GUIDELINES FOR ROAD DESIGN, CONSTRUCTION, MAINTENANCE AND SUPERVISION

Volume I: DESIGNING

Section 2: DESIGNING BRIDGES

DESIGN GUIDELINES (DG 1.2.9)

Part 9: JOINTS IN CONCRETE BRIDGES AND STRUCTURES

INTRODUCTION

Joints are essential elements both during the construction and in the service life of structures, as they enable a correct design of the construction technology, which influences substantially the structural durability. Joints shall be already planned within the building permit design and the project implementation design.

Both the design and the execution of the joints also depend on the structural scheme, properties of the concrete placed, and the way of protection of the concrete being in contact with soil, ground water or running water.

Areas at joints represent structural weak points. Therefore, the joints shall be properly conceived and designed as well as carried out very thoroughly.

C O N T E N T S

1 SUBJECT OF DESIGN GUIDELINES

In the present Design Guidelines, individual joint types are defined. In addition, motives for designing and execution the joints are presented.

Basic rules of the joint design are indicated.

2 REFERENCE REGULATIONS

The following codes, norms and technical regulations are included in the present Design Guidelines.

DIN codes
DIN 1055, DIN 4227, DIN 1072, DIN 1045, DIN 4019, DIN 7865, DIN 4060, DIN 1623, DIN 1541, DIN 4033, DIN 4062, DIN 4102, DIN 18540.

Austrian Guidelines
Wasserundurchlässige Betonbauwerke – Weiße Wannen
(Waterproof Concrete Structures–White Tubs),
Österreichischer Betonverein, March 1999

3 EXPLANATION OF TERMS

Expansion joints (EJ)

Expansion joint is a common term for an opening between two structural elements. It shall be so designed and executed as to allow displacements and rotations of structural elements, as well as to be waterproof at the same time.

Contact joints (CONTACTJ)

Contact joint is a common term for dividing of individual parts of the same structural element.

Fictive joints (FJ)

Fictive joint is a common term for weakening of the structural element section, enabling formation of controlled cracks.

Construction joints (CJ)

Construction joint is a common term for a joint appearing between two structural elements or two parts of the same structural element cast at different times.

4 GENERAL

4.1 Basic Considerations

The basic reasons requiring execution of the joints in structures are the following:
- Size of the structure (area, concrete quantity);
- Construction method (casting shifted by time);
- Creep and shrinkage phenomena.

The construction technology of major bridges and other civil engineering structures shall be thoroughly planned as to precisely define casting of individual sections at different times. Greater quantities of concrete, cast to construct individual structural elements, essentially affect the magnitude of creep and shrinkage phenomena in the structure. All these factors condition the joints in a structure. Joints shall be already planned at the stage of working out the building permit design and the project implementation design.

Joints are essential elements both during the construction and in the service life of a structure as they enable a correct conception of the construction technology, which has a great influence on the structural durability.

The joint design and execution depend, among others, on the structural scheme, properties of the cast concrete and the method of protection of the concrete being in contact with soil, ground water or running water. Namely, structures can be made either of

- Waterproof concrete in accordance with the "white tub" principle, or
- Concrete protected with the black waterproofing ("black tub").

Areas at joints represent structural weak points. Therefore, the joints shall be properly conceived and designed as well as carried out very thoroughly.

4.2 Purpose of Joints

The reasons imposing execution of structural joints are the following:

- Separation of structural elements due to the size, the construction in stages or the construction of an additional element to the existing structure;

- A better accommodation of the structure to the properties of the foundation ground where a non-uniform settlement of the structure is expected. The reasons of this phenomenon are the following:
  variable properties of the foundation ground,variable ground water level, excavation of new and particularly deeper construction pits, different dynamic effects of the traffic load, execution of individual construction sections shifted by time.

- Reducing of the effects of secondary forces and moments due to concrete shrinkage and creep, as well as by the temperature effects;

- Creation of logical construction segments for major structures, thus simplifying the formwork, reinforcement and casting;

- Taking of movements due to external load applied to the structure;

- Taking of movements due to seismic action;

- Formation of controlled cracks.

4.3 Classification of Joints

By the purpose and the method of execution, the joints can be divided as follows:

- **Expansion joints (spatial joints)**
- **Contact joints (dividing joints)**
- **Fictive joints (joints for designed cracks)**
- **Construction joints**

5 EXPANSION JOINTS (EJ)

5.1 Definition

Expansion joint is a common term for an opening between two structural elements. It shall be so designed and executed as to allow movements and rotations of structural elements, as well as to be waterproof at the same time.

Expansion joints are always required when movements of structural elements due to internal (constrained) and external forces have to be made feasible. In this way, the occurrence of tensile stresses in concrete and the formation of cracks are prevented.

Expansion joints enable movements of divided structural elements in several directions. They also allow an eventual rotation without constraints. This type of joints can also be called **spatial joints** as they allow settlements, elongations and rotations of structural elements.

Divided elements can move perpendicularly to the joint plane (opening and closing of the joint) without occurrence of constraints. Transverse movements of joint can be prevented by means of notches. This type of joints can be called **tensile joints**. They enable a change of structural element shape (length) due to phenomena of shrinkage and creep as well as to temperature changes.

An expansion joint also allows movements of divided structural elements in the joint plane (settlement of the element) without appearance of constraints. Such type of joints can be named **separating joints** or **joints allowing settlement**. They enable a non-uniform settlement of structural elements for numerous reasons indicated in 4.2

The expansion joint width shall be determined for each individual case.

Expansion joints in bridge superstructures are not subject of these Design Guidelines as they are discussed in the DG 1.2.7 Expansion Joints on Bridges.

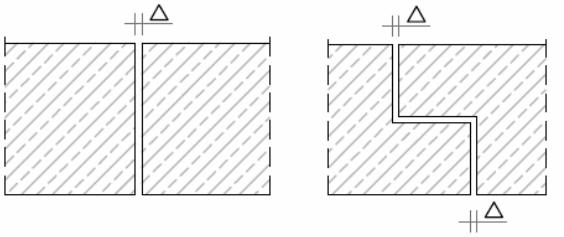


Fig. 5.1: Schematic presentation of an expansion joint

5.2 Design

Expansion joints shall be so carried out as to fully divide adjoining structural elements. The reinforcement is entirely interrupted, and the concretes of those elements are divided as well. The joint is filled up with a special material and so executed as to be waterproof.

The water-tightness of expansion joints is provided by means of sealing strips. They shall be placed on the surface of a structural element when its thickness amounts up to 50 cm, or into the cross-section interior when its thickness is > 50 cm.

In certain cases, the expansion joint width can be verified by calculation. However, it shall often be determined empirically. This particularly applies in cases where the magnitude of movements is affected by several factors, thus their total effect cannot be exactly assessed. Anyway, such a width of a joint shall be specified that no secondary forces or damages to the sealing material occur in the structure. The surrounding temperature during concreting shall be taken into account in specifying the joint width.

Both the spacing and the width of expansion joints depend on the structural type, static requirements, special construction states, structural geometry, and action effects due to shrinkage, creep, temperature, external loading, etc.

As a rule, the expansion joint width shall amount to 2 cm.

5.3 Execution

Expansion joints are executed simultaneously with erecting the formwork and placing the reinforcement.

To carry out an expansion joint, some flexible material shall be used as a formwork, which must not reduce the expansion joint opening neither affect its purpose. Subsequently, the expansion joint formwork is not removed.

On the exposed side, the joint shape is achieved by means of a trapezoidal lath.

The water-tightness of a joint is ensured by means of PVC or rubber strips, fixed in such a way that they cannot be moved or damaged.

5.4 Materials

An expansion joint shall be made of a hard foamy (polystyrene), rubber or bituminous panel. On the exposed side it shall be sealed with sealing mastic or a sealing strip of the colour of concrete surface. On the backside, a sealing strip shall be placed.

The sealing strips shall be made of durable PVC material or synthetic rubber.

On the exposed side of the structure, the joint shape is achieved by means of a trapezoidal lath.

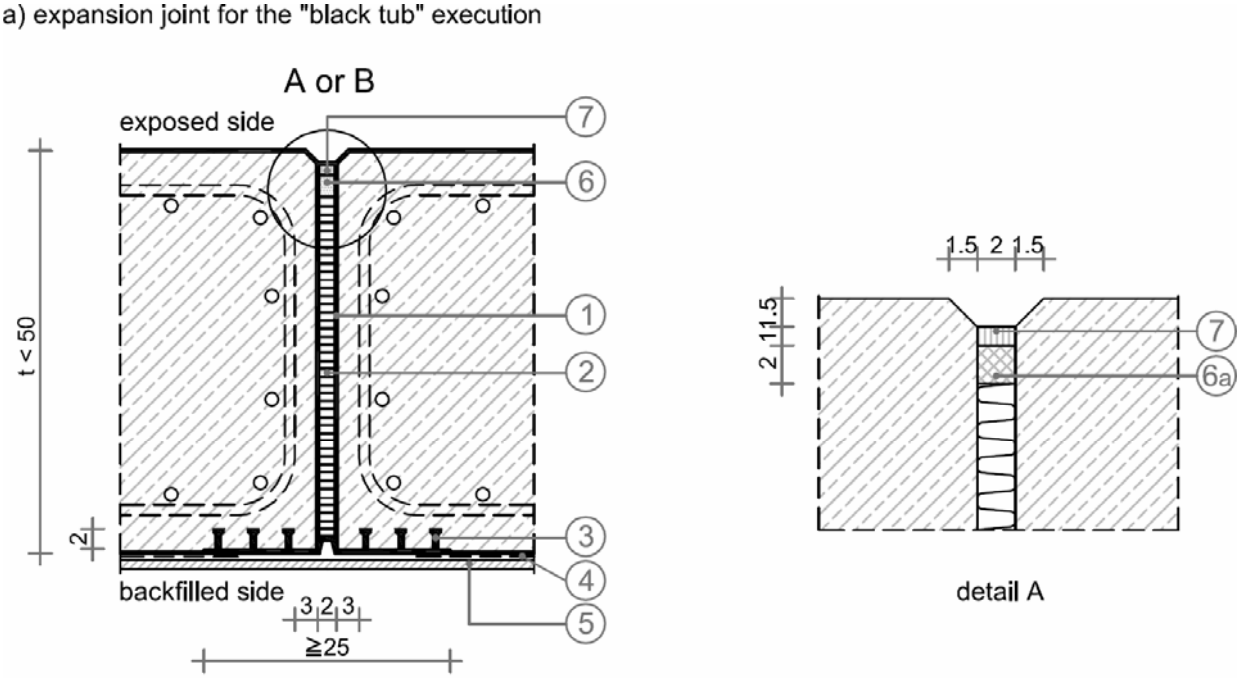
5.5 Maintenance

On the backside, the expansion joint shall be executed in such a way that it is durable as no maintenance is feasible.

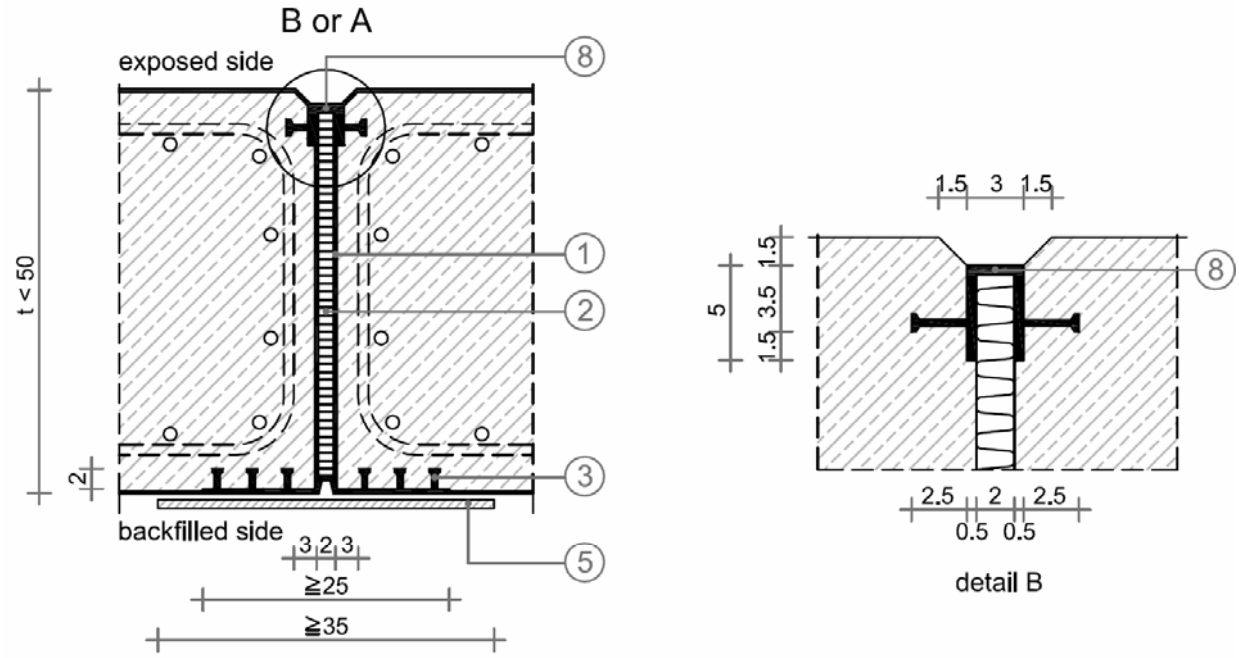
On the exposed surfaces, the mastic shall be restored and mechanical damages to concrete made good (trapezoidal shape).

When an expansion joint does not ensure the water-tightness, it shall be adequately repaired.

a) expansion joint for the "black tub" execution



b) expansion joint for the "white tub" execution



(1) one-sided incombustible coating
(2) hard foamy panel
(3) expansion joint external sealing strip
(4) sealing strips
(5) mechanical protection of sealing
(6) joint filler (foamy rubber)
(6a) durable elastic filling material
(7) durable elastic joint compound
(8) expansion joint end strip

Fig. 5.2: Expansion joints for structural elements of a thickness < 50 cm, with a sealing strip on the backfilled side

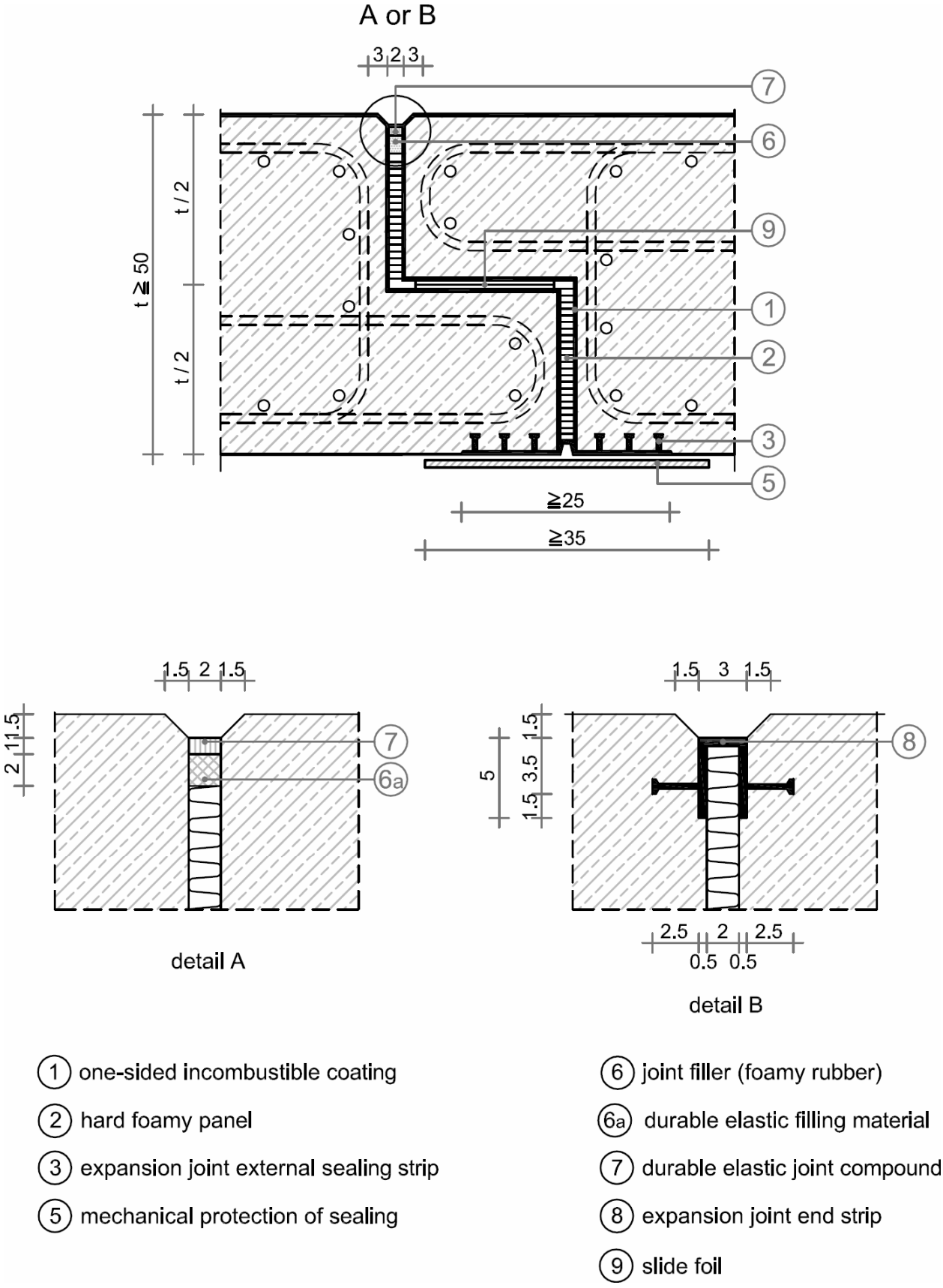
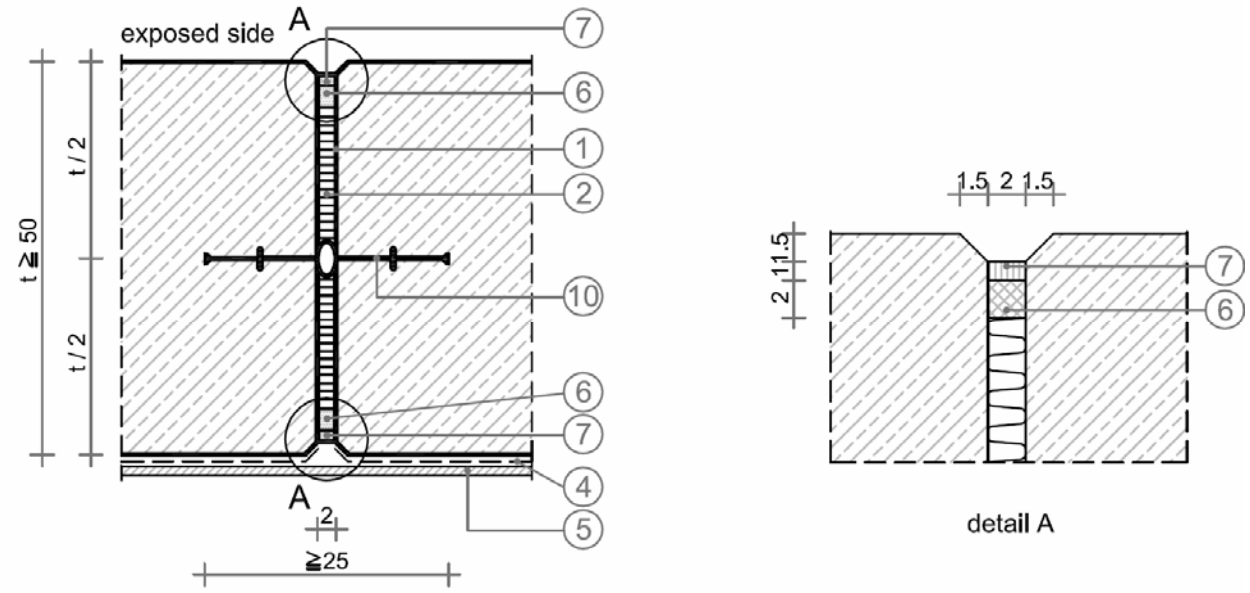
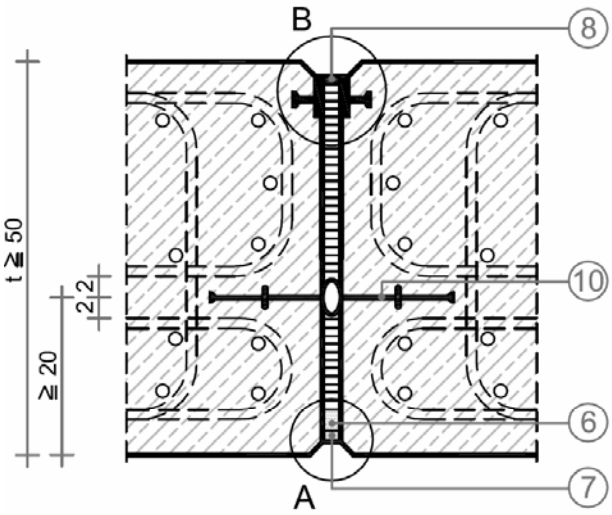


Fig. 5.3: Expansion joints for structural elements of a thickness > 50 cm with a groove

a) expansion joint for the "black tub" execution



b) expansion joint for the "white tub" execution



(1) one-sided incombustible coating
(2) hard foamy panel
(4) sealing strips
(5) mechanical protection of sealing
(6) joint filler (foamy rubber)
(7) durable elastic joint compound
(8) expansion joint end strip
(10) inner sealing strip

Fig. 5.4: Expansion joints for structural elements of a thickness > 50 cm with a sealing strip in the cross-section interior

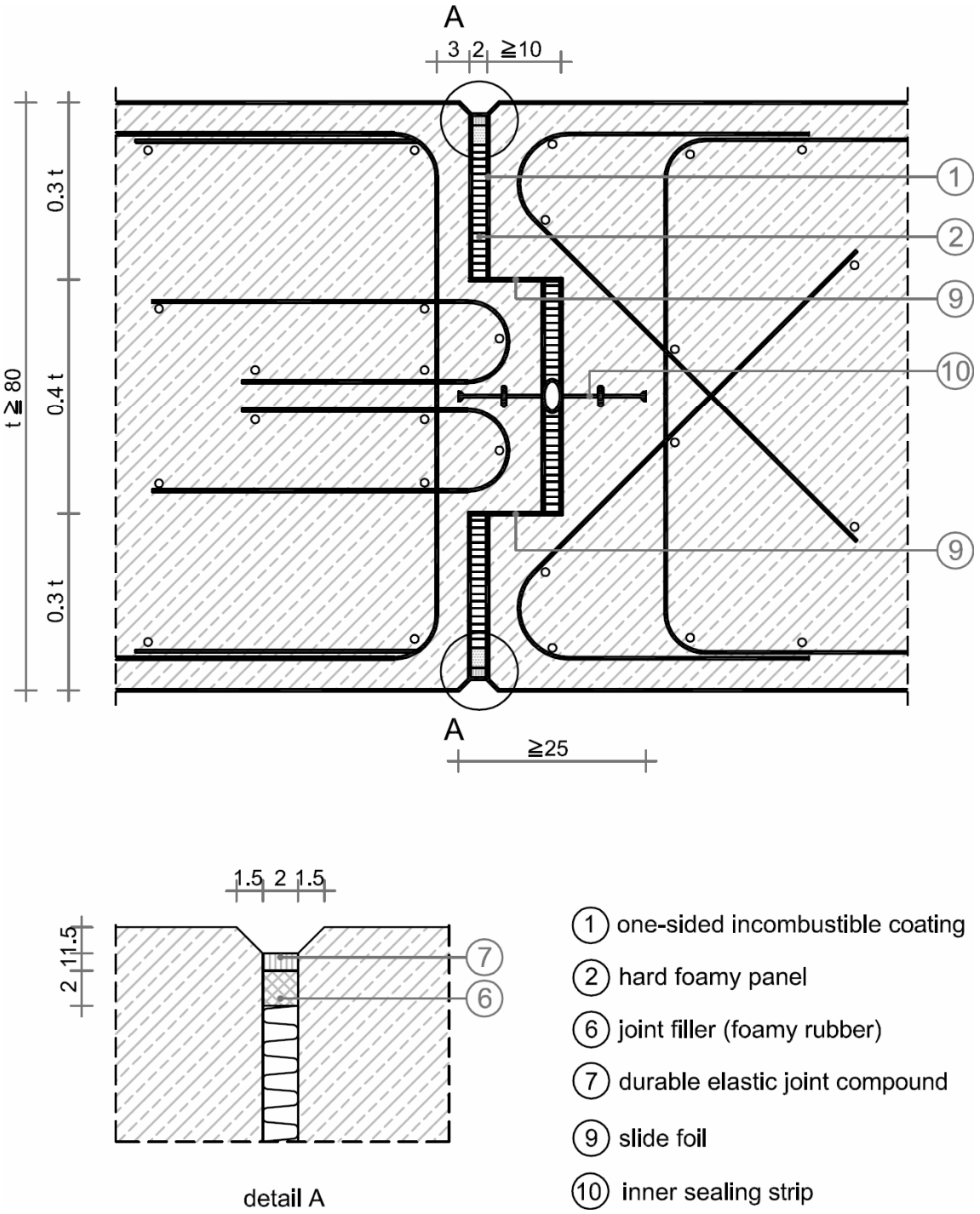


Figure 5.5: Expansion joints for structural elements of a thickness > 80 cm with a groove

6 CONTACT JOINTS (CONTACTJ)

6.1 Definition

Contact joint is a common term for dividing of individual parts of the same structural element.

The following types are distinguished:

- Contact joints without interspacing (Fig.6.2)
- Contact joints with interspacing (Fig.6.3)

Contact joints allow only insignificant movements and rotations of individual parts of a structural element. They render possible a subsequent construction of individual parts of a structural element.

Contact joint with an interspacing allow movements due to shrinkage, temperature action and settlement. As soon as the changes of the length and of the position of individual parts of a structural element are completed, the interspacing shall be cast.

Contact joints with an interspacing enable the change of the stiffness of a structural element, the modification of the stress distribution, and the change of the static system. For these properties, contact joints can be distinguished from very similar construction joints, which are exclusively imposed by technological reasons.

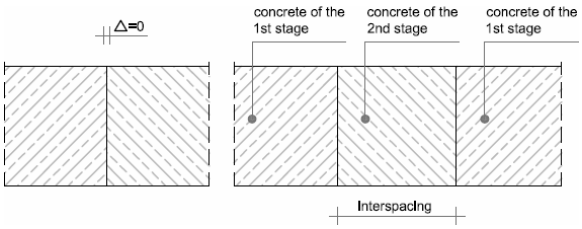


Figure 6.1 Schematic presentation of a contact joint without interspacing, and of a contact joint with interspacing

6.2 Design

Contact joints without interspacing are carried out in such a way that the parts of a structural element are cast one by one without homogenous connection. The reinforcement is interrupted. The concretes of the adjoining parts are divided by means of a thin dividing foil such as different types of coatings, oiled paper, cardboard, etc.

The water-tightness of contact joints is ensured by means of sealing strips. They shall be placed on the surface of a structural element when its thickness amounts up to 50 cm, or into the cross-section interior when its thickness is > 50 cm.

The spacing of contact joints without interspacing depends on the construction technology.

Contact joints with interspacing are carried out during erecting the formwork and placing reinforcement of a structural element. The interspacing is shaped by means of a ribbed ductile steel plate.

Both the width and the shape of an interspacing depend on the spacing of contact joints, the concrete thickness and the type of the structural element, which they appear in.

The reinforcement in the cross-section is not interrupted.

Contact joints with interspacing can be sealed with a sealing strip on the surface or in the interior of the structural element, or they are executed without sealing strip, when the structure is protected by means of a black waterproofing.

Spacing of contact joints with interspacing depends on the structural and static properties of the particular structure, or on the construction method.

Both the shapes and the methods of execution of contact joints with interspacing are shown in sketches hereinafter.

6.3 Execution

Contact joints are executed simultaneously with erecting formwork and placing reinforcement of a structural element.

A contact joint without interspacing is executed in such a way that the parts of a structural element are cast one by one. The reinforcement is interrupted, so that there is no homogenous connection between individual parts. The dividing layer can be a sort of coating, oiled paper, cardboard, etc.

The sealing PVC or rubber strips ensuring the water-tightness shall be adequately fixed to prevent their movement or damage. The shape of a contact joint without interspacing can be achieved by means of a triangular lath.

A contact joint with interspacing shall be formed during erecting formwork and placing reinforcement of a structural element. A ribbed ductile steel plate shall be applied as the joint formwork. The contact joint shall be appropriately reinforced as well.

The exposed sides of the contact joint on wall elements shall be shaped by the aid of trapezoidal laths.

6.4 Materials

The dividing layer of a contact joint without interspacing can be a type of coating, oiled paper, cardboard, etc.

The formwork for contact joints is made either of a ribbed ductile steel plate or a profiled panel.

The sealing strips are made of durable PVC material or synthetic rubber.

The shapes of contact joints on exposed sides of the particular structure shall be achieved by means of trapezoidal, triangular or rectangular laths.

6.5 Maintenance

On its backside, a contact joint shall be executed in such a way that it is durable, as no maintenance is practicable.

On exposed sides, mechanical damages to concrete shall be made good (trapezoidal, triangular shape).

When a contact joint does not ensure the water-tightness, it shall be adequately repaired.

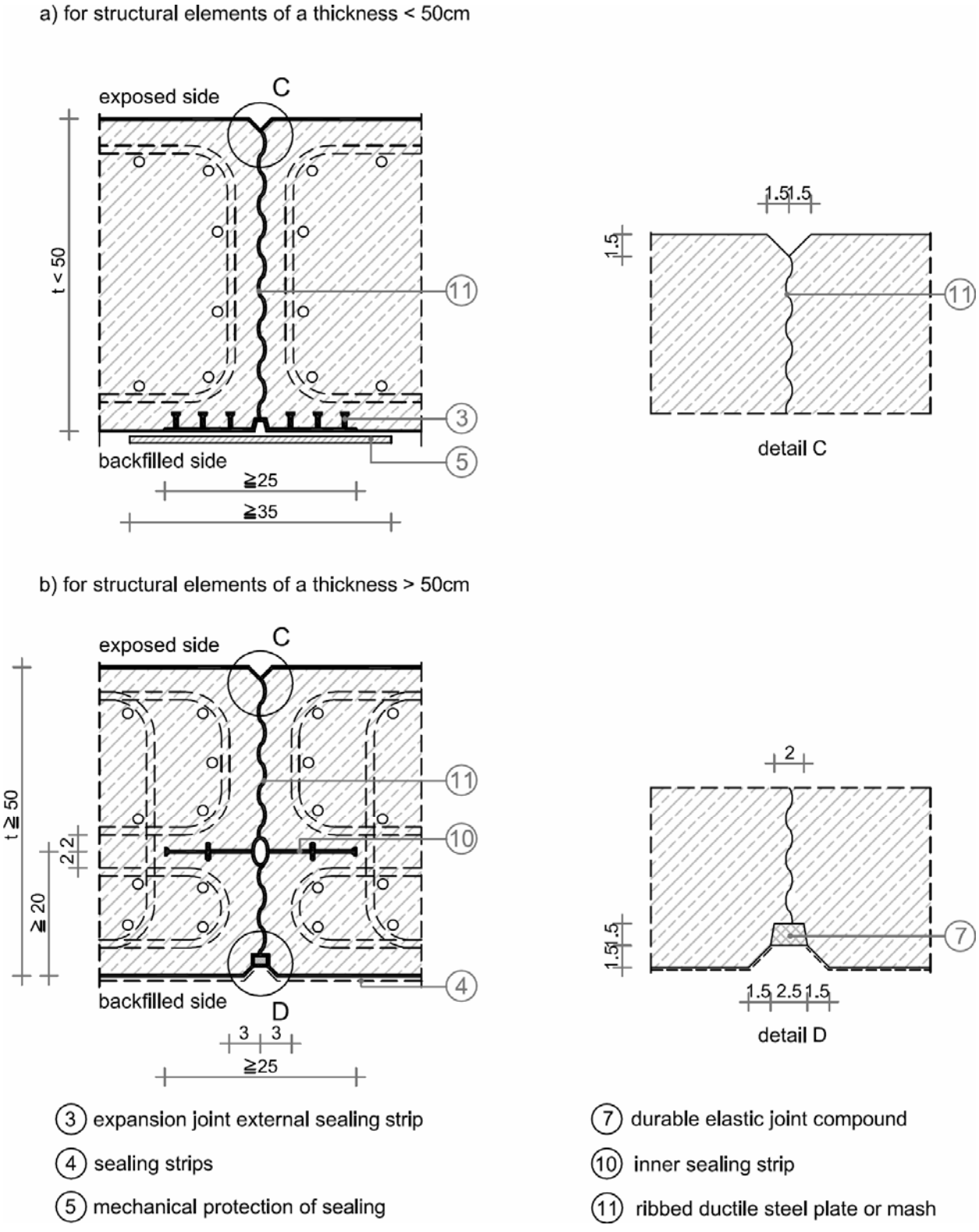
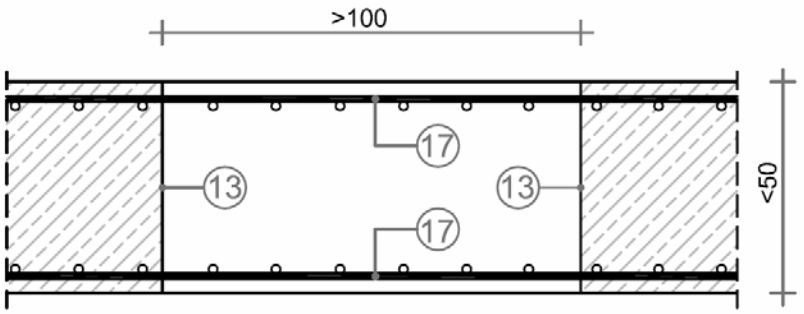
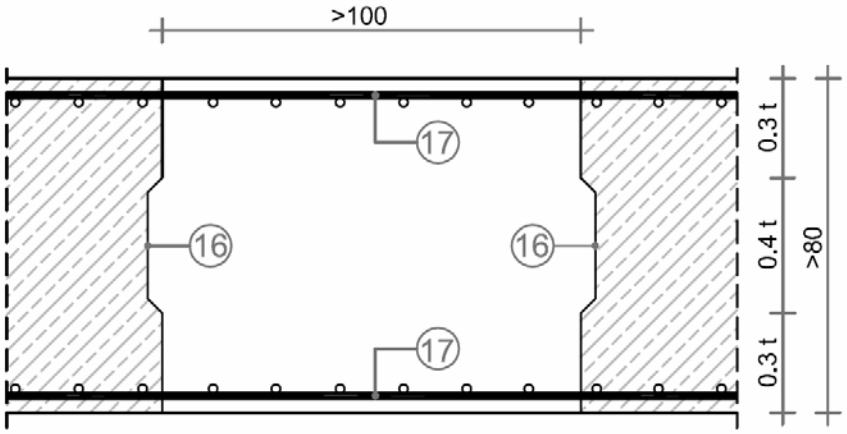


Fig. 6.2: Contact joints without interspacing

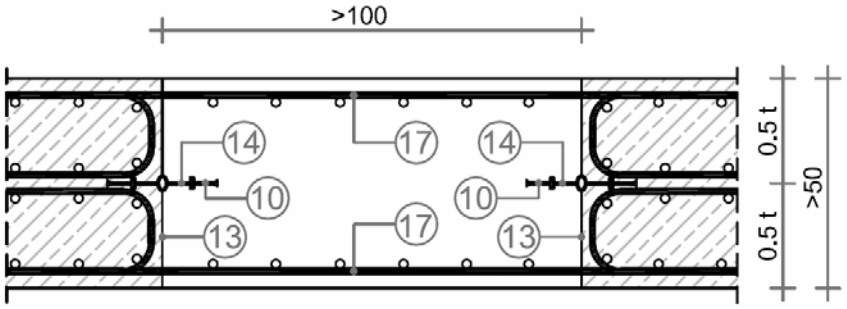
a) on a carriageway slab (superstructure or wall not in contact with soil for t < 50cm



b) on a carriageway slab (superstructure or wall not in contact with soil for t > 80cm



c) on a slab or wall in contact with soil for t > 50cm



(10) inner sealing strip of rubber or plastic

(13) straight construction joint

(14) sealing strip, steel plate 300/1mm

(16) grooved construction joint

(17) continuous reinforcement

Fig. 6.3: Contact joints with interspacing

7 FICTIVE JOINTS (FJ)

7.1 Definition

Fictive joint is a common term for weakening of the structural element section, enabling formation of controlled cracks.

Fictive joints are arranged on locations where tensile stresses and, as a consequence, cracks are expected due to creep and shrinkage effects in young concrete.

The purpose of fictive joints is achieved when they weaken at least a third of the structural element cross-section.

7.2 Design

A fictive joint is carried out in such a way that the cross-section of a structural element is weakened by at least one third. For this purpose, different water-resistant materials can be used. (Fig.7.2)

In structural elements where shrinkage is restrained, the distance between two adjacent joints amounts to 5 – 8 m for a concrete thickness up to 1.0 m. For greater concrete thicknesses, this distance shall amount to 4 – 6 m.

In structural elements where shrinkage is not restrained, these distances can be greater.

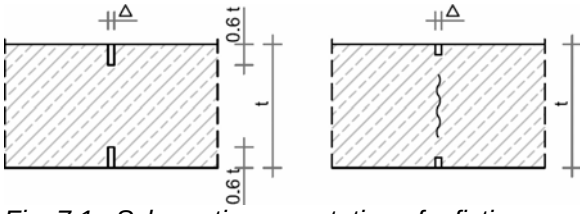


Fig. 7.1: Schematic presentation of a fictive joint

7.3 Execution

Fictive joints are carried out in such a way that planks, hard plywood panels, foamy panels or circular pipes are inserted into the structural element cross-section during erecting formwork and placing reinforcement. These inserted pieces shall be waterproof.

The locations of cross-section weakening shall be adequately sealed.

The joint water-tightness is ensured with PVC or rubber strips, which shall be properly fixed to prevent their moving or damage. Into the cross-section interior, injection pipes enabling subsequent injecting and sealing of the cross-section can also be inserted.

In the cross-section, the reinforcement runs continuously, or it is partly interrupted

7.4 Materials

Inserting pieces used to carry out fictive joints can be made of planks, hard plywood panels, foamy panels or circular pipes. All those materials shall be waterproof.

Inserting pieces located out of the cross-section thus being covered with the protective concrete shall be treated with a special end strip.

The backside of a fictive joint shall be sealed with an adequate strip made of durable PVC material or synthetic rubber; it can also be sealed by means of a special sealing coating.

On the exposed side the fictive joint shape is achieved with the aid of a trapezoidal lath.

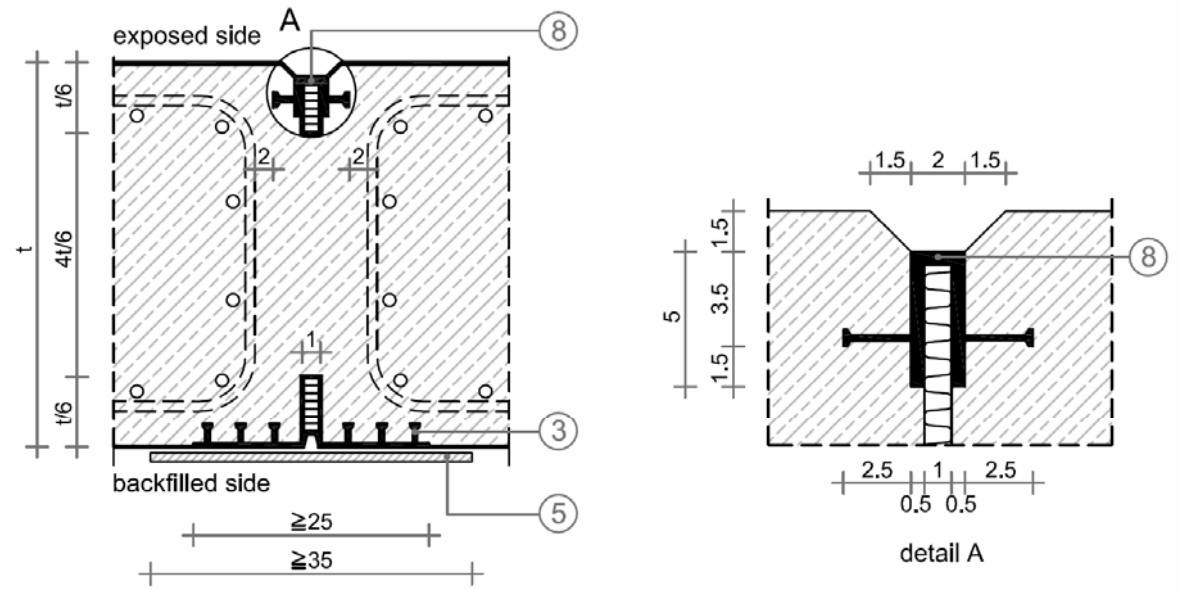
7.5 Maintenance

On the backside, the fictive joint shall be executed in such a way that it is durable and no maintenance is required.

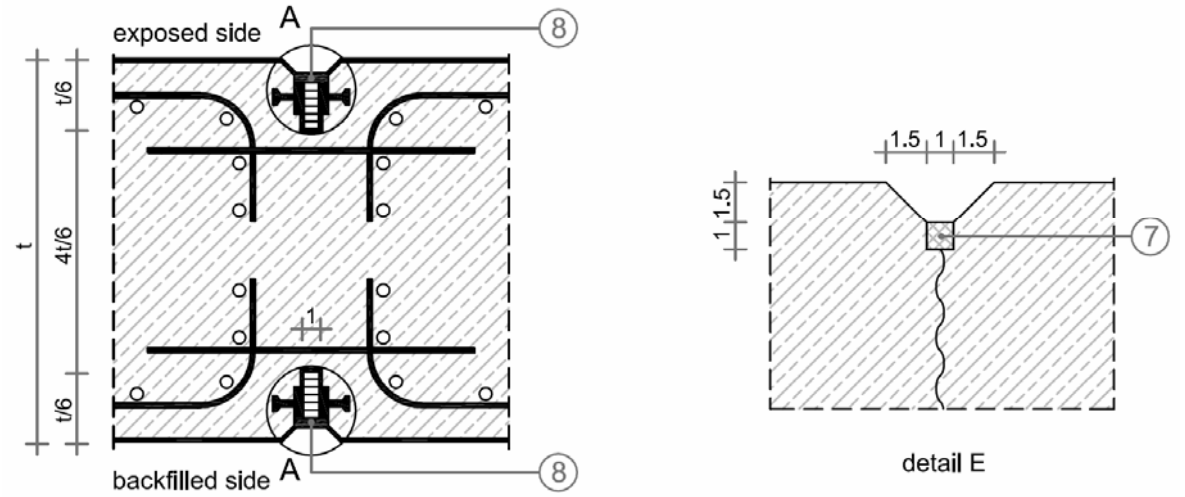
On the exposed surfaces, mechanical damages to concrete shall be made good (trapezoidal shape).

When a fictive joint does not ensure the water-tightness, it shall be adequately repaired.

a) contraction joint with a sealing strip on the backfilled side for the "white tub" execution



b) contraction joint with an end sealing strip



c) contraction joint for the "black tub" or the "white tub" execution

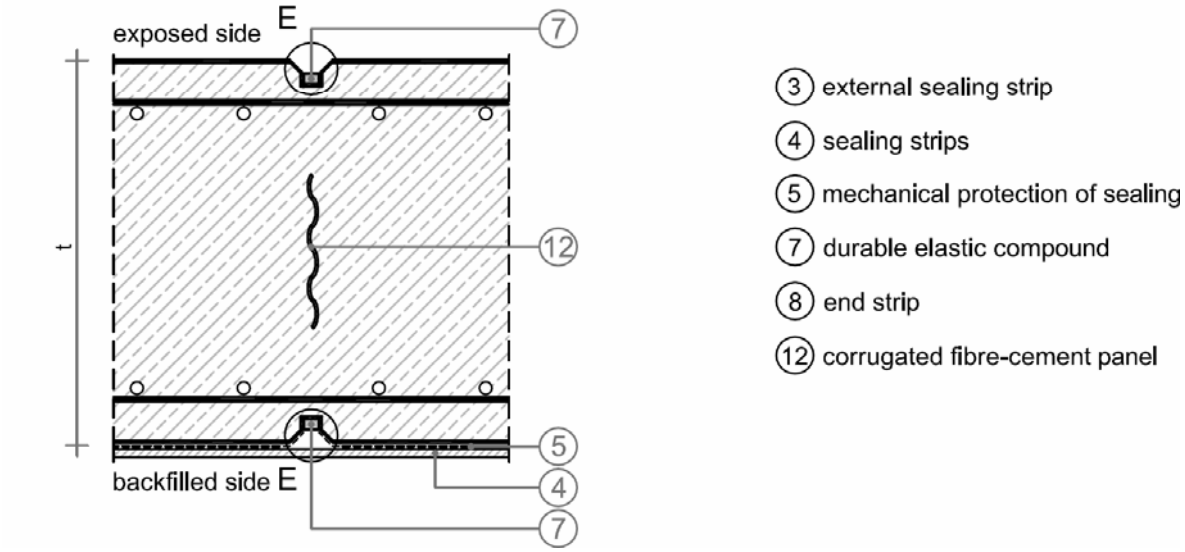


Fig. 7.2: Fictive joints

8 CONSTRUCTION JOINTS (CJ)

8.1 Definition

Construction joint is a common term for a joint appearing between two structural elements or two parts of the same structural element cast at different times.
By means of construction joints, large bridges and other civil engineering structures are divided in smaller working units, which makes placing of formwork and reinforcement easier, and reduces the concrete quantity.
The arrangement of construction joints depends on the structural type, on the way, how the structure is used, on static requirements, special construction states, structural geometry, and creep and shrinkage effects in the concrete.
Construction joints can run either horizontally or vertically.
As the construction joints are weak points in the structure, they shall be reasonably arranged and their number limited.
Notwithstanding the break of casting, a construction joint shall represent a solid and waterproof contact between two construction segments, so that all the action effects appearing in the cross-section can be transferred.

8.2 Design

Construction joints shall be foreseen at those places in the structure where casting of concrete is interrupted. They are located between individual structural elements (foundation – wall, wall – superstructure), or within a structural element dividing it in several units (carriageway slabs).
Construction joints can be either horizontal or vertical.
Both the position of construction joints and the method of their execution shall already be determined at the design stage of bridges and other civil engineering structures.

8.3 Execution

A construction joint takes rise at the spot of interrupting casting of concrete.
The structural element reinforcement continues without any disturbance. The concrete surface of the cast segment shall be suitably after-treated. The concrete shall be protected from frost and drying-up, and washing-out of the fresh concrete shall be prevented.
Prior to casting the subsequent segment, the surface of the construction joint of the existing element shall be cleaned and moistened to achieve a better adhesion between the existing and new concrete, and to prevent the existing concrete to absorb the moisture from the new one.
The construction joint surface shall also be adequately roughened (exposed coarse grains), which can be achieved by washing the concrete surface with a high-pressure water jet immediately after striking the structural formwork, by sandblasting of the hardened concrete or by means of a pneumatic hammer.
Special attention shall be paid to the formwork of the subsequent structural element. In the joint area, the formwork shall be pressed tightly to the hardened, old concrete. In this way, a harmonized continuation of the following structural element or construction segment is made possible, as well as flowing-away of the cement wash and occurrence of “nests” in the concrete prevented.
Vertical construction joints are carried out with the help of a profiled formwork or ribbed ductile steel plate, which are removed only in cases where the structural elements are subjected to a high loading.
In case that the construction joint formwork remains in its position permanently, no further treatment of the construction joint surface is required. Otherwise, it shall be suitably protected, cleaned, roughened and moistened.
Construction joints can be carried out as waterproof. They are sealed with strips made of durable PVC material or synthetic rubber placed on the outer side of the structural element. As sealing material within the cross-section, strips made of steel plate can be used. They shall be adequately fixed to prevent their moving and damage during casting operations.
Into the cross-section interior, injection pipes enabling subsequent injecting and sealing of the cross-section can also be inserted.

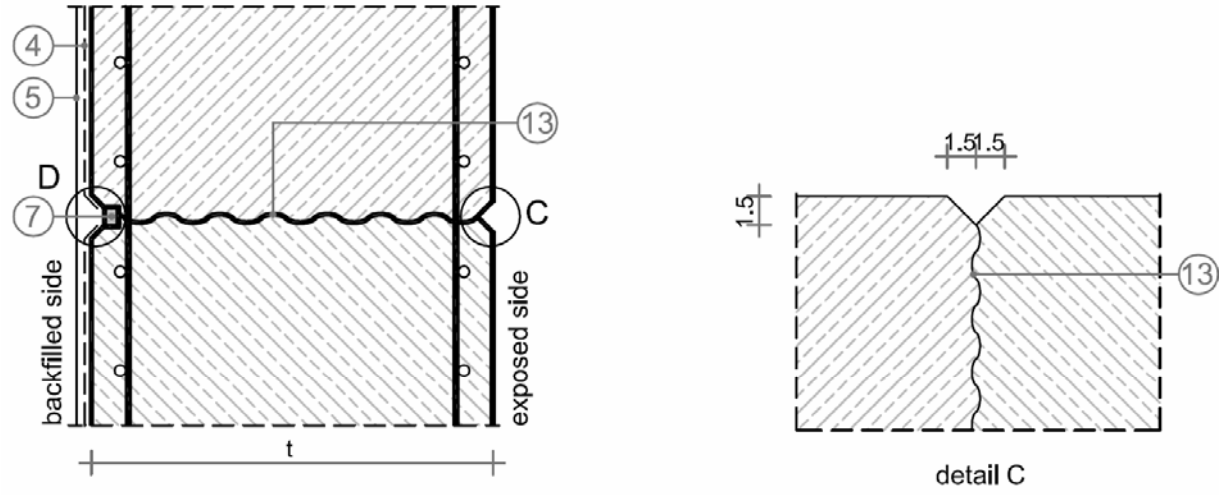
8.4 Materials

Vertical construction joints are carried out by means of a profiled formwork or ribbed ductile steel plate.

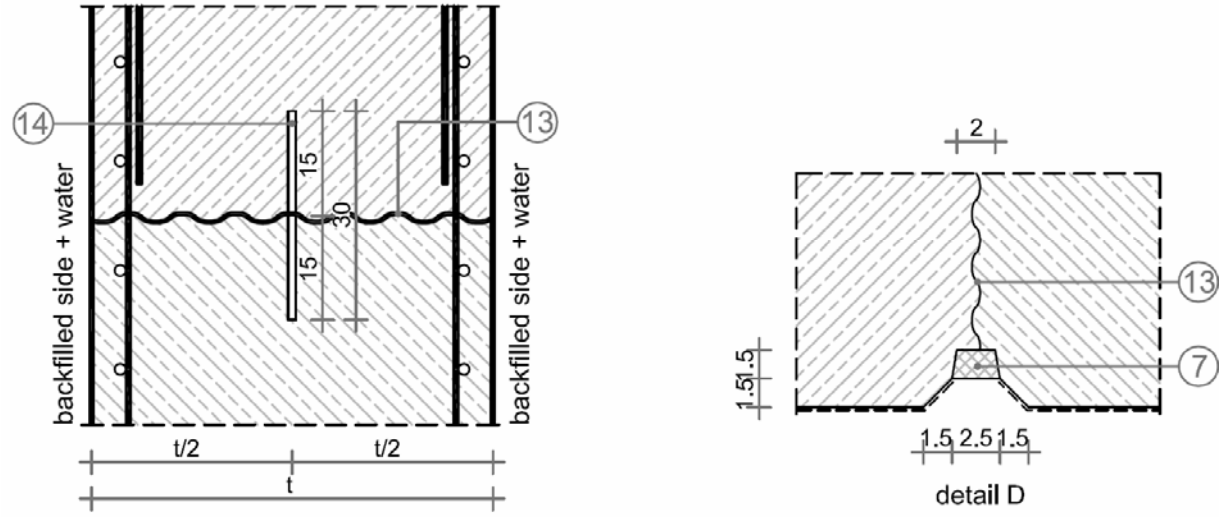
Construction joints are sealed with the aid of suitable strips made of durable PVC material or synthetic rubber placed on the external side of the structural element.

Into the cross-section interior, pipes to perform injecting, and strips made of steel plate are built-in.

a) contraction joint in a wall for the "black tub" execution



b) contraction joint in a wall for the "white tub" execution



c) contraction joint in a wall for the "white tub" execution

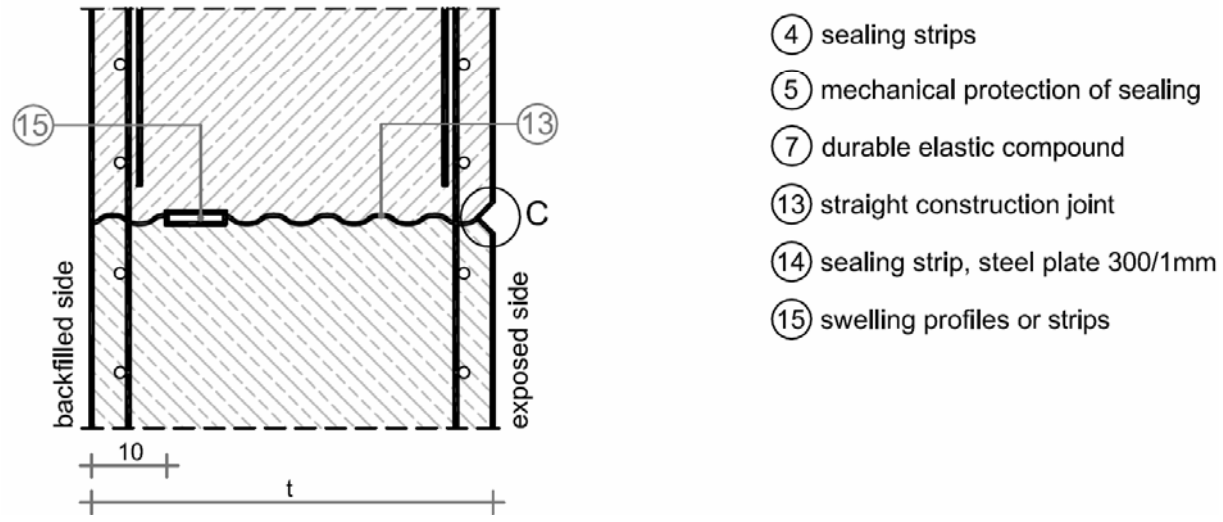


Fig. 8.1: Construction joints

9 JOINTS IN CULVERTS

9.1 Joints in monolithic culverts

The following culvert types can be distinguished:
- Pipe culverts encased in concrete;
- Box culverts;
- Arch culverts.

For longer monolithic culverts expansion joints in transverse direction are designed.

The transverse expansion joints are placed at spacing of 10 – 20 m, whereas their width amounts to 2.0 cm.

The wall and slab thickness of monolithic culverts is less than 50 cm. Therefore the expansion joint shall be designed as shown in Fig. 5.2.

The expansion joint arrangement depends on the following:
- ground properties,
- fill thickness above the culvert,
- culvert geometry,
- construction method.

In the cross-section of monolithic culverts construction joints are foreseen. The construction joint arrangement depends on the culvert type and dimensions.

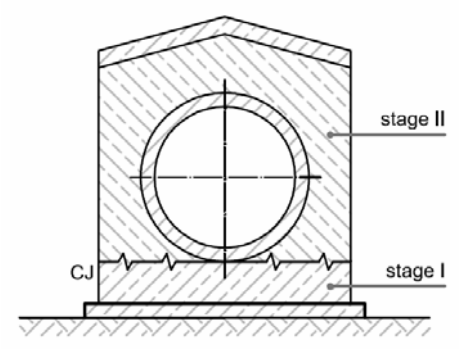
For culverts encased in concrete, horizontal construction joints are designed in the culvert walls only, 15 cm above the bottom slab (Fig. 9.1a).

Contact joints between pre-cast pipes, which serve as the inner formwork, are not treated. However, flowing-out of cement wash through these joints shall be prevented.

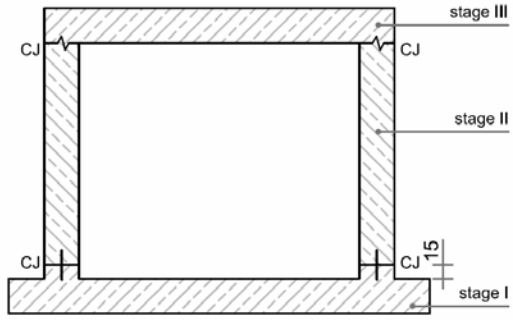
For box culverts, construction joints are foreseen at the contacts bottom slab – wall and wall – upper slab (Fig. 9.1b). The joint detail is similar to that shown in Fig. 8.1b or 8.1c.

For arch culverts, horizontal construction joints are only foreseen at the joint bottom slab – arch (Fig. 9.1c). The joint detail is similar to that shown in Fig. 8.1b or 8.1c.

a) pipe culverts encased in concrete



b) box culvert



c) arch culvert

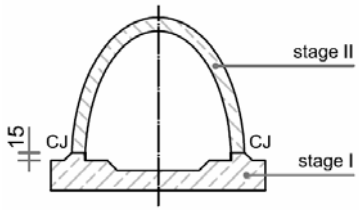


Fig. 9.1: Construction joints in transvers direction of monolithic culverts

9.2 Joints in pre-cast culverts

In the pre-cast culverts made of pre-cast elements such as pipes, box elements or arch elements, the in-situ joint is actually a transverse expansion joint, which has to be adequately treated.

In the pipe foundation, transverse expansion or contact joints at spacing of 10 – 20 are located, depending on the ground properties and the fill thickness above the culvert (Fig. 9).

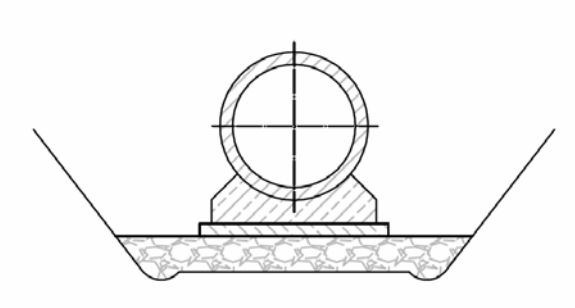
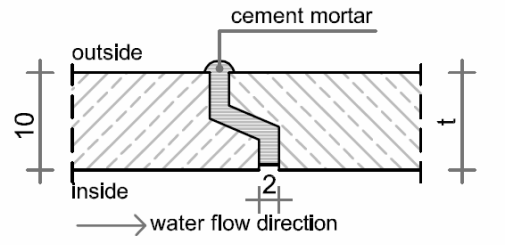


Fig. 9.2: Cross-section of a pipe culvert not encased in concrete

In Fig. 9.3 details of transverse expansion – contact joints of pre-cast pipes are indicated in dependence of the pipe wall thickness.

a) for ϕ100cm (ϕ150cm)



b) for ϕ200cm

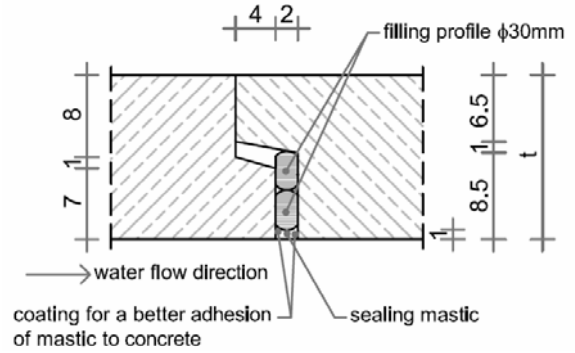
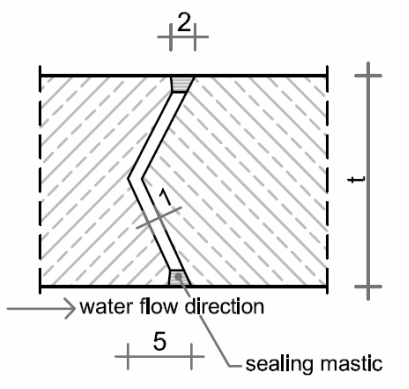


Fig. 9.3: Detail of expansion – contact joint in pre-cast pipe culverts

In Fig. 9.4 details of transverse expansion – contact joints of pre-cast box or arch segments are shown.

a) wedged expansion – contact joint



b) straight expansion – contact joint

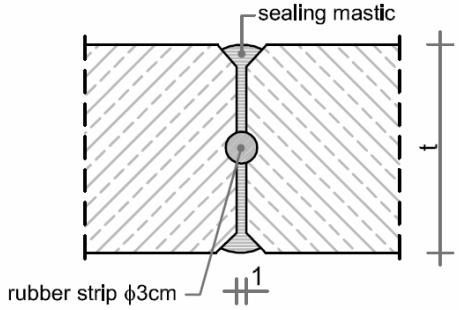


Fig. 9.4: Detail of expansion – contact joint in pre-cast box and arch culverts

10 JOINTS IN FRAME AND BEAM SINGLE-SPAN BRIDGES

In frame and beam single-span bridges all the types of joints can occur:
- expansion joints
- contact joints
- fictive joints
- construction joints.

Both the expansion and contact joints reduce the negative effects of creep and shrinkage, of temperature, as well as of variable ground properties.

Fictive joints are designed in the walls of wide frame structures, which are typical of motorway bridges. By means of fictive joints the cross-section is weakened, thus locations of controlled cracks are achieved.

The horizontal construction joints are imposed by the construction technology.

In a strip foundation, expansion or contact joints can be foreseen, when this is required by the ground properties.

At the joint foundation – wall and wall – superstructure horizontal construction joints appear.

The position of the horizontal construction joint at the contact wall – superstructure is selected in such a way that all the modifications of the section shape are carried out in the joint plane (cantilever for transition slabs, Fig. 10.1).

In the frame wall, expansion, contact and fictive joints can be foreseen in the transverse direction (Fig. 10.2).

Both the expansion and contact joints are designed particularly in case of wide bridges (on motorway and highways) and deformable ground. They can also occur, when a new bridge is constructed next to the existing one. The fictive joints only weaken the cross-section, thus controlled cracks are allowed by the execution of those joints.

Both the expansion and contact joints are carried out either as smooth or grooved. The latter is required when a static interaction of adjoining elements should be attained. The groove shape depends on the wall thickness.

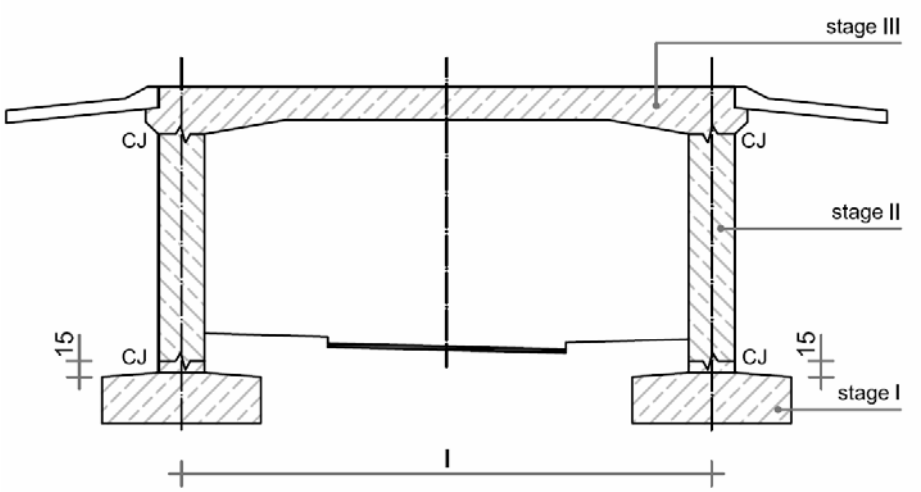


Fig. 10.1 Arrangement of construction joints in bridge frame structures

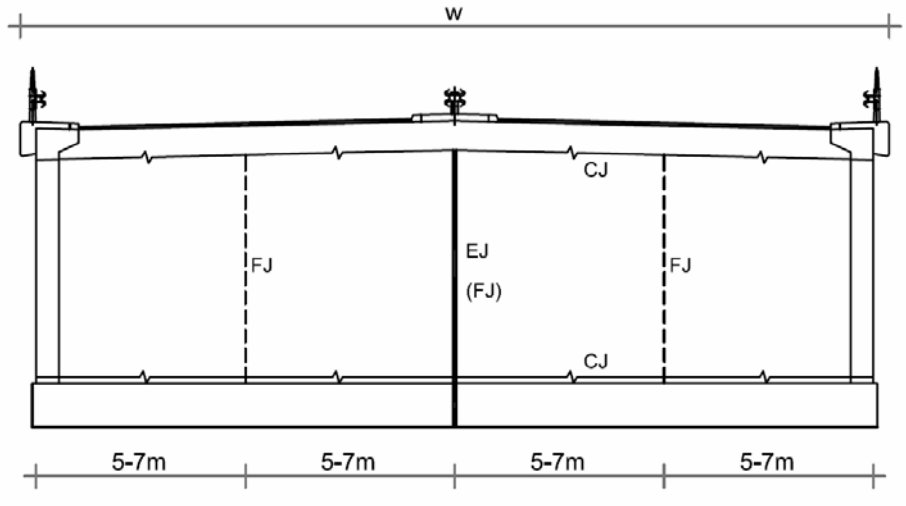


Fig. 10.2: Arrangement of both expansion and fictive joints in the walls of frame bridge structures on motorway and highways

11 JOINTS IN FRAME AND BEAM MULTI-SPAN BRIDGES

11.1 General

In frame and beam multi-span bridges all the types of joints can occur:
- expansion joints
- contact joints
- fictive joints
- construction joints.

Both the expansion and contact joints reduce the negative effects of creep and shrinkage, of temperature, as well as of variable ground properties.

Fictive joints are designed in the walls of wide frame structures, which are typical of motorway bridges. By means of fictive joints the cross-section is weakened, thus locations of controlled cracks are achieved.

The horizontal construction joints are imposed by the construction technology.

In the strip foundation of frame structures, expansion or contact joints can be designed, when this is required by the ground properties.

At the joints foundation – wall (end, intermediate) and wall (end, intermediate) – superstructure, horizontal construction joints appear. In both end and intermediate walls of a frame, expansion, contact and fictive joints can be planned in the transverse direction. In the superstructure, only contact joints can be foreseen.

In the strip foundation of beam structures, expansion or contact joints can be designed, when this is required by the ground properties.

At the joints foundation – abutment and foundation – pier, horizontal construction joints occur. In abutments and piers, transverse expansion, contact and fictive joints can be foreseen, when the abutments and piers are designed as walls of greater width.
In the superstructures, only contact joints are possible.

Expansion joint structures bridging a movable joint between the superstructure and the abutment or between two parts of the superstructure are discussed in an extra Design Guideline.

11.2 Joints in Abutments

Abutments of a width of < 8.0 m comprise only horizontal construction joints (foundation – wall and wall – superstructure or support upper part). Other types of joints are not required.

Abutments of a width of 8.0 – 12.0 m comprise, in addition to the abovementioned horizontal construction joints, a fictive joint in the wall as well.

In the abutments wider than 12.0 m, expansion, contact and construction joints can occur in the foundations and walls. Construction joints in the foundations as well as those in the walls shall be mutually shifted.

In the walls, fictive joints are also possible, yet it is recommended to unite them with the construction joints.

At the joints foundation – wall and wall – superstructure (or support upper part) horizontal construction joints appear.

Both the expansion and the contact joints are executed as smooth or grooved. The latter is required, when a static interaction of adjoining elements should be attained.

11.3 Joints in Piers

In the piers, horizontal construction joints are foreseen at the joint foundation – wall (pier). In the wall piers of underpasses and overpasses of a length of > 10 m, both expansion and contact joints can also be foreseen, when this is required by the ground properties.

Both the expansion and the contact joints are executed as smooth or grooved. The latter is required, when a static interaction of adjoining elements should be attained.

11.4 Joints in Superstructure

11.4.1 Slab Superstructure

In the superstructure of a slab cross-section both construction and contact joints are foreseen. They are imposed by the construction method as well as by the creep and shrinkage effects. Contact joints with interspacing allow a modification of the structural element stiffness, of the stress distribution, and of the static system as well.

11.4.2 Beam Superstructure

In the superstructure of a bean cross-section both construction and contact joints are designed. They are imposed by the construction technology as well as by the creep and shrinkage effects. Contact joints with interspacing allow a modification of the structural element stiffness, of the stress distribution, and of the static system as well.

11.4.3 Box Cross-Section Superstructure

For superstructures of box cross-section horizontal construction joints are designed at the joint lower slab – web and web – upper slab.
In the longitudinal direction, both construction and contact joints are foreseen in dependence on the construction method.
When a deck is constructed by means of the cast-in-situ free cantilevering or incremental launching method, construction joints are foreseen, whereas contact joints are designed in case of the segmental construction technology.

11.4.4 Composite Superstructure With Pre-Cast Girders

For composite decks with pre-cast girders both construction and contact joints are designed in the carriageway slab and above the piers. Contact joints with interspacing allow a modification of the structural element stiffness, of the stress distribution, and of the static system as well.

12 JOINTS IN RETAINING STRUCTURES

12.1 General

In the retaining walls all the types of joints can occur.
At the joint foundation – wall, a horizontal construction joint imposed by the construction method is foreseen.
Expansion joints and contact joints can also be designed. They reduce negative effects of creep and shrinkage, of temperature and of variable ground properties.

Fictive joints are foreseen in exceptional cases only. By means of these joints, visible effects in concrete due to the contact between formwork panels can be hidden, and large exposed surfaces can be divided in accentually vertical, horizontal or raster components.

It is recommended to unite the fictive joints with the construction ones. The fictive joints can also weaken the cross-section and allow the formation of controlled cracks.

12.2 Gravity Wall

To execute a gravity wall, a horizontal construction joint foundation – wall is required. The joint shall be grooved to take the earth pressure more reliably.
Gravity walls of a greater length are carried out of longitudinal segments of 4.0 – 8.0 m in length (most frequently of 6.0 m). Contact joints are foreseen between those segments.
Expansion joints are designed at every two or three longitudinal segments, at spacing of 12 – 13 m.
Both expansion and contact joints are executed as straight or grooved ones. They shall be waterproof.

12.3 Reinforced Concrete Wall of “L” Shape

To execute a concrete wall of “L” shape, a horizontal construction joint foundation – wall is required. The joint shall be grooved to take the earth pressure more reliably.
“L” walls of a greater length are carried out of longitudinal segments of 4.0 – 8.0 m in length (most frequently of 6.0 m). Contact joints are foreseen between those segments.
Expansion joints are designed at every two or three longitudinal segments, at spacing of 12 – 13 m.
Both expansion and contact joints are executed as straight or grooved ones. They shall be waterproof.

12.4 Anchored Wall Constructed in Segments From the Top Downwards

Anchored walls constructed from the top downwards, are executed of longitudinal segments of 3 x 2.20 m in width and of 2.55 – 3.0 m in height.
At the joint of adjacent longitudinal segments, vertical contact joints occur. After the casting of three longitudinal segments is completed, an expansion joint is carried through at a distance of approx. 20 m. The latter shall be waterproof.
At the joint of adjacent height segments and at the joint foundation – wall, horizontal contact joints are foreseen.

12.5 Pile Wall

For a pile wall, expansion joints with a groove are designed in the area of the beam, which function is to interconnect the piles. Expansion joint with a groove are placed at the spacing of 10 – 12 m. In case that a wall of 2.0 – 6.0 m in height is constructed above the pile wall, expansion, contact and construction joints are foreseen in such a wall, as it applies to "L" walls.

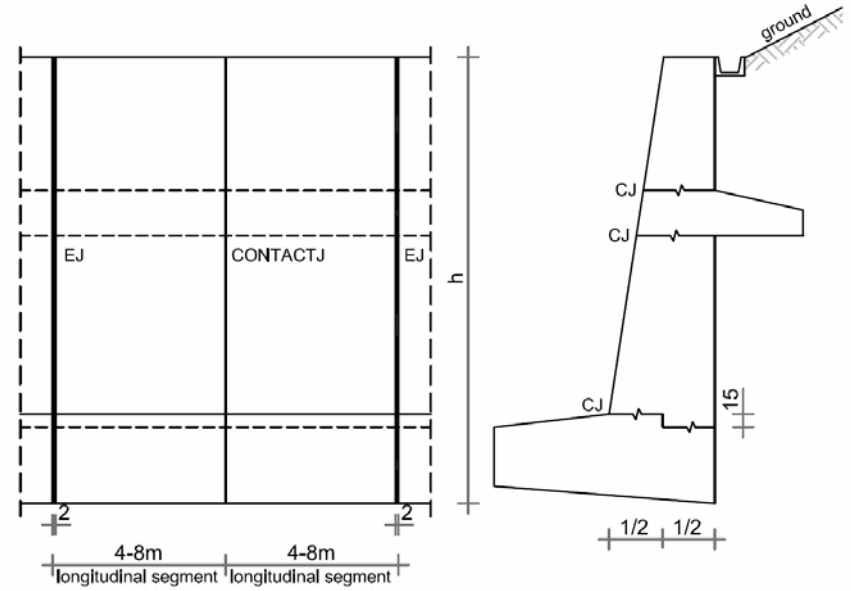


Fig. 12.1: Joints in gravity walls with or without a relieving cantilever

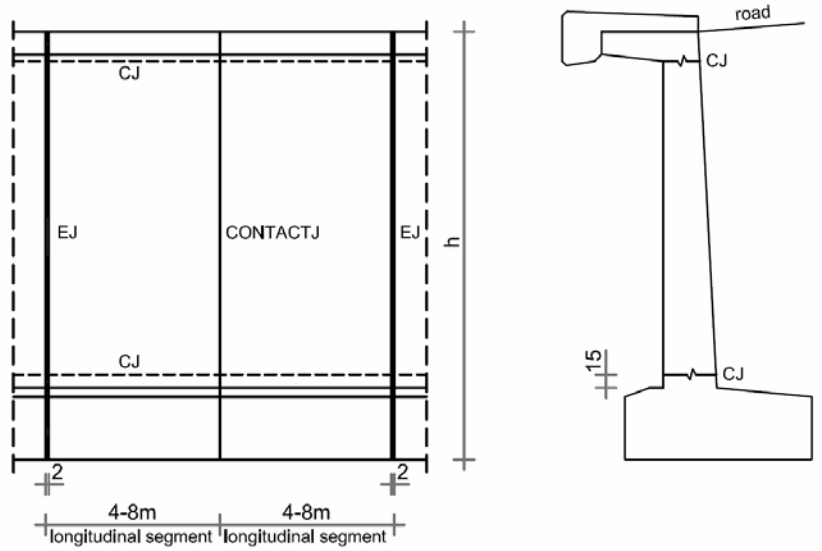


Fig. 12.2: Joints in reinforced concrete walls of "L" shape

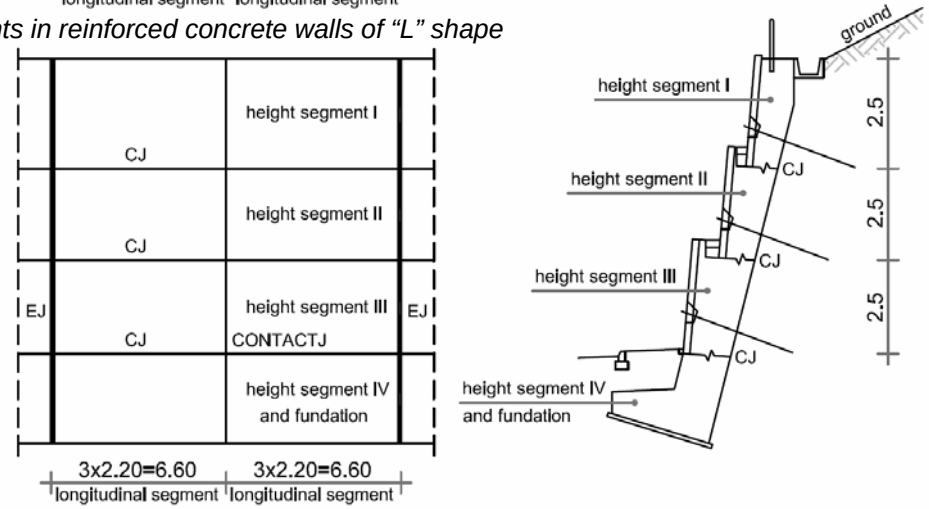


Fig. 12.3: Joints in anchored walls constructed in segments from the top downwards