

Deficiencies in Urban Roads - the perspective of Vulnerable Road Users

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Abstract

While guidelines, processes and recommendations for designing motorways, highways and interurban roads are mostly very well structured, organised and known all over the world there is a lack of knowledge concerning urban roads. On the background of several accidents in urban roads the analyse of accident risks have to be improved especially for urban roads. The most deficiencies in urban roads are related to Vulnerable Road Users (VRU). For road safety on urban roads it is important to consider the sight distance (intervisibility) between individual motorized and non motorized traffic. Especially when choosing the number and character of the parking facilities, the intervisibility between vehicles and pedestrians/bicyclists is to guarantee at crossroads, T junctions, access roads and pedestrian crossings. Obstructions of sight prevent the cognition of conflict situations in sufficient time. In this case the situation on all continents is still comparable to urban European roads. On the other hand big obstacles especially at sidewalks could be recognised much more often in developing countries. In Egypt for example serious deficiencies on characteristics such as mixed functions crossing small villages and towns with severe problems for vulnerable road users, dangerous urban road sections with an uncoordinated or inconsistent alignment which causes high speed in urban areas and serious safety deficiencies for vulnerable road users in general can be found.

1. Introduction

At the University of Wuppertal several design plans and existing situations of urban roads were analysed which were made at training courses for Road Safety Auditors for urban roads and cross-town links. In 25 urban road design plans from Germany 625 deficiencies have been found. Serious consequences could not be excluded at 54 % of the deficiencies. In addition the experience of a Twinning Project for enhancing road safety in Egypt [1] can show the differences of deficiencies in situations and plans comparing developed countries and countries in transition. Urban planning is worthy to be improved and in principle should come under scrutiny of safety management processes.

To make a statement on the frequency of singular safety deficits, the deficiencies have been categorised with the help of groups of deficits (design and operation criteria, etc.), subgroups of deficits (pedestrians, bicyclists, private transport, etc.) and the character of the breach of the rules (grave violation of road guidelines, minor violation, etc.).

2. Reasons for Deficiencies from the perspective of VRU

Worldwide Vulnerable Road Users (VRU) such as pedestrian, cyclists, riders etc. are among most of the victims of road traffic. Children, disabled and elderly people are especially vulnerable: Children cannot be expected to follow all rules and act sensibly and attentively all the time, while disabled and elderly people often cannot react as fast as necessary. Therefore the state and planning of roads should always take the requirements of VRU, especially of children and elderly people into consideration.

Figure 1 shows a typical example of a black spot in Wuppertal, Germany. On a 2-lane urban main road with a normal urban traffic situation (15.000 vehicles/day, speed limit 50 km/h) eight severe accidents happened in between three years. The characteristics of the accidents are every time the same: There is a bus stop at both sides and pedestrians have the aim to reach the bus. By crossing the road they didn't recognize the oncoming car. Unfortunately most of them were severe injured. Four of them were at the age under 13, two of them at the age above 67. This typical situation leads to a main problem of urban roads: they are mostly designed for car drivers taking into account the requirements of capacity and traffic flow – but in only a few cases the requirements of VRU. The accident commission in Wuppertal found a not costly solution with warning signs and marking of a refuge island, which could reduce the complexity by crossing the road (Figure 2). Since then no more accident happened there.

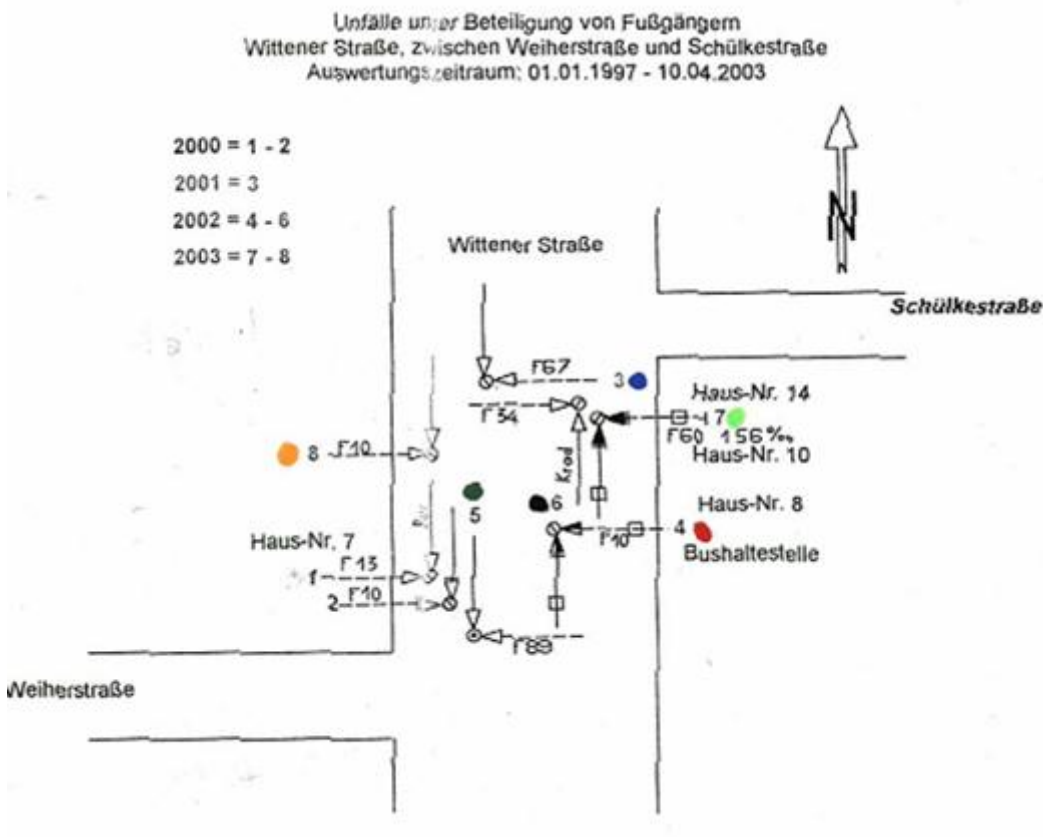


Figure 1: Accident Diagram of a black spot at a bus stop in Wuppertal, Germany

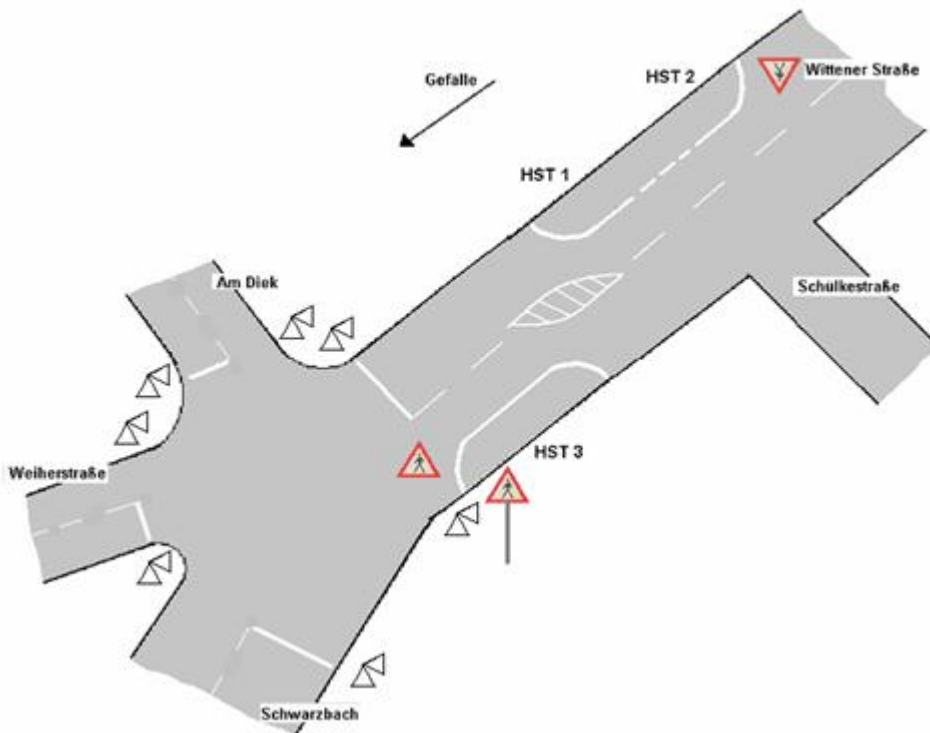


Figure 2: Useful solution with a refuge island for a black spot in Wuppertal, Germany

Children, elderly, and disabled people are particularly vulnerable in built-up areas. Safe sidewalks and pedestrian crossings, including centre refuge islands, both along the road and at intersections are very useful safety features. In addition strong regulations against parking on sidewalks should be considered. All too often the needs of pedestrians and other vulnerable road users are ignored and they are forced to share the carriageway with fast moving traffic.

Safety deficiencies have one of their reasons in the stage of planning a road. According to this, preliminary and detailed designs regularly include in part grave safety deficits. Causes for this purpose are manifold. They are not picked out as a central theme here. In general it has to be mentioned, that the education and training of planners is often quite good – the reasons for safety deficiencies are more to be found in missing coordination between various parts of authorities and in particular when the requirements from several person and institutions concerned reduce the safety. For example there could be the requirement for parking facilities which are expressed by tradespeople and politicians although it hinders the visibility of an intersection. Another reason is that the sensibility of planners concerning safety is not as high as the interest for capacity.

3. Typical Deficiencies in urban roads in developed countries

German urban main roads have been analysed in detailed planning. The results may be typical for developed countries. Researching into the subgroups of deficiencies the accumulations shown in table 1 are to be found.

group of deficit	subgroup of deficit	number	deficit
L	bicyclist/ pedestrians	12 x	lack of or insufficient pedestrians crossing
JW	pedestrians	22 x	lack of or insufficient waiting areas
PC	bicyclist/ pedestrians	12 x	line-of-sight obstruction at bicyclist/pedestrians caused by parking cars
PC	motorized traffic	22 x	line-of-sight obstruction caused by parking cars
PT	pedestrians	10 x	lack of or insufficient waiting areas
		13 x	Lacking consideration of people reduced in mobility
PL	bicyclist/ pedestrians	15 x	line-of-sight obstruction at bicyclist/pedestrians
PL	motorized traffic	17 x	line-of-sight obstruction

Table 1: accumulation of deficiencies in detailed plannings of German urban main roads

An assortment of the most frequent deficits of the detailed and execution planning concerning main roads is given below. The examples are made up of singular deficits (often there were other (main) deficits beside this in the planning). That is to say that in addition to the named deficit further deficits can exist that are not illustrated.

One main deficiency, which can mainly be found in developed countries is the „Line-of-sight obstruction at bicyclist/pedestrians caused by parking cars“. For road safety at main roads it is important to consider the sight distance (intervisibility) between individual motorized and non-motorized traffic. Especially when choosing the number and character of the parking areas, the intervisibility between vehicles and pedestrians/bicyclists is to guarantee at crossroads, T junctions, access roads and pedestrians crossings (Example see Figure 3). Obstructions of sight prevent the cognition of conflict situations in sufficient time.



Figure 3: Sight obstructions at pedestrian crossings caused by parking vehicles

Another main deficiency is the „Lacking of a barrier-free design“. The principle „Design for All“ is very important to fulfil the needs of vulnerable road users – many design plans and existing situations have severe lacks and in most cases children, elderly people and handicapped people have to deal with barriers which could be avoided very easily.

One typical deficiency can be found at pedestrian crossings, where the different handicaps are not taken into consideration. Sometimes the curb is lowered to 0cm and blind people have no chance to recognize the end of sidewalks and the beginning of lanes. In other cases there is a high curb and wheel chair drivers or users of walking frames have no chance to negotiate the border. In many cases tactile elements are still missing. Figure 4 shows a good solution for a double crossing, which can easily be used by both groups.

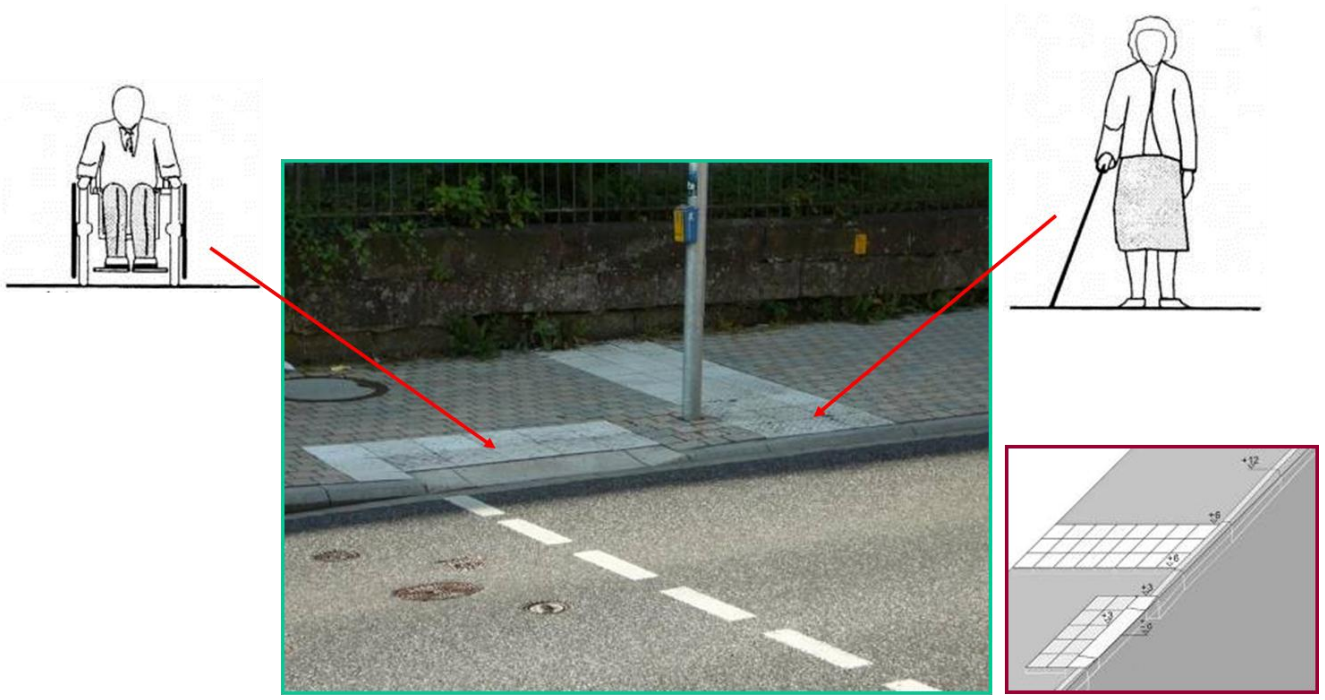


Figure 4: Good solution of a double crossing with different lowered kerbs for blind people and wheel chair drivers/walking frame users

A further circumstance that is to be mentioned is the frequent use of segregated unsignalized right turning lanes, although they often are black spots of main roads. Segregated right turning lanes are characterised by accumulations of rear-end collision accidents, to some extent with involved bicyclists and pedestrians crossing the road. This circumstance is shown in the collusion diagram (1-year) below (Figure 5). Nevertheless segregated right turning lanes are popular to reduce time of waiting at highly frequented junctions (by the account of road safety).

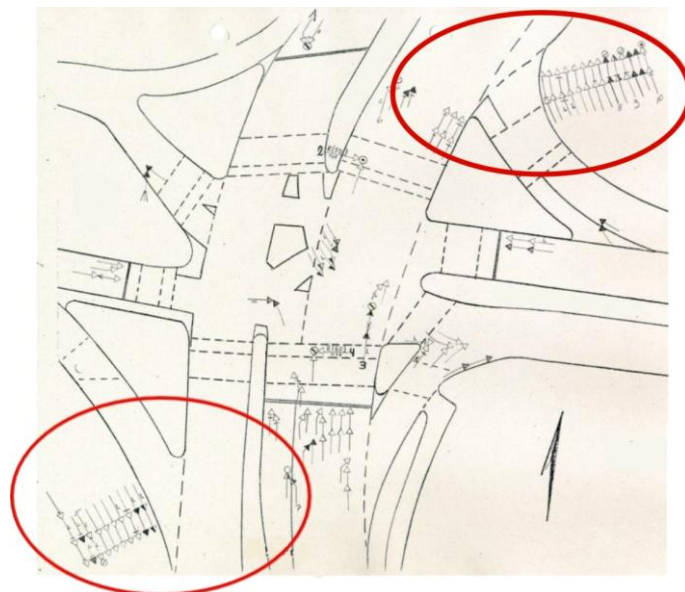


Figure 5: Accident diagram at segregated right turning lanes

In assessed design plans of German urban side roads the accumulations of deficiencies is shown in table 2.

group of deficit	subgroup of deficit	number	deficit
P	motorized traffic	8 x	combination of minimum sizes
L	pedestrians	11 x	lack of or insufficient pedestrians crossing
	motorized traffic	7 x	adversarial line management (excessive speed)
JO	motorized traffic	7 x	line-of-sight obstruction
S	motorized traffic	17 x	lack of or insufficient speed reduce
		7 x	unsuitable elements
PC	pedestrians	12 x	line-of-sight obstruction at bicyclist/pedestrians caused by parking cars
	motorized traffic	55 x	line-of-sight obstruction caused by parking cars
		12 x	lacking/inadequate measures to prevent illegal parked cars

Table 2: accumulation of deficiencies in detailed plannings of German side roads

One typical deficiency is the „Combination of minimum sizes“ (example see Figure 6). Combining minimum sizes causes a rising risk of using other, not assigned areas by road users. This involves a certain amount of risk, especially for pedestrians and bicyclists. Minimum sizes shall not be combined.

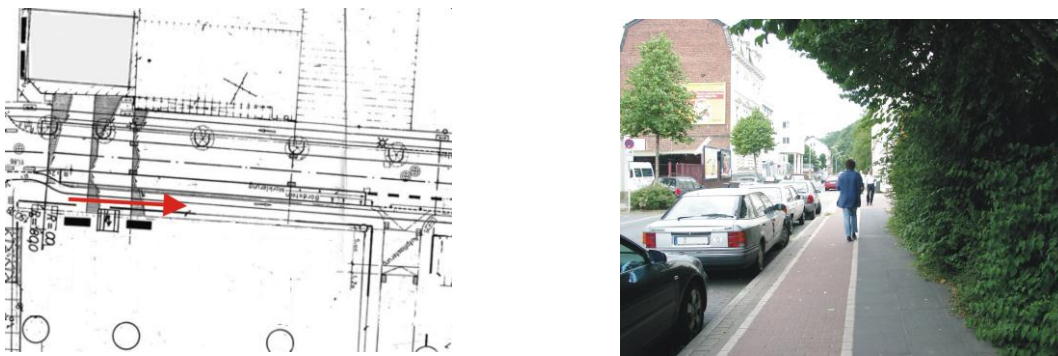
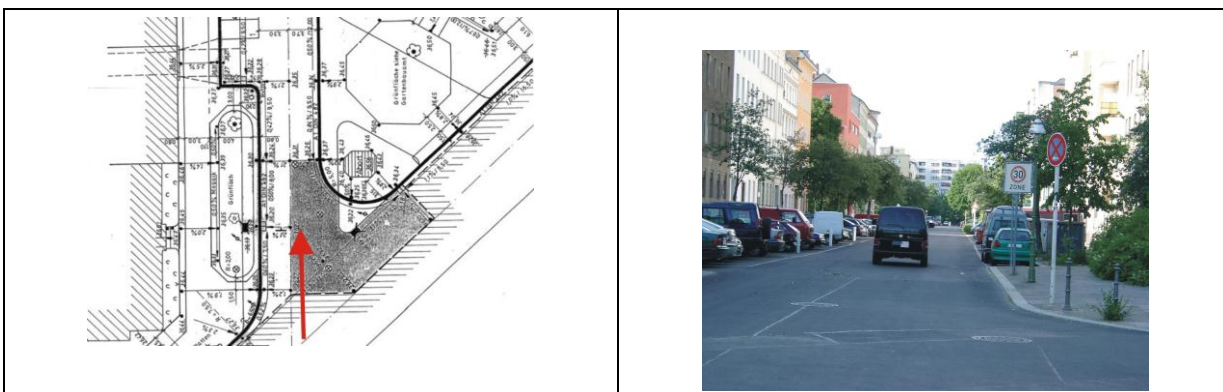


Figure 6: Combination of minimum sizes in a side road

Another deficiency in side roads is an „Adversarial line management“ which leads to excessive speed (example see Figure 7). Straight-line roads without line sections lead to high speed. The delay of break, the possibility to avoid and the impact in case of collision depend on the cruising speed. To provide for adequate road safety it is important to make the driver the recommended speed clear with the help of traffic calming elements.



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Figure 7: Straight-line side road with excessive speed

4. Typical Deficiencies in urban roads in developing countries and countries in transition

A most common deficiency in developing countries and countries in transition is the lack of access control along motorways and highways going through urban areas. The different functions of roads are not properly separated so that there is along most of the public roads a dangerous mixture of Connectors and Access Roads.

In Egypt for example is one of the most dangerous examples the Cairo - Alexandria Agriculture Road (Figure 8).



Figure 8: Example of a Motorway through urban areas without access control (Cairo-Alexandria Desert Road in Egypt)

A speciality of mixed functions are so called linear settlement along interurban roads, where for the lack of access control especially poor people are settling very narrow to the carriageway of high speed roads. In other cases private enterprises get the possibility to access directly to highways and motorways. In general a structure of a clear hierarchy of the road network, following the objectives of land use, is missed very often. Express roads should generally not lead through cities and small towns and should have no linear settlements like it is still required for motorways. If there are cross town links on express roads they should be replaced by new sections of bypasses going outside the built-up areas step by step. An important task is to establish bypass programs in developing countries and countries in transition. In these cases the existing road should be reconstructed and after the reconstruction the responsibility should change to the Governorates or local administrations. The reconstruction should include a narrowing of the carriageway, traffic calming measures and a widening and improving quality of pedestrian and cyclist facilities.

The lack of separating the agriculture vehicles and vulnerable road users from the fast and far going truck and vehicle traffic on express and rural roads is one more serious gap in respect of road safety in agriculture and urban areas. The mixture of slow and fast traffic on

one carriageway (example see Figure 9) is dangerous per se especially with unsafe vehicles and uneducated road users. Their separation is a very important task in many developing countries.



Figure 9: Donkey carts on carriageway on the wrong side of an express road

The idea of wide hard shoulders which can be found at many express roads is to separate the slow traffic from the fast and to give safe stopping facilities to vehicles in emergency cases. But in fact these shoulders give the impression of an extra wide road for overtaking by opposite traffic. These manoeuvres cause regularly serious accidents with many fatalities. For this reason cross sections of this type have been excluded from European standards and should no longer be used in developing countries. A clear separation by own paths for VRU should be improved instead.

Many intersections in urban areas of developing countries are of an unusual design comparable to solutions for normal t-junctions or roundabouts in other countries. U-turn solutions are often used (example see Figure 10). In Egypt U-turns in highways, rural and urban roads have been built for enforcing the right of way when entering the main road from the secondary road or for normal left turning. In urban areas U-turning takes time, creates traffic congestions and accidents especially with VRU using or crossing the road. The Egyptian drivers are used to this solution but they are not educated and trained to respect the right of way without enforcement, in most areas even not at signalized intersections. In addition a so called Y-intersection can still be found in design regulations and for example recently realized at the bypass of Biba, National Road Nr. 2 in Egypt. This type of intersection is extremely dangerous and it is strongly recommend excluding it from the regulations. At least the standards and practice for roundabouts have to be improved in many countries because over-dimensioned round about solutions with too large diameters and insufficient deflection faces the problem of high speed and low respect on the right of way for the circling traffic.



Figure 10: Dangerous U-Turns in urban areas

When entering built-up areas, speed has to be reduced to the speed limit for built-up areas. It has been found out, that traffic signing is not sufficient. It needs enforcement by design respectively traffic calming measures. One of the most effective measures are traffic islands at the entrance of the built-up areas which could be combined with speed humps as traffic calming measures.

In built-up areas, people should be able to walk in reasonable comfort and safety, as walking is an essential part of a wide variety of activities. It is vital to the environmental quality of urban areas to provide a high standard of pedestrian facilities, slow speed, recognising the vulnerability of all pedestrians and the special needs of the young, the elderly and people with disabilities. In respect to the development of public transport it is essential to have good walking facilities between the stations and bus stops and safe crossing facilities at each bus stop.

In many urban roads of developing countries sidewalks are missed in general (Figure 11). However if there are sidewalks they are very often hardly to use because of goods and other deposits of materials or road trading and cooking. In rural areas sidewalks, if there are, are often blocked or unusable by high kerbs and bad maintenance so that pedestrians are forced to use the carriageway which is most dangerous even in the dark.



Figure 11: Urban main road with missing or not usable sidewalks

Pedestrian facilities should generally provide a high quality with sufficient widths, lowered kerbs at crossings and without any obstacles. The minimum width of a sidewalk should be 2,50m so that two people can go side by side with comfortable distances from the carriageway (Figure 12). In cases of shopping streets or in cases of high pedestrian volumes the width should be widened up to 6,00 m or more.

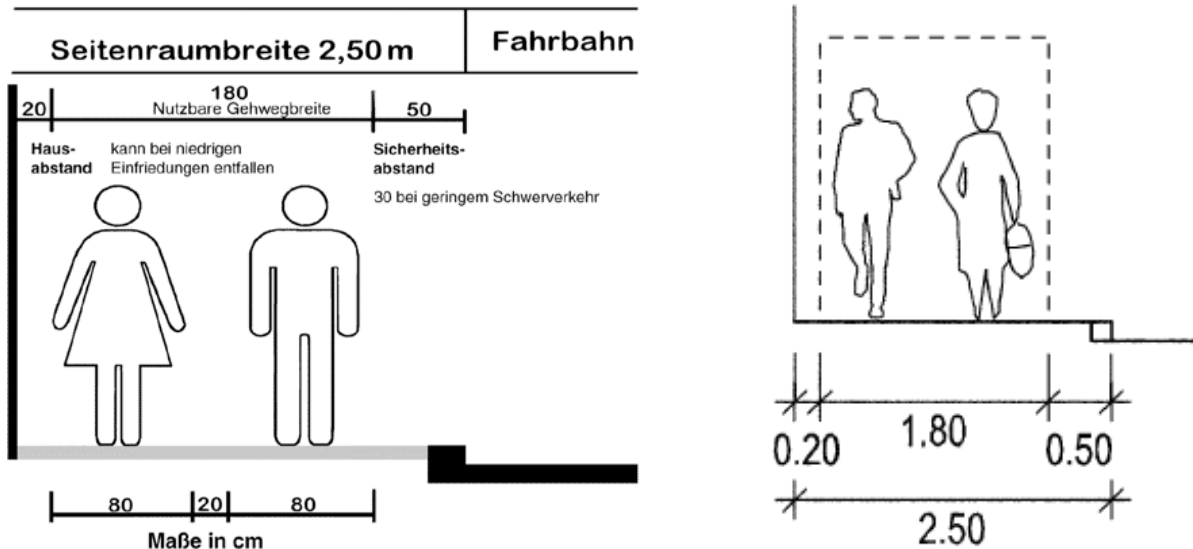


Figure 12: Pedestrian facilities with a width of minimum 2,50 m [1]

Many accidents with VRU involved happen by crossing the road (Figure 13). Therefore safe pedestrian crossings should be improved to direct the vulnerable road users to a suitable point for crossing the road and also to draw the motorists' attention to the fact that people want to cross the road. It is very important to find out the pattern of movement before a pedestrian crossing is established. The location must be chosen so that the pedestrians' movements are taken into account. In some locations, due to through traffic and high speed special attention must be paid to pedestrian crossings and traffic calming measures. It is particularly important that schools located along such roads be provided with adequate equipped crossings. One solution could be to put guardrails or fences to channel pupils' movements and prevent them from crossing the road elsewhere. Road markings and signs, warning for school, should be used. Generally the speed should be reduced to 30 km/h on all roads which have an access to schools.

In especially problematic areas signalled pedestrian crossings could be considered, for example where:

- Large number of children has difficulty in crossing a road carrying a large amount of traffic.
- Vehicle speeds are so high that pedestrians' confidence in a pedestrian crossing is insufficient.

Pedestrian crossings are particularly dangerous in the dark, but introducing streetlights can solve this problem to some extent. It can also be very effective to use reflective material at pedestrian crossings.



Figure 13: Dangerous pedestrian crossings

To improve the crossing a refuge island generally should be constructed in the middle of a road. It is one of the best ways to ensure a safe crossing. For Children and elderly people it is nearly impossible to calculate the time gaps in two opposite traffic directions. Once on the carriageway they can not repair a wrong decision or the mistake of a driver. Traffic islands as crossing helps gets more and more installed in Western Europe.

Refuge islands usually take the form of a longitudinal island, built in the carriageway with or without facilities for pedestrians, to improve lane discipline, restrict overtaking or lower vehicle speeds by reducing lane-width and separating cyclists from other vehicles. Refuge islands are a low cost method of improving crossing facilities for pedestrians. Different studies show that 2/3 of all accidents take place at the far side of the crossing. Therefore a pedestrian refuge island will give a great improvement in road safety since pedestrian refuge islands separate two-way traffic and permit pedestrians to cross the road in two stages. Then the pedestrian only has to concentrate on looking in one direction at the time and feel safe while waiting in the middle to cross the next lane.

Pedestrian over- or under-passes are the safest solutions in respect of road safety but they have disadvantages too. At overpasses pedestrians have to climb up 5-6m which might be a difficult task for elderly and handicapped people. Most pedestrian try to avoid this strain and will cross the road on the carriageway. This has to be prevented by railing and fences. In addition pedestrian underpasses are uncomfortable and can lead to security problems. Therefore pedestrian over- or under-passes should be generally avoided especially at urban roads. If there is no other possibility, e.g. at motorways or express roads, than it should be proved whether it is possible to dip the road to level -0.5 to -1 so that pedestrians can cross over a bridge without high ramps or simply at ground level.

5. Conclusions

Worldwide there are many deficiencies in urban roads which could lead to dangerous situations and severe accidents. The reasons for bad road situations in urban areas are manifold and not directly comparable in between developed and developing countries. In many developing countries and countries in transition the requirements of VRU are widely neglected. The main aims should be to improve the road infrastructure with a strong road hierarchy, separation of VRU from fast traffic, good usable sidewalks and safe pedestrian crossings. In developed countries there still seems to be a lack of knowledge concerning

urban roads or simply a main focus on capacity or traffic flow instead of a needed concentration on the requirements of VRU.

Overall it is a big task to enhance road safety for vulnerable road users in urban roads.

References

[1] Twinning Project EG08/AA/TP13: The Twinning Expertise for Enhancing Road Safety in Egypt, Cairo 2011

[2] Forschungsgesellschaft für Straßen- und Verkehrswesen: Guideline and standards for the design of urban roads, orig: Richtlinien für die Anlage von Stadtstraßen, Köln, 2006