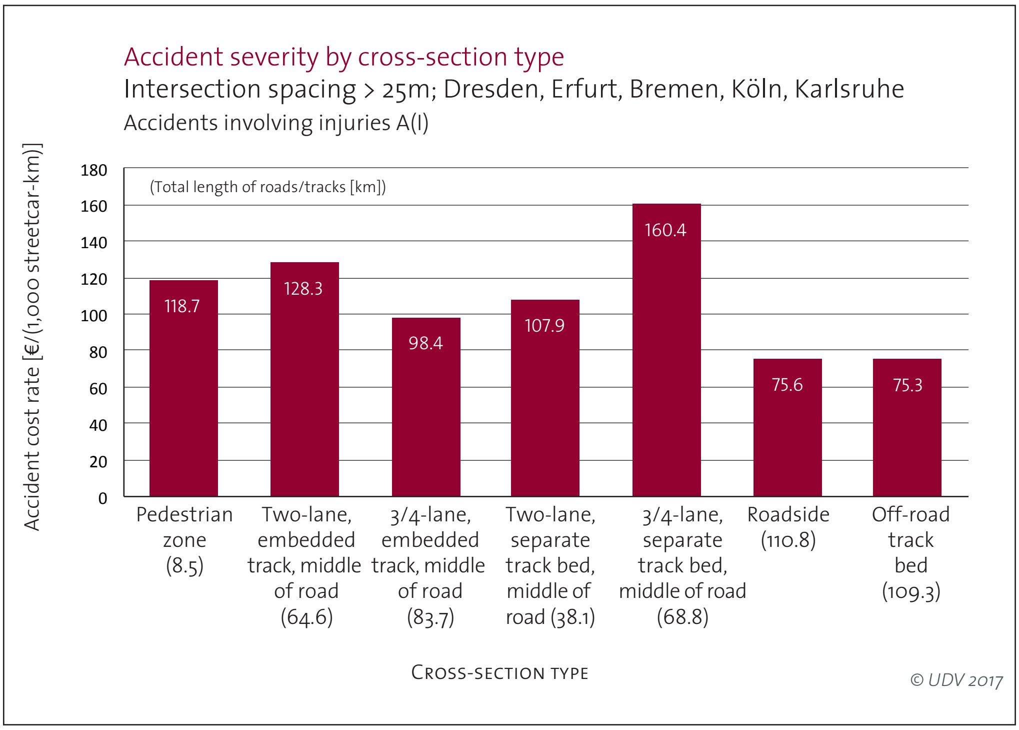



*Figure 8: Accident cost rate by cross-section type only for $A_{Streetcar}(I)$ away from intersections*

## Safety analysis of streetcar networks

In order to obtain length-related distributions of characteristics and differentiated accident parameters, a separate network analysis of the characteristics was carried out, differentiated by cross-section types and RASt road design situations, in five cities (Dresden, Bremen, Cologne, Karlsruhe and Erfurt).

The accident data used was the available georeferenced accident data recorded by the police, which was imported into a geoinformation system (GIS) and applied to the streetcar network. The accidents were assigned to network segments. Network segments with the same characteristics were grouped together, and the associated accident parameters were calculated and analyzed.

The essential results for accidents away from intersections can be summarized as follows for the road cross-section types examined.

The three- or four-lane cross-section with a separate track bed in the middle of the road particularly stands out in terms of accident consequences (Figure 7), even when only the accidents away from intersections (Figure 8) are taken into account. Moreover, the accident analysis reveals a particularly high level of accident severity here.

The off-road track bed is the safest cross-section type overall. However, if accidents occur here, they are generally particularly serious (see Figure 6). This cross-section type is generally only possible for new infrastructure or on the outskirts of cities.

The cross-section with the roadside streetcar track shows no significant improvement in safety taking into account the intersection accidents (Figure 7). Away from the intersections, however, this cross-section is about as safe as the separate track bed, although the accidents that occur here are particularly severe (Figure 6).

If the results of the studies by BAIER/MAIER, which included accidents involving motor vehicles, are taken into account, the off-road track bed and the roadside track bed can be rated the safest forms of streetcar track overall.

## Detailed analysis

In order to draw conclusions about factors associated with the various road facilities that may make accidents more likely, a detailed analysis was carried out, including site inspections at 21 selected intersections and 11 stretches of road/track.

The aim was to record characteristics and peculiarities of the road space and to identify any shortcomings of the infrastructure. To this end, elements of the local accident investigation in accordance with the code of practice for local accident investigation in accident commissions (M UKO) and of the safety audit based on the recommendations for road safety audits (ESAS) were combined. The findings of the site inspections were documented and presented in fact sheets.

The result was that deviations from the current guidelines were found at all sites. These may have an impact on safety. The general principles of safe design – in terms of identifiability, interpretability, uniformity, drivability/walkability and visibility – were not complied with.

However, many of the accidents at the road facilities studied were also attributable to a lack of acceptance of the rules of the road. In addition, pedestrian crossings in connection with pedestrian accidents were often not where they were required, such as along pedestrian axes. Moreover, streetcar stops located in the middle of the road often only had a crossing facility at one end of the platform.

Detailed analysis

*Table 4: Characteristic safety shortcomings at intersections*

| Intersections | | |
|---|---|---|
| Intersections with traffic lights | **Pedestrians** | • Missing fields of view in the event of the traffic lights being out of operation that would improve awareness of the presence of streetcars that have priority<br>• Lack of a direct route over pedestrian crossings with lights (signals) on each intersecting road<br>• Principle of continuous operation day and night not observed<br>• Restricted view of the lights<br>• Lack of synchronicity between successive pedestrian crossings with lights (signals) |
| | **Cyclists** | • Missing fields of view in the event of the traffic lights being out of operation that would improve awareness of the presence of streetcars that have priority<br>• Lack of additional signals for cyclists where cyclists are in mixed traffic on the roadway and have to use the same signals as motor vehicle traffic |
| | **Motor vehicles** | • Missing fields of view in the event of the traffic lights being out of operation that would improve awareness of the presence of streetcars that have priority<br>• Signal control not easy to recognize or interpret<br>• Principle of continuous operation day and night not observed<br>• Poor recognizability of signal-controlled track crossings away from intersections<br>• Lack of a head start (in terms of time or space) for streetcars in the event of failure to comply with rules on the direction of traffic<br>• No or unsuitable support for rules about the direction of traffic<br>• Insufficient number of permitted turning points with structurally demarcated track beds, where turning around or turning off the road is prohibited at the subsequent intersection<br>• Restricted view of signals/lights<br>• Incomplete signal control |
| | **Streetcar stop** | • Lack of speed-reducing features for cyclists on the ramps of raised platforms |
| Intersections without traffic lights | **Pedestrians** | • No suitable crossing facilities over access roads with priority |
| | **Cyclists** | • No suitable crossing facilities over access roads with priority<br>• Poor identifiability, interpretability, visibility, uniformity and usability of the cycling facilities<br>• Lack of an option to turn left for cyclists |
| | **Motor vehicles** | • Lack of signal control despite poor identifiability, interpretability, visibility, uniformity and/or relevant traffic flow at an intersection road segment |
| Roundabouts | **Pedestrians** | • Pedestrian crossings too far from the roundabout<br>• Lack of uniformity in the access and exit roads |
| | **Cyclists** | • Lack of signal control where streetcars traverse the roundabout |
| | **Motor vehicles** | • Lack of signal control where streetcars traverse the roundabout<br>• Capacity for motor vehicle traffic exceeded with a tailback to the crossing over the track on the roundabout |

*Table 5: Characteristic safety shortcomings on stretches of road/track*

| Stretches of road/track | | |
|---|---|---|
| Separate track bed in the middle of the road | **Pedestrians** | • Insufficient space between the track area and roadway where pedestrians need cannot cross an entire road, including the tracks and the roadway, in one go<br>• Lack of a crossing facility where there is a significant level of demand to cross<br>• Location of the crossing facility is not where pedestrians generally cross<br>• Where there is signal control in the track area, it is not independent of the signal control for the roadway crossing<br>• Lack of synchronicity between successive pedestrian crossings with lights/signals<br>• Lack of unambiguous signal control of the streetcars in connection with the signals F0 (stop) and F1 (go) at signal•controlled crossing facilities<br>• Long waiting times for pedestrians (end of green phase to start of next green phase, or end of amber phase to start of green phase) |
| | **Cyclists** | • The separate track bed for streetcars means there is insufficient space for other road uses<br>• Cyclists are not prevented from using public transport lanes with tracks |
| | **Motor vehicles** | • Separate track beds are not structurally demarcated from the roadway by a change of level |
| | **Streetcar stops** | • Pedestrians are required to take a detour to access the streetcar stop<br>• Location of the streetcar stop does not ensure safe access for passengers<br>• Lack of additional safety features (safety railings, additional signals/lights at a lower height, audible signals) at crossings where visibility is poor, where pedestrians or cyclists can go straight across without being guided by railings to face the traffic, or where there are large numbers of pedestrians and cyclists<br>• Pedestrians can go straight over the streetcar stop island without being guided by railings to face the traffic<br>• Crossing times of pedestrian crossings with lights/signals providing access to the streetcar stop are not synchronized with the arrival of streetcars<br>• No ramp from the streetcar stop island to the crossing point |
| Separate roadside track bed | **Pedestrians** | • Lack of a crossing facility where there is a significant level of demand to cross<br>• Location of the crossing facility is not where pedestrians generally cross<br>• Lack of synchronicity between successive pedestrian crossings with lights/signals<br>• Lack of unambiguous signal control of the streetcars in connection with the signals F0 (stop) and F1 (go) at signal-controlled crossing facilities<br>• Long waiting times for pedestrians |
| | **Cyclists** | • Lack of additional safety features (safety railings, additional signals at a lower height, audible signals) at crossings where visibility is poor, where there is a direct route or where there are large numbers of pedestrians and cyclists<br>• Lack of signal control or safety railings at crossings for cyclists away from intersections (e.g. on cycling axes)<br>• The separate track bed for streetcars means there is insufficient space for other road uses<br>• Cyclists are not prevented from using public transport lanes with tracks |
| | **Streetcar stops** | • Crossing times of pedestrian crossings with lights/signals providing access to the streetcar stop are not synchronized with the arrival of streetcars |
| Embedded track beds | **Pedestrians** | • Limited visibility caused by parked vehicles not reliably prevented |

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| Stretches of road/track | | |
|---|---|---|
| Off-road track beds | Pedestrians | • Lack of a crossing facility where there is a significant level of demand to cross<br>• Location of the crossing facility is not where pedestrians generally cross<br>• Crossing is not prevented effectively enough away from pedestrian crossings |
| | Cyclists | • Lack of additional safety features (safety railings, additional signals at a lower height, audible signals) at crossings where visibility is poor, where there is a direct route or where there are large numbers of pedestrians and cyclists |
| | Streetcars | • Failure to enforce the speed limit for streetcars |

It was also observed that motor vehicles often turned off the road to the left across track beds located in the middle of the road in violation of the rules. Accidents involving cyclists occur when they fail to recognize that the streetcar has priority or cross the track without stopping.

On the basis of the results, a checklist for assessing streetcar-related infrastructure was created to complement the recommendations for road safety audits (ESAS). This can be used to help with planning and auditing. Tables 4 and 5 summarize the safety shortcomings by type of road facility for the different groups of road users.

## Conclusion and recommendations

Most accidents involving serious injury occur at signal-controlled intersections (48 percent), priority-controlled intersections (23 percent) and stretches of three- or four-lane road with a track bed in the middle (7 percent). The analysis of the accidents indicated where there is a need to exercise particular care when planning and operating streetcar facilities, depending on the type of road use involved and the form taken by the facility.

When the accidents at intersections are taken into account, track beds in the middle of the road are significantly less safe than roadside track beds or off-road track beds. In the case of the latter, a sufficient number of safely designed, easily identifiable crossing facilities with good visibility must be provided on stretches of track. At these points, the tracks should be easily identifiable, it should be made clear that streetcars have priority, and the light signals should be easy to see and understand.

Three- or four-lane cross-sections with a separate track bed in the middle of the road have the highest accident cost rate in relation to the volume of streetcar traffic. A disproportionately high number of accidents on separate track beds are primarily caused by pedestrians. Crossing facilities are often not on well-used pedestrian routes. In addition, crossing facilities often do not have safety features in compliance with the guidelines, and their lights often cause long waiting times and remain red long after a streetcar has passed through. It is thus particularly important to provide proper signal control for pedestrians crossing the track. A careful analysis should be carried out indicating where and how many pedestrians need to cross the track, and a suitable number of safe pedestrian crossings should be provided. Moreover, the interpretability and acceptance of the lights should be improved.

There are a lot of accidents at intersections where there are separate track beds, above all, when motor vehicles turn off or around in violation of the rules. The pressure to turn can be reduced by structural means and by the provision of safe turning points on stretches of road/track and at intersections. In addition, streetcars should receive a head start (time or space) over turning motor vehicles at signal-controlled intersections.

When the accident cost rates were examined on the basis of streetcar traffic volumes, similar accident cost rates were found for signal-controlled and priority-controlled intersections. At high traffic volumes, signal-controlled intersections are safer. The difference between these two types of intersection essentially results from the difference in the structure of the main causers of the accidents. Whereas drivers are the main causer of accidents at intersections without signal control disproportionately often, pedestrians and cyclists are disproportionately often the main causer at signal-controlled intersections. Frequently found shortcomings at the audited signal-controlled intersections were that the streetcars and lights (signals) were insufficiently conspicuous. In addition, in many cases the red light is ignored by pedestrians and cyclists. Moreover, cyclists were often observed crossing the tracks at high speed in cases where there were no safety railings around the crossing in order to reduce their speed or make them dismount. A lack of identifiability, visibility or interpretability also contributed to accidents at intersections without signal control.

On the basis of these and other findings, characteristic safety shortcomings at intersections and on stretches of road/track were found during site inspections carried out as part of the detailed analysis. These included:

- Poor identifiability, interpretability and visibility of intersections
- Differences in the crossing times of successive pedestrian crossings with lights/signals
- Restricted views of the lights/signals
- A lack of crossing facilities for cyclists over access roads with priority
- Signal systems switched off at night

These findings were complemented by already known test criteria for streetcar facilities for the purpose of assessments on the basis of the recommendations for road safety audits (ESAS). The checklist of shortcomings developed in this research project builds on the checkpoints for roads in built-up areas developed by BAIER in the process of updating the ESAS.

The following recommendations can be made on the basis of the findings:

There is a higher risk of accidents associated with multilane road cross-sections with a track bed in the middle of the road than with roadside or off-road track beds. Roadside tracks should therefore be the preferred option when new tracks are laid and when tracks are altered or upgraded. Wherever there is sufficient space, off-road track beds should be preferred. Only where this is not possible should a track in the middle of the road be considered. The areas around intersections, in particular, should be very carefully planned with road safety in mind.

At intersections, efforts must be made to make the streetcar track easy to notice and to provide enough pedestrian crossing facilities with safety features and signal control to allow motor vehicles to turn off the road. The intersection area and the space around it must be kept free of obstacles to visibility and, wherever possible, from hard obstacles against which vehicles could be pushed in the event of a collision.

With existing road cross-sections, pedestrian crossings with safety features must be upgraded in locations where there is a need to cross, where there are significant flows of pedestrians or where significant numbers of crossing-related critical situations or accidents occur. A research project of the German Federal Highway Research Institute (BASt) is currently under way to ascertain what kinds of safety measures are particularly suitable. Wherever possible, there must be signal control for motor vehicles turning across the streetcar track, or turning must be prevented structurally or by traffic control measures.

Streetcars should have separate phases at signal-controlled intersections (thus preventing any conflicts with other vehicles, cyclists or pedestrians). Safety audits should always be carried out when new road infrastructure including streetcars is planned or when the existing infrastructure is being altered or upgraded. Audits are also recommended for existing infrastructure in order to identify and eliminate existing potential safety shortcomings, particularly at accident black spots. A specific checklist was developed for this during the project. This checklist can also help transport companies or accident investigators to analyze accidents.

In addition to infrastructure-related measures, there are also further measures that can improve the active and passive safety of streetcars and influence how road users behave. However, more in-depth research is required for this.

Research should be carried out to investigate whether the safety of streetcars can be improved through the development of active and passive vehicle technologies. These include automatic detection of conflict situations as a result of road users crossing the track. This could be combined with automated warnings issued to the driver or other road users by means of a bell signal. It is also conceivable that braking could be initiated here. This would both relieve the burden on the streetcar driver and prepare streetcar passengers for the stronger braking to follow (emergency braking). In addition, research should be carried out into the design of an energy-absorbing, soft front for streetcars in order to reduce the consequences of collisions with pedestrians, cyclists and other vehicles.

Research should also be carried out in order to develop suitable campaigns aimed at sensitizing all road users. These would include target group-specific appeals to drivers not to execute ill-considered turns, for example, or to pedestrians to take care when they cross.

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Design:
pensiero KG, www.pensiero.eu

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Published: 01/2018

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