Cycling and safety for cyclists

Danish experiences

Vejdirektoratet
Danish Road Directorate

Transport-, Bygnings- og Boligministeriet

The Danish Road Directorate (DRD)

The Danish Road Directorate aims to make it easy and safe for road users to use the Danish roads. This also applies to cyclists. Therefore, we carry out analyses of the road safety conditions, and we use accident statistics to monitor the development of crashes involving cyclists to be better able to prevent crashes.

DRD has a constant focus on improving the traffic safety for cyclists. We construct new cycle paths on the national road network. DRD is assisting in co-financing local projects and "super cycle highways", arranging an annual national cycling conference, coordinating changes at the national cycle routes, gathering knowledge and sharing it (inter) nationally, and making Denmark an attractive destination for cycle tourism.

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Cycling and safety for cyclists

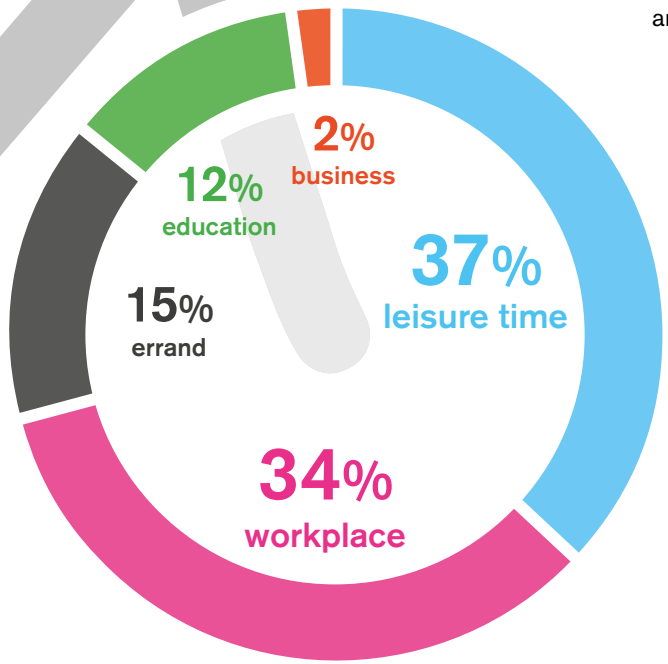
– Danish experiences

Denmark is famous for its many bicycles and in particular for its bicycle friendly infrastructure comprising many kilometers of bicycle paths and lanes. Bicycling as a common transport mode and a widespread cultural phenomenon goes back many years in Denmark.

Today it is still a common mode of transportation, especially in cities, and cyclists of all ages use the bicycle for going to school, work and leisure activities. According to the National Travel Survey 2016, almost half of the kilometers travelled by bicycle are used for daily commuter trips in Denmark.

Denmark is a very flat country and, usually only a few weeks each year, weather conditions like heavy rain, snow or ice will make cycling difficult. These conditions make bicycle an attractive alternative to other transport mode as it also is affordable and flexible. With the new e-bikes it is also possible to cover larger distances on bicycle.

You see the same picture in areas like The Netherlands, the northern part of Germany and the southern part of Sweden.



Purposes of the daily trips according to the National Travel Survey 2016

Planning of safe infrastructure for cyclists

In Denmark, the bicycle has been used as a daily means of transport for more than 100 years. Over the years, we have gained solid experience of different types of infrastructure facilities and their safety effects for cyclists. Some examples are shown in this chapter.

Bicycle paths and lanes in rural areas

Danish research studies of safety effects of building bicycle paths and marking bicycle lanes shows that:

- In general, results show that bicycle paths and lanes improve safety for cyclists on rural roads.
- In rural areas where the speed is high bicycle paths have a better safety effect than bicycle lanes.
- In rural areas the severity of crashes with cyclists increases with higher motor vehicle speed.

Bicycle paths in rural areas can be designed in various ways.

The two basic designs are:

- One-way bicycle paths in each side of the road. Normally, this is the safest solution, especially on urban roads.
- Two-way bicycle path in one side of the road. Normally, this is cheaper than two one-way bicycle paths in each side of the road, and more road kilometers can be covered on the same budget. On the other hand, safety problems may occur in junctions – especially priority junctions, because motor vehicle drivers from the side roads forget to look both ways.

Bicycle paths in urban areas

Danish research studies of safety effects of bicycle paths show that:

- Building bicycle paths or marking bicycle paths along existing roads in urban areas has very little – and sometimes negative – effect on the total number of crashes involving bicycles.
- Bicycle paths and paths reduce the number of head-on collisions and rear-end collisions involving bicycles on road sections.
- In junctions, the number of crashes involving bicycles increases, mainly due to more crashes with bicycles being hit by left or right turning cars.

The typical Danish bicycle path in urban area
In urban areas we normally have a sidewalk keeping the bicycle path separated from both sidewalk and carriageway with curbstones.

In Danish road standards it is recommended that the width of the bicycle path is 2.2 m and at least 1.7 m.

Cyclists in roundabouts

The number of roundabouts has increased in Denmark over the past 30 years to improve road safety. Many studies show little or no reduction in the number of bicycle crashes, when junctions are changed into roundabouts.

The Danish Road Directorate and Trafitec has analyzed the road safety impact of converting intersections to roundabouts – with particular focus on cyclists.

A before-after crash study of converting intersections to roundabouts has been carried out. The study included 332 converted sites, 57 fatalities, 1,271 other injuries, and 2,497 crashes.

For bicycles the primary results of the study are:

- Increased number of crashes and casualties
- Decreased number of fatalities
- Roundabouts with bicycle lanes/paths and blue crossings
  show the worst safety performance regarding bicycles

Cyclists often claim they are not safe in roundabouts (perceived safety). It seems they are right.

Cyclists' safety often worsens due to conversion of intersections to roundabouts. However, there are major differences in safety effects of different conversions. This is particularly due to different speed limits, presence of dual-way cycle paths along roads, type of bicycle facility and height of central island at roundabouts.

It is possible to convert an intersection to a roundabout and improve cyclist safety at the same time. One has to choose the intersection with care and design the roundabout in an optimal way in terms of safety.

Cycle lanes next to the circulating path produce the worst safety effects for cyclists, whereas cycle paths without priority to cyclists result in the best effects. Colored cycle paths and blue cycle crossings produced worse safety effects for cyclists than comparable bicycle facilities in paths without color.

The best safety performance in a round-about is obtained when the central islands is more than 6.6 ft (2 m) high. This produces better safety effects compared with lower central islands. Triangle or trumpet splitter islands produces better effects than no or parallel splitter islands.

For non-signal-controlled roundabouts, vehicles must give way when entering the circulation area.

Signal-controlled intersections

For several years, crashes between cyclists continuing straight ahead and right-turning heavy vehicles have been a key focus area in Denmark. These crashes typically occur at signalcontrolled intersections in both urban and rural areas.

A Danish study shows the most important safety measure to avoid crashes is a separate right-turn lane for cars. In signalized junctions with separate right turn lane for cars, two types of layout are recommended:

- advanced cycle path
- truncated bike path

In junctions with advanced cycle path some additional measures are often used:

- pre-green stage for cyclist is also recommended to make sure they get started before the motor vehicles, but also making it possible to stop the cyclists before the right-turning motor vehicles to make sure the intersection is cleared before the next stage. It may be deployed in junctions without separate right turn lane as less area is needed.

- Another measure to prevent crashes in junctions between cyclists and cars is an advanced stopline. In the Danish road standards it is recommended to have 5 m between the cyclists' stopline and the cars' stopline.

Furthermore in Denmark we are conducting a large scale study with bicycle boxes – also to avoid right-turn crashes.

These measures prevents crashes in the beginning of the green phase where cars and cyclists are starting to move into the intersection and the main purpose is to prevent right-turn crashes.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Maintenance and bicycles

The Danish Road Directorate is about to publish a guide to better maintenance of cycling infrastructure. The purpose of the guide is to help municipalities plan and carry out maintenance and winter clearance in order to achieve bicycle infrastructure that is safer and has a better accessibility all year around.

When the road is not maintained cyclist may choose to avoid the hole and stay on the road instead of using the path.

Photo: Sweco Danmark A/S

By addressing this topic the municipalities may help the cyclists to avoid crashes, typically single vehicle crashes where cyclists fall off the bicycle because of slippery surface or objects on the cycle path.

These crashes are often not reported by police and information about this type of crash therefore is very scarce in official accident statitics.

A Swedish study carried out in 2014 by VTI based on hospital data clearly indicates that many injury accidents involving a single cyclist could be avoided if the level of maintenance and winter clearance of the bicycle infrastructure had been higher, as can be seen in the figure next page.

This information might be quite obvious for the everyday cyclist but it can be a challenge to prioritize cycle path maintenance in the municipality budget.

A lot of help can be found in the guide:

- Start by mapping the bicycle infrastructure also including road network where the cyclists share the road with other vehicles.
- Consider registration method: how should the state of the road surface for cyclists be registered and how often?
- Yearly planning tool: when in the course of the year is it appropriate to plan and carry out maintenance, and who should be involved in the process?
- Involve local cycling communities in planning, mapping and prioritizing. An app for registration (for all road users) is available in Denmark.

It is important to keep the focus on improving safety for cyclists to avoid injury accidents that can have great personal and societal consequences. But a well maintained cycle infrastructure also contributes to brand the municipality as cycle friendly and environmentally conscious.

Traffic crashes involving cyclists in Denmark

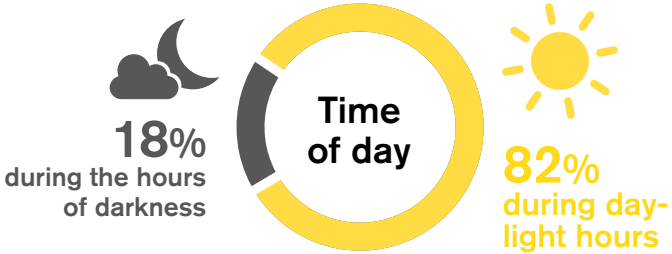
Analysis of fatal road traffic crashes

During the period 2010-2015, the Danish Road Directorate analyzed all fatal road traffic crashes in Denmark in cooperation with the police, vehicle inspectors and municipalities.

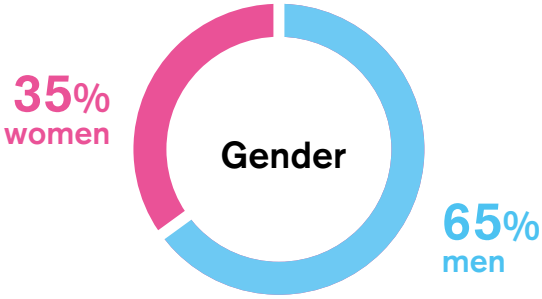
These analyses have provided new information about e.g. speed, lack of attention, weather conditions, visibility conditions and road courses, vehicle condition and road users' use of helmets and seat belts. This information can be used in analyses of crashes and provide knowledge that may improve the preventive road safety work.

Who and when?

During the period, 167 cyclists were killed (14% of all traffic deaths in Denmark). That is an average of almost 28 a year, and the level is fairly even throughout the period.



The lowest number of fatal road traffic crashes involving bicycles was in January, February and March and the highest number in July, August and September where most people use their bicycles.



The majority of the cyclists (97) were killed in crashes involving cars. 38 were killed in crashes involving trucks or buses.

Bicycles in the Danish legislation

According to the Danish Traffic Act, bicycles are vehicles and most of the rules that apply to motor vehicles also apply to bicycles. This means that on roads without any bicycle facilities (such as bicycle paths or lanes) cyclists have an obligation to ride on the carriageway – cycling is not allowed on sidewalks or in pedestrian areas, except if otherwise signposted. On roads where bicycle paths or lanes are provided, cyclists have an obligation to use this bicycle facility.

Bicycle helmets are not mandatory in Denmark. Nevertheless, in average 35 % of Danish cyclists are wearing bicycle helmet according to the Danish Road Safety Council. About 80 % of children up to 11 years use helmets. For teenagers and adults the number of users of bicycle helmets is significantly lower.

Why do fatal crashes happen?

Analyses of all fatal crashes show that most of the contributory factors are related to the road users and their behavior.

In respect to cyclists, the main factors contributing to the crashes were:

- That the cyclist did not pay sufficient attention
- That the cyclist reacted incorrectly or made a wrong maneuver
- That the cyclist was in a weakened physical condition, such as an elderly cyclist

In crashes between cyclists and trucks/buses, the most common factors in the crashes in respect to the trucks or buses were:

- That the driver did not pay sufficient attention
- That visibility from the truck/bus was poor or that mirrors were not properly adjusted
- That the speed was too high compared to the speed limit or conditions

In crashes between cyclists and cars, the most common factors in the crashes in respect to the cars were:

- That the driver did not pay sufficient attention
- That the speed was too high compared to the speed limit or conditions
- That the driver reacted incorrectly or made a wrong maneuver
- That the driver had a risk-oriented behavior

The most frequent fatal road traffic crashes involving cyclists in Denmark

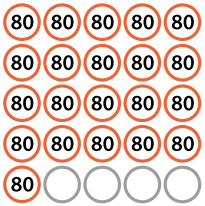
During the period 2010-2015, rear-end collisions, where cyclists are being hit from behind by a motorized vehicle, were the type of crash in which most cyclists were killed in traffic. There were 25 fatal rear-end collisions involving cyclists.

Characteristics of fatal road traffic crashes involving cyclists hit from behind:

The crashes most commonly occurred on straight sections without ribbon development and in rural zones.

Lack of or insufficient attention on the part of the driver is the most common factor in road crashes involving cars.

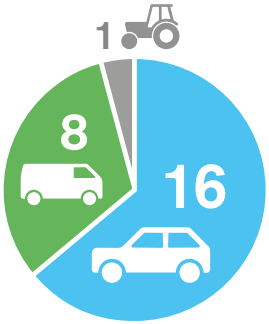
This applies in 76% of the crashes.



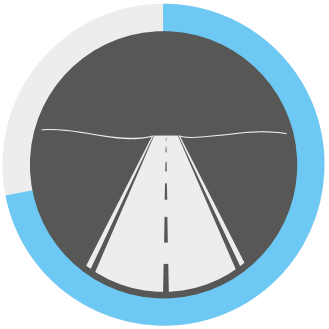
In 18 out of 25 crashes, the speed limit was 80 km/h.

In 7 out of 25 crashes, the car driver exceeded the speed limit – in 3 of the cases, the speed limit was substantially exceeded by 44%, 55% and 220%, respectively.

Most crashes occurred in the summer, in the morning or in the afternoon and in daylight.



Most cyclist were killed by normal passengers cars



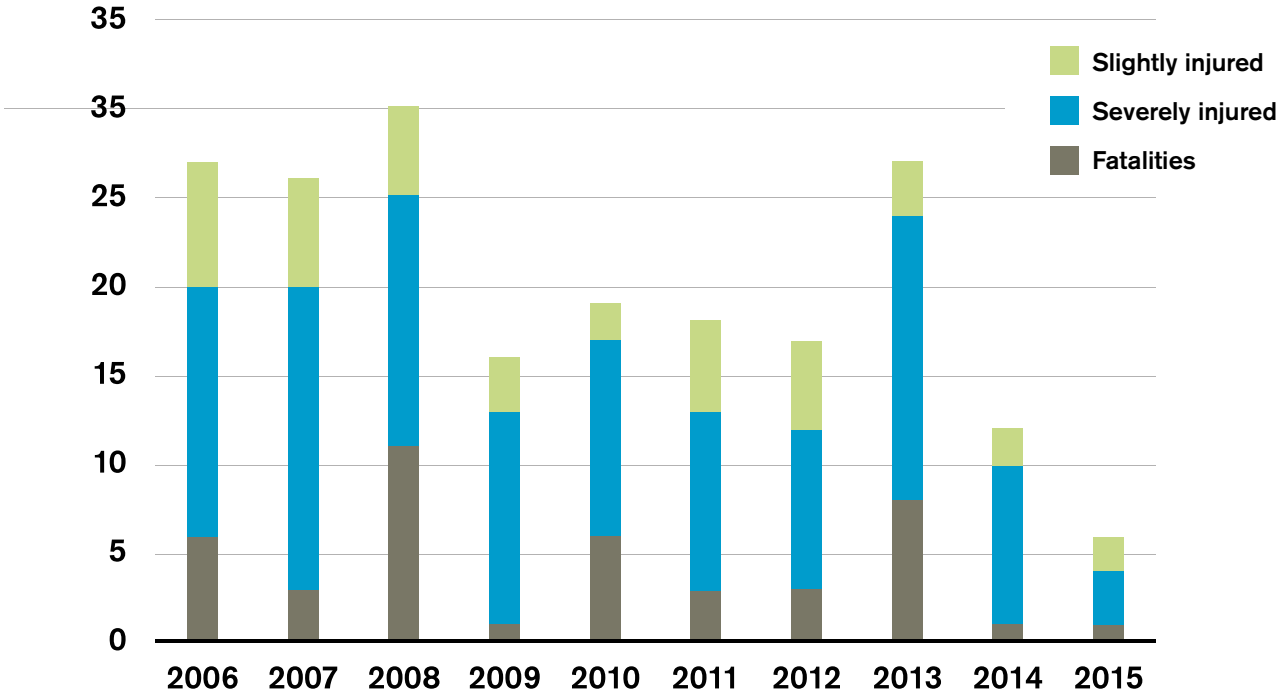
In 18 out of 25 cases,
there were no or only very narrow hard shoulder on the section and no bicycle facilities. Thus, the roads were characterized by not having an area for cyclists that was separated from the motor vehicles.

Right-turn crashes – key focus area

The Danish Road Directorate has studied right-turn crashes in Denmark over a 10-year period to gain more knowledge of this type of crash. The analysis only looked at crashes between cyclists continuing straight ahead and heavy right-turning vehicles as this particular kind of crash is often very serious for the cyclists.

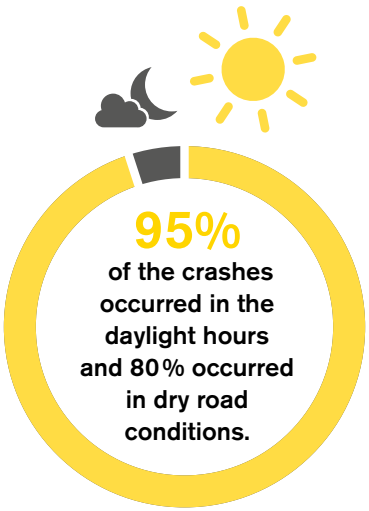
It seems that there are no significant differences in the crash pattern for right-turn crashes during the analysis period from 2006-2015 with respect to vehicles, parties involved and road condition. But the number of cyclists who were injured or killed in right-turn crashes differs from one year to the next.

Cyclists killed and injured in right-turn crashes 2006-2015



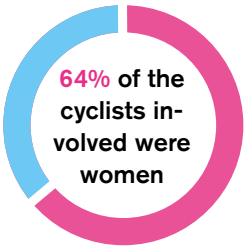
Cyclists killed and injured in right-turn accidents with heavy vehicles 2006-2015

In the analysis period 2006-2015, 195 personal injury crashes were registered, involving a total of 198 cyclists, of which 43 were killed, 115 were seriously injured and 40 were slightly injured in right-turn crashes with heavy vehicles.



98% of the crashes occurred in urban areas, of which 63% of the crashes occurred in a big city.

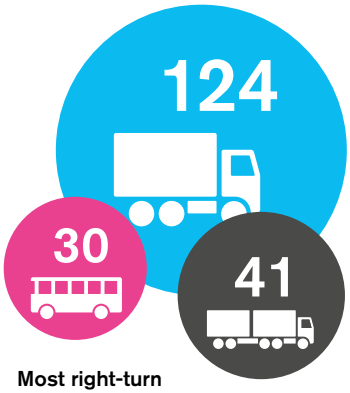
The roads in urban areas are typically local roads. The cities have the highest number of cyclists, and as a result, this is where conflicts most easily occur.



Most women who were killed or injured in bicycle crashes were in their 20s whereas most men were in their 50s.

9% of the involved cyclists were not from Denmark

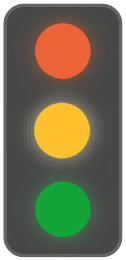
81% of the involved drivers were Danish. Among the remaining drivers, there were 11 different nationalities. Only 7 of the drivers were women, of which the 6 were bus drivers.



Most right-turn crashes involved trucks

Overall, most crashes were registered:

- in June
- on Mondays
- between the hours 7 am and 10 am



Most right-turn crashes (73%) occurred in four-legged, signal-controlled intersections.

They are often intersections with much traffic and many things to keep track of.

Vejdirektoratet har kontorer i:

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