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QUALITY REQUIREMENTS FOR ROAD BARRIER RAILS, AND SELECTION OF BARRIER RAIL TYPES

Content and purpose of the guide

This guide replaces the guide **"Information for motorway planning", no. 61B.**

This publication contains a) general criteria for selecting road barriers; b) guidance for orderers to use when stipulating project-specific requirements; and c) general quality requirements for road barriers.

This publication may also be used as a quality requirement for jobs involving design. However, each project must outline the barrier types that are suitable for the purpose and for different sections of road, as well as the need to dimension the barrier for heavy vehicles.

The guide does not relate to barriers placed at the edges of bridges.

In 2011, after notification, this publication will combine with the Finnish Transport Agency guide, which discusses barrier length, among other things. It is only then that the CE mark and the new measurements W_n, and D_n for working width will be introduced as requirements. Other requirements will be introduced for jobs starting after 1 November 2010, but they should also be applied to ongoing jobs wherever possible.

The most important amended sections appear in red. The amendments take into account the parts of standard SFS-EN 1317 that will enter into force in 2010 and 2011.

Other guidelines

The barrier types available in the Finnish market are presented in the latest issues of volume 62 of "Information for motorway planning" (A, B, etc.).

The need for and length of barriers are set out in the guidelines entitled **"Motorway planning V 2, Barriers and prevention of accidents involving swerving"** (2002).

The Public Procurement Act and the Decrees issued on the basis thereof require the EN standard to be used as a quality requirement where it exists. Standard SFS-EN 1317-2 and 5 applies to barriers. Public procurement projects must therefore normally use barriers that have been demonstrated in crash tests to be safe in accordance with that standard.

CE mark

Barriers bearing the CE mark and complying with standard SFS-EN 1317-5 are used on roads if they satisfy the requirements set out in this guide.

Exceptions:
1. The CE mark on barrier types introduced before 2009 may be replaced by 2013 with the approval of a Member State of the European Economic Area or of Turkey, based on standard SFS-EN 1317-2 or its draft version.

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2. When the speed limit on the road is 50 km/h or less, and the usual speed on the road is no more than 40 km/h, and there are no major entry roads there, the barrier need not have been crash-tested. However, barriers may not have a spiked top, or any means of preventing a car from continuing its journey by causing it to become stuck, or any joints or seams that break easily.

3. The Finnish Transport Agency may issue a temporary or object-specific licence for a new barrier type or a change to a barrier type before the CE mark is obtained. This is necessary, for example, when there is no suitable barrier on the market for the specific conditions in question.

4. Portable barriers intended for use on construction sites, for which the CE mark is not mandatory, may also be used. Barriers of classes T1-T3 under standard SFS-EN 1317-2 may not obtain a CE mark.

5. An old barrier may continue to be used and be replaced by a barrier of the same type, even if the barrier type does not bear a CE mark, if the barrier type has not proven dangerous in practice.

6. The requirement for a CE mark will enter into force in 2011, when this guide has undergone the notification procedure.

In addition to the information given in the CE mark, the barrier manufacturer must also supply the following:

- installation guidelines for the barrier fitter to erect and replace the barrier;
- a guide or recommendation for the barrier selector, explaining where the barrier may be used (soil, slopes, minimum length, permitted curve radii, anchorage of buffers, etc.);
- where requested, information about the barrier length in crash tests, anchorage of buffers, lateral movement D_n and the results of the TB11 test.

General installation guidelines can also be found in **InfraRYL2006, section 32100,** and in the **type diagrams.**

Temporary and portable structures

Bevelling at the start and end

Both ends of steel barriers must be anchored in a manner that withstands tension. Otherwise the barrier will come loose, the working width will increase and the risk of driving through the barrier will increase significantly. Bevelling is therefore required, even at the end of the barrier, and even on one-way routes.

Selecting the preliminary method

On motorways and other roads where the traffic volume exceeds 6,000 vehicles/day and the usual speed is at least 100 km/h, steel barriers always have a buffer facing towards oncoming traffic if the barrier is turned towards an external slope or central area or if it is a compression barrier. Gaps of less than 30 m may not be left between barrier sections unnecessarily.

On other roads, bevelling may be used on steel barriers with a length of at least 15 times the barrier height. The bevelling length is 12 m on a Ty 3/51 barrier. However, it is particularly recommended for a compression barrier or side-facing barrier to have a buffer when the distance from the front of the barrier rail to the front of the whole barrier is less than 1.2 m and a car could crash into the barrier and the central sections of the barrier rail if it goes over the guard rail. Bevelling of 8 m is adequate on private roads.

Sinking bevelling is used on cable barriers, since cars will not become stuck underneath it. A bevelled barrier buffer may be made for a concrete barrier when speeds of 60 km/h are not usually exceeded on the road. The length of the bevelling is at least 6 times the height of the barrier.

Side-facing barriers

The buffer for barriers that face a ditch at the side of the road or a central area is presented in type diagram Ty 3/53 (2002). It may also be used for other types of barrier. The solidity of the first column is important for a side-facing barrier. Gravel is used around the first and last columns to compensate for clay, silt and sand. The gradient may be no more than 1:6.

Compression barrier buffer

A compression barrier buffer should satisfy the quality requirements of ENV 1317-4 or NCHRP 350 at a speed of 100 km/h. Furthermore, the speed of a car crashing into the centre of the buffer at a crash angle of 0 should be less than 50 km/h at a distance of 30 m from the barrier. When SFS-EN 1317-7 enters into force, the requirement will be for the barrier to have a high-energy absorbing buffer after the transitional period. It is recommended to use barrier buffers whereby the braking force at the buffer is transmitted sideways in a crashing car and also into the body of the vehicle below the side doors, because otherwise the buffer might push the side door deep inside the car.

In most cases, a compression barrier buffer will have a fist-like part which enables it to continue working when a car crashes into it. The fist mangles or tears the guard rail or other components into strips, thus expending the energy from the movement of the car. The barrier buffer is usually approximately 12 m in length, and it corresponds to the same length of a full-height steel barrier. The manufacturer’s installation guidelines may require an extension consisting of a long section of a given barrier type before attaching it to another barrier. Compression barrier buffers are available for steel girder barriers, tubular girder barriers and some double-tube barriers.

There may not normally be a compression buffer at a distance of less than 1.5 m from another one (e.g. at the start of central or intermediary areas), but a crash deadener, or a compression buffer for a double barrier must be used, or two bevels in the case of old barriers, between which there is a high energy absorbing (HE) crash-safe lighting column.

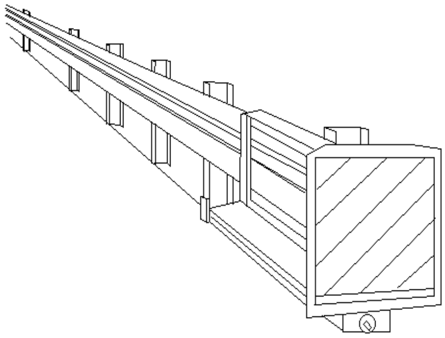


Image 1. Compression barrier buffer.

Crash deadener

Crash deadeners are required on motorways and in front of bridge heads, portals or similar barriers, where there is not a long enough barrier leading up to it. The most common case is where the barrier is situated after the separation point, and a barrier of the length presented in type diagram Ty 3/58 cannot be used. Crash deadeners on motorways should satisfy the requirements of SFS-EN 1317-3 at a speed of 100 km/h. On roads where the speed is lower, and behind a shorter, normal barrier, a crash deadener for a speed of 80 km/h may also be used as an additional form of protection.

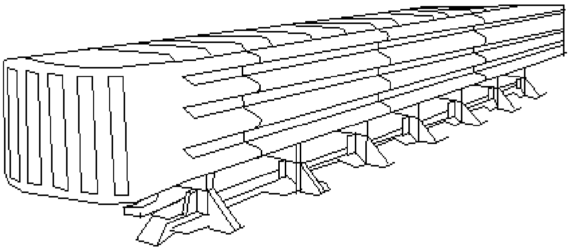


Image 2. Crash deadener

Portable structures

Switching from one type of barrier to another is done so that a car cannot crash hard into a more rigid barrier when it comes off a more flexible one, and so that the guard rail does not pierce the vehicle in the welding seams, and so that the buffers are adequately anchored to the guard rails. This is usually done as follows:

a) When the barrier is attached to a barrier on a bridge or to another more rigid barrier, the interval between columns is 2 m, at a distance of at least 16 m before the more rigid barrier and at a distance of 16 m after the more rigid barrier on two-way traffic routes. The type diagrams for bridge barriers show how a guard rail is attached to a guard rail for a bridge barrier;

b) The barrier is attached to a concrete barrier in accordance with type diagram Ty 3/86. The concrete barrier buffer is turned to the side at the start, and also at the end on two-way traffic routes, at a distance of 1 m behind the steel barrier. A steel guard rail is started at the end, and also at the start on two-way traffic routes, so that the end of the guard rail is not visible to oncoming traffic. In other words, it starts where the bevelling of the concrete barrier ends, where there is a hollow in the concrete barrier, or at the end of the concrete barrier on one-way traffic routes. The guard rail is attached to the bevelling on the concrete barrier at a distance of approximately 1 m from the bevelling crease using two M 16 8.8 screws in 18 mm holes and using a chemical anchoring agent;

c) When the barrier is attached to a supporting wall, the same principles apply as for attaching the barrier to a concrete barrier. The bevelling on the concrete barrier is required;

d) The barrier is attached to a steel noise barrier in accordance with the principle set out in diagram Ty 3/73. The noise barrier buffer is turned to the side at the start, and also at the end on two-way traffic routes, at a distance of 1 m behind the steel barrier. The steel guard rail is started and attached as described in point b).

In all cases, the interval between columns is 2 m, at a distance of at least 16 m before a rigid barrier and at a distance of at least 16 m after a rigid barrier on two-way traffic routes.

When developing new portable structures, prEN 1317-4 should be taken into account.

Barrier types

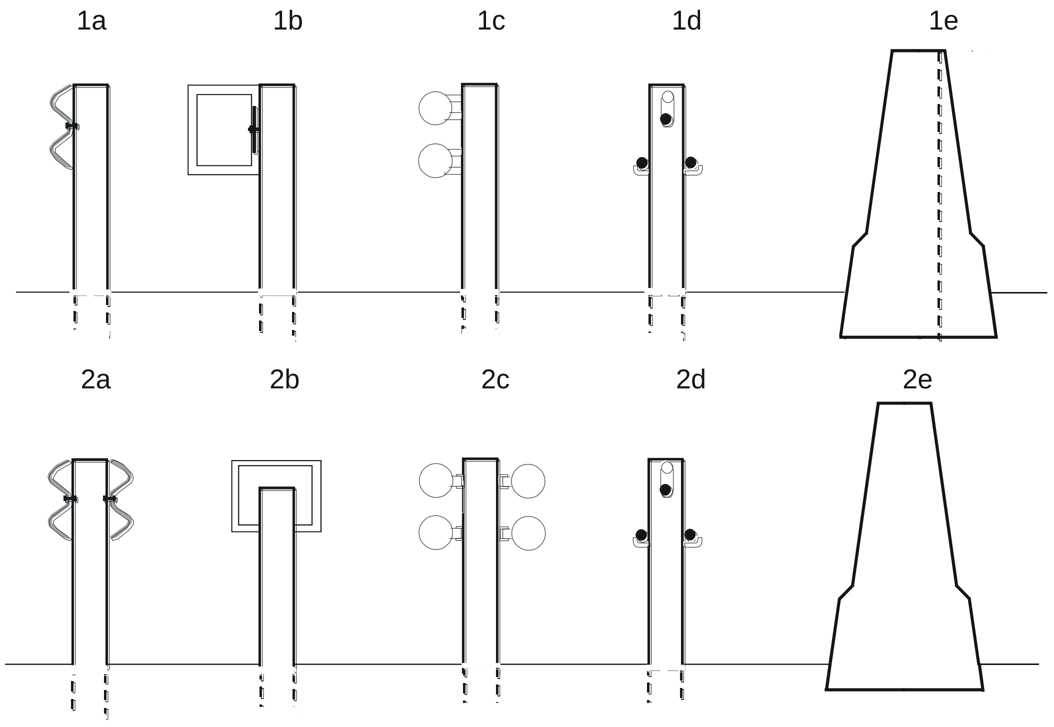


Image 3. Background information on the barrier types.

At the edge of the road or a broad central reservation:

1a *Steel girder barrier. Several types in class N2, including Finnish Ty 3/51, which has a W-230/4 guard rail and, among other things, Swedish type EU, which has a W-300/3 guard rail.*
1b *Tubular girder barrier. Several types in classes H1 and N2.*
1c *Double-tube barrier. Several types in class N2.*
1d *Cable barrier. Several types in class N2. Some versions of the cable barrier have been tested and approved for 1:3 gradients, where the distance from the side of the road is no more than 1 m. The cable barrier does not form snowdrifts.*
1e *Concrete barrier. The concrete barrier is embedded in the ground or installed on the surface.*

On the road

2a *Double-sided steel girder barrier. Several types in class N2. Finnish Ty 3/51, which has two W-230/4 guard rails which are attached alternately to each of the columns. In Germany, barriers of classes H1 or H2 are used. These have two W-300/3 guard rails attached to a transversal extension.*
2b *Tubular girder barrier. Several types in classes H1 and N2.*
2c *Double-tube barrier.*
2d *Cable barrier. Several types in classes N2 and H1.*
2e *Concrete barrier. The concrete barrier is embedded in the surface or installed on top of the surface.*

Selection of on-the-road barrier type

The guidelines relating to the selection of barriers for the side of the road also relate, where applicable, to barriers situated on the road.

Broad central reservation

- There are usually two barriers that work independently and which prevent vehicles from falling onto the other side of the road. Lighting columns and bridge pillars may be situated between them.
- If there are no lighting columns or bridge pillars situated in or earmarked for that space, one double-sided barrier may be placed in the central reservation, ideally on the side of the traffic route that faces towards the inside of the curve. The barrier should also be selected and positioned so that it can remain in place if the road is subsequently lit. The location of bridge barriers should also be taken into account. Snaking is to be avoided.
- The crash resistance class must be N2. When there is 4-6 m between the two traffic routes and the mean daily traffic volume exceeds 36,000 vehicles/day and the speed is at least 100 km/h, H2 may be required in some individual cases.
- If there are two barriers in the central reservation with a space between them that is to be mown, a passage should be arranged for the mower.
- If a barrier is located in the central reservation, the gradient will place restrictions on the barrier types that may be selected. Permitted gradients are set out in the section entitled “Selection of barrier type for the roadside”.
- Concrete barriers are not used in broad central reservations, since the angle of the fall may become too great if the distance from the side of the road exceeds 3 m, or 4 m on the inside of a curve.
- If the traffic routes are staggered, the barrier should be at the side of the uppermost traffic route.
- Furthermore, all requirements relating to roadside barriers shall be complied with (selection of crash resistance class for the barrier, and before a bridge, working width, external appearance, resistance to snow-ploughing, etc.).

Road with a central barrier or narrow central reservation (no more than 4 m between the traffic routes)

- A tubular girder barrier is usually used, since the ends of the columns will be hidden, and this is good from the perspective of external appearance and motorcyclists. A tubular girder barrier requires a smaller flexibility margin than most other types of barrier, and it does not need to be repaired after every crash. Traffic signs may be fitted to tubular girder barriers.
- A symmetrical type of tubular girder barrier is to be selected with a crash resistance class of at least H1. The working width for class H1 may be no more than 1.7 m if the distance from the front of the barrier to the lane behind it is no more than 1 m. In order to reduce the need for maintenance, the working width of a TB11 may be no more than 0.6 m, and the snow-ploughing resistance class should be at least 4.
- Compressive buffers shall be used at the ends of barriers that are used on motorways and other fast roads (mean daily traffic volume > 6,000, 100 km/h).
- An opening for emergency vehicles shall be made in the tubular girder barrier at intervals of 2-3 kilometres, in accordance with the separate guidelines.
- The columns for tubular girder barriers may also be installed in a sleeve, from which the column may be removed and replaced easily. Installation in a sleeve is required on 1+1 roads and at a distance of 40 m in places where the passing lane turns into a two-way passing lane on a 1+2 road. Elsewhere, the columns shall be installed in a pilot hole or sleeve filled with gravel.
- In places permitted separately by the road authority (mainly in areas on the western coast where there is little snow), cable barriers may also be selected on a case-by-case basis, if they are of crash resistance class H1 or N2. On the basis of experience from Sweden, the cables do not pose any significant danger to motorcyclists. Cable barriers have to be repaired almost every time they are hit, although it is relatively easy to repair them. The columns for cable barriers are to be installed in sleeves, from which the column can be removed when the barrier needs to be repaired or temporarily removed.
- A double-sided steel girder barrier may be used when the central reservation narrows over a short (200 m) distance, and two separate steel girder barriers are joined together. A steel

girder barrier is poorer than a tubular girder barrier in terms of its external appearance, its need for repairs and performance for motorcyclists.

- If lighting is intended in the middle of the road where there is a narrow central reservation, or where there are bridge pillars on a narrow central reservation, a concrete barrier is to be used. Otherwise, a concrete barrier is not usually approved, since they cause snowdrifts to pile up outside densely built-up areas. A concrete barrier embedded in the surface is more durable than if it is installed on the surface, and does not need to be moved again when resurfacing work is done.
- Barriers of class N2 made of portable concrete components installed on the surface may also be used on roads leading into densely built-up areas. If the mean daily traffic volume exceeds 36,000 vehicles/day and the speed is at least 100 km/h, the crash resistance class must be at least H2.

Selection of barrier type for the roadside or a broad central reservation

For large spaces at the side of the road, the steel girder or double-tube girder of class N2 that is cheapest in terms of its total cost is to be used, unless otherwise specified in the reasons below. (In previous investigations, the barrier in type diagram Ty 3/51 of the Finnish Road Administration has proven to be cheaper, but the contractor should be permitted to select another barrier.)

In small places where a barrier is required, the barrier type traditionally used at that place is generally used, owing to the need for spare parts and expertise in terms of repair work, unless this conflicts with the requirements set out below.

Factors relating to the selection of a crash resistance class and barrier type, and to the need for a flexibility margin:

When the barrier is designed solely to prevent falling from the embankment, the working width of the barrier is not usually taken into account. On steep gradients (> 1:2) on high embankments of at least 2 m, a plateau of at least 0.5 m shall be made behind the front of the barrier. When constructing a barrier on an existing road, 0.3 m is sufficient if it completely eliminates widening of the road and the barrier columns are erected using a method verified in accordance with InfraRYL.

Rigid barriers or protected objects behind barrier rails. When the traffic volume exceeds 3,000 vehicles/day, the speed is at least 80 km/h and a barrier crash resistance class of N2 is required, a flexibility margin is required between the front of the barrier and the front of the protected object. Such a margin shall be at least as large as the working width $N2W_n$. This must be used whenever it can be achieved by shortening the gap between the columns for the barrier type in question.

If it is not possible to reduce the working width $N2W_n$ adequately by shortening the gap between columns, the road authority may approve the value of $TB11W_n$ as being adequate in places where the crash angle or probability of a crash is greater than normal. This must, however, lead to a saving for the road authority (EUR 2,000 reduction in project value, from all bridge pillars, portals and other rigid barriers, or 5 lighting columns).

By way of exception to the above, when the speed level or traffic volume falls below the above-mentioned limits, the working width $TB11W_n$, will be suffice as a flexibility margin when the crash probability or angle is not greater than normal.

When using more rigid barrier types, owing to the small flexibility margin and in order to give the barrier a more flexible barrier rail as an extension, a more rigid barrier type that can be attached to it should be compatible with the joint. These are barrier combinations approved in accordance with ENV 1317-4 or prEN 1317-4 or otherwise approved by the Finnish Transport Agency. Failing this, the following types may be approved, for example:

a) a barrier type that can be stiffened adequately by shortening the gap between the columns;
b) an H2 class concrete barrier with a portable structure in accordance with Ty 3/86;
c) a TIEH H2-22 bridge barrier attached to a Ty 3/51 barrier in accordance with R15/DK H2-8;
d) a Ty 3/63 tubular girder barrier attached to a Ty 3/51 barrier in accordance with Ty 3/65. (Ty 3/65 has not been published.)

Options a) and b) should be recommended when there is a lot of long-distance coach traffic on the road, even if the traffic volume in the following section is not exceeded. The flexibility margin should therefore be at least the class N2 working width, if it is difficult to achieve the class H2 working width.

A more rigid barrier shall start 20 m before the protected object, and it shall end 13 m after it, unless another minimum measurement has been confirmed for the more rigid barrier.

When there is a lot of long-distance coach traffic, this shall be taken into account in areas where there is a busy international airport or where there are often particularly large sporting events or travel exhibitions at which many coaches arrive from outside the area. On such routes, when the traffic volume exceeds 36,000 vehicles/day and the speed level is at least 80 km/h, a barrier of at least 1.0 m in height and of at least class H2 shall be selected to go next to the support column for any bridge pillars or large portals (boards A > 15 m^2 or span > 20 m), for the safety of coach passengers. The same applies to ramps and points in the road where there is little traffic if there are many coaches and the risk of crashing is great, owing to the geometry, speed level, location of pillars, etc. at that point. The flexibility margin should be at least the class H2 working width (W_n) and range (VI_n). However, when constructing a barrier on an existing road, the road authority may decide that a smaller flexibility margin will suffice. On such routes, a bridge barrier will start 40 m before a bridge over a waterway or road, and it must be at least 40 m in length. On bridge extensions, a flexibility margin of $N2W_n$ will suffice.

Bridge pillars that are not designed to withstand a lorry collision. These are intended to protect people on the bridge from falling and to protect those using the road below from a falling bridge. When the traffic volume on the road exceeds 6,000 vehicles/day and the speed level is at least 80 km/h, a barrier of at least 1.0 m in height and of at least class H2 shall be selected as the barrier, in order to prevent the bridge from falling. The same applies to ramps where there are many lorries or coaches and the risk of crashing is great, owing to the geometry, speed level, location of pillars, etc. at the ramp. The flexibility margin may not be less than the working width (W_n) or the range (VI_n) required for the class. In the above case, when the traffic volume on the road above or below exceeds 36,000 vehicles/day, a slide-moulded H4 class concrete barrier is used for collisions, or an H2 barrier of concrete components is anchored using drilled piles in accordance with type diagram Ty 3/84. The flexibility margin is therefore no less than $H2W_n$ and $H2VI_n$.

Other objects requiring special protection. These are intended to protect important buildings, irreplaceable monuments or people in or near the building from collisions by heavy vehicles. The need for these will be considered on a case-by-case basis, bearing in mind the fact that statistics show that it is rare for heavy vehicles to fall and that a more rigid barrier is more hazardous to cars than a normal one. If it is far enough away from the road, the object should offer protection by being sited at least 2 m above the road, so that a lorry would probably be prevented from striking the object.

In places where groundwater is being protected, a concrete barrier is often used on the embankment, since packing materials do not work properly on sloped embankments, and because in most cases a concrete barrier can be used to prevent tankers from falling far into the vicinity of the groundwater. A splash-proof barrier of at least 1.0 m and ideally of class H4, for example a slide-moulded concrete barrier, shall be selected as the barrier. When the traffic volume is no more than 6,000 vehicles/day, class H2 will suffice.

For noise barriers, a class H2 concrete barrier is usually used. However, the working width $N2W_n$ will suffice as the flexibility margin if the other reasons set out in this chapter do not require a greater margin. The guide **"Planning noise barriers on roads"** presents other requirements for noise barriers and, for example, for steel noise barriers.

Using concrete barriers on embankments. On steep gradients (> 1:2) on high embankments of at least 2 m, a plateau of at least 0.5 m shall be made behind the back of the barrier. When constructing a barrier on an existing road, 0.3 m may be approved if it completely eliminates widening of the road. However, when the first 50 m of a concrete barrier are located on a steep-sloped embankment at least 2 m in height, it must be ensured that a collision does not make the start of the barrier fall away from the embankment. One of the following measures must be used: The first two components of the barrier are anchored to the ground in accordance with type diagram Ty 3/84, and joints that withstand stress ($\geq$ 60 kN) are used. Slide moulding or another method whereby the mass of the concrete sections is at least 16 tonnes shall be used. A plateau is made behind the concrete barrier, the width of which shall be at least 2/3 of the lateral movement $H2D_n$. Merely using a grooved joint would not even be approved if it were to come after the start of a barrier on an embankment.

Supporting wall acting as a concrete barrier. The surface of a smooth, vertical supporting wall or a supporting wall in the shape of a step barrier may act as a barrier if its distance from the side of the nearest lane is 1-3 m and the area in between is flat. A greater distance from the lane makes it possible to have larger crash angles, and this reduces safety. Collisions at the start of the supporting wall will be prevented by means of another barrier, and for the rest of the supporting wall there will be a side-facing concrete barrier following the principles of Ty 3/86.

Columns and pillars in a concrete barrier. In the case of a concrete barrier, a bridge pillar, portal or lighting column may be embedded either in concrete or in a hole covered with steel discs following the principles of Ty 3/87 or 88, where the required flexibility margin is $N2\ W_n$. The concrete barrier must be at least 1.0 m in height.

For an extension to a bridge barrier, a bridge barrier, or another barrier of at least 1 m in height and of crash resistance class H2, may also be used on an embankment where a fast road (mean daily traffic volume > 6,000 vehicles/day and speed of 80 km/h) crosses a particularly important railway or motorway. A bridge barrier shall start 40 m before the bridge. It shall also continue for 30 m after the bridge where there is a two-way traffic route. The bridge barrier may be made smaller if the routes cross diagonally and the terrain does not impede falling onto the lower route. The length shall be defined during planning by the road authority. If there are protected structures behind the barrier, but the points set out above do not require the use of an H2 barrier there, the flexibility margin $N2W_n$ will suffice behind an H2 barrier.

Need for space between the barrier rail and the barrier

Barrier working width

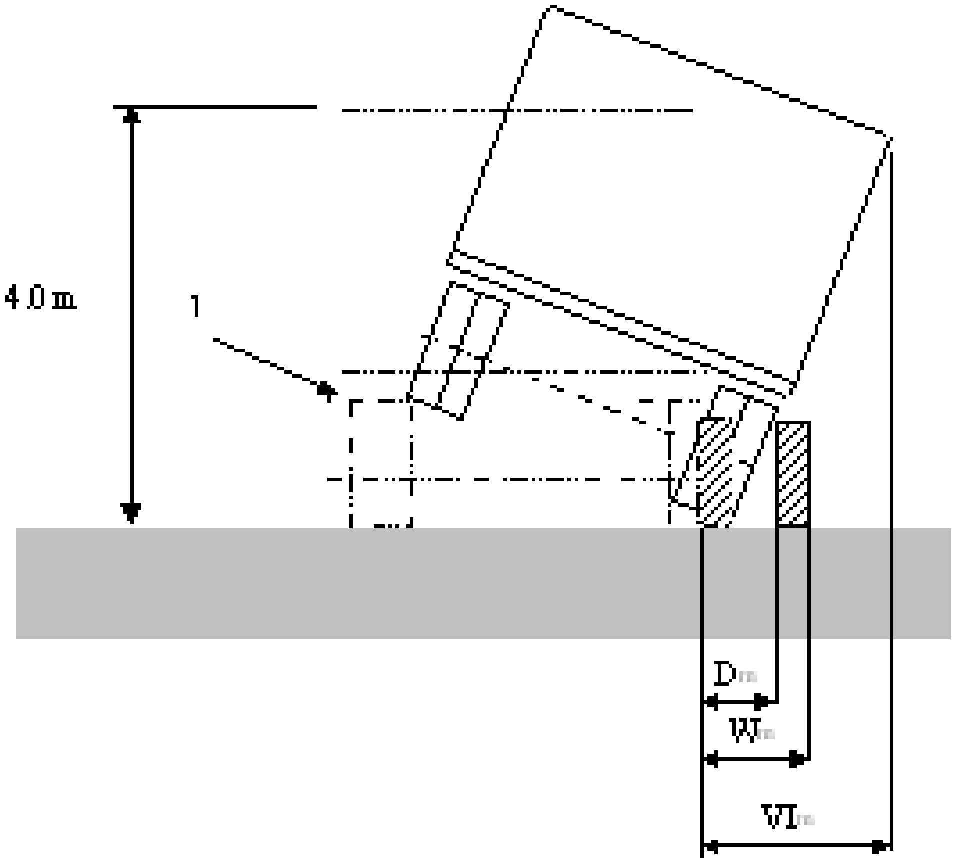


Image 4. Measurements relating to lateral movement:

- *The normalised working width W_n describes how far the barrier will be at its farthest point during a crash; and*
- *Lateral movement (normalised dynamic deflection) D_n, describes how far away the front of the barrier will be. This is usually = W_n – barrier thickness;*
- *Vehicle intrusion VI_n, describes how far a heavy vehicle would have travelled if its height were 4 m.*

Lateral movement is measured from the original front of the barrier. For concrete barriers, W_n is the same as the barrier thickness if the barrier does not move. When comparing the working widths of different barriers, it must be ensured that they compare working widths measured in the same crash resistance class (e.g. N2).

The working width of the barrier will always be defined according to the crash resistance class (e.g. H2) and a TB11 working width caused by a small car. For example, an N2 crash test is not usually conducted on an H2 class barrier when the working width for class N2 is undefined. If a class N2 crash test or simulation is not conducted, the working width $N2W_n = (TB11W_n+H1W_n)/2$; $(2TB11W_n+H2W_n)/3$ or $(4TB11W_n+HW_n)/5$. Similarly, $H2W_n =(2TB11W_n+3H4W_n)/5$ and $N1W_n = TB11W_n$. $TB11W_n$ is obtained from the TB11 D_n value by adding the thickness of the extension or of the barrier (for concrete barriers) to it.

Before 2010, the working width was stated by means of the W sign. This did not take into account any crash speeds and angles that complied with the standard but differed from the crash speed used for the test. Some W values also include a high vehicle intrusion value. A representative of the barrier manufacturer should supply W_n and VI_n values for unstandardised working width W, as well as the D_n value for the TB11 test. W_n is usually smaller than W.

The need for a flexibility margin is discussed in more detail in the section entitled ***"Selection of barrier type for the roadside"****. The design should use the notations set out in Table 1.*

Table 1. Simplified summary of the selection of crash resistance class and the need for a flexibility margin. The minimum height of an H2 barrier is 1 m.

Use	Minimum crash resistance class/flexibility margin	Deviation	Risk level
Roads with little traffic			
Embankment 1:1.5	N2/0.5 m plateau	N2/0.3 m [1]	A
Normal barrier	N2/TB11W_n		A
Roads with a lot of traffic (> 3,000 vehicles/day and ≥ 80 km/h)			
Embankment 1:1.5	N2/0.5 m plateau	N2/0.3 m [1]	A
Normal barrier	N2/N2W_n	N2/TB11W_n[2]	A
Portal or pillar, small space	N2…H1/ N2W_n or **H2…4**/N2W_n		A B, C
Concrete noise barrier	**H2**/N2W_n		B, C
Groundwater protection	**H4**/N2W_n	**H2**/N2W_n[3]	B, C
Roads with a lot of traffic (> 6,000 vehicles/day and ≥ 80 km/h)			
Weak bridge pillar	**H2**/**H2**W_n and VI_n	**H4/0.8-1.2 m**[4]	B, C
Lengthening of bridge barrier	**H2**/N2W_n		B, C
Bridge pillar, coach protection	**H2**/**H2**W_n and VI_n[4]	**H2**/N2W_n[5]	B, C

1) If an old road is not widened.
2) Secondary value from which the value is deducted.
3) Mean daily traffic volume ≤ 6,000 vehicles/day
4) Mean daily traffic volume ≥ 36,000 vehicles/day,
5) If there is not much space on an old road.

The notation N2/TB11W_n means that a barrier class of at least N2 is required, and that there needs to be space between the front of the barrier rail and the front of the barrier appropriate for the working width measured in the TB11 tests.

The notation H2/H2W_n and VI_n means that a barrier class of at least H2 is required, and that there needs to be space between the front of the barrier rail and the barrier appropriate for the working width and vehicle intrusion measured in coach crash tests.

The width of the plateau for a steel barrier anchored in the ground is calculated from the front of the barrier, and the width of the plateau for a concrete barrier is calculated from the back of the barrier.

The length of the barrier has usually been 60-100 m in crash tests. The vehicle usually crashes into the first third of the barrier from the start of the barrier, and the greatest lateral movement is usually found in the second third of the barrier. Barriers that are shorter than the test length may have a greater working width than in the crash test. The same applies to barriers where the anchor at the end of the barrier has been replaced with a joint to give a more flexible barrier type.

If no special anchorage is used to restrict increases in lateral movement, a proportion of the lateral movement observed in crash tests for the same class shall be added to the working width observed, as follows:

a) 0.2 D_n, when the anchorages at the ends of the barrier, which are bevelled to the ground, are removed and replaced by a joint connecting it to another, more flexible, barrier type at a distance of less than 50 m before a hazardous barrier;
b) 0.2 D_n, when the barrier length is 70% of the test length. Shorter barriers than this are not used;
c) 0.2 D_n at the start and end of the barrier at a distance that is 30% of the test length.

Working widths obtained from crash test simulations should be used instead of the above-mentioned corrections. In this way, it could also be investigated what influence improving the anchoring at the ends of a barrier made of concrete components would have on the performance at the start of such a barrier.

Table 2. Examples of working widths and vehicle intrusion for different barrier types (the values for W_n and VI_n are preliminary estimates).

Barrier type	Interval between columns	Intrusion VI_n	Working width W_n (m)			
		H2	H2	H1	N2	TB11(0.9t)
Ty 3/51	4 m				2.1	1.4
Ty 3/51	2 m				1.7	1.1
Ty 3/61, 84 m	2 m			1.5	1.1	0.6
Safety f.z.REU2	2 m				0.8	0.5
Bridge barrier TIEH H2 in ground 28 m		1.9	1.3		0.7	0.3
Bridge barrier TIEH H2 in concrete 28 m		1.6	1.1		0.6	0.3
Ty 3/84 28 m or sliding cast 60 m		1.4	0.7	0.5	0.5	0.5

The flexibility margins for other barrier types can be found in the publication “Information for motorway planning”, no. 62, in the CE marks for the barrier types and in approval decisions.

If the manufacturer supplies only the working width class instead of the working width, the classes shall be turned into working widths as follows: W1 = 0.6 m; W2 = 0.8 m; W3 = 1.0 m; W4 = 1.3 m; W5 = 1.7 m; W6 = 2.1 m; W7 = 2.5 m; W8 = 3.5 m.

The H2 intrusion $H2W_n$ for an unanchored, slide-moulded concrete barrier or a concrete barrier anchored in accordance with Ty 3/84 may be reduced by making the barrier taller. When the thickness of the barrier type is at least 200 mm, the following assumptions may be used: $H2W_n$ v= 1.2 m, kun h = 1.4 m and $H2W_n$ = 0.7 m, where h = 2.0 m.

Other requirements and grounds for selection

Hardness of the barrier in the event of a car crash. Barriers of crash resistance classes N2 and H1 should be of risk level A (best). Classes B and C are also permitted in crash resistance classes H2-H4. However, C class barriers must be avoided if their ASI value, as measured in crash tests, exceeds 1.6. The ASI value, which describes the acceleration experienced by a passenger in a crash, may be obtained from the manufacturer.

Slopes. A cable barrier or double-tube barrier, tested and approved on a slope, may be installed on a slope at a distance of 1 m from the side of the road, when the gradient is 1:4 (1:3). The minimum gradient for cable barriers and double-tube barriers is otherwise 1:6 (1:4). The maximum gradient for steel girder barriers with a normal guard rail (≥ 230) is 1:8 (1:6); the maximum gradient for steel girder barriers with a narrow guard rail is 1:10 (1:6). The values in parentheses may be used on short distances and when the barrier is no more than 0.5 m from the side of the road. On steeper slopes, a car will go over the top of a barrier of normal height, or go under the rail of a raised barrier.

Visibility. Particularly at diamond interchanges, bridge barriers and road barriers restrict visibility when they are connected from a ramp to a road on the bridge. In such cases, the visibility of the bridge barrier is estimated in accordance with the guidelines entitled **"Bridge barriers",** and the most transparent type possible in the required crash resistance class will be selected, and a double-tube barrier will be used as the road barrier. This procedure may be followed in other places where it is intended to provide visibility from the road to the downward slope. A barrier will create a barrier to visibility on the inside of a curve in the road, irrespective of the barrier type.

Snowdrifts. On the shores of lakes and at the edges of large swathes of fields, a normal barrier will cause snowdrifts to pile up more than a double-tube barrier or cable barrier. The difference is significant. A concrete barrier causes snowdrifts to pile up more than other barrier types.

External appearance. On roads leading into densely built-up areas, it may be wished for a barrier to give the road a certain special appearance or to blend in as much as possible. In such cases, a more expensive than normal, fully tested, suitable barrier that has a better external appearance may be selected; or, failing this, an approved barrier type may be changed as permitted in the publication entitled "Road and bridge barriers" (in Finnish Road Administration report 67/95), but preferably not in areas with speeds exceeding 80 km/h. If barriers with the same external appearance are to be selected, a version of the barrier that has been approved and tested in accordance with standard EN 1317-2 must be selected first, and not a version of a tested barrier that has been changed significantly. At the same time, it must be ensured that the barrier retains its external appearance despite snow-ploughing and dents. If there are many pavements there, it is also worth taking the details into account. Wooden barriers of class N1 or N2 may be used on roads where there are museums.

Spare parts. An unnecessarily large number of barriers may not be put in the same place, since this increases the need to store spare parts and to provide training for maintenance workers or to delay repairs. The barrier type manufacturer must show that spare parts are readily available, and must undertake to send spare parts and repair guidelines at a fair price to all those who repair barriers.

Resistance to snow-ploughing. Barriers are classified for resistance to snow-ploughing in accordance with Table 3. Class 4 is usually required as a minimum requirement. In coastal areas 30 km wide, and in densely built-up areas, between Porvoo and Vaasa, and on sloped barriers, the road authority may also approve class 2 or 3. The requirement for resistance to snow-ploughing does not affect the ends of compression barriers or crash deadeners.

Table 3. Classes of resistance to snow-ploughing of metal barriers.

Class of resist-ance to snow-plough-ing	Distance of the front of guard rail from column	Density of strength-adjusted material in the guard rail 1)		Bending resistance to horizontal force (cm^3) 1)		Screw between column and guard rail 2)
		Open section	Tube	Guard rail	Column	
4	≥ 50 mm	≥ 4 mm	≥ 2.9 mm	≥10	≥12	M10 4.X
3	≥ 50 mm	≥ 3 mm	≥ 2.2 mm	≥5	≥9	M10 4.X
2	Cable barrier					
1	Other					

1) = material density x $[f_{yd}/(235\ N/mm^2/1.1)]^{0.5}$.
2) or fixing that has a similar shear strength against vertical loads.

For resistance to snow-ploughing in classes 3 and 4, the front of the guard rail must reach the front of a column of at least 40 mm, and there may not be any screws or protuberances on the guard rail (or concrete barrier) or on the plough's contact surface that could prevent the plough from sliding. The bending resistance of a narrow (< 120 mm) guard rail may be 50% smaller if the plough does not strike it.

Monolithic concrete barriers belong to class 4. Other barrier products may be approved for snow-ploughing resistance classes 3 and 4, on the basis of tests with snow ploughs and practical experience.

Steel and preventing corrosion. The density of zinc in steel guard rails and columns shall comply with standard SFS-EN 1461, but it shall be at least 0.075 mm locally for snow-ploughing resistance class 4. For guard rails, the steel must be of class J2 in standard SFS-EN 10025. The Finnish Transport Agency may approve other forms of protection and other steel qualities that are suitable owing to their cold properties, external appearance and weather resistance.

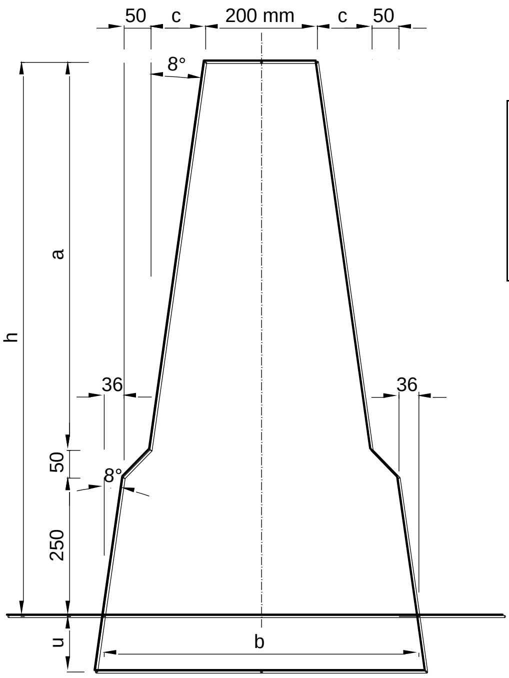
Installing a bridge barrier in the ground. *A barrier that has been tested as a bridge barrier shall be installed in the ground in one of the following ways:*

a) *The column for the bridge barrier shall be embedded in a drilled pile in accordance with diagram R15/DK H2-22, and wedged in place using 0/11 or 0/16 gravel. The column will usually have a lug to prevent the column from being pushed too far down into the drilled pile. The installation method allows the column to move after a crash and allows the barrier to rise if the ground presses against the bridge extension. It is also easy to drive drilled piles into broken rocks and cliffs. Alternative drilled piles and embedding depths are 1) RD170x10, S355, L = 1.5 m, 2) RD 140x8, S355, L = 1.65 m and 3) RD 115x8, S550, L = 1.85 m;*

b) Screws are used to attach the column to the component that traces the edge girder of a bridge that has been installed in the ground, following the principles of R15/DK H2-21.

General quality requirements for concrete barriers. When a concrete barrier is used as a noise barrier, groundwater protection, bridge barrier extension or permanent protection for bridge pillars or similar, or when an immovable central barrier is intended, the concrete barrier shall be embedded approximately 100 mm below the surface. Barrier types will therefore not be approved if there is an almost vertical part of less than 200 mm in height at the bottom of a section that is clearly weaker in the bottom part of the front surface. This is because resurfacing or ice layers will change excessively the way in which the barrier functions. For concrete barriers, 40 mm may be reserved for resurfacing. The durability requirement for concrete complies with the section in InfraRYL entitled “Fixed components of concrete barriers cast on the spot” (K45-1, P50, XF4, XC4, XD3, 30 years). Only shallow grooving or brushing may be done on the front of a concrete barrier. The seams on the components shall be bevelled.

When it is intended that a concrete barrier should be movable, the components of the barrier are installed on the surface, and raised onto the new surface when thick resurfacing work is done. The durability requirement for barriers of crash resistance classes H2-4 is the same as above, but N2 barriers must comply with the section entitled “Movable components of concrete barriers” in InfraRYL. The corners of the components shall be bevelled.



h	a	b	c
800	500	514	71
1000	700	570	99
1200	900		127

Image 5. The most strongly recommended type of concrete barrier is a step barrier. The width of the barrier type is usually 200 mm, when the b measurement in the table is taken. Underneath the surface of the ground, and at heights of above 1,000 mm, the surface may alternatively be vertical. The embedding depth u is usually 100 mm.

Standard SFS EN 1317 classes 2 and 3

Table 4. *The approval criteria that apply to barriers according to standard SFS-EN 1317-2 are as follows: A car may not fall, go through it or go over it. A car may not bounce sharply off the barrier, and those in the car may not be subject to excessively great deceleration (risk level A is best), and no large parts of the barrier may penetrate the car or fly through the air. A barrier type that is approved for a higher crash-test class automatically satisfies the requirements of a lower class. Two crash tests are usually required. The crash durability classes are:*

Class	Crash test				Crash test (small car)			
	vehicle	Weight (tonnes)	Speed (km/h)	Angle (degrees)	Vehicle	weight (tonnes)	speed (km/h)	angle (degrees)
N1	car	1.5	80	20	not required			
N2	car	1.5	110	20	car	0.9	100	20
H1	lorry	10	70	15	car	0.9	100	20
H2	coach	13	70	20	car	0.9	100	20
H3	lorry	16	80	20	car	0.9	100	20
H4	lorry	30/38	65	20	car	0.9	100	20

Table 4 does not show classes L1-L4, which will be introduced in 2010. They will differ from classes H1-H4 in that they will also require an approved test with a car weighing 1.5 tonnes at a speed of 110 km/h. The safety of a class L barrier will thus be tested more thoroughly than for a class H barrier.

Table 5. *The approval criteria that apply to crash deadeners under standard SFS-EN 1317-3 are the same as for barriers in principle. At least 2-6 crash tests are required. The crash resistance classes are as follows:*

Class	Head-on (Weight of car in tonnes x speed km/h)		Off-centre	15° to the end	15° to the side	165° to the side (only 2-way)
50	0.9x50				1.3x50	
80/1		1.3x80	0.9x80		1.3x80	
80	0.9x80	1.3x80	0.9x80	1.3x80	1.3x80	1.3x80
100	0.9x100	1.3x100	0.9x100	1.3x100	1.3x100	1.3x100
110	0.9110	1.3x100	0.9x100	1.5x110	1.5x100	1.5x110