

**GUIDELINES FOR ROAD DESIGN,  
CONSTRUCTION, MAINTENANCE AND  
SUPERVISION**

**Volume I: DESIGNING**

**Section 2: DESIGNING BRIDGES**

**DESIGN GUIDELINES (DG 1.2.11)**

**Part 11: BRIDGE MAINTENANCE EQUIPMENT AND  
MAINTENANCE PLAN**



## INTRODUCTION

Bridge maintenance equipment is essential for bridge inspection and particularly for bridge maintenance and repair works.

Each bridge shall comprise maintenance equipment such as stairs, benchmarks, informational boards, ventilation openings and access points. A direct access or such by means of a special vehicle shall be ensured to all the bridge structural elements and furniture.

To each road bridge a maintenance plan is mandatory. It shall comprise all the essential information of the bridge, as well as the conditions on and the methods of the bridge inspection and maintenance.

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## 1 SUBJECT OF DESIGN GUIDELINES

Bridge maintenance equipment is essential for bridge inspection and particularly for bridge maintenance and repair works.

Each bridge shall comprise maintenance equipment such as stairs, benchmarks, informational boards, ventilation openings and access points. A direct access or such by means of a special vehicle shall be ensured to all the bridge structural elements and furniture.

To each road bridge a maintenance plan is mandatory. It shall comprise all the essential information of the bridge, as well as the conditions on and the methods of the bridge inspection and maintenance.

## 2 REFERENCE REGULATIONS

The present Design Guideline is based on the Rulebook on Technical Norms for Concrete and Reinforced Concrete (*Pravilnik o tehničkim normativima za beton i armirani beton*), PBAB 87, Yugoslav Official Gazette No. 11/1987, Articles 286 and 287, as well as on the German Guidelines *Richtzeichnungen für Brücken und andere Ingenieurbauwerke* (Guide-Drawings for Bridges and Other Civil Engineering Structures).

## 3 EXPLANATION OF TERMS

**Bridge equipment:** all the elements, which do not belong to the bridge structure, yet they are required for a proper functioning of a bridge.

**Maintenance plan:** all the documents providing adequate instructions for the bridge management after the construction has been completed, ensuring a maximum reliability and durability of a bridge.

**Maintenance stairs** serve bridge inspectors and maintainers to reach all the essential places on a bridge and/or to those places, from which it is possible to come to the spot of inspection or maintenance.

**Benchmarks** are required to control road bridge deformations and settlements.

**Informational boards** comprise the information of the year of construction, the investor, the contractor, the designer, etc.

**Ventilation openings** are required to ventilate confined box cross-sections.

**Special vehicles for inspection** are vehicles equipped with a collapsible scaffold allowing an access to those structural elements, which are inaccessible by common means, in order to carry out inspections and eventual repairs.

**Technical inspection** is a professional inspection of works performed, where the latter are compared with the drawings, technical description and technical conditions. Form, quality and stability of the structure are inspected.

**Routine inspection:** by this inspection, condition of the structure is established and the defects jeopardizing the traffic are made good simultaneously.

**Regular inspection:** by this inspection, which is carried through every two years (unless a main inspection is foreseen in the same year), all parts of the bridge furniture, carriageway and load bearing system being accessible without any special equipment are checked. Beside the phenomena endangering the traffic safety, eventual damages or adverse effects that might jeopardize structural safety, serviceability and durability shall be found out.

**Extraordinary inspection** is carried out by professional commissions, whose task is to assess the condition of the bridge during or immediately after an exceptional event (flood, heavy transport, etc.).

**Main inspection** is performed every six years and upon expiry of the guarantee period. The extent of this inspection is the same as that of the extraordinary inspection. However, the main inspection also covers items and places, which are hidden or inaccessible by regular means.

**Detailed inspection** is a base for an assessment of the actual quality and safety of the entire structure, or a base for diagnosing and determining the rehabilitation method.

#### 4 BRIDGE MAINTENANCE EQUIPMENT – GENERAL

Bridge maintenance equipment is essential for bridge inspection and particularly for bridge maintenance and repair works.

When designing a new bridge, due regard shall be given to the feasibility of its inspection, maintenance and rehabilitation. Special attention shall be paid to bridges comprising plenty of furniture and installations. This applies in particular to urban bridges.

Each bridge shall comprise maintenance equipment such as stairs, benchmarks, informational boards, ventilation openings and access points. A direct access or such by means of a special vehicle shall be ensured to all the bridge structural elements and furniture.

Bridges shall be conceived in such a way that different installations and furniture do not affect adversely their appearance, that maintenance carriages can be employed, and an access for inspection vehicles is ensured.

To each road bridge a maintenance plan is mandatory. It shall comprise all the essential information of the bridge, as well as the conditions on and the methods of the bridge inspection and maintenance.

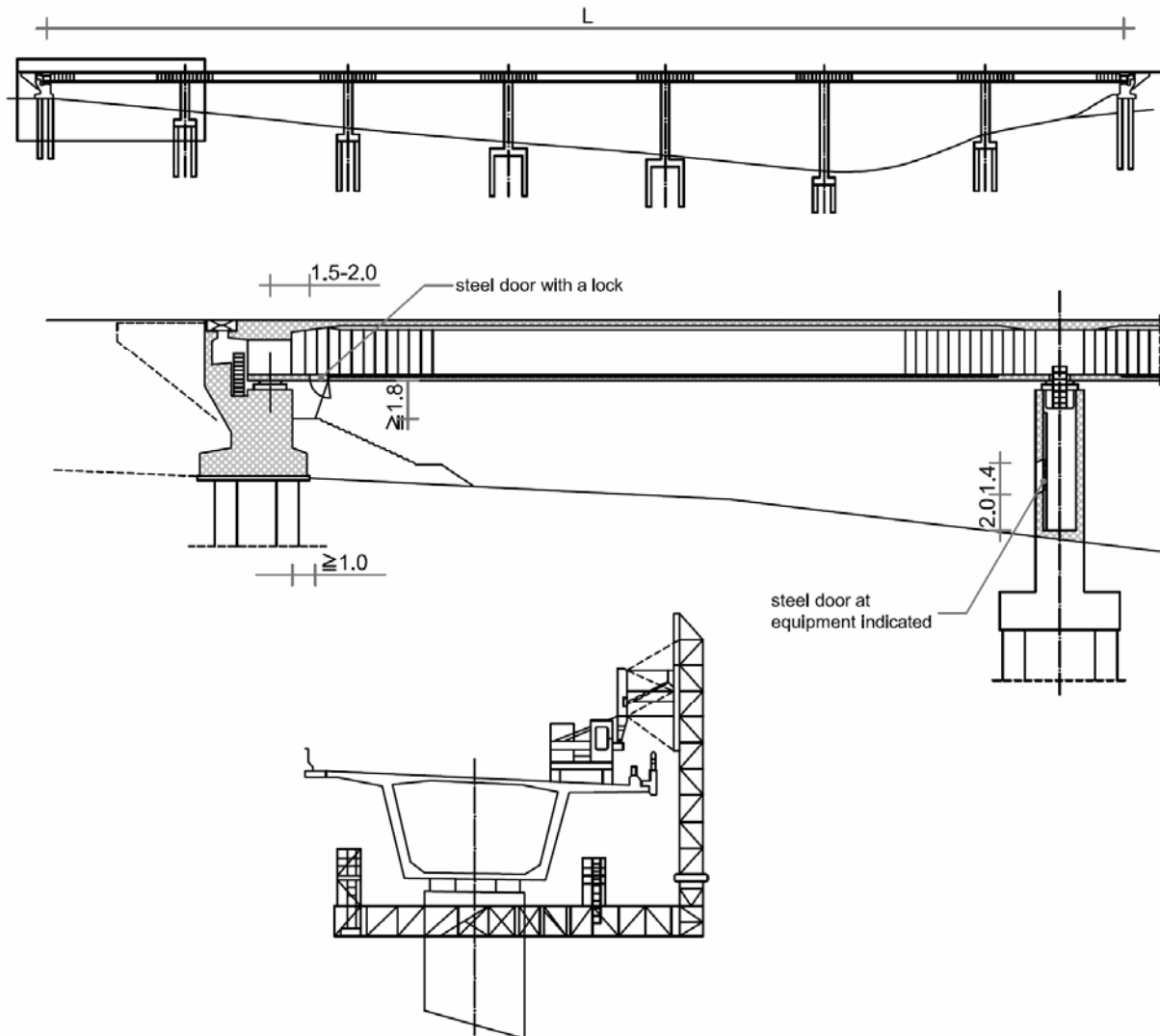


Fig. 4.1: Bridge scheme with maintenance equipment indicated

## 5 MAINTENANCE STAIRS

### 5.1 Stairs at Abutments

For all bridges an access to the abutments from the road level shall be ensured (Fig. 5.1, 5.2)

Stairs at abutments shall be carried out on one side at the wing, parallel with the bridge axis. The width of the stairs shall amount to 80 cm minimum, whilst the height of each stair shall be 17-18 cm.

The slope below the stairs shall be additional consolidated, and a foundation shall be constructed at both the beginning and the end of the stairs. The dimensions of each foundation depend on the ground type and quality; in general they shall amount to 50/80 cm.

The thickness of the bearing slab of the stairs shall amount to approx. 15 cm. The slab shall be constructively reinforced. The upper

surfaces of the stairs can be of concrete or stone. Minimum concrete grade shall be C25/30, and freeze resistance XF3 shall be ensured.

For wide bridges (four traffic lanes), particularly on motorways, stairs shall be executed on both abutment sides.

For bridges and overpasses where a road is running below, the access to the abutments shall be made feasible from the road below, in the bridge/overpass axis (Fig. 5.2).

For minor bridges (of a height < 3 m) and slopes of 1:1.5 – 1:2.5, stairs can be omitted. In such a case, the access is enabled over the slope.

Before the abutment, an access path of 1.0 m width and  $\geq 1.80$  height shall be executed.

Detailed technical sketches are shown in Fig. 5.3 and 5.4.

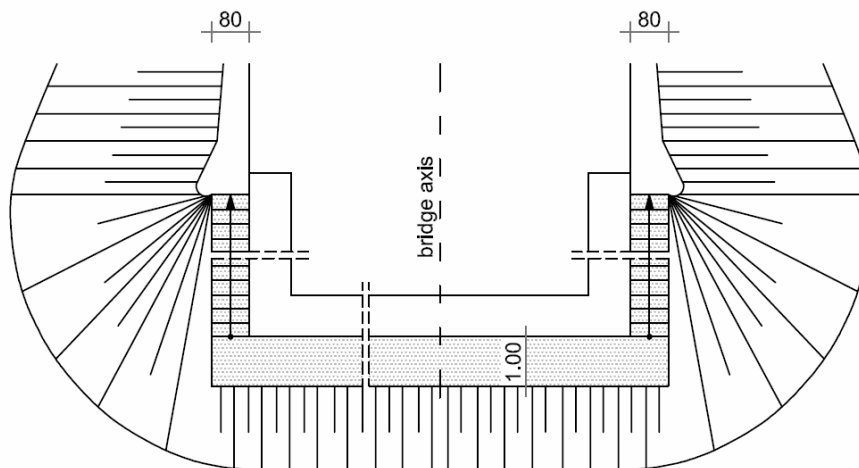


Fig. 5.1: Position of stairs enabling access to below the bridge

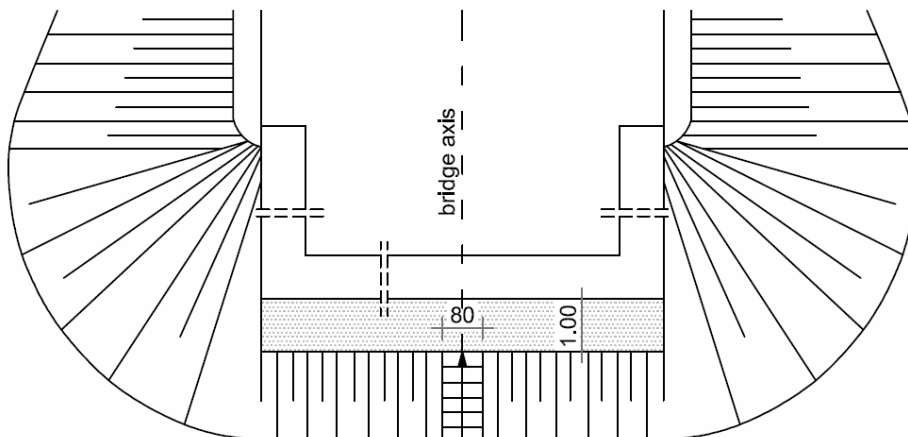
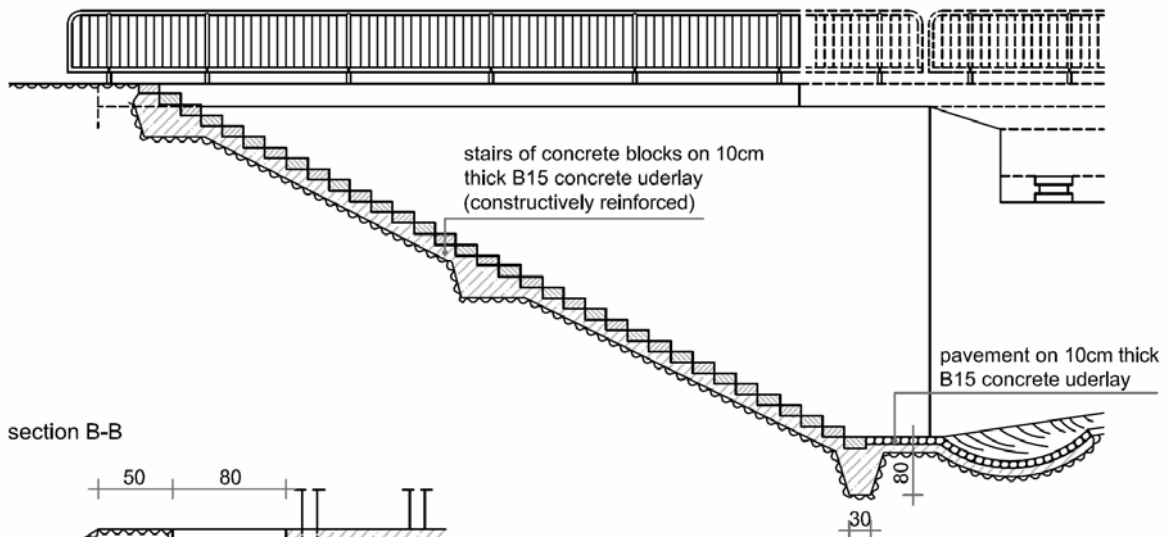


Fig. 5.2: Position of stairs enabling access to bearings from the road below the bridge

section A-A



section B-B

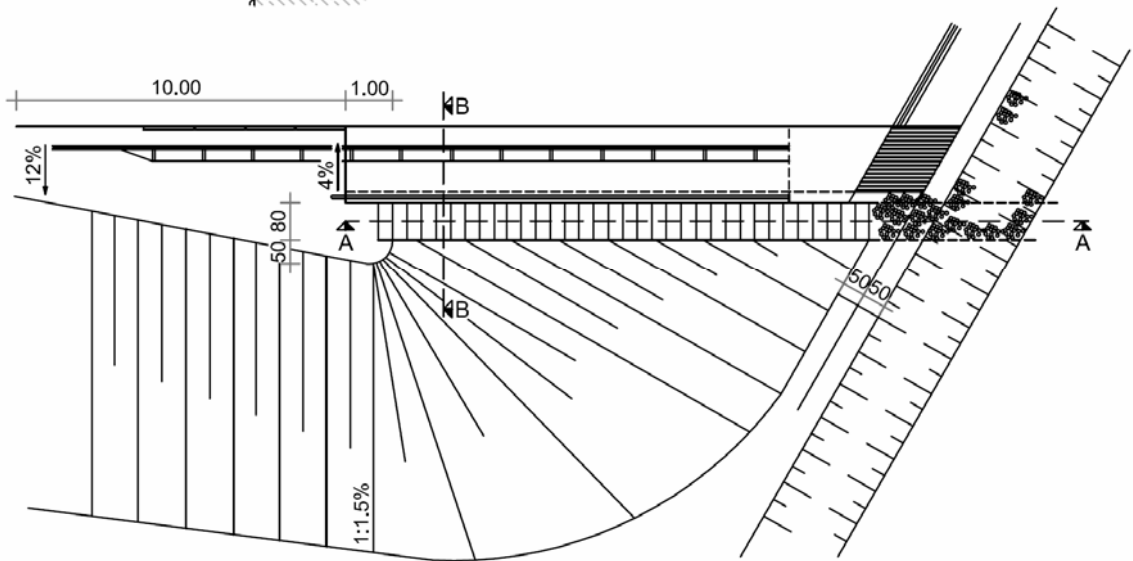
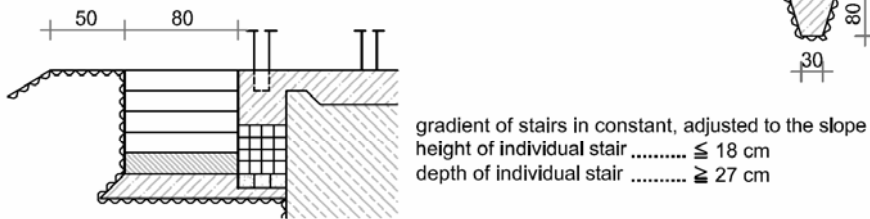


Fig. 5.3: Sketch of stairs running parallel with the structure



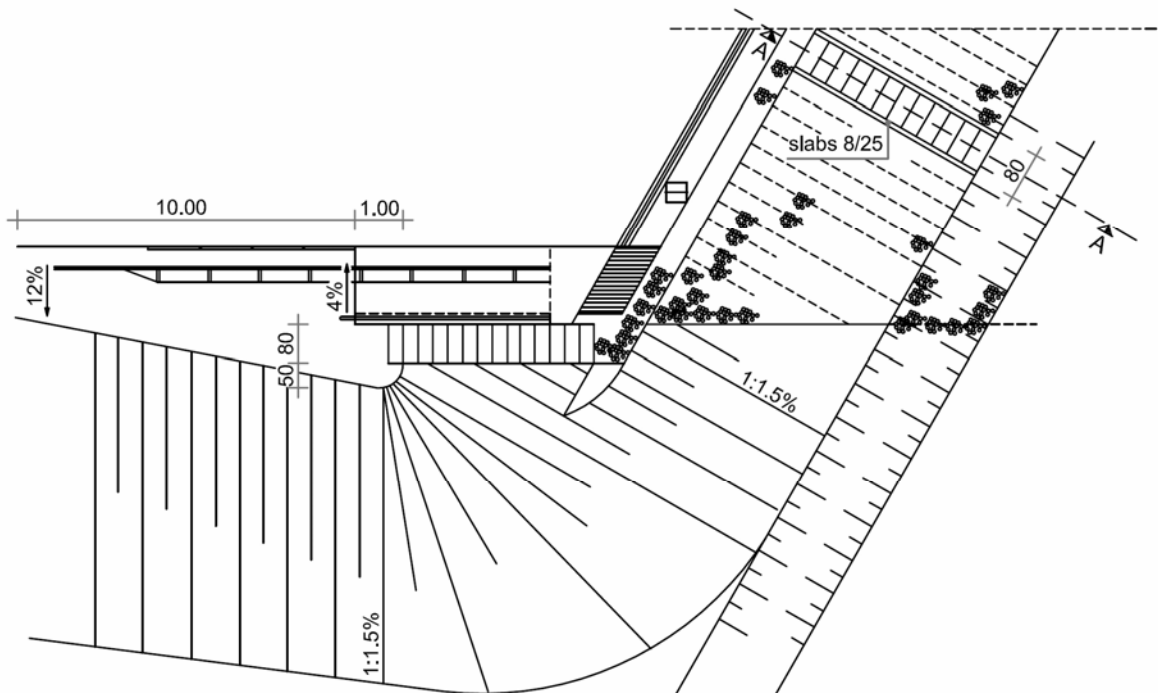
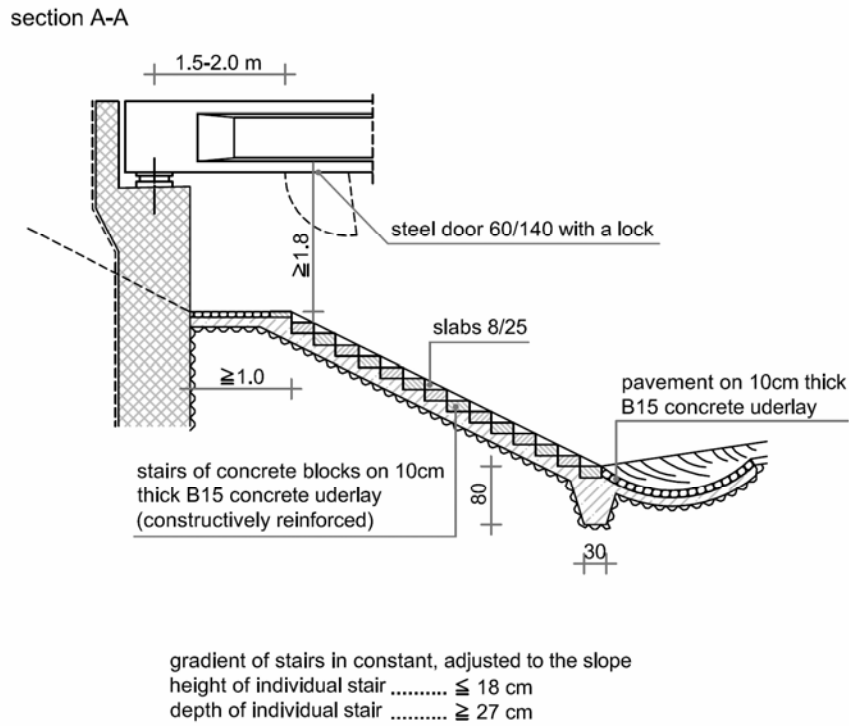


Fig. 5.4: Sketch of stairs enabling access below the bridge

## 5.2 Stairs in Hollow Piers

Hollow piers of internal dimensions greater than 1.5 m, shall receive, at a height of 2.0 m from the ground, an opening including a steel door of 90/140 cm, equipped with a lock.

Access to the pier interior is made possible through the door (Fig. 5.5). A steel ladder with a back-guard is fixed to the pier wall over the entire pier height. By means of the ladder, inspection and minor repairs are allowed (Fig. 5.6).

When a box superstructure supported by means of bearings is placed onto such piers, a free pass from the pier into the superstructure and vice versa shall be carried out (Fig. 5.7). For piers, which are rigidly connected with the bridge deck, such provision is not required.

## 5.3 Accesses to Superstructures

For bridges having a chamber at abutment a free pass to the box superstructure through this chamber shall be enabled.

Bridges without a chamber shall have an access opening, i.e. a door in the box girder lower slab.

The opening size amounts to 60/140 cm. For an easier placing of eventually required additional tendons, the opening shall be placed at a distance of 1.5 – 2.0 m from the abutment. Box girders comprising wall cross girders shall have openings of 80/140 cm minimum in these cross girders to enable a free pass.

## 5.4 Maintenance of Bridge Installations

Installations placed in the bridge walkways, shall be conducted in PVC ducts of  $\phi 110$  or  $\phi 80$  mm. Installation inspection shafts of 41/107 cm ensure interventions during inspection and maintenance. Their arrangement shall be agreed with the relevant public service administrations.

Installation of major dimensions, such as water supply, sewage system, hot-water supply, low-pressure gas conduit, shall be conducted on steel brackets with suitable fixed or movable supports. For longer and higher bridges, maintenance of essential installations on the outer side of the bridge shall be made feasible by means of a specially arranged carriage.

For larger bridges, i.e. of a length more than 100 m, where major installations are conducted, the maintenance of the latter shall be made possible by providing of permanent steel walkways of 80 cm width, or a carriage shall be foreseen, from which all the works can be carried out.

On box girder bridges installations are often led in the bridge interior. Their location shall be selected in such a way that they do not hinder placing of additional tendons eventually required for bridge strengthening. For maintainers of the installations, an access to the box deck is enabled through suitable openings.

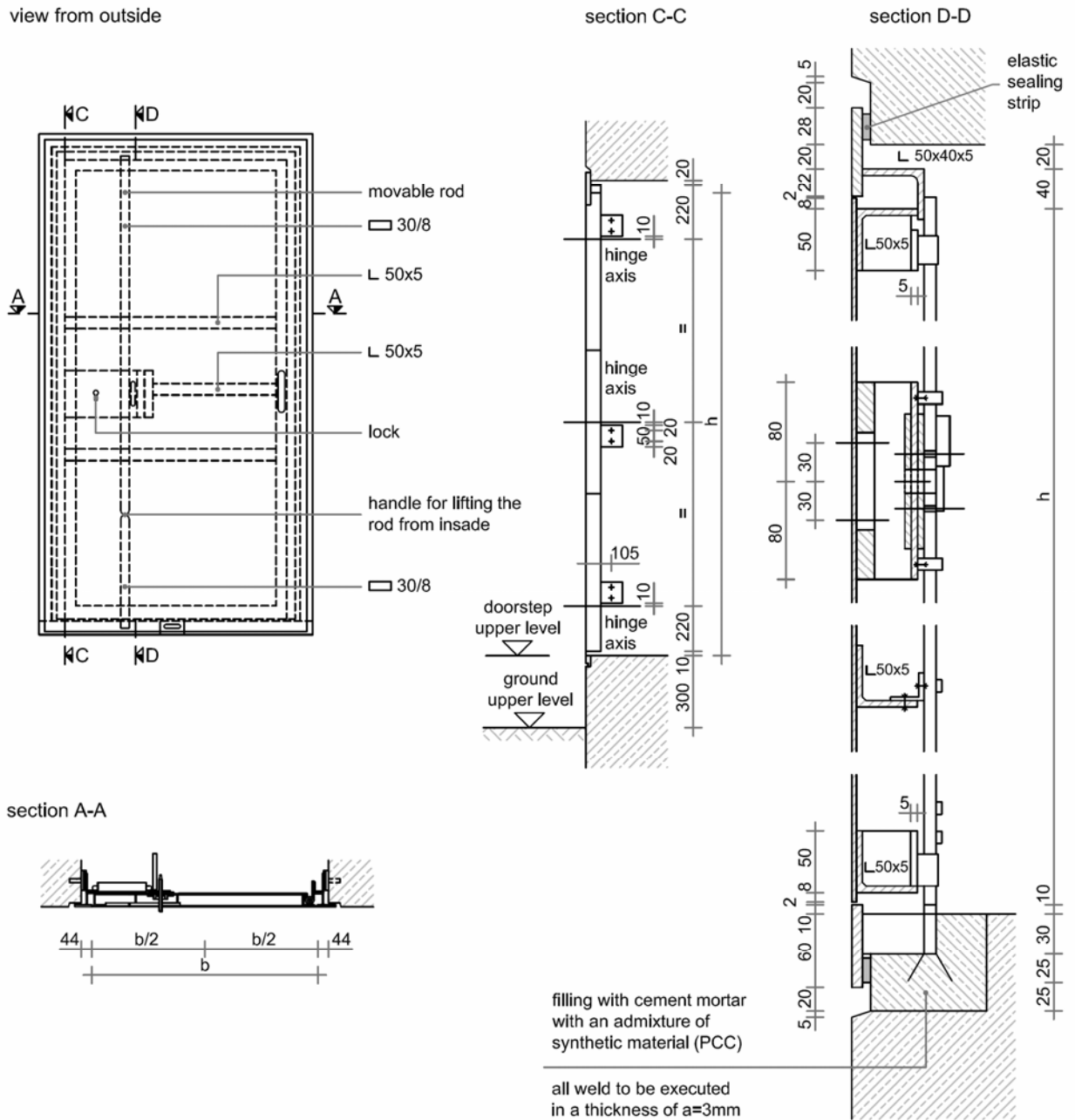
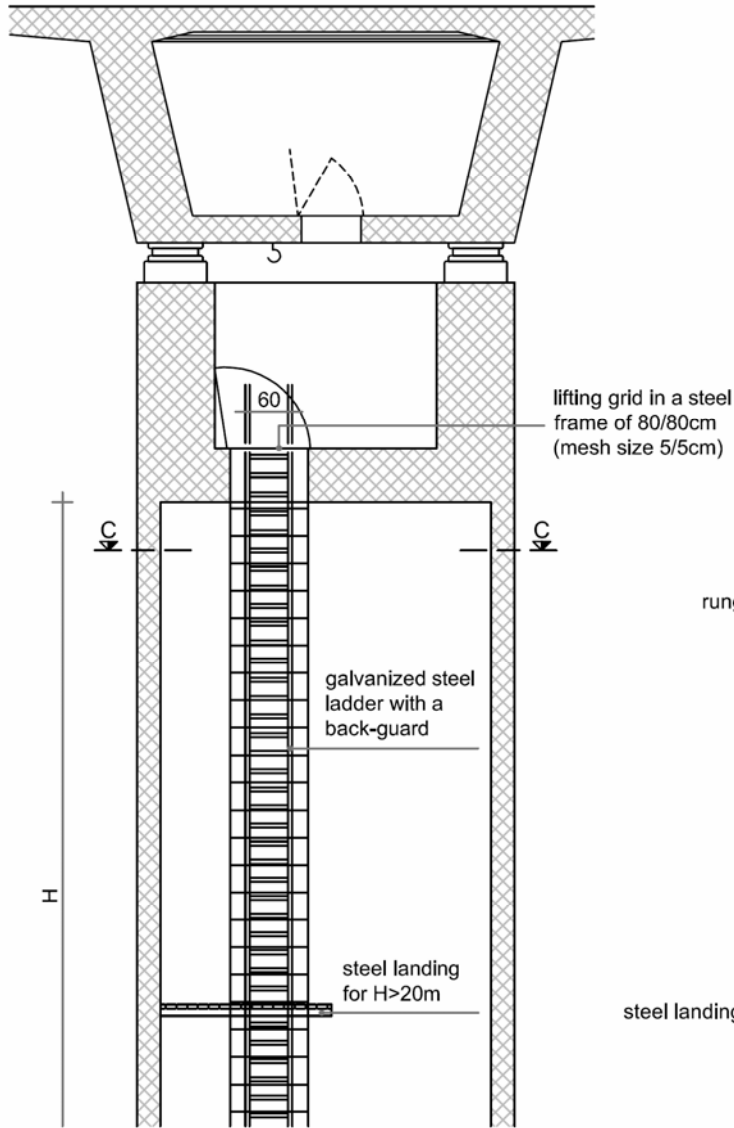
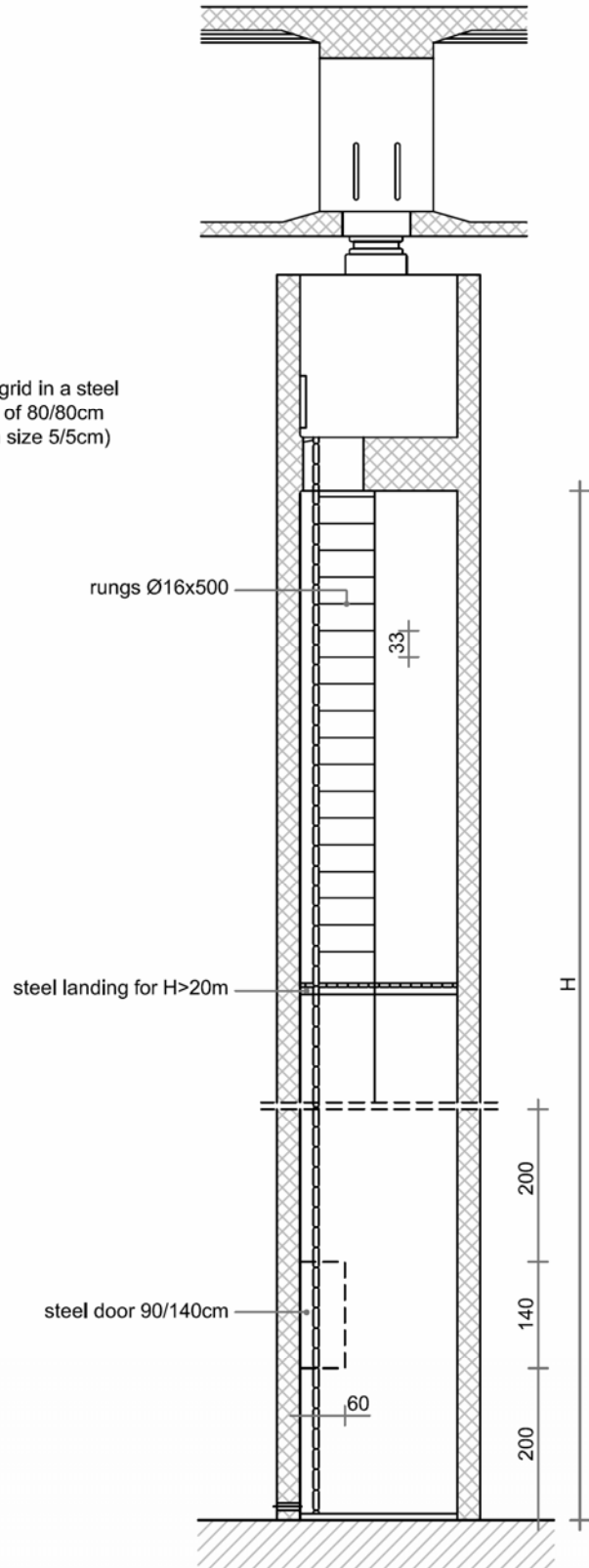


Fig. 5.5: Galvanized steel door enabling entry into hollow piers

section A-A



section B-B



section C-C

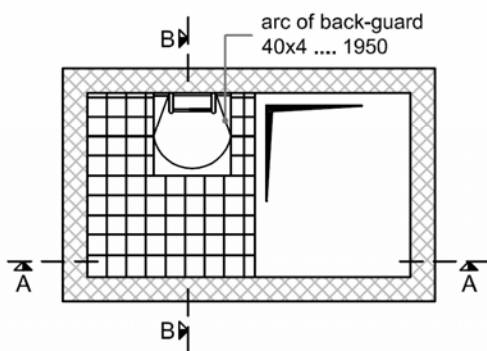


Fig. 5.6: Steel ladder enabling inspection of hollow pier interior

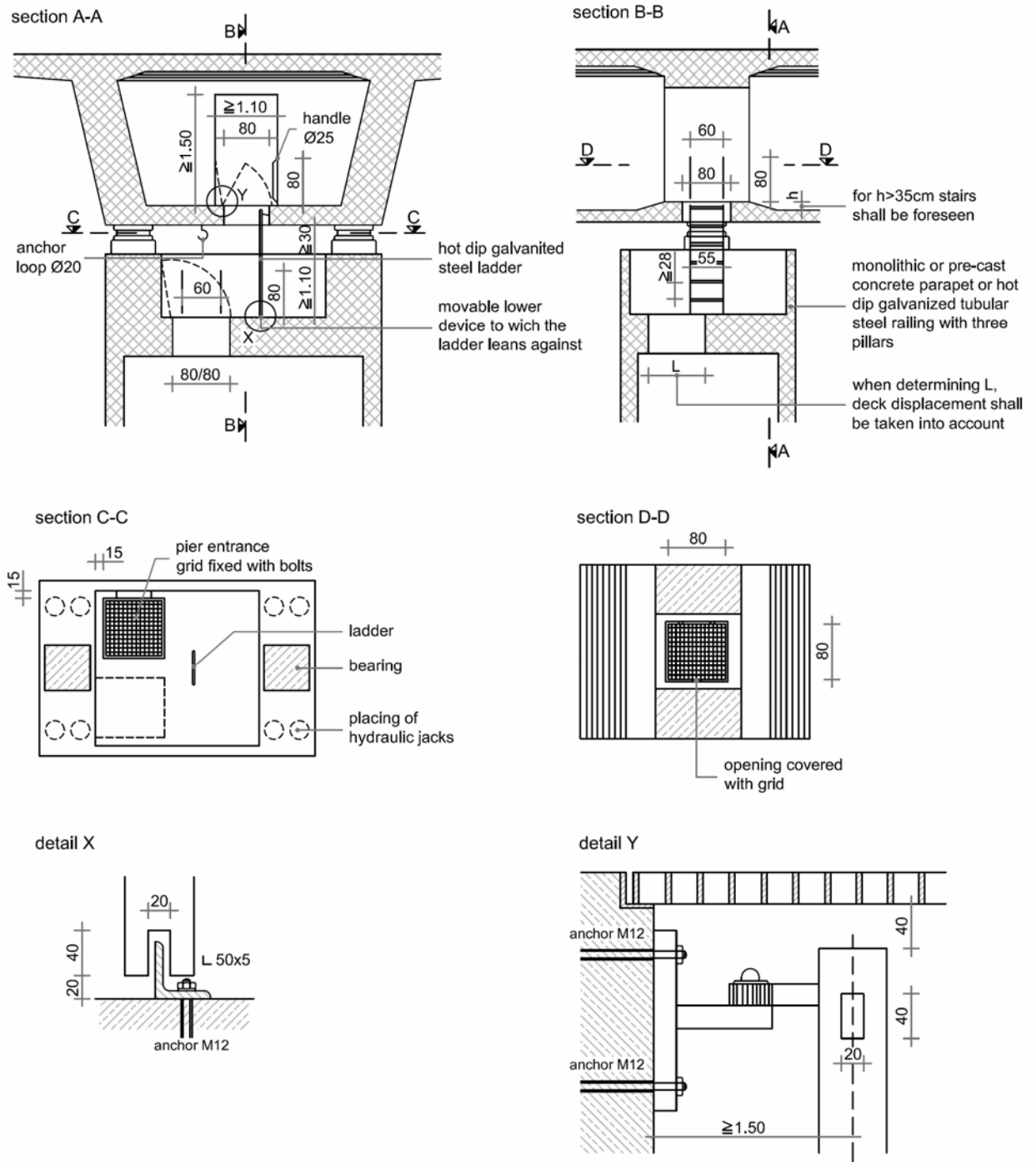


Fig. 5.7: Passage from the box deck into the pier and vice versa

### 6 BENCHMARKS FOR BRIDGE GEOMETRY AND DEFORMATION CONTROL

During construction of a bridge, benchmarks referring to the existing level net (in heights above sea level) shall be built-in in certain places being adequately guarded. In this way, a survey control of the bridge during the construction and in the service life is made feasible (Fig. 6.1, 6.2, 6.3).

The following two criteria are decisive to select the benchmark locations on bridges:

- they shall be fully accessible and protected from damage,
- they shall be built-in on both sides, on all the piers and at particularly deformable locations.

The levelling of benchmarks built-in shall be in heights above sea level. It shall be prepared by an authorized institution.

The results of the zero-measurement of all the bridge benchmarks shall be recorded in an adequate form specified by the maintenance plan.

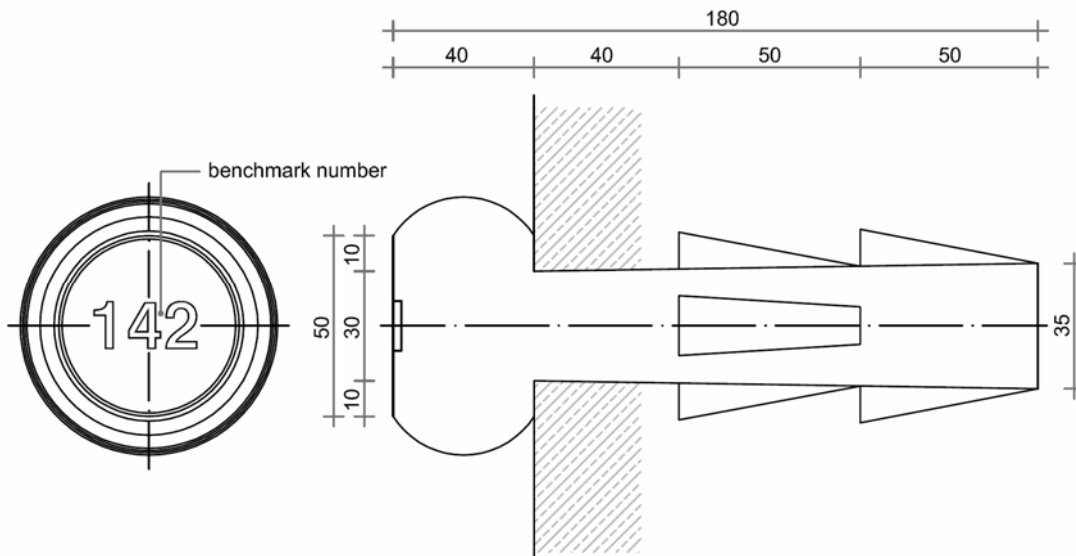


Fig. 6.1: Detail of a benchmark on pier

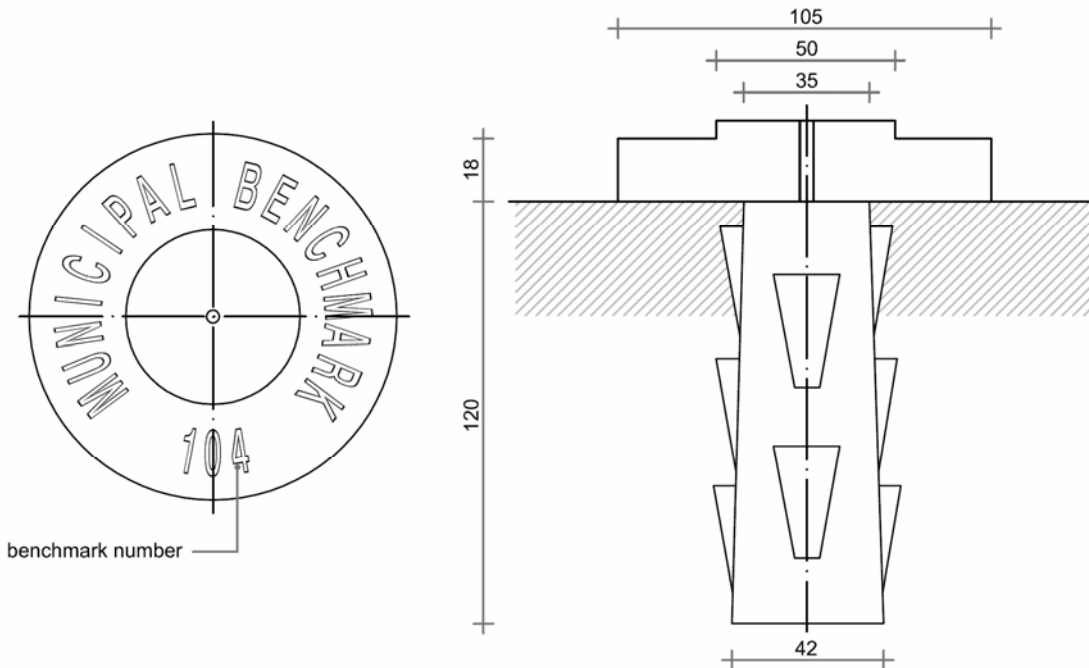


Fig. 6.2: Detail of a benchmark on abutment or outside the bridge

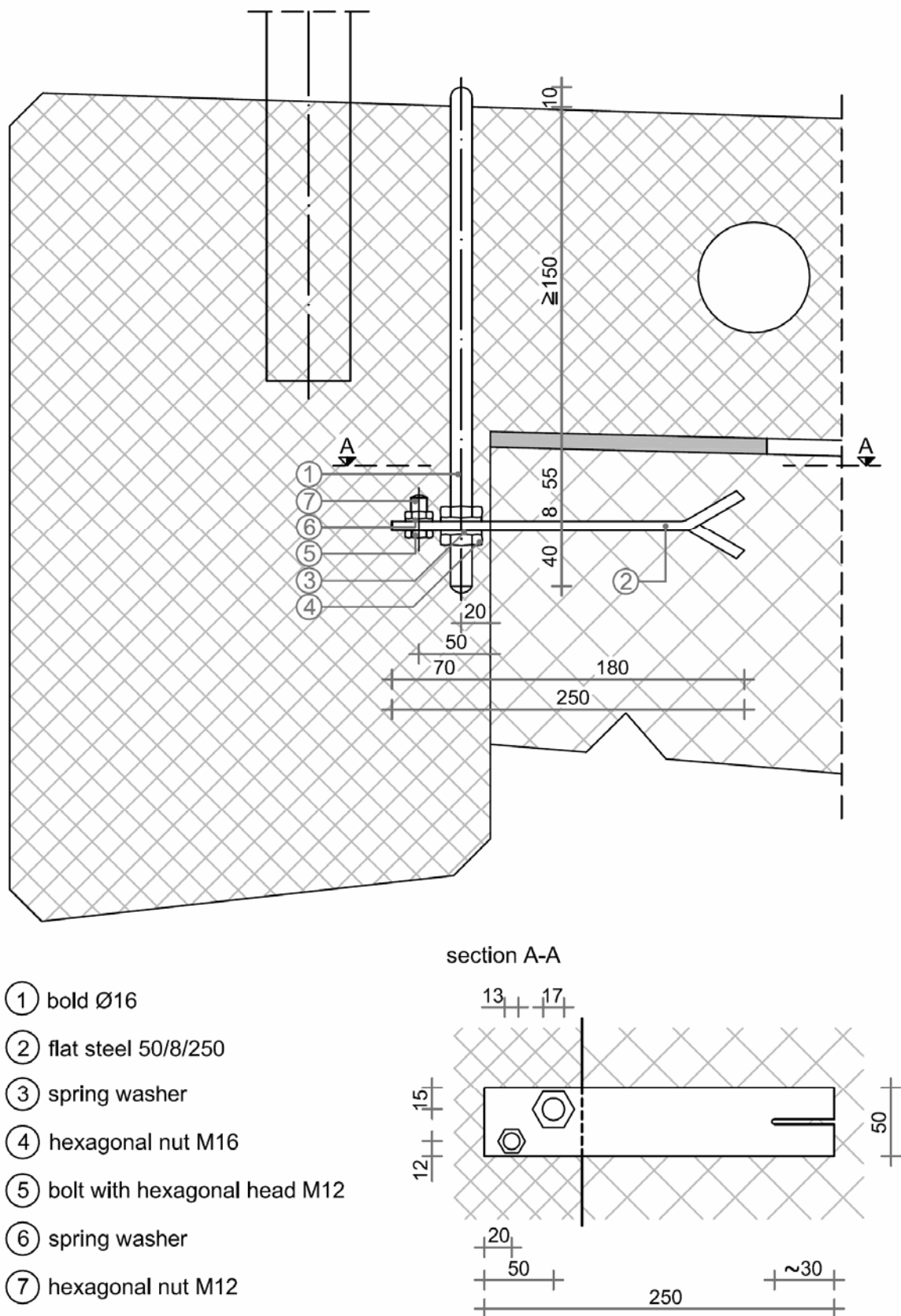
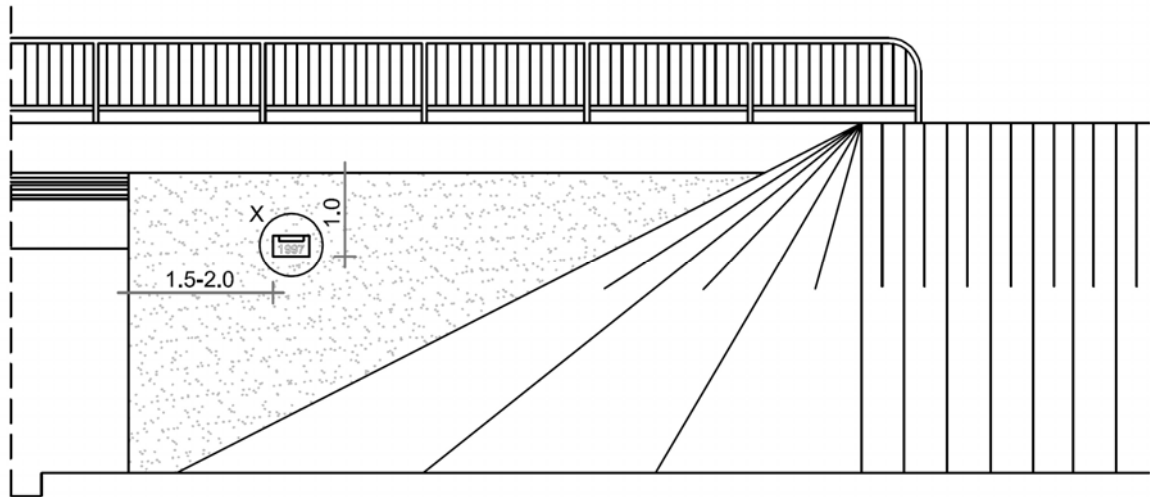


Fig. 6.3: Detail of a benchmark on superstructure

### 7 INFORMATIONAL BOARDS

All bridges shall be fitted with an informational board made of brass and fixed to the abutment. It shall indicate the contractor's name and the year of construction (Fig. 7.1).

Boards indicating the title of the bridge or the obstacle, or providing information relating to the traffic safety are a constituent part of the traffic design.



detail X

section A-A

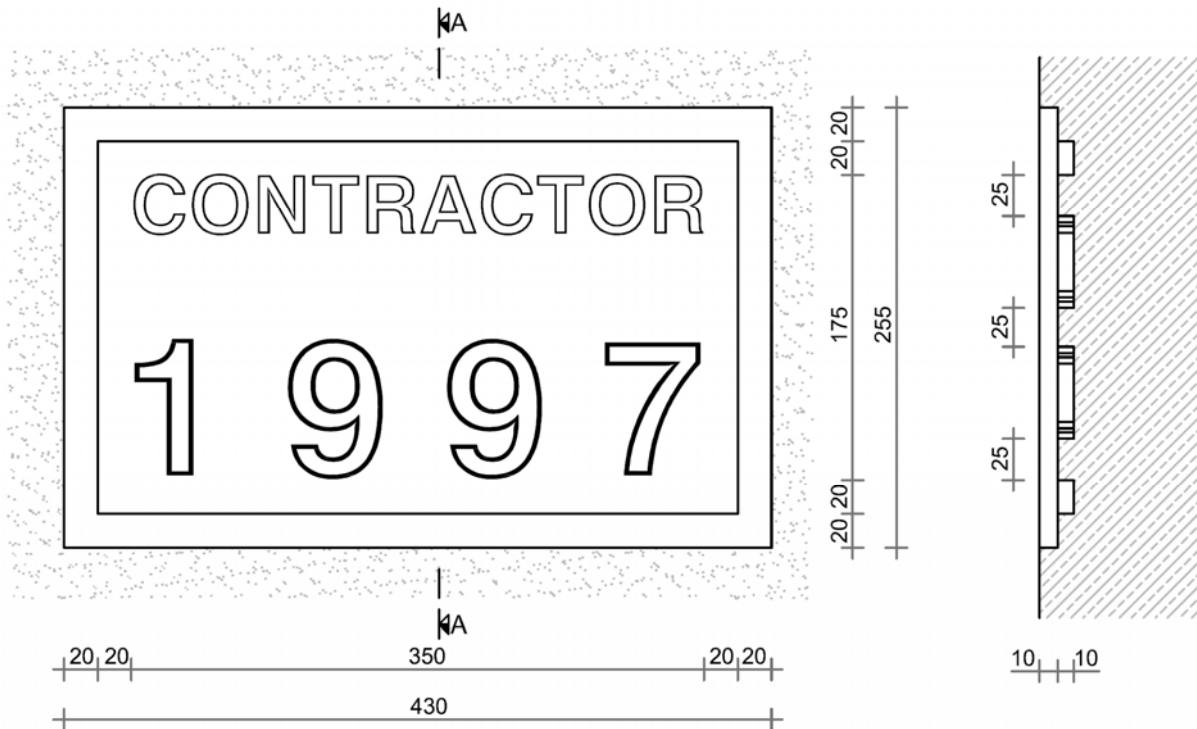


Fig. 7.1: Informational board



## 8 OPENINGS FOR VENTILATING AND DEWATERING BOX CROSS-SECTIONS

For closed superstructure and substructure box sections, ventilation openings shall be foreseen.

In the superstructure openings of  $\phi$  200 mm spaced at 20 m shall be executed. Each opening shall be protected with a mesh of 1x1 cm, as the birds must be prevented to enter the structural element. Openings are also indispensable at the lowest points of the box cross section to enable draining condensed water or the water from the

section A-A

sewage system running through the deck box girder (Fig. 8.1).

Hollow piers shall receive ventilation openings next to the top in a cross line through both walls. In this way it is possible, during bridge repair works, to insert steel girders for erection of working scaffolds or jacks used to repair/replace the bearings (Fig. 8.2).

At the bottom of hollow piers, openings for evacuation of eventual water shall be executed.

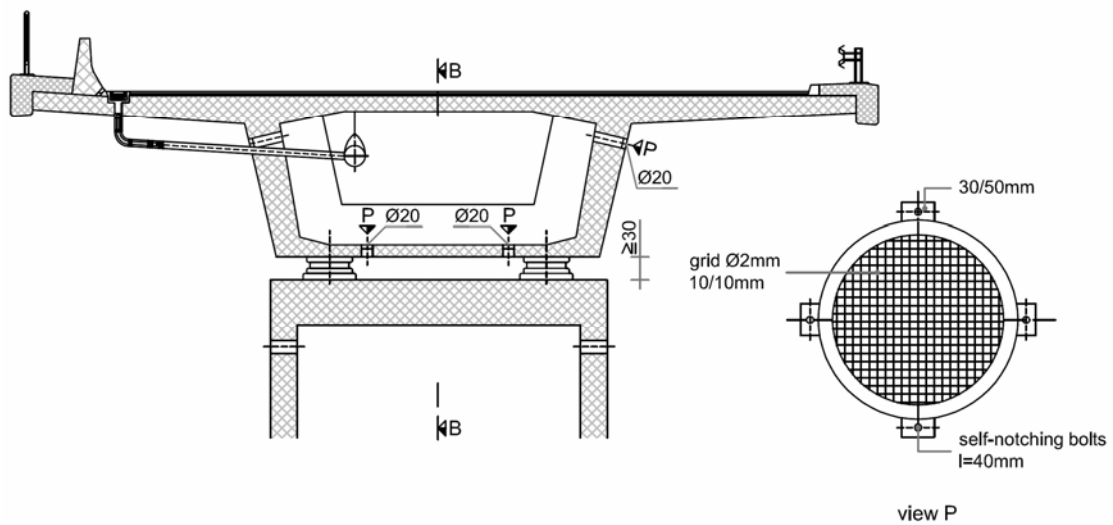


Fig. 8.1: Ventilation openings

section B-B

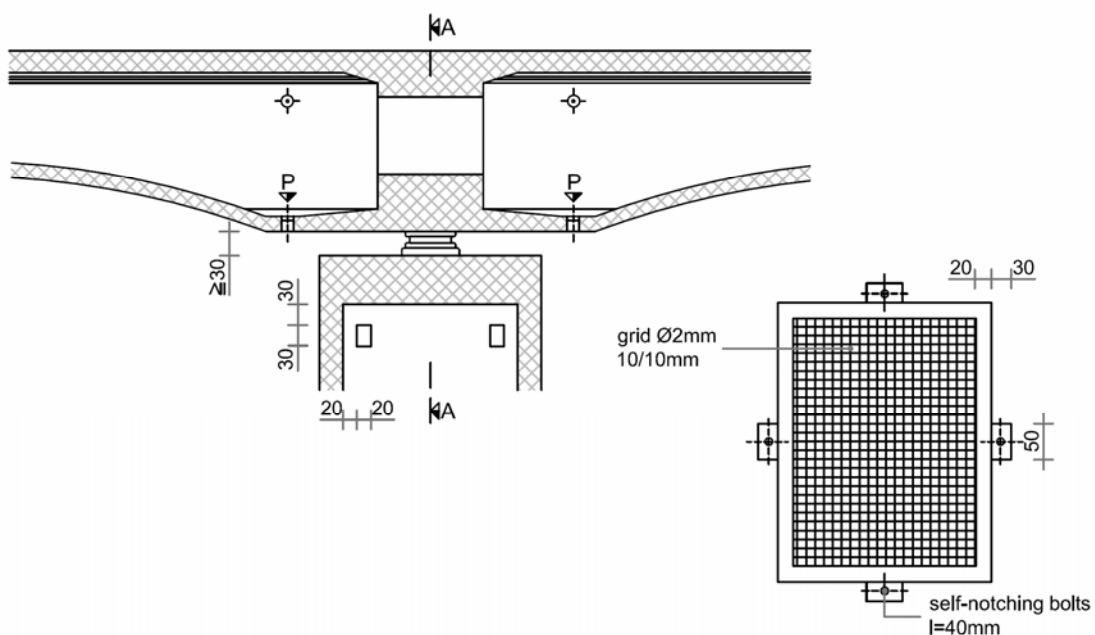


Fig. 8.2: Openings for hollow pier ventilation

## 9 SPECIAL VEHICLES FOR BRIDGE INSPECTION AND MAINTENANCE

Bridge inspection and maintenance are extremely important, since due repairs can prevent major damages to the bridge.

For this purpose the following equipment can be used:

A suitable steel ladder fixed to the bridge railing. By means of such a ladder, particularly installations on outer bridge sides can be inspected, where the cantilever amounts to less than 1.5 m.

A prefabricated carriage, placed onto the walkway and supported as cantilever over the railing, is used for inspection and maintenance of installations on larger bridges. The structural design of the carriage should allow the adjustment with regard to the walkway width, and a simple assembling.

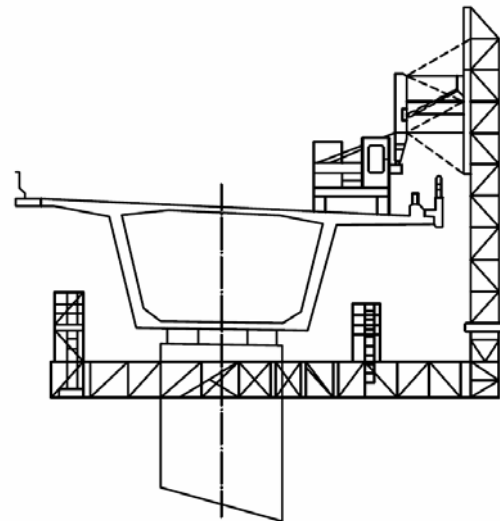
A basket on a hydraulically controlled arm is foreseen for inspection and minor repair of superstructures at certain inaccessible locations, when employment of special vehicles is not reasonable.

A movable, 1.0-1.5 m wide platform made of aluminium, which can be synchronically moved in either vertical or horizontal direction. It is intended for minor maintenance works on bridge superstructures.

A special vehicle for inspection and maintenance works on both superstructure and substructure of a bridge. It is essential to be familiar with all the characteristics of such a vehicle in view of its mass, accessibility, manoeuvring capabilities, outline dimensions and platform load bearing capacity.

### 9.1 Characteristics of Special Vehicle

The special vehicle MB1 180-1,7/S is intended for bridge inspection. In addition, such a vehicle can also be used for minor maintenance and repair works (Fig. 9.1 and 9.2).



<i>horizontal reach</i> .....	18m
<i>platform width</i> .....	1,7m
<i>width required on the bridge</i> .....	2,5m
<i>maximum weight acting on the bridge</i> .....	600kg
<i>maximum weight of the telescopic platform</i> .....	300kg
<i>maximum lowering depth</i> .....	9,0m
<i>platform rotation</i> .....	180°
<i>total weight</i> .....	26.000kg
<i>total length</i> .....	12,0m
<i>total width</i> .....	2,5m
<i>total height</i> .....	4,0m
<i>own hydraulic drive</i>	
<i>power supply to the platform</i>	

Fig. 9.1: Scheme and characteristics of the special vehicle MB1 180-1,7/S

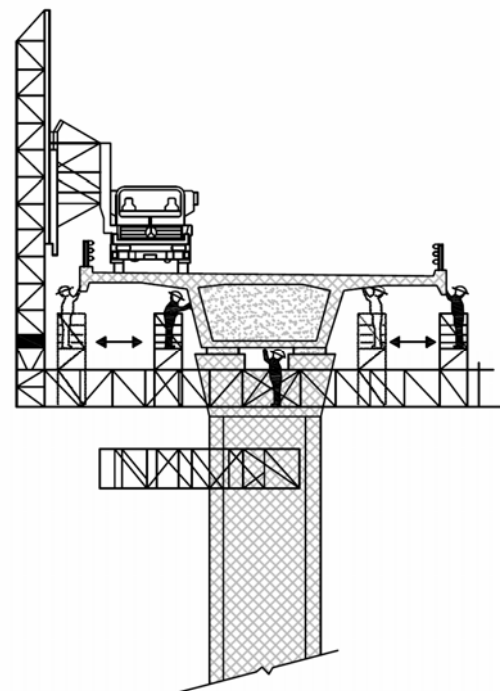
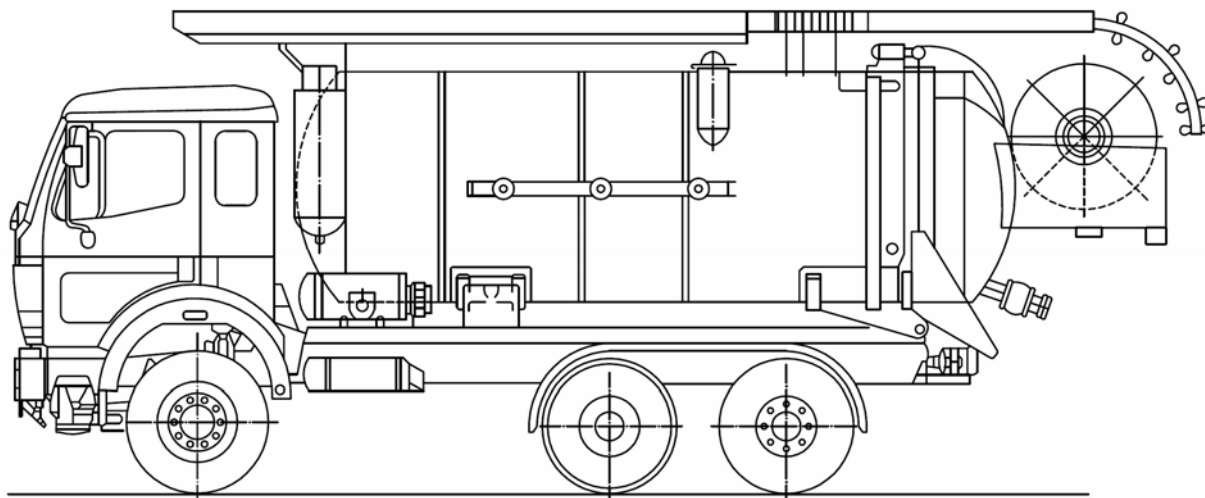


Fig. 9.2: Possible use of special vehicle

## 9.2 Vehicle for Maintenance of Bridge Drainage and Piping

In accordance with the maintenance plan, an annual cleansing of drainage pipes is foreseen immediately after the wintertime. For this purpose, companies carrying out maintenance are equipped with suitable vehicles (Fig. 9.3).



- tank volume 10.000 l
- useful volume 6.000 l
- additional suction connection for taking the water from open sources
- high pressure washing-out hose 13-40 m and 25-120 m
- watering can 0,5m
- cleansing head AQUA-BULL 250N
- pneumatically controlled closing pins
- negative pressure pump – suction capacity at 400 mbar – 1.060 m<sup>3</sup>/h
- high pressure pump – capacity 320 l/min
- working pressure 170 bar
- control of filling, water chamber, mechanical float and external pointer
- box for suction hose and suction hose itself

Fig. 9.3: Scheme and characteristics of a vehicle for drainage maintenance

## 10 BRIDGE MAINTENANCE PLAN

Bridge maintenance plan (BMP) is a constituent part of the as-built design for bridges of spans of  $\geq 5$  m.

BMP belongs to the contractor's obligations. It shall be worked out by the structural designer who was responsible for the bridge detailed design.

The goal of the BMP is to present briefly all the general information on the road, bridge, designer, contractor and supervisor, as well as on the load bearing structure, foundation, ground, foreseen settlements and bridge furniture. The BMP shall also include the maintenance instructions to preserve the designed function, service level, safety and durability of the particular bridge.

The bridge maintenance plan comprises the following:

- Technical report
- Provisions of bridge superintendence
- Bridge maintenance instructions
- Drawings and tables.

### 10.1 Technical Report

- General information: road, section, bridge, contractor + subcontractors, designer, supervisor.
- Extent and content of the bridge as-built design.
- A brief general description of the bridge.
- Design loading in the bridge service life (live load, wind, earthquake) and conditions for heavy transports.

- Materials of the bridge load bearing structure.
- Description and technical characteristics of the bridge load bearing structure (foundations, piers, abutments, superstructure).
- Expected settlements of the piers and embankments at piers in view of the ground characteristics, and provisions to accommodate inadmissible differential settlements.
- Bridge construction technology.
- Description and technical characteristics of the bridge furniture (bearings, expansion joints, drainage and piping, waterproofing, asphalt carriageway, railings, barriers, installations).
- Description and technical characteristics of maintenance equipment.
- Bridge particularities.

## 10.2 Bridge Superintendence

By implementing the bridge superintendence, traffic safety, serviceability and durability of a bridge are ensured. A level of the regular maintenance can be determined, and deficiencies that might cause major damage can be established and made good.

The bridge superintendence is composed of the following activities:

- carrying out inspections,
- preparation of reports,
- planning maintenance or repair works.

Bridge inspections are divided by time and function in the following ones:

- technical inspection (upon bridge handing over),
- routine inspections (at least once a month)
- regular inspections every 2 years,
- main inspections every 6 years and prior to expiry of the guarantee period,
- extraordinary inspections (immediately after exceptional events),
- detailed inspections (with a special intention).

In the guarantee period the inspections, with the exception of the routine ones, are carried through with the knowledge of the contractor liable to the guarantee. The bridge owner/maintainer is obliged to inform the contractor of the date of inspection. In the guarantee period, the owner/maintainer must also organise an extraordinary inspection in case of an exceptional event.

### 10.2.1 Technical Inspection

The technical inspection upon bridge handing over, also called zero-inspection, is carried out in accordance with the current Construction Law by the authority that has issued the building permit.

The following is established by the technical inspection:

- whether the bridge has been executed in accordance with the design documents and construction rules/standards;
- presence of all the quality control certificates,
- evidence of general safety of both the bridge and traffic.

Test loading of bridges, having a span more than 15 m, shall be carried through. The test loading results shall comply with the design values.

Both the zero levelling and the protocol of the measurement of reference points shall be attached to the maintenance plan. By means of these documents, settlements and deformations in the bridge service life will be checked (Table 1).

On the basis of positive results of the technical inspection, the relevant authority issues a service licence for the bridge.

### 10.2.2 Routine Inspection

Routine inspections are carried out by road inspectors at least once a month. The goal of a routine inspection is to find out and make good particularly those deficiencies that might jeopardize the bridge.

Extent and method: visual establishing of deficiencies on the bridge structure, carriageway and furniture, as well as making good of minor defects, particularly cleaning, announcing noticeable settlements or deformations of both the structure and road body at abutments.

Documents: an evidence of inspections performed shall be kept in the bridge maintenance book. When a major defect is discovered, the inspector is obliged to inform the road maintainer in writing.

The inspection shall be carried out by the road inspector being supplementary schooled in this domain.

### 10.2.3 Regular Inspection

Regular inspections are carried out every two years, unless a main inspection coincides with the regular one.

The intention of the regular inspection is to check all the elements of the bridge furniture, carriageway and load bearing system, which are accessible without any special devices. Beside phenomena, that threaten the traffic safety, damages and adverse features on the structure, which could jeopardize the bridge safety, serviceability and durability, shall be found out.

Extent:

- on the entire bridge, all the changes that have occurred from the last regular inspection shall be established;
- condition of the bridge and individual elements shall be assessed, as well as a deviation from the original quality shall be found out;
- eventual major deformations of both the superstructure and substructure shall be measured;
- upon first inspection, levelling of reference points (benchmarks) shall be carried out, and the results shall be recorded in an adequate form;
- eventual measures for additional investigations shall be proposed;
- maintenance provisions shall be suggested.

Method: the condition is assessed within the abovementioned scope, especially visually and by means of simple investigations (percussion, sclerometry, levelling, etc.).

Documents: a record of the inspection shall mandatory be kept. General data as well as bridge and furniture condition shall be recorded. A standard record can be used. In the conclusion of the protocol, measures to make good defects and to ensure bridge durability shall be foreseen.

Performer of the inspection: a crew under the lead of an expert, i.e. civil engineer having passed a professional exam and being adequately experienced. In the guarantee period, a representative of the contractor, who is liable to the guarantee, shall be informed of the inspections planned.

### 10.2.4 Main Inspection

Main inspections are carried through every six years and upon expiration of the liability period.

Intention: goals and content of main inspections are the same as it applies for regular inspections. However, a main inspection shall also cover locations of an insufficient accessibility or covered places, such as lower side of the deck, piers, bearings, etc. Suitable devices enabling access shall be employed.

During each main inspection, levelling of reference points, i.e. benchmarks shall be performed, which must be entered into a suitable form (Table 1).

Performer of the inspection: a crew under the lead of an expert, i.e. civil engineer having passed a professional exam and being specially qualified for inspection of bridges and assessment of their condition.

### 10.2.5 Extraordinary Inspection

Extraordinary inspections shall be carried out during/after exceptional events such as:

- earthquake, heavy rainfall, flood, landslide, exceptional temperatures, fore in close vicinity;
- serious traffic accidents and impacts of vehicles on the bridge;
- exceeded loading or phenomenon of sudden damages;
- spilling of liquids harmful to the load bearing structure;
- events during war.

Both extent and goal of the inspection depend on the type and extent of damages or on the reason of the inspection.

### 10.2.6 Detailed Inspection

Detailed inspections serve as a base to assess the actual quality and safety of the entire structure or as a base to carry through a diagnosis and define the rehabilitation principle. A detailed inspection shall be executed in the following cases:

- if the quality, bearing capacity or safety are doubtful;
- in case of increase of loading or in when heavy transports are foreseen;
- if the results of regular or main inspections impose certain rehabilitation measures;
- in case of disputes, litigations or similar.

The content and extent of a detailed inspection depend on the motives for such an inspection. Beside visual inspection, the structure shall be tested statically and dynamically. In addition, characteristic structural elements and their materials shall be investigated as well.

Detailed inspections are performed by professional institutions, having at disposal adequate equipment and experienced staff being able to execute the investigations required and to interpret the results obtained. The report shall include the results of all the measurements carried out, as well as appropriate decisions foreseen.

### 10.2.7 Measurements in Periods Between Individual Inspections

On certain bridges, where major settlements due to poor foundation conditions or major deformations due to particularities of the bridge deck are expected, some measurements shall also be performed in periods between individual inspections (Table 1). Both extent and frequency of such measurements shall be indicated in the technical report of the maintenance plan (9.1.7).

In the guarantee period, those measurements shall be carried out by the bridge contractor. Preliminarily, the bridge maintainer shall be informed of the measurements. The results of those measurements shall be submitted to the bridge maintainer by the contractor.

## 10.3 Bridge Maintenance Works

Information of certain specific climatic conditions for bridge maintenance works. Beside cleansing of the bridge and its furniture as well as replacement of wearing parts, all other works not intervening in the bridge structure also belong to the maintenance.

The extent of the required maintenance works, except regular cleansing, is determined by the conclusions of the abovementioned inspections.

For each bridge, a maintenance book shall be kept where all the events that have happened on the bridge (such as maintenance works, inspections, exceptional heavy transports, etc.) are recorded. The maintenance book shall be accessible to the contractor until the liability period has expired.

### 10.3.1 Regular Cleansing of Bridges

Regular cleansing of a bridge includes a general cleansing twice a year, i.e. in the spring and autumn, and an additional cleansing ordered by the road inspector, when his own capabilities are exceeded. Both the date and extent of regular cleansing shall be recorded in the maintenance book.

The spring cleansing shall be carried out after the winter season of ploughing and strewing sand or de-icing salt.

Regular cleansing includes particularly the following:

- washing of concrete safety barrier to remove the salt on the inner exposed side,
- cleaning of carriageway surface and removal of sand,
- cleansing of gullies and drainage through the gullies,
- cleansing of expansion joints being nearly fully opened in that period.

The autumn cleansing shall be performed prior to the winter season. All the dirt due to the traffic and vegetation shall be removed.

The following works are included:

- cleaning of carriageway surface (removal of oil and other debris from the vehicles, leaves and other vegetation);
- cleansing of gullies;
- cleansing of expansion joints;
- cleaning of bearing block at the abutment.

Additional cleansing is carried out when the road inspector orders so. The reasons that have led to such decision shall be done away.

### 10.3.2 Other Maintenance Works and Particularities

Other maintenance works are determined on the basis of conclusions of bridge inspections and to ensure the traffic safety. Particularly the following is comprised:

- repair of damages to bridge drainage,
- touching-up corrosion protection coating on steel elements,
- repair of barriers damaged due to vehicle impact,
- replacement of furniture wearing parts,
- application of protective coating to exposed concrete surfaces,
- maintenance of electronic weather station and emergency call,
- patching asphalt,
- filling cracks and joints.

**Expansion joint:** it is essential to cleanse the expansion joint opening. In case that the expansion joint sealing strip is mechanically damaged, which can be perceived on the basis of bearing block soaking or visually from above, the strip shall be completely or partly replaced within the scope of the maintenance works.

Where an expansion joint is fitted with two sealing strips, the height position of the middle steel beam compared to the both end beams shall be checked upon passing over of a heavy vehicle. An increased noise at that moment can also be an indication that certain expansion joint elements are damaged or worn out.

For the needs of the winter service, the expansion joint location on a bridge shall be marked.

**Bearings:** reinforced rubber bearings do not require any special maintenance. Eventual changes established on the bearings shall be recorded. In case of irregularities such as

- horizontal deformation greater than 70% of the thickness,
- cracking of rubber by layers (due to overloading),
- irregular cracking of rubber (due to its age or other reasons),
- other deformations (rotations, slips, turning up, one-sided lifting, etc.), suitable measures such as loosening of bearings, repair of bearing cushions or replacement of bearings shall be foreseen.

**Drainage and piping:** checking of gullies, seepage water pipes, superstructure dewatering pipes, expansion joint drainage, dewatering of bearing blocks and other load bearing structural elements and furniture DG 1.2.5.

#### 10.4 Drawings

Characteristic reduced scale and uniform layout drawings of a bridge (plan, longitudinal section, characteristic cross section, section through abutments, section through characteristic piers), emphasizing maintenance equipment such as stairs, ladders, openings and doors (Fig. 10.1).

A sketch of reference points/benchmarks required for checking bridge deformations and settlements, including the information of the zero benchmark with reference to the existing level net.

A table comprising the results of checking reference points/benchmarks, including the results of the zero measurement prior to bridge technical inspection (Table 10.1).

Magnitudes of critical settlements and deformations shall be indicated. When the specified values are exceeded, prompt action shall be taken and the investor, contractor and designer shall be advised.

The zero reference point/benchmark including its height above sea level shall be indicated and drawn.

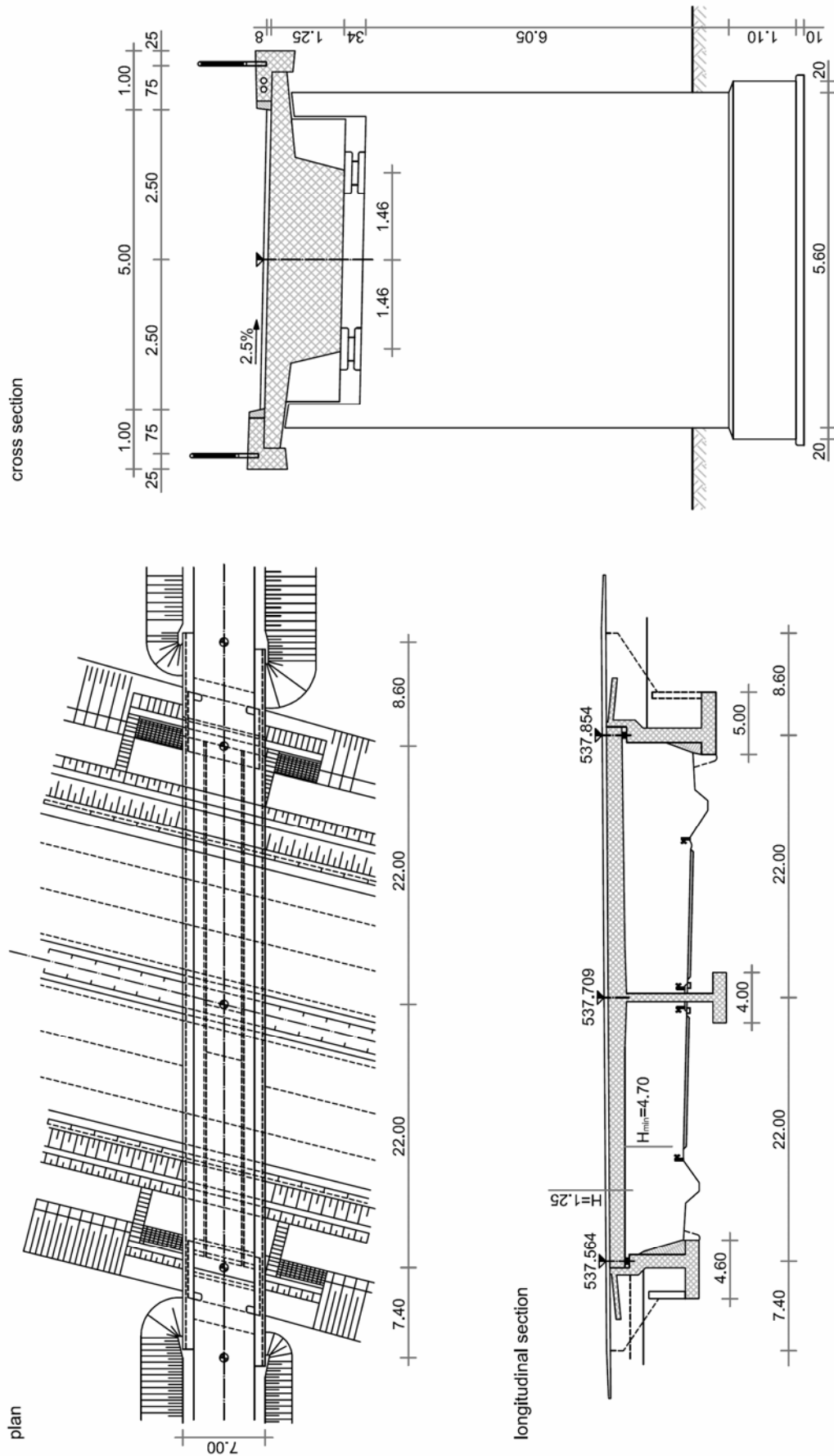

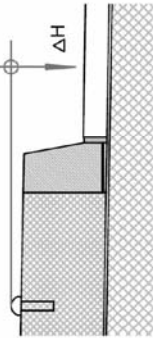


Fig. 10.1: Bridge layout drawing indicating arrangement of benchmarks (1 – 10)



Table 10.1

Road	km	Structure	Page													
Measurements of settlements	Walkway south															
Benchmark																
No.	Height (m)															
		 type 1	 type 2													
Measurements performed by	Contractor's representative	Weather and visibility	Temperature													
Date	Measuring point	$\Delta H$ (mm)	<b>1</b>	Measuring point	$\Delta H$ (mm)	<b>2</b>	Measuring point	$\Delta H$ (mm)	<b>3</b>	Measuring point	$\Delta H$ (mm)	<b>4</b>	Measuring point	$\Delta H$ (mm)	...	$\Delta H$ (mm)