# UIC CODE 777-1

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*Original*

**R**

# Measures to protect railway bridges against impacts from road vehicles, and to protect rail traffic from road vehicles fouling the track

*Mesures pour prévenir les chocs des véhicules routiers contre les ponts-rails et visant à empêcher la pénétration de véhicules sur la voie ferrée*
*Maßnahmen zum Schutz der Eisenbahnbrücken gegen Anprall von Straßenfahrzeugen und des Schienenverkehrs vor abirrenden Straßenfahrzeugen*

UNION INTERNATIONALE DES CHEMINS DE FER
INTERNATIONALER EISENBAHNVERBAND
INTERNATIONAL UNION OF RAILWAYS

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## Application :

With effect from 1 January 1997
All members of the International Union of Railways

## Record of updates

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|---|---|
| **1st edition, January 1997** | First edition |
| **2nd edition, June 2002** | Retyped in FrameMaker and amendments to Appendix E |

*The person responsible for this leaflet is named in the UIC Code*

# Contents

# Summary

From the railway operating standpoint, the collision of vehicles with railway bridges represents a danger, especially if the route is used by high-speed trains. Such collisions have already resulted in serious accidents to trains. A further danger is the fouling of the track by road vehicles falling from road bridges or straying off course from roads running parallel to the railway.

This leaflet must be read in conjunction with any relevant statutory or responsible supervisory authority requirements in the zone of intended application.

# 1 - Collision of road vehicles with the piers of railway bridges

## 1.1 - Equivalent loads

### 1.1.1 - New or reconstructed bridges

If the pier or the supporting part of a railway bridge lies within a certain distance from the outer edge of the road, as defined by the responsible supervisory authority, it should be designed for static equivalent loads.

The static equivalent loads for the ultimate limit state are:

- 1000 kN in the direction of movement of the road traffic (1),

- 500 kN at right-angles to the direction of movement of the road traffic (2).

The point of application of the loads lies 1,25 m above the level of the road.

Loads (1) and (2) do not act simultaneously.

Instead of the equivalent loads calculation described above, passive measures of protection may also be adopted, when these are capable of preventing a collision.

When the distance between the outer edge of the pier and the outer edge of the roadway is < 1m, the static equivalent loads should be taken into consideration for design purposes even if passive measures of protection have been adopted.

### 1.1.2 - Existing bridges

If piers of an existing bridge are unable to withstand the forces defined in this paragraph, passive measures of protection should be taken.

## 1.2 - Passive measures of protection

Passive measures of protection may be necessary to protect the pier against damage from road traffic when the bridge has insufficient redundancy to cater for the loss of the pier. The arrangement of passive protection is based on a risk analysis using the following criteria:

| Road traffic | Rail traffic |
|---|---|
| Speed of road traffic | Speed of rail traffic |
| Road traffic density | Rail traffic density |
| Road curvature, alignment and gradient | Track alignment |
| Horizontal and vertical distance of piers from the road | |
| Dangerous goods traffic | Dangerous goods traffic |
| Heavy freight traffic | Heavy freight traffic |
| Single or multiples lanes | Route classification |

Possible passive measures of protection are e.g.:

- earthworks: earth banks and ditches,
- means of protection: crash barriers and shock-absorbing beams,
- protective walls, cable barriers, deflecting kerbs and barriers.

# 2 - Collision of road vehicles with the superstructure of railway bridges

## 2.1 - Principles

Owing to the wide variety of vehicles and structures it is difficult to predict theoretically the damage from a vehicle impact.

Practical design measures should therefore be such that an impact against the superstructure will not result in major damage and, in particular, the safety of rail traffic on the bridge will not be impaired.

## 2.2 - New bridges

For reasons of safety, preference should be given to superstructures which will withstand severe impact (i.e. with high-quality resistance, e.g. reinforced concrete, prestressed concrete or rolled beams in concrete superstructures with continuous ballast bed).

New bridges should be designed for the standard headroom as specified by the relevant supervisory authority. Bridges with a headroom of more than 6m require no further protective measures or do not require verification against the impact loads of point 2.4 - page 5 below.

In the design of new bridges, the following should be prevented:

- localised damage due to a minor impact (through suitable protection such as angle steel fixtures, etc.),

- displacement of the entire structure due to a severe impact (through suitable measures such as anchorage).

## 2.3 - Existing bridges

Existing bridges with lightweight superstructures and insufficient headroom should be replaced as soon as reasonably practicable by structures which are more resistant to severe impact, or else the headroom prescribed by the supervisory authority should be provided. If this is not reasonably practicable for economic or technical reasons, then measures from the list below should be taken, based on a risk analysis:

- erection of a shock-absorbing beam (for example: see Appendix A - page 10) on the existing abutment in front of the superstructure, to absorb the impact. The beam should be placed slightly lower than the existing minimum headroom of the bridge and should be made of either reinforced concrete or steel,

or

- where permitted by the relevant supervisory authority, erection of a protective portal (for example: see Appendix B - page 11) on the approach to the bridge, in order to absorb the impact. Position and material as for the beam (see point 2.5 - page 6).

Depending on the importance of the road and/or the railway line, a more lightweight portal may be chosen. This will give the road vehicle a blow which will cause the driver to stop;

- installation of a visual warning system (traffic lights - for example: see Appendix C - page 12) at an adequate distance from the bridge, to allow overheight vehicles to divert.

In addition to the measures described above it is necessary - if the headroom under the bridge is less than the standard headroom - for the highway authority to draw attention to the height by means of road signs. A safety margin should be provided, so that the headroom shown on the signs is less than the actual headroom under the bridge (for example: see Appendix E - page 14).

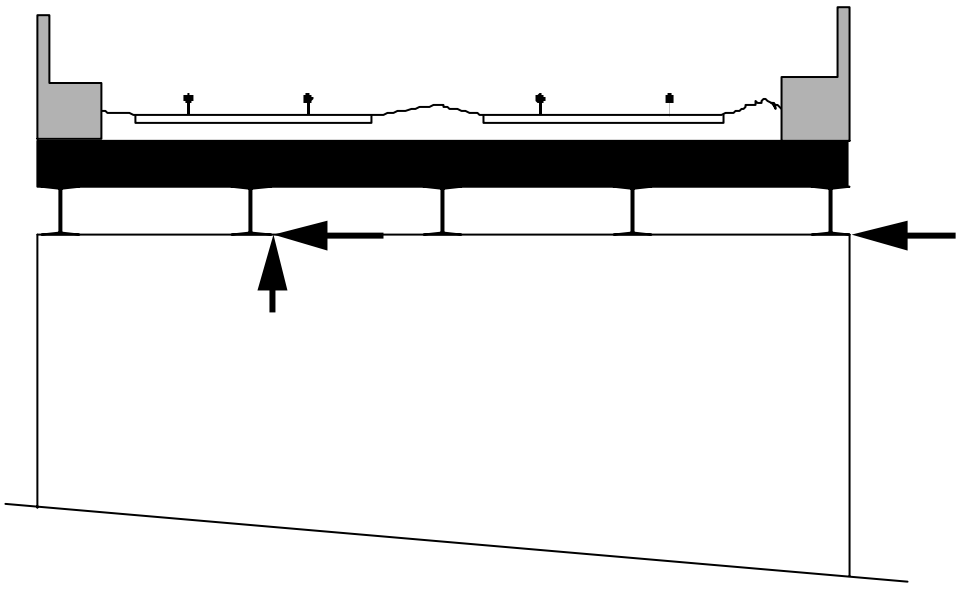
## 2.4 - Vehicle impact loads against superstructures of railway bridges

The calculated impact load for an overheight vehicle, applied as an individual load, is determined as follows unless otherwise specified by the supervisory authority. No calculation is required for bridges with a headroom of more than 6 m:

- 500 kN horizontal and parallel to the road below (1),

- 250 kN at right-angles to the road below (2).

Loads (1) and (2) act separately and should be applied to the beam at the most adverse point above the road. The effects of a vehicle impact are considered only at the ultimate limit state. The loads may have an internal or an external point of application. In each case only the effect of an individual vehicle impact is considered.



The dimensions of the abutment and the anchorage of the shock-absorbing beam or protective portal should be calculated accordingly.

Minor damage to the protective structures is acceptable. The shock-absorbing beams may also be used as offset walkways.

## 2.5 - Installation of shock-absorbing beams or protective portals

The distance between the shock-absorbing beam and the bridge parapet should not be less than 50 cm for deformable beams and 10 cm for rigid beams. The beams should be so supported or secured as to prevent them from falling on to the road in the event of breakage of the anchorage.

The beams should be installed 1 - 2 cm below the existing minimum headroom and their front should bear suitable markings (warning stripes) (for example: see Appendix E - page 14).

## 2.6 - Anchorage of bridge superstructures

So far as possible, superstructures of lightweight construction should be so anchored that they will not be displaced by minor accidents. In addition, localised damage should be avoided by means of suitable measures similar to those described under point 2.2 - page 4 and point 2.3 - page 4 above.

# 3 - Road vehicle incursions onto the railway

## 3.1 - General

Road traffic represents a hazard to rail traffic, in particular:

- due to road vehicles or their loads falling from bridges on to the railway,
- due to road vehicles straying off course at points where roads approach the railway,
- due to road vehicles straying off course at points where road and rail run parallel.

Rail traffic should therefore be protected effectively against road vehicles straying off course.

## 3.2 - Road vehicles deviating from bridges or their approaches

Protective measures are required to prevent road vehicles straying off course from bridges or their approaches. For this purpose a risk analysis should be made, based on the following criteria, so that suitable measures may be selected:

| Road traffic | Rail traffic |
|---|---|
| Speed of road traffic | Speed of rail traffic |
| Road traffic density | Rail traffic density |
| Road curvature, alignment and gradient | Track alignment |
| Road classification | Route classification |
| Relative difference in height between rail and road | Electrification |
| Dangerous goods traffic | Dangerous goods traffic |
| Heavy freight traffic | Heavy freight traffic |

### 3.2.1 - Protective measures on the bridge

The following measures of protection may be provided:

- means of protection: crash barriers and shock absorbing beams, walls with integrated steel cables where applicable,
- means of deflection: concrete or steel protective walls, cable barriers, deflecting and guiding kerbs.

In addition, on high-speed lines for speeds in excess of 250 km/h, a warning system may be provided for road bridges carrying heavy traffic. This will be triggered by vehicles straying off course and will be linked to the railway signalling system (for example: see Appendix D - page 13).

The choice and calibration of protection systems, and the calibration procedures applicable where appropriate shall be specified by the supervisory authority.

### 3.2.2 - Protective measures on the approaches

On the approaches to bridges, crash barriers should be provided at a reasonable distance from the bridge. They should be continued over the bridge or linked to other protective fixtures on the bridge itself.

Where curves are involved, additional traffic engineering measures should generally be provided, e.g. reinforced crash barriers, etc. Features such as earth banks and ditches may also be used to provide protection.

## 3.3 - Roads running parallel to the railway

Protective measures are required to prevent road vehicles straying off course where road and railway run parallel. For this purpose a risk analysis should be made, based on the following criteria, so that suitable measures may be selected:

| Road traffic | Rail traffic |
|---|---|
| Distance between road and rail | Distance between rail and road |
| Difference in height between road and rail | Difference in height between rail and road |
| Road alignment | Track alignment |
| Road traffic density | Rail traffic density |
| Speed of road traffic | Speed of rail traffic |
| Dangerous goods traffic | Dangerous goods traffic |
| Heavy freight traffic | Heavy freight traffic |

This problem is of particular importance for railway lines carrying passenger traffic and on high-speed lines.

Where new railways or roads are built, the greatest possible distance between rail and road should be provided. As a rule the railway should be at a higher level than the road, or at least on the same level.

The minimum distance between rail and road before protection measures are required should be determined by the supervisory authority on the basis of the criteria listed in this paragraph.

### 3.3.1 - Roads at a higher level than the railway

On the basis of a risk analysis, the following measures of protection may be required:

- earthworks: earth banks, ditches and/or,

- means of protection: (walls with integrated steel cables, crash barriers, concrete or steel protective walls).

### 3.3.2 - Road and rail routes on approximately the same level

On the basis of a risk analysis, the following measures of protection may be required:

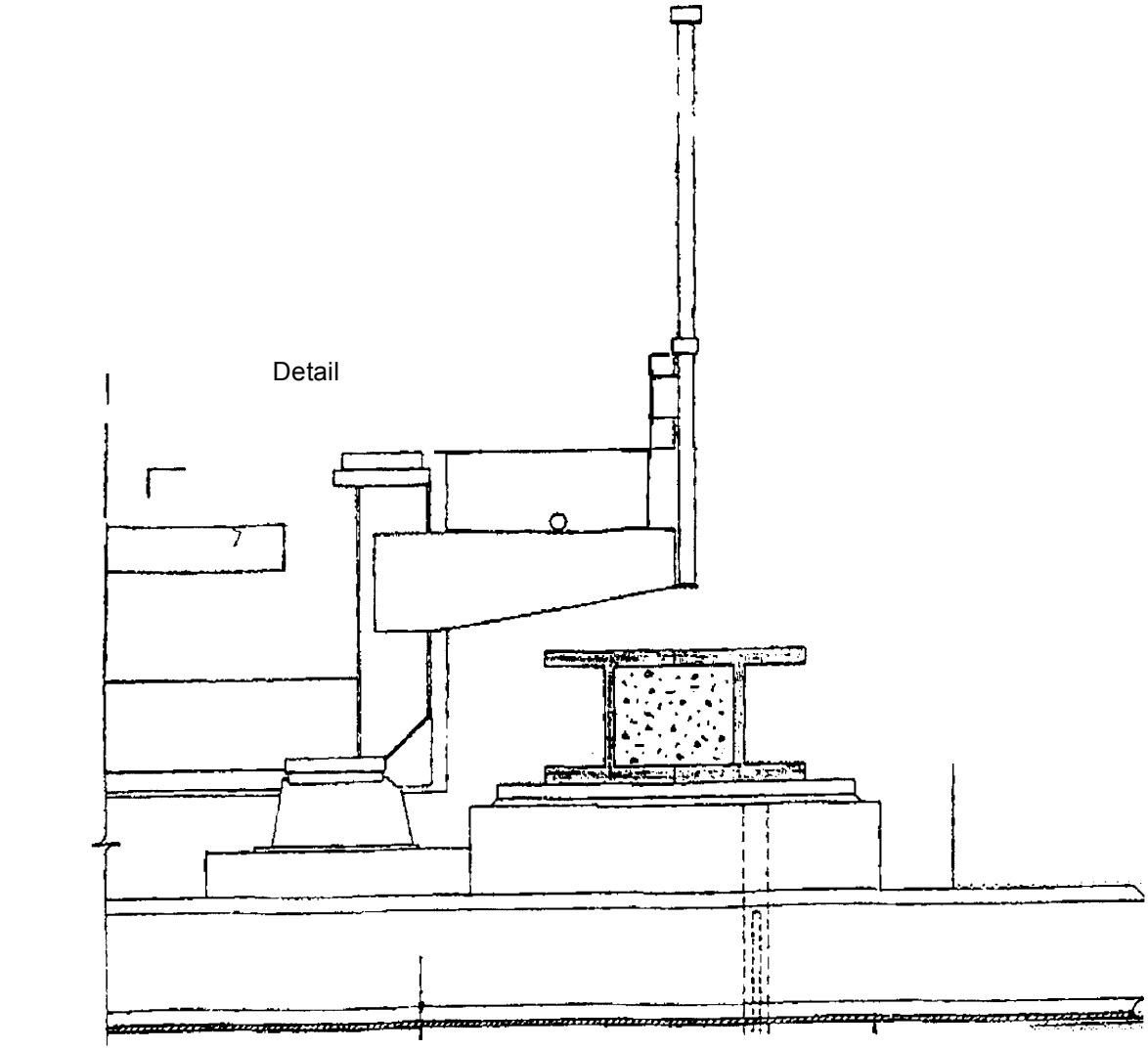
- earthworks: earth banks, ditches and/or,

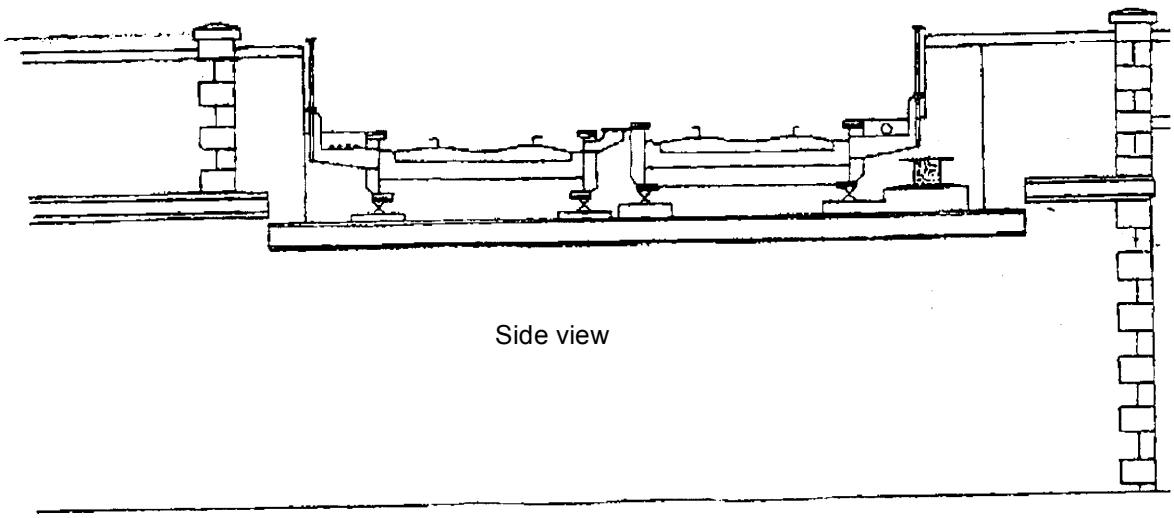
- means of protection: (walls with integrated steel cables, crash barriers, concrete or steel protective walls).

### 3.3.3 - Roads at a lower level than the railway

If the road runs more than 3 m below the railway, no protection measures are required, unless the supervisory authority prescribes otherwise, in which case suitable protection measures should be taken as above.

# Appendix A - Shock-absorbing beam (Great Britain)



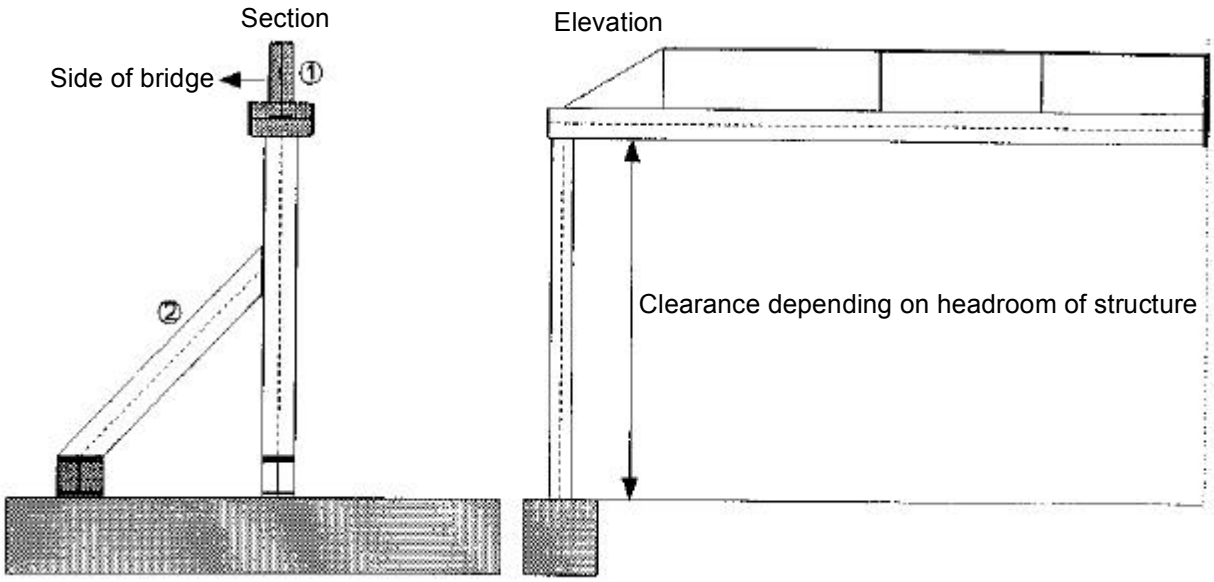



Side view

# Appendix B - Protective portal: outline view (Germany)

## Distance from centre-line of bridge approx. 5 - 20 m:

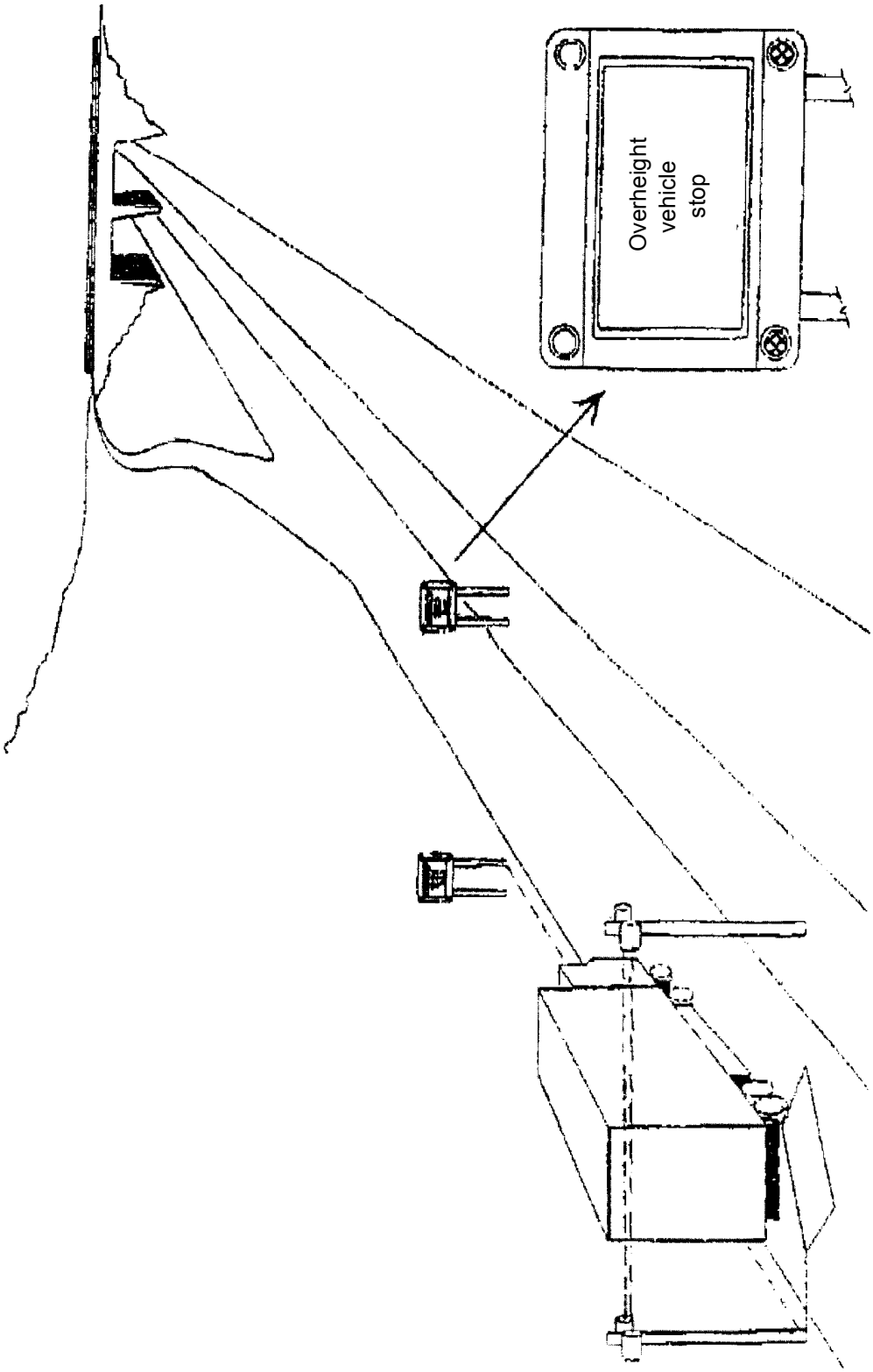
### Protective portal with rigid shock-absorbing beam




① In the case of bridges with low headroom, the upper vertical reinforcing beam may be dispensed with; a horizontal beam will be sufficent.

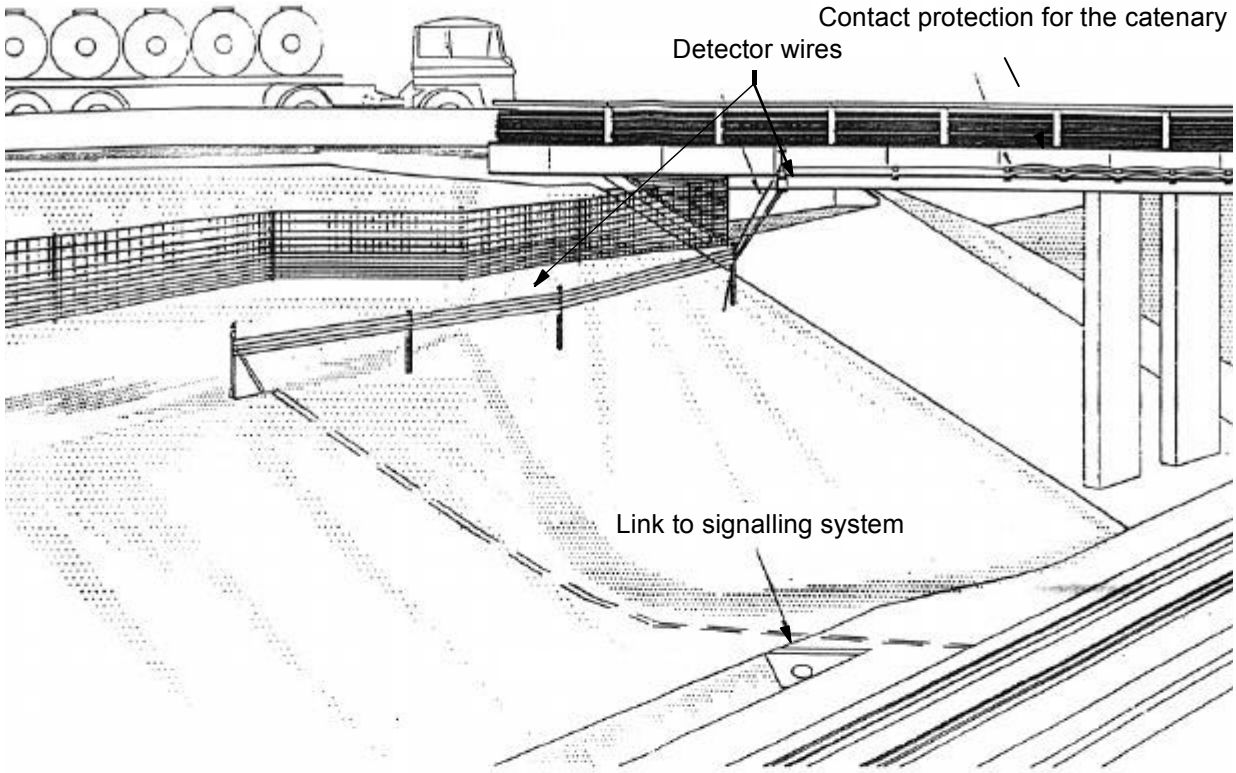
② The inclined support may also be dispensed with if there is suitable anchorage in the ground.

# Appendix C - Warning system for overheight vehicles (Great Britain)

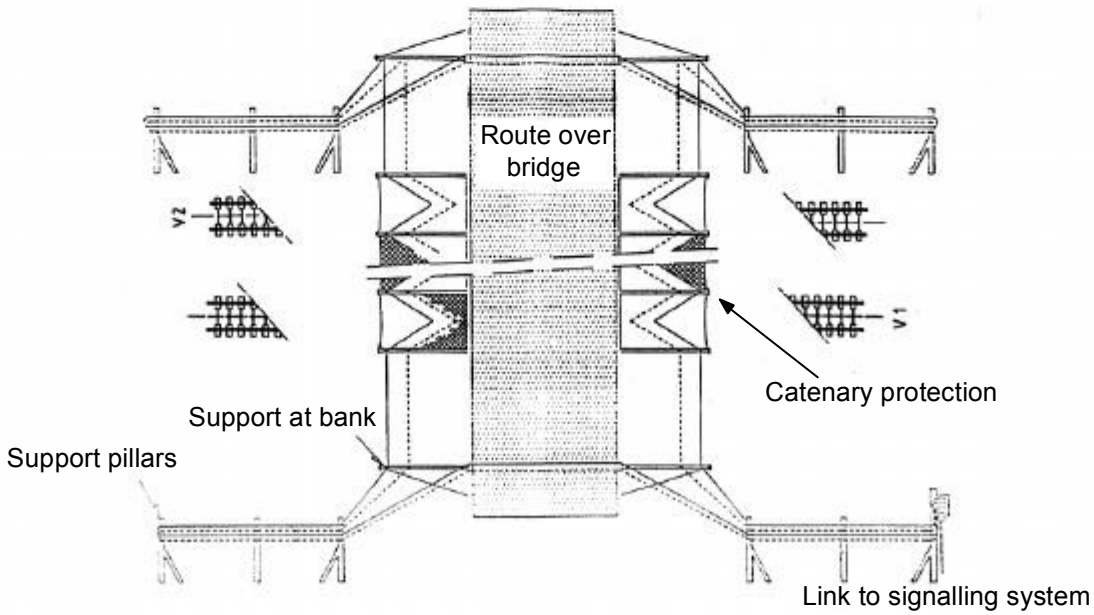


# Appendix D - System to detect vehicles falling on to high-speed lines (France)

**View**




**Plan**



# Appendix E - Examples of road signs for bridges (Germany)

## a) Horizontal warning stripes

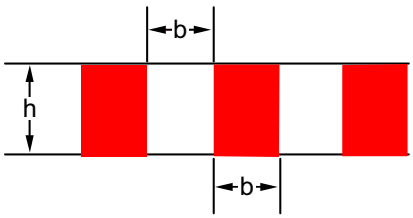



Fig. 1

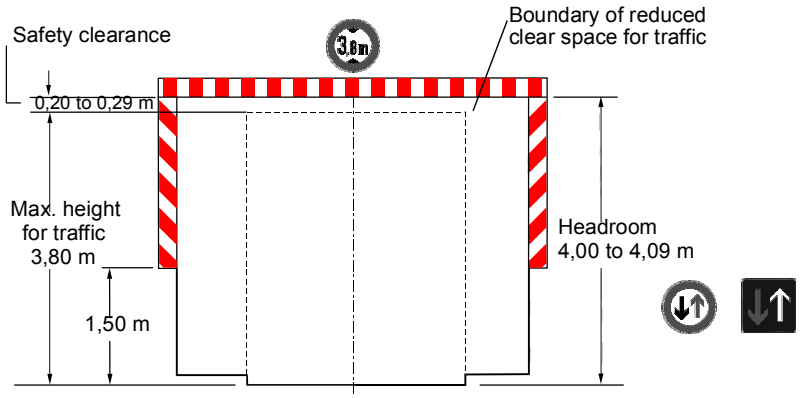



Fig. 2

## b) Vertical warning stripes

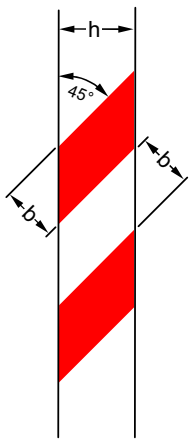
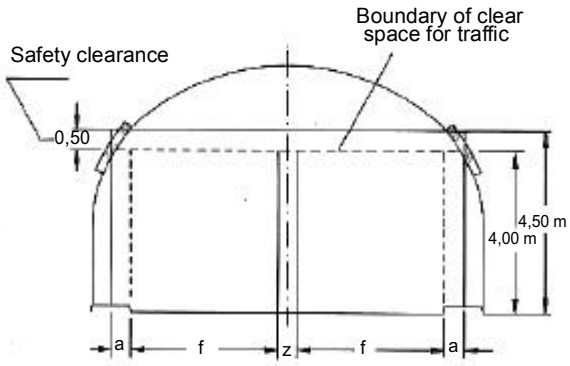



Fig. 3




f = Traffic lane = 3,00 m
a = Safety clearance at edge of carriageway = 0,50 m
z = Safety clearance between vehicles = 0,50 m

Fig. 4

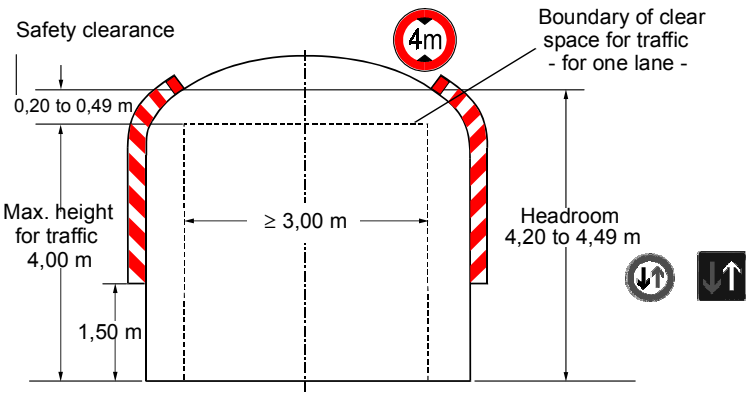
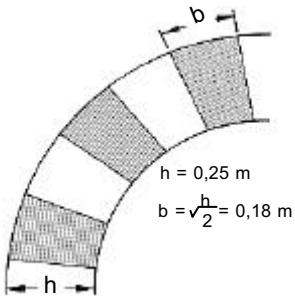



Fig. 5

## c) Curved and oblique warning stripes




Colour : white RAL 840 R
shade 9001

red RAL 840 R
shade 3000

Fig. 6

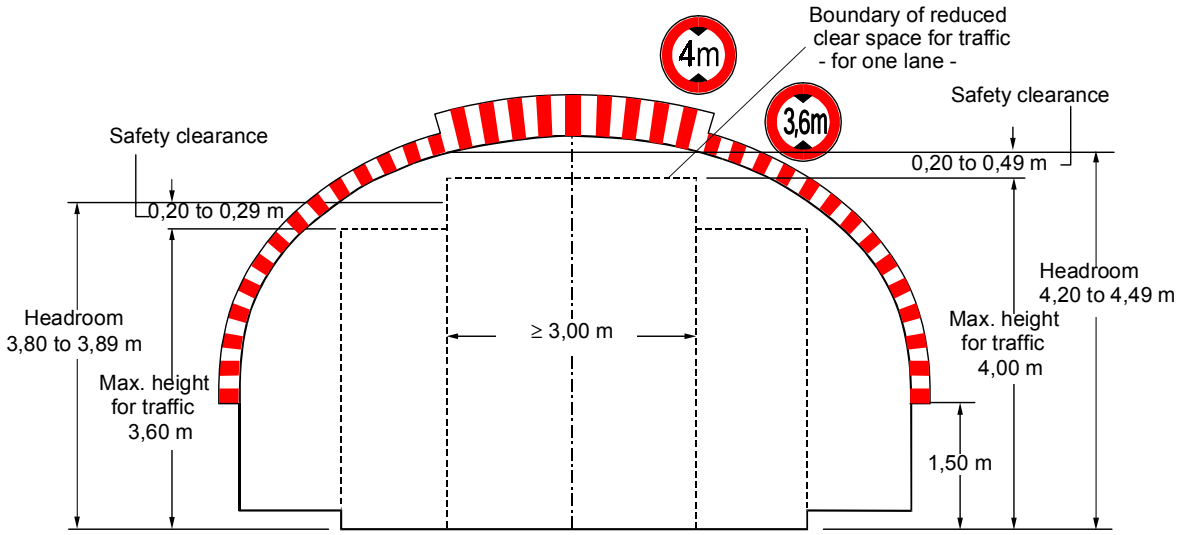



Fig. 7 - Example of bridge with two road signs relating to height

# Bibliography

## 1. UIC leaflets

**International Union of Railways**
*Leaflet No. 777-2: Structure built over railway lines - Construction requirements in the track zone,* 1st edition of 01.01.97

## 2. Minutes of meetings

**International Union of Railways**
*Sub-Committee 7J "Bridges" (Item 4.4: Approval of new Leaflet 777-1: Measures to protect railway bridges against impacts from road vehicles, and to protect rail traffic from road vehicles fouling the track),* January/February 1995, January 1996

*"Infrastructure" Commission (Item 10.2: Bridges - Approval of Leaflets 777-1 and 777-2) ,* November 1996

## Warning



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