

## Summary

# Unmarked crosswalks – Traffic safety and universal design

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Authors: Alena Katharina Høye, Siri H. Berge, Kjersti V. Øksenholt & Katrine Karlsen  
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*In Norway, unmarked crosswalks are meant to facilitate pedestrian road crossing at locations where marked pedestrian crossings are not recommended. Unmarked crosswalks are not marked by zebra stripes or signs. In contrast to marked crosswalks, drivers of motor vehicles are not obliged to give way to pedestrians using unmarked crosswalks. The dropped curbsides of unmarked crosswalks are meant to indicate and facilitate pedestrian crossings; there may also be a pedestrian refuge or island. In this report, we investigate the effect of unmarked crosswalks on road user experience and behaviour. We use video observation, roadside surveys with crossing pedestrians, and focus group interviews with older persons, visually impaired persons, parents, and car drivers. Compared with non-facilitated crossing locations, we find that unmarked crosswalks improve mobility for most people, but most respondents report experiencing unmarked crosswalks on roads with a lot of traffic and/or high-speed traffic as unsafe. Uncertainty surrounding give-way rules at unmarked crosswalks causes confusion, especially at junctions. For some pedestrians, unmarked crosswalks may present unsurmountable barriers, and some may prefer to choose alternative routes, or even abstain from walking to their destination altogether. Such pedestrians need their crossing facilitated to a greater degree than that currently achieved by unmarked crosswalks. Challenges are mainly associated with dependence on large enough gaps in the traffic for crossing, or on drivers waiting for pedestrians to cross even if not obliged to do so. Visually impaired persons may have difficulties orienting themselves at unmarked crosswalks.*

## Unmarked crosswalks

The National Public Roads Administration's (NPRA's) Handbook V127 gives recommendations for location and design of unmarked crosswalks in Norway. Unlike conventional pedestrian crossings, unmarked crosswalks do not have zebra stripes or pedestrian crossing signs. While they are designed to facilitate pedestrian crossing, for example, by virtue of dropped curbsides or traffic islands, drivers are not obliged to give way to the pedestrian users of unmarked crosswalks. To avoid confusion with marked crossings, unmarked crosswalks do not have tactile measures to facilitate crossing of visually impaired pedestrians. Beyond this, there are no universal design requirements for unmarked crosswalks. Unmarked crosswalks can be constructed at locations where conventional pedestrian crossings are ruled out based on high speed of passing traffic or too few pedestrians. They should not be constructed where pedestrian crossings have been removed due to elevated accident risk.

The reason for having unmarked crosswalks is to improve mobility for crossing pedestrians and to channel them such that they cross the road at the same location. Improved traffic safety is not one of the aims of unmarked crosswalks, but they should in any case not increase the accident risk. Some examples of unmarked crosswalks are shown in Figure S.1. More examples can be found in Appendices 1, 2 and 3.



Figure S.1: Examples of unmarked crosswalks.

Practitioners lack documented knowledge about unmarked crosswalks, on conditions for their establishment, or on how different road user groups experience them. NPRA have received feedback on the challenges and insecurity experienced by certain user groups.

Considering this the current report was commissioned to gather knowledge about the experiences of pedestrian crossers of roads and cycle lanes, to help provide an overview of solutions that work well or not so well for different road user types, and to generate ideas for improved solutions that offer benefits for both traffic safety, pedestrian security and mobility. The results will interest those considering changes to existing guidance on pedestrian crossings.

## Method

The study was carried out in several parts with different empirical approaches:

- (1) **Current practice.** We collected examples of different types of crossings in use in Norway
- (2) **Video observation.** We observed crossing behaviour and interaction between pedestrians crossing and drivers, at six unmarked crosswalks with the help of video. Altogether we observed 540 pedestrians, 69 cyclists and nine scooter users.
- (3) **Roadside survey.** We performed observations and questionnaire surveys at five unmarked crosswalks. We observed 336 pedestrian crossers, of which 80 (24%) also completed the survey.
- (4) **Focus group interviews.** We carried out structured interviews about unmarked crosswalks with six groups representing older persons, visually impaired persons, parents and drivers.

Only unmarked crosswalks traversing roads used by cars are included in the empirical part of the study.

In addition we held a workshop about unmarked crosswalks in Oslo, Norway, with participants from NPRA, national blind and disabled persons interest groups, a state specialist education service, and Trondheim Council. The workshop generated ideas on areas for improvement for unmarked crosswalks.

## Establishment, location and design of unmarked crosswalks: Current practice

We found 53 examples of unmarked crosswalks, 21 on road stretches, 22 at junctions or roundabouts (over side roads leading to roundabouts) and ten over cycle paths or lanes. Unmarked crosswalks over cycle paths and lanes are not defined in any of NPRA's handbooks and there are therefore no general criteria or recommendations for location and design of such crossings.

Unmarked crossings on straight stretches of road were typically located in rural areas and often by bus stops. In contrast, most unmarked crosswalks by junctions or roundabouts and all crossings over cycle paths/lanes were in built-up areas. Most roads with unmarked crosswalks had two *lanes of traffic*, some had just one, and none had more than two. The *speed limit* on road stretches crossed by unmarked crosswalks was mostly 60 km/h; and 30 or 50 km/h where unmarked crosswalks crossed at junctions or near roundabouts. *Traffic volumes* (number of vehicles passing per 24-hour period, averaged for the year, ADT) were found to be either low (under 800) or high (5,800-16,000), i.e. none of the unmarked crosswalks in the study were in roads with traffic volumes between 800 and 5800. Even though unmarked crosswalks should not have *tactile measures*, we found that five of the 43 unmarked crosswalks crossing roads used by cars, had tactile measures for visually impaired persons on either side of the crossing; and two of the ten unmarked crosswalks crossing cycle paths/lanes had tactile measures. Interestingly, all unmarked crosswalks with tactile measures were located near bus stops.

Dropped curbstones normally represent *the boundary between pavement and road*, but in around half of the cases we studied, this boundary was not clear on at least one side of the road. *Pedestrian islands* were found in six (of 21) cases of unmarked crosswalks located on road stretches, and ten (of 22) cases of unmarked crosswalks at junctions or near roundabouts. Traffic volumes were relatively high for crosswalks over stretches of road with pedestrian islands, but not all roads with high traffic volumes had pedestrian islands. *Speed-reducing measures* were only found for two of the unmarked crosswalks over roads used by cars – both on stretches with low speed limits and traffic volumes.

## How do unmarked crosswalks work in practice?

*Pedestrian channeling works – but only partly.* When pedestrians must take a detour to use the unmarked crosswalk, many choose instead to take a shortcut across the road outside the intended crossing location. At two study locations, use of the crossing involved a clear detour, and here two-thirds of pedestrians crossed outside the crossing. For crossings that are “en route”, almost all pedestrians use the crossing.

*Of those who can, many pedestrians run.* Among those crossing pedestrians who had an interaction with a cycle or motor vehicle, almost a third (30%) ran while they were crossing, mainly on stretches with high traffic volumes, high speeds and lacking pedestrian islands. Many of those who ran were under 20 years old.

*Many cyclists get off their bike on interacting with motor vehicles.* Over half of those cyclists interacting with motor vehicles, got off their bike to cross the road, but those who did not interact with motor vehicles cycled over the road.

**Knowledge of give-way rules varies.** Around half of those responding to the roadside survey answered a question on give-way rules correctly. Most respondents under 20 years old answered incorrectly. In the focus group interviews, most answered correctly, but many were unsure, especially about rules for unmarked crosswalks at junctions.

**Right knowledge does not necessarily lead to right behaviour.** We found that unmarked crosswalks can often lead pedestrians to behave as if drivers were obliged to give way. This was the case especially for visually impaired and parents of small children, and especially at junctions.

**Surprisingly many drivers let pedestrians cross first.** On average about half of pedestrians we observed crossing at unmarked crosswalks, crossed in front of a waiting vehicle. Even on roads with the highest speed limits and traffic volumes, at least 44% of crossing pedestrians cross in front of waiting drivers. The share of pedestrians crossing in front of a waiting vehicle was greatest among older pedestrians (possibly because car drivers are more considerate for them) and among those between 15 and 19 years old (possibly because they have the most assertive crossing behaviour).

**Pedestrians experience some unmarked crosswalks as unsafe and difficult to use.** On stretches with a lot of traffic and high speeds, over two-thirds of respondents said that it was unsafe and difficult to cross, that they would have taken a detour to a marked crossing if there was one, and that the cars never or almost never stopped for them (despite evidence that cars stopped relatively often). Unmarked crosswalks could also cause confusion, especially at junctions, and they can act as barriers to visually impaired persons and children.

**Pedestrians can also experience unmarked crosswalks as safe.** Most respondents experienced unmarked crosswalks with little passing traffic, or those on roads with lower speeds, as safe.

## How do location and design of unmarked crosswalks affect road user experience and behaviour?

**Traffic volume and speed is most decisive for uncertainty.** At higher traffic volumes (<5800) and speed limits (especially 60 km/t), two-thirds of pedestrians experienced the crossings as unsafe and difficult to cross. In these contexts, more pedestrians also run in front of waiting cars during crossing at unmarked crosswalks. A particular additional challenge to a lot of traffic and high speed was uncertainty about whether drivers would stop or not. The insecurity experienced is not, however, necessarily linked to higher accident risk. The physical design of the unmarked crosswalk seems to have no or little effect on insecurity reportedly experienced by pedestrians.

**Pedestrians experienced unmarked crosswalks on stretches of road as most unsafe and difficult to use.** This is possibly because unmarked crosswalks on stretches tend to have more traffic and higher speeds than crosswalks at junctions and near roundabouts.

**A pedestrian island simplifies crossing, but does not necessarily make it safer.** On roads with a lot of traffic and high speeds, a pedestrian crossing can simplify crossing for pedestrians, who must only negotiate traffic coming from one rather than two directions. Islands do not, however, reduce insecurity and may even increase uncertainty about who is obliged to give way.

***Unclear boundaries between pavement and roads are dangerous for visually impaired persons.*** The point at which pavement becomes road must be clear enough for visually impaired persons using a white cane. We found many cases where the boundary was not clear enough. At worst, pedestrians could walk out into the road without realizing it.

***High curbsides present potential barriers to those using wheels.*** If the height discrepancy between pavement and road is too high, a potential barrier is created for certain crossers (e.g. movement impaired persons using wheeled walkers or wheelchairs).

## How do unmarked crosswalks affect traffic safety?

If it instils caution, feelings of insecurity at unmarked crosswalks could theoretically reduce accident risks compared with e.g. zebra crossings. Insecurity is not, however, a reliable indicator of risk. At junctions, confusion surrounding who should give way can lead to misunderstandings, in turn leading to more conflicts and accidents. A pedestrian island can be thought to reduce accident risk at unmarked crosswalks.

For visually impaired persons, unmarked crosswalks can present a substantial risk. These persons can:

- Walk out into the road without realizing it, due to uncertainty about when the pavement turns into road
- Mistakenly assume that it is a conventional marked pedestrian crossing where drivers are obliged to give way to pedestrians
- Cross the road even if they are not certain whether oncoming traffic will give way to them
- Become disoriented while crossing and struggle to mount the pavement on the other side, or find the pedestrian island
- Experience problems handling guide dogs who are trained to find zebra stripes

For drivers using the road, there is potentially an increased risk of rear-end collisions compared with marked crosswalks or signal-regulated crossings.

## To what extent are unmarked crosswalks universally designed?

Universal design involves giving *all* road users wishing to cross the road sufficient information and opportunity for a safe and simple crossing. Based on this definition, unmarked crosswalks cannot be considered as universally designed. They can lead to substantial problems for:

- Visually impaired persons (see over on accident risks)
- Persons who cannot walk fast or run and use a long time to cross, many of whom will also struggle to find alternative places to cross
- Children who can walk some routes alone but are not completely independent yet

When crossing, these groups need to be accommodated by crosswalks to a greater degree, such that they can cross safely and simply. Nevertheless, most will have fewer problems at unmarked crosswalks than crossing at other locations where no facilitative measures are provided.

## Guidance and proposed measures

In the following passage, we list possible measures and improvements for unmarked crosswalks.

**Defintion: What is an unmarked crosswalk?** Current guidance (Handbook V127, page 26) contains relatively general and unclear criteria and guidelines for unmarked crosswalks. We suggest a clearer definition of unmarked crosswalks, which should cover both intentionally facilitated crossing locations and other locations where pedestrians cross the road (in the absence of measures such as marked crossing zones or signal regulation).

We also recommend defining minimum criteria that all unmarked crosswalks should fulfil, e.g. clear boundary between pavement and road that makes boundary crossing clear to visually impaired persons, and at the same time do not act as barriers to pedestrians using wheeled walkers or wheelchairs.

**Criteria: Mobility and universal design.** The results from our study clearly imply that unmarked crosswalks facilitating crossing to some degree, are for road users in general better than having no facilitated crossing locations. Some groups, however, require more facilitation in at least some types of location – if they are to cross safely and independently. Costs of measures to facilitate crossing to a greater degree for some pedestrians need to be weighed up against the numbers who will benefit from them, as do potential disadvantages extra facilitation could bring to drivers.

**Criteria: Speed and traffic volumes.** To avoid creating barriers to certain user groups, and to avoid misunderstandings and confusion, we recommend (1) assessing whether to increase measures that facilitate crossing at locations that are unsafe for marked crossings (typically on roads with high traffic volumes and vehicle speeds); and (2) to consider the use of marked crossings at locations for which current guidance considers them unnecessary due to too few pedestrians crossing (typically at crossings over side-roads with relatively little and/or low-speed traffic).

**Criteria: Road user perspective and intuitive design.** To ensure that unmarked crosswalks are optimally tailored to the needs of those that use them, a case-by-case assessment of unmarked crosswalks could be made. The aim would be to understand any challenges related to confusion, to assess amenability to simple, safe crossing by *all* users (children, visually impaired persons and others), to capture potentially practical challenges presented to specific groups, and to assess context e.g. schools, other institutions nearby implicating high use by certain user groups.

**Unmarked crosswalks as an element in the National Road Database.** There exists today no overview of unmarked crosswalks in Norway, nor of accidents occurring at such crosswalks. We recommend that unmarked crosswalks be included as a distinct element in the NPRA's National Road Database.

**Unmarked crosswalks at junctions and near roundabouts.** These unmarked crosswalks can cause confusion and misunderstanding, partly because there are many similar crossings with zebra stripes. Such misunderstanding can be avoided if the design were consistently different for distinct types of crossing, e.g. junctions of similar design over a larger area.

**Unmarked crosswalks over cycle paths or lanes.** The design of unmarked crosswalks crossing cycle paths or lanes varies widely, and has the potential to cause misunderstanding. One can ask whether it is necessary to have a special definition of unmarked crosswalks crossing cycle paths and lanes. It is possible using current handbooks to construct marked crossings over cycle paths and lanes. To formulate criteria for unmarked crosswalks would nevertheless be difficult, because it will often not be possible to use standardized solutions. Nevertheless, it would be useful to define general recommendations on design of locations where pedestrians cross cycle paths and lanes, to avoid confusion and potential conflicts in traffic.

**Pedestrian islands.** Recommendations in the guidance could include a need to assess the use of pedestrian islands on all roads with a lot of traffic and/or higher speed limits. Planners should also assess the need to increase the breadth of the islands on roads with higher volumes and speeds.

**Waiting areas.** It is probably not appropriate to recommend special waiting zones at all unmarked crosswalks. In cases where there is pavement with curbstone, there will in most cases be insufficient space to construct such an area – and it may often not be necessary.

**Speed-reducing measures for drivers.** Very few of the examples of unmarked crosswalks have speed-reducing measures. We do not recommend speed-limiting measures, but rather that planners should assess case-by-case whether physical measures to reduce traffic speeds near the crosswalk are appropriate.

Variable speed limits are also potentially interesting in relation to unmarked crosswalks, where stricter limits are applied in periods with most pedestrian traffic. As a rule, drivers keep to variable speed limits to a far greater degree than they do permanent speed limits.

**Speed-reducing measures for cyclists on combined pedestrian and cycle paths.** Speed-reducing measures for cyclists could, for example, be pedestrian markings across all types of lanes or cobblestone stripes. Depending on their location and design, these can increase pedestrian alertness at the crossing. At some unmarked crosswalks, a chicane barrier could help reduce dangerous situations arising from misunderstandings. These should, however, be designed to reduce the risk of being runover as much as possible, and this risk must be assessed against the risk for accidents in the absence of chicane barrier. Further, they should not present a barrier for pedestrians with prams or other groups.

**Universal design – Dropped curbstone.** Dropped curbstones are not part of all unmarked crosswalks, even if, strictly speaking, is part of the Norwegian definition of unmarked crosswalks. (In Norwegian, the term for unmarked crosswalk is *tilrettelagt kryssing*, the literal translation of which is “facilitated crossing”). The reason for this is that some unmarked crosswalks do not have curbstones in the first place. A more general recommendation could be, for example, that the boundary between pavement and road is marked with dropped curbstone with 2 cm curbstone where it is possible, and that the boundary must otherwise be low enough for pedestrians to cross with wheeled aids, but at the same time be high and clear enough for visually impaired persons to detect them.

**Universal design – Tactile pavement.** Per Handbook V127, there should not be «tactile lead lines» by unmarked crosswalks. We have found a number of examples of unmarked crosswalks with different types of tactile pavement. Based on our results, we recommend:

- **No tactile pavement** at locations with a clear boundary between pavement and road (this will normally be a dropped curbstone with sufficient height difference) to avoid giving visually impaired persons the incorrect impression that drivers are obliged to give way at the crossing.

- **Tactile pavement** where there is otherwise no clear boundary between pavement and road to prevent visually impaired persons walking out into the road without noticing.

In the case of each of the unmarked crosswalks we have found with tactile pavement, the tactile pavement is part of a continuous line of tactile indicators leading to bus stops. Crosswalks leading to bus stops could therefore be an exception to the recommendation about not constructing tactile pavement by unmarked crosswalks. Alternatively, other types of crosswalks could be recommended near bus stops e.g. cobblestone.

**Other measures:** Many other measures are possible for use with unmarked crosswalks. For these measures, we do not have concrete empirical results on which to base recommendations for guidelines. This applies to signage, sighting/visibility improvements, lighting, street parking, design of midlines, edge-lines and guide fencing design.

**Give way and due care regulations at cross walks:** Many unmarked crosswalks can share characteristics with marked crosswalks, causing considerable confusion among pedestrian users and drivers. If pedestrians had greater responsibility for checking and ensuring themselves at marked crosswalks, before they begin crossing, that any approaching drivers will give way and stop, many misunderstandings and possible conflicts and accidents at unmarked crosswalks could be reduced. In addition, safety at marked crosswalks could potentially also be improved.

## Checklist for the assessment of unmarked crosswalks

Based on our results, we have developed a checklist that can be used to help assess unmarked crosswalks, and find solutions to possible problems. Each of the questions concerns a concrete “task” to be accomplished by crossing pedestrians if they are to utilise the crossing.

- **Find the road:** Is it clear to the pedestrian, cyclists or others who wish to use the pavement or crossing that this is a crossing location? For most users, this is probably not a big problem, but can visually impaired persons also find the crossing?
- **Move between pavement and road:** Will all potential users manage to move, unhindered, between pavement and road?
- **Detect the boundary between pavement and road:** Is the difference or boundary between pavement and road clear enough for all crossers, including visually impaired? Can they always be clear over whether they are in relation to road and pavement?
- **Manage to cross the road:** Will all potential users manage to find a gap in the traffic that is large enough to allow them to comfortably cross?
- **See other road users:** Have both pedestrians/drivers sufficient view, in both directions, to be able to see the crosswalk and drivers/pedestrians at sufficient distances?
- **Whole picture and potential for misunderstandings:** Is there potential for the crossing to be misinterpreted as a (kind of) marked crosswalk, or will the crossing lead pedestrians to behave as if they had give-way obligation? Does the unmarked crosswalk otherwise fit in well with the whole traffic picture? For example, are there similar crosswalks nearby that utilise different measures to facilitate crossing, such that misunderstandings can be created?



## **Suggestions to try**

We have assembled some questions that can lead to new studies or the development of new measures for testing.

- Should some unmarked crosswalks at junctions be converted to marked crosswalks?
- Can signs at unmarked crosswalks increased driver attention and awareness of pedestrians?
- How do pedestrian islands influence pedestrian feelings of security and the extent to which unmarked crosswalks present barriers to some pedestrians?
- Can pedestrians be made attentive to unmarked crosswalks and their give-way obligation with the help of markings, signs and indicators?
- How can we help visually impaired persons orient themselves by unmarked crosswalks?