



**Statens vegvesen**

Norwegian Public Roads Administration

*Manual*

## MC Safety

Design and Operation of Roads and Traffic Systems



## Norwegian Public Roads Administration Handbooks

This is one of a series of handbooks prepared and issued by Norwegian Public Roads Administration, a collection of consecutively numbered books, which primarily are written for use within the Administration.

This English version is a translation of the Norwegian one. In case of linguistic differences between the two versions, the Norwegian version is the valid one.

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*Level 2:* Blue marks on the cover indicates Instructions, Teaching Manuals and Road Data approved by individual departments authorised by the Directorate of Public Roads.

### **MC Safety**

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# Foreword

In the National Transportation Plan (NTP 2002 – 2011) the government states that the traffic safety effort shall be aimed towards a vision of no one being killed or severely injured in road traffic. Motorcycle driving is a form of activity that entails a high risk of severe injuries. In the National Action Plan for Road Traffic Safety it is therefore suggested that a guide be prepared to assist those in charge of designing and operating the road and traffic systems. It covers road and road environmental aspects of significance to motorcyclists' safety.

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# Use of handbook

## 1.1 What Do We Mean by MC?

In this handbook the term MC is used as a general expression for all motorized two-wheelers such as mopeds (up to 50 ccm), light motorcycles (50 – 125 ccm) and intermediate to heavy motorcycles (over 125 ccm). Scooters are also included in this definition of MC.

Correspondingly, for the sake of simplicity, the term motorcyclist is here meant to include mopedists and scooter operators. Only where there are special reasons is it distinguished between motorcyclists and mopedists.

## 1.2 Why Writing the Handbook?

According to the «*National Action Plan for Road Traffic Safety 2002 – 2011*», which is a follow-up and concretization of the National Transportation Plan (NTP), the Norwegian Public Roads Administration was obliged to prepare a handbook on traffic safety for motorcyclists.

The need for such a handbook is associated with the fact that

- motorcyclists in Norway run a relatively high risk of accidents compared with Norwegian motorists and compared with motorcyclists in other Nordic countries.
- the number of MC accidents in Norway has increased the last 10 years as a result of a large increase in the number of motorcyclists.
- motorcyclists are a vulnerable group of travellers and MC accidents can easily result in severe injuries.
- road environment measures are often designed based on four-wheeled vehicles. Such measures generally provide a high level of safety also for motorcyclists, but sometimes they can have a negative effect for this road user group.
- increased awareness and knowledge about MC in planning, construction and maintenance can provide improved traffic safety for motorcyclists.

The increase in motorcyclist related accidents is, however, much lower than the increase in the number of motorcycles, indicating that the risk to motorcyclists has been significantly reduced the last 10 years. There should also be a potential for accomplishing a further risk reduction through a conscious effort to improve road and traffic conditions and road user behaviour.

This handbook shall contribute to increased attention to motorcyclists as a road user group, increased insight into causes of MC accidents and better understanding of how road and traffic conditions affect motorcycle safety. This should result in road hazards

being eliminated and conditions established to ensure safe travel by motorcycle, resulting in fewer motorcyclists being killed or severely injured.

The recommendations and guidance given in this handbook are intended to improve motorcyclist safety. This can also, however, have a concurrent positive effect on other road users' safety.

## 1.3 For whom is the Handbook Written?

The handbook is primarily written as a guide and reference for anyone working on planning, construction, operation and maintenance of roads and traffic systems. Those that themselves do not currently operate or have not in the past operated motorcycle and moped, are from the outset less qualified to understand how road conditions affect traffic safety for such vehicles, and for these the book will be an aid in selecting favourable solutions.

The handbook also addresses motorcyclists and mopedists, driving-test candidates and anyone with responsibility for driver training and motorcyclist and mopedist behaviour measures. With a better understanding of risks involved and accident causes, it will be easier to adjust driving behaviour to attain lower risk.

Motorcyclists are encouraged to request safe roads with reference to the handbook. This will make road authorities pay more attention both to motorcyclists and the handbook. This handbook is a result of a constructive cooperative effort between motorcyclists and central road authorities. Similarly, constructive cooperation at the local level will contribute to safer traffic solutions.

# 2

## Background

### 2.1 The Use of MC in Norway

Until the 1960s, motorcycles and mopeds were largely utilitarian vehicles used both for goods transportation and work trips. During the 1970s and 1980s, heavy motorcycles rapidly gained in comfort, road handling and performance and became more popular for leisure activities and relaxation. Lately, however, there has been an upturn in the use both of motorcycles and mopeds for work and school trips. New types of scooter resembling motorcycles and mopeds have contributed to this development.

Various types of motorcycle, such as off-road, custom, touring and sports cycles have developed in different directions, often having significant differences in handling characteristics, driving style and accident involvement. In 2004, high performance sports cycles with favourable handling properties, made up a large and increasing share of MCs in Norway, and it is this type of motorcycles that is most frequently involved in accidents. Two paradoxes have their explanation:

It is a paradox that the fastest sport cycles are more popular in Norway than in countries with roads designed for higher speeds. Part of the explanation for this is that such cycles also handle better on winding roads.

It is a paradox that cycles with superior handling are those most frequently involved in accidents. Part of the reason for this is that motorcycles built for higher speeds are driven faster than cycles built for cruising and recreational use. Motorcycles having a high performance image attract adventure seeking drivers, and it is this type of drivers that are most involved in accidents.

### 2.2 MC Physics

#### Handling

In contrast to cars, motorcycles have only two points of contact against the ground and can therefore not remain upright when standing still. To balance/steer a motorcycle can be compared to balancing a hammer with the handle down towards the palm of the hand. When the hammer starts leaning to one side, the hand must move in the same direction in order to again position the point of contact with its support (the palm of the hand) directly below the centre of gravity. Thus the balance is being regained. Balancing a forward moving motorcycle can be explained in a similar manner. When the motorcycle tilts to one side,

while the operator wishes it to move straight ahead, the handlebar is used to change the point of contact with the surface. In practical terms, this means that the operator turns in the direction of the tilt, sufficiently to have the wheels steered directly underneath the centre of gravity of the cycle. The effect of such steering is amplified by increased speed – a slight turn of the handlebar at 90 km/h moves the wheels much faster than at walking speed.

The steering geometry of the motorcycle, which is determined by dimensions and angles of the front fork, provides the desired stability and self-correcting balancing capability making continuous driving corrections unnecessary. Together with the steering geometry design, the gyro effect of the rotating masses of wheels and engine also contribute to stability.

It is the same balancing exercise, albeit in a reverse order, that is used to make a motorcycle change direction (turn). In addition, the roundness of the tire profile assists in and facilitates the turning movement.

Modern motorcycles are equipped with very efficient brakes. Lately there have also appeared models with ABS equipped brakes. But ABS equipped brakes do not improve the ability to undertake emergency braking while turning in the manner possible with cars.

### What can go wrong?

A motorcycle accident normally occurs because of a breakdown in the cooperation between motorcycle – operator – road. On curves, the cycle can scrape the ground and lose road grip on uneven surface. Emergency braking while turning can cause the cycle to straighten and aim for the edge of the road. The wheels can also lock up making it more likely for the cycle to overturn. With gravel, dirt, oil spill, cattle guards, markings etc. on a curve, the wheels can lose their grip and the cycle skid and overturn. With gravel, dirt, oil spill, markings etc. in front of an intersection, the wheels can lock and the cycle overturn or require longer braking distance.

### What can the driver do to prevent accidents?

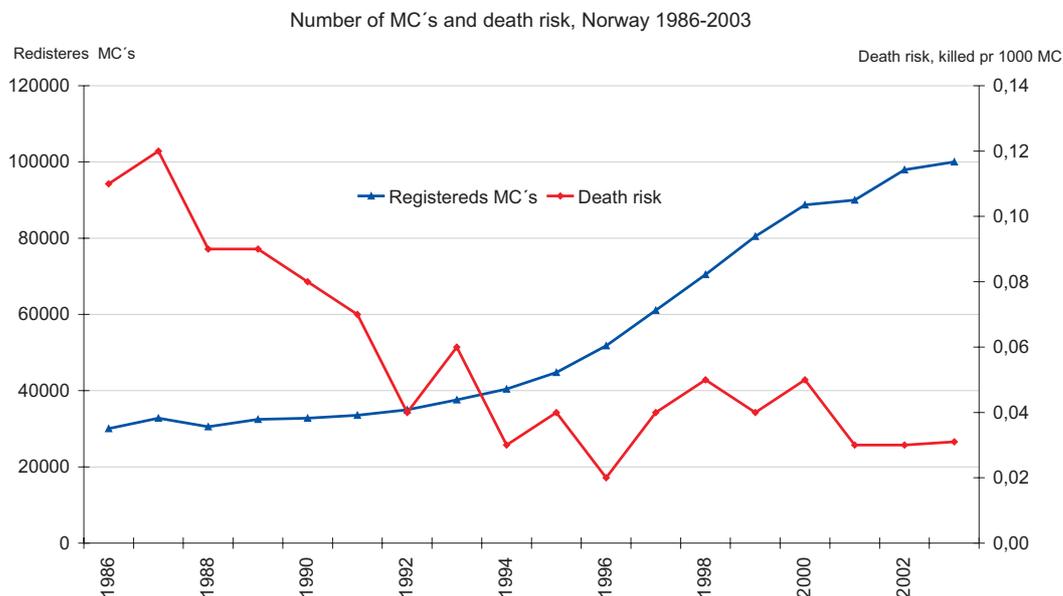
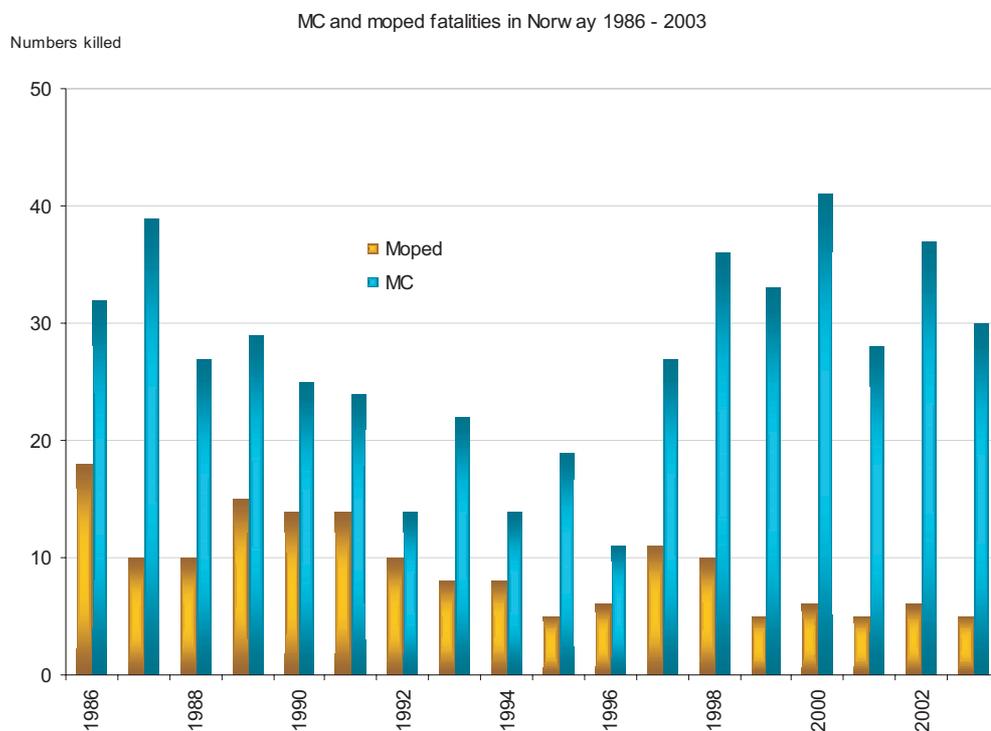
To lower the risk of injury to motorcyclists to the same level as for motorists, all road users must take on their part of the responsibility. The road keeper must take responsibility for road conditions not unexpectedly becoming so adverse that an untrained and inattentive motorcyclist loses control and gets killed or severely injured. Other motorists must take responsibility and pay attention to the motorcyclists even if they sometimes are barely visible and appear suddenly.

But first and foremost, motorcyclists must take responsibility for their own safety by keeping the motorcycle in good condition, using protective gear and ensuring that own driving skills and driving behaviour is of high standard. Most motorcyclists maintain their cycles in safe condition and are meticulous about wearing safety gear. But driving skills are often inferior, and driving behaviour is in some instances reprehensible and dangerous. To improve skills and behaviour, together designated as driving proficiency, the Norwegian Motorcycle Union (NMCU) among others prepared the information booklet «*Full Control*». Specially trained driving instructors also offer safety courses to improve motorcyclists' driving proficiency.

It is a problem that motorcyclists are being overlooked by motorists that are required to yield. This can be counteracted by the motorcyclists themselves by using supplementary driving lights and bright colours on driving suit and helmet and by adapting speed and position to make them more detectable. Motorcyclists can also contribute to collision avoidance with vehicles required to yield by ensuring eye contact and the certainty of having been observed.

## 2.2 Accidents

### Annual numbers killed



After an impressive decline in heavy/light MC fatalities in Norway from 1987 to 1996, there has been seven subsequent years with numerous fatalities. In the 1997 – 2003 period, about 35 died annually in heavy/light MC accidents and six on moped accidents. Motorcyclists and mopedists make up about 13% of road traffic fatalities.

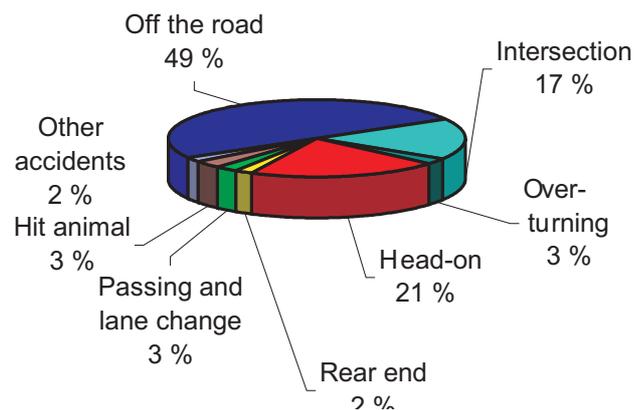
## Risk of being killed

This increase in the number of MC fatalities in Norway at the end of the 1990s reflects clearly a corresponding increase in number of motorcycles. The number of heavy/light motorcycles was between 30,000 and 40,000 for many years until 1994. From 1994 to 1999 the number increased to 80,000 and in 2003 there were about 100,000 heavy/light motorcycles registered in Norway. Motorcyclists' risk of being killed in traffic has been reduced by 70 – 80% the last 20 years and it has never been lower than now; at 0.03 persons killed per 1000 registered motorcycles. Thus, it was actually much more dangerous to drive motorcycle 20 years ago.

Nevertheless, motorcyclists run a higher risk of being killed than other road user groups and mopedists have the second highest risk, expressed in fatalities per million hours. Expressed in fatalities per million km, mopedists have the third highest risk after motorcyclists and pedestrians.

## Accident types

**Heavy/light MC fatalities 1996 - 2000**



Half of all fatal heavy/light motorcycle accidents during the 1996 – 2000 period were off-the-road accidents. This is a significantly higher proportion of off-the-road accidents than for fatal car accidents. Only a third of heavy/light motorcycle person injury accidents were off-the-road accidents and this is roughly the same percentage as for car person injury accidents. This means that the severity of off-the-road motorcycle accidents is high.

For moped accidents the situation is different. Here intersection accidents dominate while off-the-road accidents are less pronounced. This is associated with the fact that mopeds are largely used at low speeds in urban areas while motorcycles are mostly used on the open highway at higher speeds.

## Off-the-road accidents

Annually about 15 motorcyclists are killed in off-the-road accidents in this country.

The most typical off-the-road MC accidents involve running off the road on the right-hand side on a left turn. In addition there have been numerous off-the-road accidents to the left on right turns. Such accidents are often caused by excessive speeds relative to driving skills. Sometimes, special and unforeseen road conditions have contributed to problems for the driver. The last part of the curve can unexpectedly become sharper than the first part of the curve or the friction can be reduced due to diesel spills, dirt or gravel on the roadway. Such situations have resulted in the motorcycle overturning or running off the road with the motorcyclist hitting the guardrail or a roadside obstacle. The severity has often been high with extensive bodily and head injuries. While the proportion of fatal accidents out of all recorded MC accidents was 4.5%, the proportion of fatal accidents when hitting an obstacle was 8.5% and the proportion of fatal accidents hitting guardrail 9.5%.

Official statistics show that the number of person injury accidents by type obstacle being hit is distributed in the following manner:

Hitting guardrail/fence	45
Hitting boulder, rock	20
Hitting curb	7
Hitting tree	7
Hitting signpost	7
Hitting light masts/light poles	6
Hitting walls/buildings	5
Hitting other masts/poles	5

A study undertaken by the Norwegian Directorate of Public Roads shows that the annual number of person injury accidents that involves hitting guardrail is distributed as follows:

Injured when hitting pavement	10
Thrown over guardrail	6-7
Injured when hitting the rail	5-6
Injured when hitting rail post	5-6
Injured while skidding under rail	2-3

The study revealed that the severity was highest when hitting the rail.

Lesson for road keeper:

1. If the driver receives proper signals on speed adaptation when entering the curve, the accident can be avoided.
2. Well-designed guardrail and side slopes can reduce the injury severity of off-the-road accidents.

## Head-on collisions

Another serious type of MC accident involves head-on collisions on curves. The causes of such accidents are often the same as with running off the road on curves. As far as road conditions are concerned, poor visibility is frequently a contributing factor.

Head-on collisions make up 9% of light/heavy MC person injury accidents and 21% of fatal accidents. Meeting on curves make up 6% of person injury accidents and 13% of fatal accidents.

Lesson for road keeper:

Good visibility can prevent collision with MC on curves.

## Intersection accidents

Intersection accidents make up 30% of light/heavy MC person injury accidents and 17% of fatal accidents.

For mopedists, intersection accidents are more dominant. This is so because mopeds are largely used in urban areas with numerous intersections, while motorcycles are to a greater extent used at higher speeds on the open road. The typical moped accident is an intersection accident where either the mopedist or the motorist fails to yield where required.

Most moped and MC intersection accidents occur when making left turn from a main road onto a side road where the person turning overlooks the opposing vehicle on the main road. Another typical situation occurs when a person turning left from a side road onto a main road overlooks a vehicle on the main road approaching from the left.

A Norwegian study (SINTEF) showed that in 41 out of 48 light/heavy MC intersection accidents (87%) the motorist was obliged to yield. In seven of the 48 intersection accidents (13%) the motorcyclist should yield.

Lesson for road keeper:

1. Good visibility gives reduced risk of MC accidents at intersections
2. Reduced speed gives fewer accidents and less severe injuries when the accident happens

## Age, experience and accident risk

The majority of accidents involve young and inexperienced MC operators. Some studies indicate that these operators also have a higher accident risk than other drivers. This may be due both to the drivers' lack of experience and the choice to practice high risk driving.

Lesson for road keeper:

Making difficult driving conditions more evident can prevent accidents involving inexperienced and inattentive motorcyclists

# 3

## New Roads and Road Reconstruction

The Norwegian Roads Administration's handbooks, including HB017 *Road and Street Design*, HB235 *Trunk Road Design* and HB018 *Road Construction*, provide directions on planning and construction of roads and streets. The handbooks shall ensure an adequate road design for all vehicle types, and it is most often the larger vehicles that dictate the geometric design. This will not normally create a problem for motorcyclists, but there are certain factors important to motorcyclists that are not addressed in the handbooks mentioned. Such factors are given special attention in this MC safety handbook.

The Norwegian Public Roads Administration's handbook is based on «*Vision Zero*», the vision of a road system that does not lead to loss of life or permanent injury. A road must be designed in a manner that encourages safe behaviour without accidents, and protects against fatal consequences in case an accident still occurs.

This handbook on MC safety also includes measures that are beneficial to motorcyclists but not in accordance with current standards. The purpose is to point out potential safety improvements even if some of these might require an acceptance from the Norwegian Public Roads Administration before implementation. Adhering to current standards does not always provide the best answers to traffic safety issues, and alternative measures must be sought.

### 3.1 MC Considerations in the Planning Phase

#### Conflict with other considerations

##### PROBLEM

When planning new roads or road improvements, conflicts can appear in conjunction with various considerations. Sometimes this can be at the expense of one of these considerations. Examples are found where consideration to aesthetics and landscape has been so dominant that traffic safety concerns have lost out. There are also special cases where the choice of measure is being experienced as a conflict between MC safety and that of other road users.

Here a traffic hazard is being built. When passing the end of the guardrail you arrive at a roundabout you cannot see. You are obliged to yield to traffic in the roundabout such as for example a motorist you cannot see.



## SOLUTION

### - Maintaining safety through cooperation and common understanding of risk

Solutions can often be found through mutual efforts that pay attention to all considerations where neither traffic safety considerations nor any individual road user groups lose out. To achieve a mutual understanding of risk, it can be wise to undertake a joint «imaginary» run through the planned road system from the various users' point of view. Each will then attempt to envision what can represent a risk and what can be the resulting consequences.

### - When conflicting with other considerations, risk assessments must be part of the foundation for decision

Risk is a function of probability and consequence. Assessing the risk of MC accidents, means assessing both the probability of an MC accident occurring and the consequences or extent of injuries if such accident takes place. Where there are different options available, attempts should as far as possible be made to describe what the various solutions can result in in terms of future MC accidents. This must be part of the basis for decision when safety is being assessed against other considerations and against costs. The decision maker needs to know what a chosen solution means risk-wise. Also in special circumstances where motorcyclist safety is in conflict with safety of other road users, for example when choosing wire barrier, risk assessments must be basis for the chosen solution.

### - Decisions that put other considerations ahead of traffic safety must be made at sufficiently high level

If traffic safety is threatened when considered against other factors, such as aesthetics or financial limitations, the choice of solution and choice of risk must be taken at a sufficiently high level. The decision maker must take responsibility for a conscious choice of risk of future accidents.

## Curves and roadside

Curvy roads are often popular among motorcyclists. This is most likely due to the fact that curves give the motorcyclist greater driving technique challenges and greater experiences from the effects of physical forces. Moreover, many curvy roads offer exceptional natural scenery and some of these roads have little traffic. But because driving motorcycle on curvy roads represents an additional challenge, it may also be more risky.

## PROBLEM

Motorcycles are manoeuvred according to other principles than cars (ref. chapter 2.2). Therefore, problems that can be encountered in conjunction with driving through curves will also be different.

For example, it is much less feasible to brake on curves with motorcycle than with cars. When road grip is poor as a result of wet pavement, oil spill, gravel or other foreign matter on the roadway, the wheels will lock when braking and the motorcycle overturn. Even with favourable friction, many motorcyclists will have problems handling forceful braking while turning because the cycle will be affected by forces that will contribute in straightening the cycle and counteract directional changes. It is also a fact that many motorcyclists «freeze» when discovering that the turning speed is too high in relation to their driving skills.

Because of difficulties with braking on turns, the motorcyclist has an even greater need of predictability than does the motorist. This concerns predictability regarding curvature and road grip on approaching curve and relative to the direction of the road

ahead. For example, if the curve radius gradually gets smaller or the road unexpectedly changes direction, an inexperienced driver might get into problems. He can be misled to choose too high a speed when entering a turn that will be more demanding than it appears. This type of problem can easily result in the motorcyclist coming over onto the opposing lane in a right turn, or driving off the road on a left turn.

The extent of injury when driving off the road depends on what the motorcyclist runs into. Trees, poles, boulders, rocky outcrops etc. will often lead to severe injuries. Hitting guardrail will also often result in serious injury if the motorcyclist hits posts or the rail. If the motorcyclist is thrown over the guardrail it all depends on what he can hit behind.

It is advantageous for the motorcyclist to look far ahead to achieve good balance, favourable path of travel and safe driving. Even though the motorcyclist is responsible for adjusting his speed according to conditions, such factors as vegetation or objects can reduce forward visibility, thereby hampering the potential for safe driving.

## **SOLUTION**

### **– Build the road with a predictable geometry**

A predictable curvature will normally not represent any major problem or particular risk to motorcyclists.

### **– Eliminate vegetation and whatever impairs forward visibility**

Good visibility forward allows for detection of hazards in time and planning the driving accordingly.

### **– Avoid post mounted rails on outer curve if alternatives exist**

At locations with major risk of overturning or driving off the road, alternatives to guardrail must be evaluated. Such measures may involve eliminating or rendering obstacles harmless, flatten ditches and embankments and smoothing and covering rock cuts with soil. If guardrail still has to be erected, a type should be chosen that will represent the least hazard to motorcyclists and must be located as far as possible from the edge of the roadway. Guardrail placing and usage is discussed in a separate chapter.

### **– Avoid hazardous road installations on outer curve**

Obstacles that can worsen the severity of injuries when overturning or driving off the road with motorcycle, such as sign posts, light poles, utility cabinets and bars, should not be placed where there is a major risk of driving off the road. When such installation cannot be avoided, the elements should be drawn as far as possible away from the edge of the road or as a last resort be protected by a guardrail. Exiting a roundabout is a problem that is discussed below.



RV 23 the Oslofjord Connection. Road equipment is placed where the probability of running off the road is greatest, at the exit from the roundabout.

## Intersections

### PROBLEM

The accident statistics show that there have been many moped intersection accidents in urban areas and many accidents with heavy MC at T-intersections on the open highway with a high level of speed. We also see that the severity of these types of accident is often higher for a motorcyclist than for a car occupant.

Poor visibility and discernibleness are contributing factors in such MC intersection accidents. A motorcycle or moped has a relatively small frontal area compared with other motor vehicles and will as a result, even when using low beam headlights, easily be overlooked by other travellers. Every year, motorcyclists and mopedists are killed in this country because motorists fail to yield at intersections. A study shows that in 41 out of 48 intersection accidents, the motorist was required to yield (SINTEF 2000). In such cases the motorist can have seen the motorcyclist but failed to perceive what he had seen. In some cases the motorcyclist also could have had a speed in excess of what the motorist could have anticipated.

Right turning lanes/deceleration lanes most often are parallel with and placed next to the through lane. With such design large vehicles in the turning lane can hide a motorcyclist in the through lane. A motorist on the side road does not see the motorcyclist and may enter the main road in the belief that all is well. The motorcyclist does not see the motorist entering from the side road in time and the collision is unavoidable.



Rv 35 Vikersund. A large vehicle in the turning lane can hide a motorcyclist in the through lane.

Roundabouts generally have a low accident rate, but motorcyclists can encounter special problems when the design is wanting. Roundabouts that are not easily seen or having a wide approach, do not provide adequate visual message on speed adaptation. Motorcyclists can then encounter problems when exiting the roundabout, resulting in severe injury if hitting road installations or other fixed objects even when speeds are not particularly high.



On the Oslofjord connection through Røyken and Hurum, the roundabouts are not easily detected and have a wide approach.

Inlets, catch basins or road markings may create problems for a motorcyclist when placed in the roadway where the motorcyclist must turn or brake.

#### **SOLUTION**

**- Sight zones must be free of sight reducing obstacles so that motorcyclists can see and be seen**

A motorcycle is small, and vegetation, noise barriers, guardrails and signs must not be placed in such a manner that motorcycles partly or fully «disappear» behind. It is worth noticing that the motorcyclist most often is sitting such that he can see crossing vehicles before himself being observed. This can give the motorcyclist a false sense of having been seen. The challenge is to have an intersection design that provides crossing traffic the opportunity to see the whole motorcycle in the entire sight zone.

**- T-intersections should be constructed so that those required to yield will see traffic from the side, not frontally**

To most easily being able to observe and react to a crossing motorcycle, the motorist must view it from askew and over a certain period of time. This provides opportunity to evaluate speed and distance.

**- Consider if right turn lanes/deceleration lanes can be separated from through lanes or be removed**

Right turn lanes/deceleration lanes should be considered moved to the right if that can create a better sight situation for side road traffic. With light turning volumes, consideration must be given to removal of the right turning lane.

**- Designing roundabouts to avoid excessive speeds**

It is of major importance that roundabouts are easily seen from a distance and that it is designed in a manner that does not invite high entrance speeds. Narrow approach and ample deflection will contribute in approach speeds to the roundabout being reduced. Placing of road installations, catch basins and inlets are discussed in the previous chapter.

## Guardrail

Previous guardrail standards do not cover concern of motorcyclists, but in the new guardrail standards, Handbook 231 (2003), this has been included in chapter 3.3.4 Guardrail and motorcycles. There are so far no standardized requirement where consideration to motorcyclists has been given in conjunction with testing and approval of guardrail, guardrail terminals and impact attenuation devices, but in Norway consideration is given to MC when testing and approving guardrail.

### PROBLEM

In Norway there are about 30 accidents reported annually where motorcyclists are injured in collision with guardrail. In addition there obviously are a large number of unreported accidents. Among the injured in such accidents, about 3 motorcyclists are killed annually and 11 severely injured.

Guardrails are constructed to take care of car occupants and to some extent to prevent a car from hitting other travellers. Guardrails are not especially constructed with motorcyclists in mind and they do only to a minor degree provide safety protection for motorcyclists. The same goes for breakaway guardrail terminals and impact attenuation devices. Some of the impact absorbing guardrail terminals have posts with sharp edges and are equipped with a sharp-edged plate protruding outwards to hold onto the body of the colliding car. Such impact absorbing terminal can inflict critical injury to a motorcyclist.

For both motorcyclists, motorists, pedestrians and cyclists, the guardrail can be a hazard in itself. It is dangerous to hit and it can reduce the opportunity to avoid an approaching car when needed. Assessing advantages and disadvantages of using guardrail is not always being done, but the advantage of selecting alternative measures is often underestimated or not considered at all.

With guardrails using steel rail, tube railing or wire, the rail/wire will often be mounted so high that motorcyclists when overturning will slide underneath the rail/tube/wire and hit the posts. Steel posts are relatively narrow and sometimes with sharp edges which can inflict severe injury to motorcyclists. Exposed structural details or poor execution can contribute in worsening the injuries.

Concrete barriers have a broad and smooth surface that catches the motorcyclists. When the angle is small, this takes care of the motorcyclist's safety, but when hitting at a large angle the impact may be sufficient to inflict serious injury.

Guardrail with sharp edges and inferior curb termination



Picture of sharp edged impact absorbing guardrail terminal that can inflict critical injury to a motorcyclist



## SOLUTION

### - Avoid guardrail if this can be done with alternative measures

If it is possible to remove or make safe the hazards the guardrail was intended to protect travellers against, this will often provide greater safety than erection of guardrail. Elimination of trees, boulders, rocky outcrops etc. flattening side slope, covering the transition toward rock cuts with soil and the construction of earth mounds should be considered.

Guardrail should as far as possible be avoided where the risk of motorcycles running off the road is particularly high, i.e. on outer curves. Annually, 11–12 motorcyclists are being killed in this country (40% of those killed) when leaving the roadway on an outer curve and hitting the guardrail or some other object. Alternative measures can prevent serious accidents involving driving off the road.

### - Placing the guardrail further from the edge of the roadway

Where guardrail cannot be avoided, consideration must be given to where to best place the guardrail. A motorcyclist who overturns or falls off the cycle will normally continue in the direction of travel. On a road with sweeping curvature, the motorcyclist seldom ends up far from the edge of the road. Neither do drivers who lose control at low speed on sharp curves. It is therefore important to keep in mind that injuries can be avoided if the first few meters from the edge of the roadway are kept free of fixed obstacles. Guardrail installed in the median is less of hazard to motorcyclists if placed closest to the roadway with the larger radius.

### - Selecting guardrail without sharp or protruding details

The new guardrail standards state that:

*«Post mounted guardrails, including those using steel rail, tube rail and wire, also represent a risk of injury to motorcyclists. Guardrails with stiff and sharp edged posts and/or protruding elements are significantly more hazardous than guardrails with even and rounded posts and smooth parts. Therefore, guardrail design is obliged to meet certain requirements to limit the extent of injury in the event of being hit. Guardrail posts with sharp edges shall not be used, here meaning posts with an edge radius of less than 9 mm.»*

*«At locations especially prone to off-the-road incidents involving motorcycles, a barrier with a smooth surface such as concrete barrier, will be the safest solution.»*

### - Using round posts

Using round posts is significantly better for motorcyclists than sharp edged posts. Approved guardrails with round posts both for steel rail, tube rail and wire are available in this country. With new installations, round posts should be selected. Whenever there are weighty reasons for why round posts should not be selected, it should be based on a risk assessment.

### - Cover posts with plastic plates

Both in this country and elsewhere, efforts are under way to develop more motorcycle friendly guardrails. Trials are now in progress to cover the posts with a protective plastic board composed of 4-5 welded plastic tubes. Evaluation might also be undertaken regarding the effectiveness of mounting a plate on top of the rail and posts to provide protection when falling on top of the rail. This development effort takes place in cooperation between a guardrail manufacturer, a plastic product manufacturer, the Norwegian Motorcycle Union and the Norwegian Public Roads Administration.

## Bridges

### PROBLEM

A bridge will not normally represent a traffic safety problem to motorcyclists, but there are still some situations that might contribute to increased risk.

When road bridges are constructed on sharp curves, the risk of motorcycle accidents will increase. Where the bridge is being constructed with concrete pavement, it will in most cases have a lower friction than the asphalt pavement on the approaches, and even poorer friction where a wooden deck is used. Unexpected poor friction can in certain situations be a contributing factor to accidents happening.

Curbs can be useful because they can catch skidding motorcyclists, they can reduce the extent of injury when hitting the guardrail posts or they can prevent the motorcyclist from skidding under the guardrail and off the bridge. Where the curbs end abruptly they can, however, inflict major injury to a motorcyclist who has overturned.

### SOLUTION

#### - Use asphalt pavement on bridges on curves

Where a bridge must be placed on a sharp curve, the same type of pavement should be used on the bridge as on the approaches.

#### - Use curbs

In addition it is recommended that curbs be given a height of minimum 30 cm measured from top of the pavement.

#### - Terminate curbs so that there will be no abrupt unprotected ends

Alternatively the ends can be tapered off downward or to the side.

Regarding use of guardrail and posts, see previous chapter.

## Road markings, manhole covers and cattle guards

### PROBLEM

Road markings, manholes and cattle guards tend to be more slippery than the rest of the road surface, especially when wet. For motorcyclists this can create problems when braking and turning.

### SOLUTION

#### - Select road marking material with favourable frictional properties

Sometimes there will be a conflict between frictional properties and other functional properties when selecting marking material. Normally, other functional properties will be prioritized, but with road marking in areas where motorcyclists must brake and/or turn, the frictional properties must be prioritized.

#### - Preferably avoid pedestrian crossings on curve

Pedestrian crossing on a curve is a poor solution both because motorcyclists may skid on the slippery markings and because the visibility relative to pedestrians and cyclists is poor.

#### - Avoid pavement markings closer than 10 meters from a stop or yield line

This will give the motorcyclist an adequate area for braking and turning at intersections.

#### - Place catch basins outside travelled way

This is particularly important where motorcyclists need to brake or turn. When catch basins are placed outside travelled way or alternatively on a closed off section, inconvenience will thus be avoided when later undertaking maintenance such as paving.

#### - Avoid cattle guards on or in conjunction with curves

Cattle guards are more slippery than the remaining roadway and when placed on a curve, ahead of/after a curve or in an S-curve, will always be unfavourable to motorcyclists.



Pedestrian crossing on a curve is a poor solution both because motorcyclists may skid on the slippery markings and because the visibility relative to crossing pedestrians and cyclists is poor.

## Road installations

### PROBLEM

Road installations such as light posts and sign posts shall be impact absorbing when hit by a car, but can still be fatal when hit by a motorcyclist.

Road installations are often placed where most convenient for its function. For example, is there a need for signs at the end of a difficult curve? Such installations at such location might represent a hazard to motorcyclists driving off the road.

A problem in conjunction with road installations is that motorcycles are not always detected by induction loops in front of intersections, resulting in traffic signals remaining red. The motorcyclist can finally become impatient and chose to drive on red in spite of the fact that this is illegal and hazardous.

### SOLUTION

- **Select road installations that will minimize possible injuries to motorcyclists**

Sharp and protruding details must be avoided.

- **Avoid placing road equipment at the most exposed locations**

The probability of driving off the road with MC is especially high on sharp curves and when exiting roundabouts. Road equipment placed at such locations will make motorcycle accidents more severe and, moreover, result in major needs for repairs and replacement of equipment.

- **Motorcycle and moped sensitive detectors are used at intersections with traffic actuated signal control**

## 3.2 MC Considerations in the Construction Phase

### Construction traffic on adjoining roads

#### PROBLEM

Constructing a road adjacent to a road open to traffic can in some cases contribute to an increased risk to motorcyclists:

- Dirt and clay can be dragged along in conjunction with mass being hauled across and along the road open to traffic. During periods of rain, the surface can become so slippery that motorcyclists might encounter serious problems.
- Excavation and mass replacement on existing road can create abrupt and sharp edges and crossing these might make motorcyclists lose control.
- Transition to gravel surface or lose gravel on top of the asphalt pavement might also cause motorcyclist to lose control.
- Placing tools and equipment on the road might represent a collision hazard for motorcyclists, especially on roads not illuminated.

#### SOLUTION

- Include mc safety considerations in the safety routines
- Undertake a safety assessment and evaluate the need for additional mc safety measures



Signing specifically for motorcyclists can be appropriate, in some cases with a supplementary sign displaying the motorcycle symbol (see picture).

### When the road opens to traffic in the construction phase

#### PROBLEM

An unfinished road can have significant deficiencies. Some factors can create particular problems to motorcyclists and the result of an accident will most likely be more severe for a motorcyclist than for a well protected car occupant:

- Longitudinal edges or unexpected changes in surface conditions can create problems for motorcyclists, in particular for inexperienced drivers who might get scared and lose control.
- Gravel or dirt on the pavement can cause motorcyclists to lose control.
- Deficient signing, road markings, illumination and retro reflection increase the risk of accidents.
- Temporarily placed material or machines at the edge of the road can represent a significant risk of being hit by motorcyclists, especially when the road is not illuminated.

#### SOLUTION

- Undertake a risk assessment where mc is studied especially before an unfinished road is opened to traffic

## 3.3 TS Audit of Plans and Completed Construction

When auditing construction plans and auditing constructed road before being opened, there can be a particular need to assess motorcyclist safety. Auditor must ensure that details regarding location and design will not create significant problems to motorcyclists.

With such work the following checklist can be used:

### **Motorcyclist safety checklist when auditing road plans and completed road construction**

- Is the geometry predictable?
- Are T-intersections designed such that yielding vehicles can see approaching vehicle from the side and not the front?
- Are roundabouts designed to provide adequate signals regarding correct speed adaptation?
- Are sight zones free of sight reducing obstacles where motorcyclists need to be seen?
- Are signs located such that they do not restrict motorcyclists from seeing or being seen?
- Are safety zones prepared and made «forgiving» with motorcyclists in mind?
- Have alternatives to guardrail been considered where there is a particular risk of motorcyclists driving off the road?
- Where guardrail cannot be avoided, is it placed as far away from the edge of the pavement as possible?
- Has the terrain behind the guardrail been assessed with regard to motorcyclists being thrown over the guardrail?
- Has placing of road equipment been avoided where the risk of being hit is particularly great?
- Are types of guardrail and road equipment selected that will not inflict unnecessary severe injuries to motorcyclists?
- Have round guardrail posts been selected?
- Are catch basins, pedestrian crossings, directional arrows and other road markings placed in a manner that will not create poor friction for motorcyclists at critical locations?
- Do bridges on sharp curves have asphalt pavement?
- Do bridges have curbs to stop motorcyclists from hitting guardrail posts or fall off the bridge?
- Is termination of curbs and bridge railings designed not to represent an unnecessary risk to motorists?
- Is the transition between new road and existing road free of unexpected and abrupt changes in standard such as jump in pavement standards?
- Is regard to motorcyclists included in the project safety routines?

# 4

## Existing Roads

### 4.1 MC Considerations with Operation and Maintenance of Roads

When undertaking operations and maintenance measures, the absence of consideration or knowledge about MC can lead to:

- traffic hazards being created for motorcyclists
- the avoidance of implementing efficient safety improvements for motorcyclists

With an increased understanding on how road conditions affect motorcyclists' risk of accidents, personnel responsible for operations and maintenance can contribute to avoid serious person injury accidents.

Handbook 111, *Standards for Operations and Maintenance*, states minimum requirements. In some cases the handbook on MC safety measures suggests solutions that go beyond Handbook 111. This implies an invitation to make an extra effort where significant safety benefits to motorcyclists can be gained.

#### Roadway cleaning

##### **PROBLEM**

Due to their operational characteristics, motorcycles are sensitive to dirt on the roadway, especially on turns. A number of serious motorcycle accidents could have been avoided each year with better cleaning or warning signs installed to inform about the problem.



On Rv 40 near Geilo a motorcyclist was killed one spring day when he overturned on a curve and hit the guardrail. He lost control because he discovered too late that rain had carried sand from winter maintenance operations from the shoulder onto the road itself. The Public Roads Administration this spring had skipped sweeping to reduce maintenance costs.

On curves, gravel can remain that has fallen off a truck or has been thrown in from a gravel shoulder. In early spring, it is in particular important to pay attention to the quantities of sand at the edge of the road left from sanding during winter. Surface water can also carry sand onto the roadway from the edge of the road and from side roads and access drives.

Diesel fuel spilled from heavy vehicles can also make the roadway slippery. The problem is greatest on curves and at intersections near gas stations where fuel is spilled from full tanks.

So much soil and mud can be dragged onto the roadway from maintenance on or along the road, such as with ditch cleaning, that it will create a problem for motorcyclists. The same can happen with traffic by construction and agricultural machinery.

Inadequate cleaning and deficient signing can result in an increased accident risk for motorcyclists.

## **SOLUTION**

### **- Ensure that traffic improvement plans are prepared and are being followed**

Before roadwork commences, plans must be prepared that include consideration to all road users, also motorcyclists. Factors that might lead to motorcyclists losing control must be avoided or made sufficiently noticeable to avoid hazardous situations from occurring.

### **- Keep roadway clean**

Agreements and routines must be established to ensure the implementation of early spring sweeping, especially on the more popular motorcycle roads. Mapping of locations in special need of early sweeping must be undertaken.

The Public Roads Administration must develop a more firm policy related to fouling up the roadway. Anyone involved in activities that now and then are dirtying the roadway, must be informed about their responsibilities. Still, road keeper must always ensure that dirt on the roadway is removed without waiting for the doer to clean up by himself. Settlement with the one or those responsible must come later.

### **- Pave at least one meter into side roads/access drives**

This will in most cases contribute to a reduction in gravel/sand dragged onto the roadway.

### **- Select correct material when adjusting shoulders after paving**

When road shoulders are adjusted, regular use of crushed asphalt will represent a smaller risk of material being dragged onto the roadway than using crushed gravel. If other types of material than crushed asphalt are selected, these should be well graded and stable (for example 0-20 mm).

### **- Lead running water away from the road**

At some locations it will pay to undertake measures that will reduce or eliminate what causes the need for sweeping. If running water can be prevented from dragging gravel or dirt onto the roadway, this will as a rule reduce both the accident risk and future maintenance expenses.

## Friction

### PROBLEM

Motorcycles are to a much larger extent than 4-wheeled vehicles dependent on good, even and not at least predictable friction. Even at moderate speeds, a motorcyclist can lose control over the cycle when the friction (road grip) suddenly becomes poorer on a curve or at an intersection. Problems with poor friction can occur due to paving, water on the pavement, oil spill, gravel on the roadway, sand dressing of recently laid asphalt or oil spill for example in conjunction with a traffic accident. Poor friction can also occur without any preceding special activity at the location, especially on curves or on grades with frequent deceleration/acceleration. Since the problem is little visible to road users, it is important that warning is being given immediately after the hazard has become known.



The Public Roads Administration was by the Supreme Court convicted of negligence due to inadequate signing where a motorcyclist was killed on E16 near Sollihøgda.

### SOLUTION

#### - Use asphalt with good frictional properties

Especially when paving curvy road sections, it must be emphasized that the pavement shall have good frictional properties both when newly laid and after having been worn. Friction studies show that material with particle size up to 11 mm over time has better frictional properties than material with greater particle size.

#### - Avoid terminating paving on curve or at intersection

When paving is terminated on curve or at intersection, altered friction or pavement joints can create problems for motorcyclists. With foresight this should easily be avoided.

#### - Mill or repave curves with poor friction

With structural or horizontal pavement milling, a significant frictional improvement can be achieved, especially with wet pavement. This will reduce the probability of MC accidents, also those involving other vehicles. Milling, however, must not be with such coarse pattern that inexperienced motorcyclists will become insecure and lose control. On roads with heavy traffic, frictional improvements from milling will rapidly decline.

#### - Act quickly and correctly with friction problems

Road keeper must at all times be prepared for parts of the road network having frictional conditions that will be hazardous to motorcyclists. When an acute frictional problem is identified, for example in conjunction with diesel fuel spills or paving, quick action is called for. It can be necessary to direct traffic or stop the motorcyclists manually. Signs must be put up and good and lasting improvement measures must be implemented as quickly as possible. It is important to notice that all forms of sanding of cold asphalt pavement will have a negative effect on motorcyclists and should therefore be avoided.

## Patching asphalt pavements

The term patching of asphalt pavement refers here to patching of individual or a collection of holes or cracks in the asphalt pavement.

### PROBLEM

Pavement damage can greatly influence a motorcycle's handling and situations can easily occur that the driver is incapable of handling. The problems will be greatest when the damages are in conjunction with a curve and the problems are possibly extra large in spring when the motorcyclists are out of practice. Poor or wrongly performed patching results also in many cases to just as great an accident risk as the lack of patching.



Picture from Fv 3

### SOLUTION

#### - Pavement damage must be repaired quickly using correct method

No other patching methods and materials should be used than those giving a lasting and safe result. When properly done, the patching material is level with the adjoining pavement and the frictional conditions very similar. When patching/filling cracks with bitumen, it is essential that the material is sand dressed in a manner ensuring that it will not give poorer friction than on adjoining pavement. Loose material from the operation shall not remain at the site when opened to traffic.

## Asphalt

### PROBLEM

When temporary signing and work implementation is done in accordance with regulations, the asphalt paving will not create any problems for passing motorcyclists. But where this is not given adequate attention, traffic hazards can be produced in the process in the form of pavement edges or bitumen soiling.

### SOLUTION

#### - The road keeper establishes safety requirements for the asphalt contractor

Requirements on contractor conduct must be established at the site. When paving is being planned, the need for additional measures to safeguard motorcyclists must also be considered. Such requirements can include instructions not to spray emulsion over distances beyond what can be covered in the course of the shift. Another consideration that can warrant additional preparedness is the fact that some types of asphalt will more easily produce «blank spots» than others.

Paving undertaken each day shall be done in such a way that longitudinal edges are avoided.

## Road markings

What is written on road markings in chapter 3 will also apply to road marking on existing road. In addition it is important that road keeper, when planning marking repairs, does not describe measures that together with existing lines will give a line thickness in excess of 4 mm.

## Guardrail improvement

Guardrails are discussed in more detail in chapter 3.1.

### PROBLEM

Guardrails often have a negative effect on motorcyclists' safety. Annually, about 10-12 motorcyclists are severely injured in collision with guardrail.

One problem is that motorcyclists overturn, skid along the pavement and hit guardrail posts and/or the rail. Sharp edged posts will inflict more severe injury than round posts and it is fortunate that we in this country have largely been sticking to round wooden posts. The accident statistics would probably have been even uglier if sharp edged posts had been more common.

Another problem is that motorcyclists drive into the guardrail and hit the rail or wires. They can be seriously injured both in the collision with the guardrail, by first being wedged between the railing and the pavement or being thrown over the guardrail and hitting obstacles behind.

### SOLUTION

#### - Eliminate the guardrail and replace it with other measures

The need for guardrail must be assessed as an alternative to flattening side slopes or eliminating or making fixed obstacles less hazardous.

#### - Replace post mounted guardrails with concrete barriers

Concrete barriers as a rule provide much better safety for motorcyclists than post mounted guardrails and where there also is a need for noise abatement, concrete barriers will provide an extra benefit.

#### - Fit sharp edged posts with plastic tube

A plastic tube can be tread down onto the posts after the rail has been disconnected. Such tube will in 2004 cost about NOK 20,- per post, and for motorcyclists this will represent a significant safety improvement.

#### - Install a lower rail when such solution is approved

An even greater safety improvement can be realized if a secondary rail is installed in front of the posts between the roadway and the ordinary rail (or tube). Work is ongoing to find good solutions for this. Preliminary simulation testing indicates that a wide secondary plastic rail can effectively prevent motorcyclists from hitting the posts or slide underneath the rail without having negative effects for cars. When this becomes an approved measure, it is recommended used at locations where the risk of overturning and subsequent collision between motorcyclist and guardrail posts is large.



#### - Making the top of the guardrail less dangerous

At some locations sharp slanting cut rail posts extend up over the rail. A motorcyclist falling on top of the rail will then easily be thorn apart by the post ends. It is entirely unnecessary that the posts extend more than 1 cm above the rail. Posts that are too high must be cut.

An effort must also be made to find a solution involving the installation of a minor top rail to prevent motorcyclists and cyclists falling on top of the guardrail from being cut up by the upper edge of the rail. In one fatal accident a motorcyclist hit the guardrail and punctured a lung.

## Signing

The purpose of signing is mainly to give travellers information needed to arrive safely at their destination. The consequences of not getting the information can sometimes be very serious.

### PROBLEM

There is a general problem that signs are not perceived by travellers. This can be caused by:

- there are more signs at a location than the traveller is capable of perceiving
- the signs are considered to be of no interest to the traveller
- the signs are old with poor discernibleness
- the signs are placed so that they are hardly visible

It is also a problem where signing is lacking, that for example a motorcyclist does not receive the information needed to adapt his speed as approaching a critical point.

At some locations it is also a problem that signs hamper visibility and take attention away from traffic.

### SOLUTION

#### - Evaluate if mc safety considerations warrant additional signing

In some cases conditions can be so difficult for motorcyclists that it is necessary to sign even where motorists are not in need of signs. Then it is required that the person in charge of signing also shows regard for motorcyclists.

#### - Utilize separate supplementary signs for mc

Where conditions are particularly difficult for motorcyclists, ordinary signs can be supplemented with special auxiliary signs with motorcycle symbols. This has been tested in Buskerud and the response from motorcyclists has been favourable. Such signing is probably more easily perceived by the motorcyclists. Such use of auxiliary signs presumes approval by the Public Roads Administration in each individual case.

Other general signing measures such as cleaning of signs, replacement of old signs, clearing sight obstructions near signs, removing superfluous signs etc. will also contribute in improving motorcyclist safety.



Supplementary sign for MC on Rv 7 Ramsrud

## Tunnel illumination

### PROBLEM

It is a problem for all travellers that many tunnels are badly illuminated in the entrance zone or lack lighting altogether. For motorcyclists this is particularly serious. Those who are not entirely conscious about the problem and do not reduce their speed significantly, can experience that they are driving in complete darkness. The time required for the eyes to adapt to the dark might be long enough for something serious happening. A motorcyclist was killed when entering the Vågslid tunnel on E134 in Telemark. In the darkness of the entrance zone he ran into the rear of a truck in his own lane.

A motorcyclist often experience reduced visibility when wearing glasses, visor or windshield. Manoeuvring capabilities will be reduced when references from the surroundings disappear and incorrect steering and braking can result in overturning or driving mistakes. The consequences of colliding with a car or hitting a fixed obstacle or the tunnel wall are much more severe for a motorcyclist than for a person sitting protected in a car.

### SOLUTION

#### - Ensure adequate illumination in the entrance zone

Illumination in the entrance zone should be controlled by photocells outside the tunnel so that the tunnel lighting can be adjusted to the eye's ability to adapt.

#### - Supplement with guide-light

LED (Light Emitting Diodes) can be utilized in tunnels as supplement to ordinary lighting. The guide-light provides helpful assistance in keeping correct distance from the edge of the road and to follow the curvature of the road. It also improves driving conditions and traffic safety when the ordinary lighting fails or has inadequate intensity. LED lighting requires modest operating costs, very low power consumption and favourable operational reliability. It is relatively new as a source of road lighting, but it has already been used in some tunnels such as on E6 north of Trondheim and on E18 near Porsgrunn.

## Dew in tunnels

Sometimes temperature and humidity conditions in some tunnels will create dew covering windshields, visors and glasses immediately as the tunnel is entered. This can have fatal outcomes for motorcyclists. In August 2003 a foreign motorcyclist hit a passing truck in the Strømsås tunnel, Drammen, after his visor dewed up.

### SOLUTION

#### - Place warning signs about the dew problem

The sign must explain the problem with text and symbols in a manner understood by foreign travellers.

#### - Improve the technical installations in the tunnel

Depending on conditions, it can be relevant to improve ventilation and illumination or install LED lights in the tunnel.



Picture of the warning signs E 134 Strømsås tunnel

## 4.2 Existing Road Work Area Traffic Safety

### PROBLEM

Driving conditions for motorcyclists can significantly deteriorate when approaching sections where roadwork is ongoing. This can involve such factors as pavement conditions, road width, curvature, illumination, high pavement edges etc. There can also be construction machines and equipment on or near the roadway. The risk can be much greater for a motorcyclist than for a motorist.

### SOLUTION

- **Include mc safety consideration in the safety routines**

With a little concern and attention to MC, accidents can be avoided.

- **Assess the need for additional safety measures for mc**

To safeguard motorcyclists, loose gravel, washboard, abrupt changes in pavement height, large potholes etc. should be avoided, particularly in combination with a sudden turn. Where conditions are difficult for motorcyclists, signing should be implemented even though motorists are not in need of signing.

- **Utilize auxiliary signs for mc**

Where conditions are especially difficult for motorcyclists, the ordinary sign can be supplemented with a special auxiliary sign with motorcycle symbol. Until further such signing must be approved by the Public Roads Administration in each individual case.



Picture of sections where roadwork is ongoing

## 4.3 Traffic Safety Audit of Existing Road

By showing consideration for MC during traffic safety auditing of existing road, this can contribute in fewer MC accidents in future years.

### Checklist

- Are pavement conditions adequate so that motorcyclists will not encounter surprise problems with changes in friction, cracks, rough spots, potholes, surface water, gravel, dirt, oil spills etc.?
- Are guardrails designed and placed so that they do not represent an unnecessarily large accident risk to motorcyclists?
- Can guardrail be replaced by alternative solutions that give better safety for motorcyclists?
- Are side slopes properly designed to prevent motorcyclists from suffering injuries when driving off the road at locations where the probability of such accidents is large?
- Are signs and other road equipment placed such that they do not represent an additional hazard to motorcyclists?
- Are signs important to motorcyclists visible enough?
- Is there a need for supplementary signing, possibly including auxiliary warning signs for motorcyclists?
- Is the illumination adequate in tunnels and at locations where road conditions change, or should illumination be improved or supplemented with for example guide-lights or retro-reflective devices?
- Is there a need for measures against wild game accidents, for example by clearing of forest, wild game fences or road lighting?
- Is there a need for sight clearance on inner curves so that motorcyclists and other travellers can obtain a better view of the road and the traffic in front?

# 5

## Reporting Road Hazards

Road hazards can be reported to the Public Roads Administration in various ways depending on how serious it is and how urgent the need is to mitigate existing conditions.

Address and telephone lists to the Norwegian Public Roads Administration's district road offices, road traffic centres and regional traffic safety coordinators are found at the rear of this handbook.

### 5.1 Telephone no.175

Telephone no.175 is the Norwegian Public Roads Administration's joint report telephone for the entire country that travellers can call at any time, including the reporting of road hazards. By calling this number, one will be connected with the Road Traffic Centre (VTS) in the region calling from. There the message is received and logged and conveyed to the one or those in charge of implementing measures at the location in question.

This manner of reporting road hazards is the safest. If contact is not achieved when dialling telephone no.175 and there is an urgent need for the immediate reporting of a serious condition, the police may be called. They have a prioritized direct line to the Road Traffic Centre.

### 5.2 Road Hazard Reporting Forms

The NMCU joint reporting form can be used to report conditions that are not sufficiently serious to warrant immediate action. The form is filled out and sent to the Public Roads Administration in the region in question.



# Statens vegvesen

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