10.0 STRUCTURE JOINTS AND CLOSURE SECTIONS

10.1 General

Joints are generally provided to perform one or both of the following functions:

- Provide a convenient stopping point in the sequence of construction; and/or
- Accommodate movements within a structure or component thereof without structural distress.

Three types of joints namely, construction, contraction, and expansion joints, are typically used as described below. The illustrations of contraction and expansion joints provided in this section are applicable to slabs and walls. Similar joints for conduits are included in Section 13.6.

Within the joints, the position of the waterstop relative to shear keys should be carefully considered to ensure that the more compressible waterstop does not affect the shear capacity of the concrete key.

In addition, closure sections, constructed using construction and/or expansion/contraction joints, can be used to allow movements to occur for an extended period prior to completing the structure.

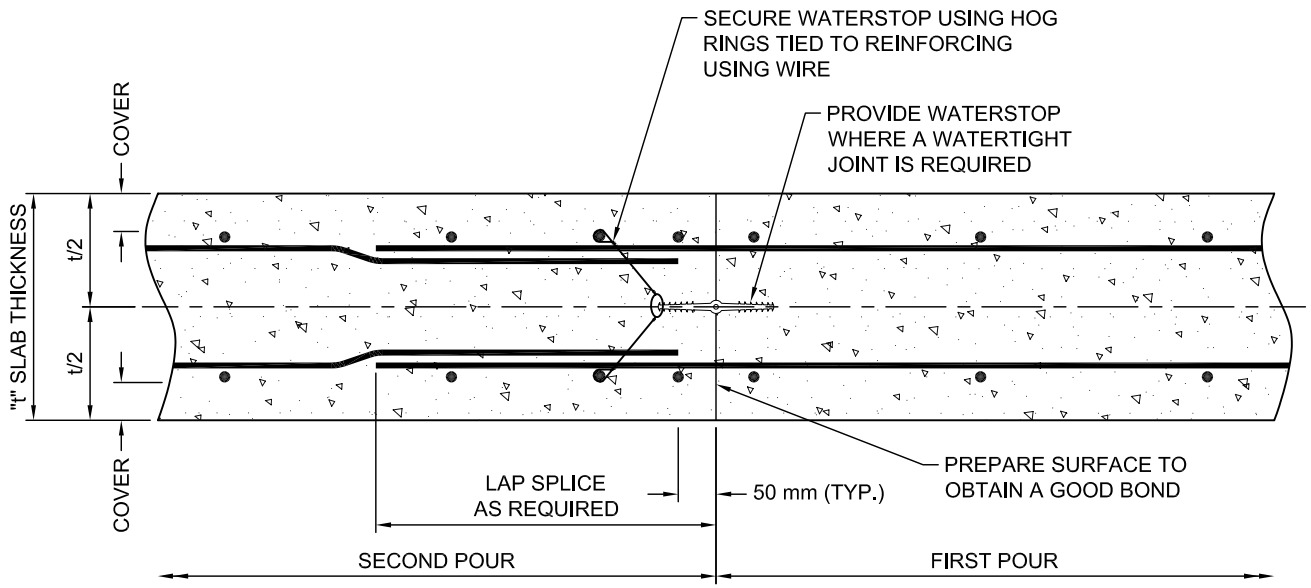
10.2 Construction Joints

Construction joints are incorporated in the design to provide convenient stopping points during construction. Typical details for vertical and horizontal construction joints are shown on Figures 10-1 and 10-2, respectively.

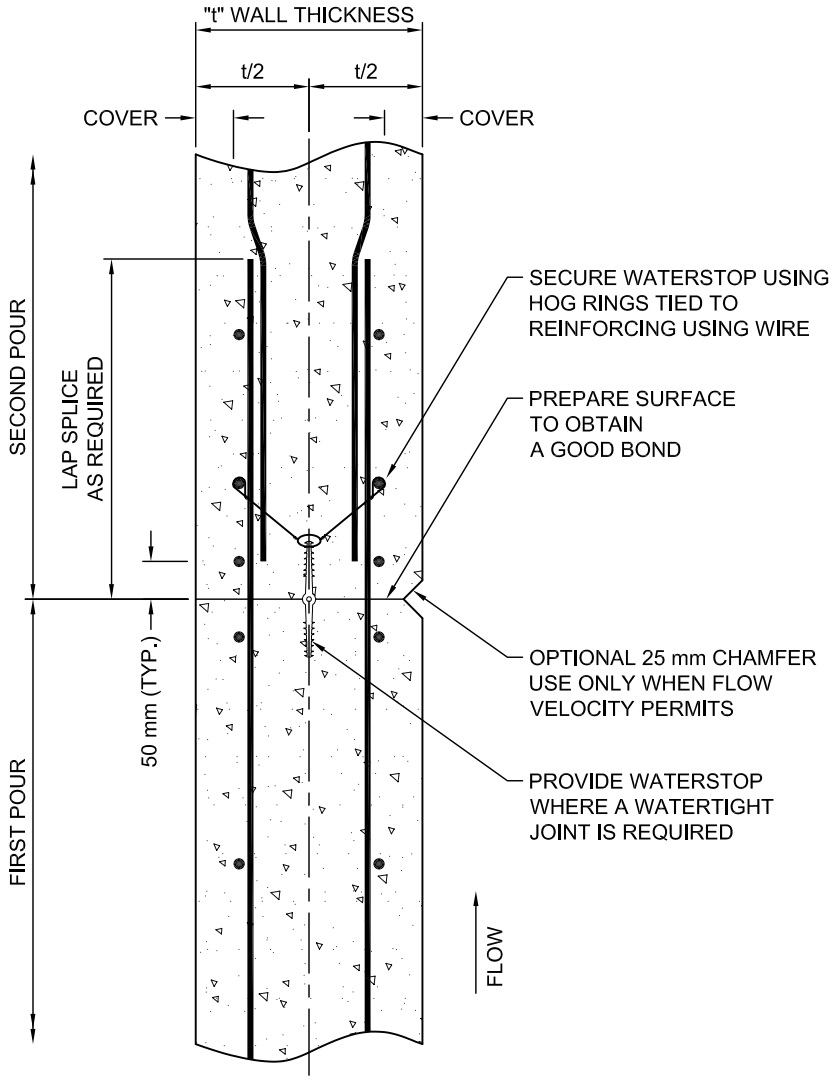
The continuity of the structure is maintained by extending the reinforcement through the construction joint, and by taking steps to obtain a good concrete bond across the joint.

Proper steps for bonding fresh concrete to hardened concrete should include:

- Thoroughly cleaning the concrete surface of foreign matter and laitance;
- Suitably roughening the concrete surface and cutting it back so that the aggregate is partially exposed;
- Providing tight forms that do not allow mortar to leak out;
- Saturating the concrete surface to provide a damp condition with no free water immediately prior to placing new concrete; and
- Ensuring that the fresh concrete is well vibrated.



SLAB



WALL

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WATER MANAGEMENT OPERATIONS

WATER CONTROL STRUCTURES - SELECTED DESIGN GUIDELINES

TYPICAL VERTICAL CONSTRUCTION JOINT

DATE:	CAD FILE:	FIGURE No.:
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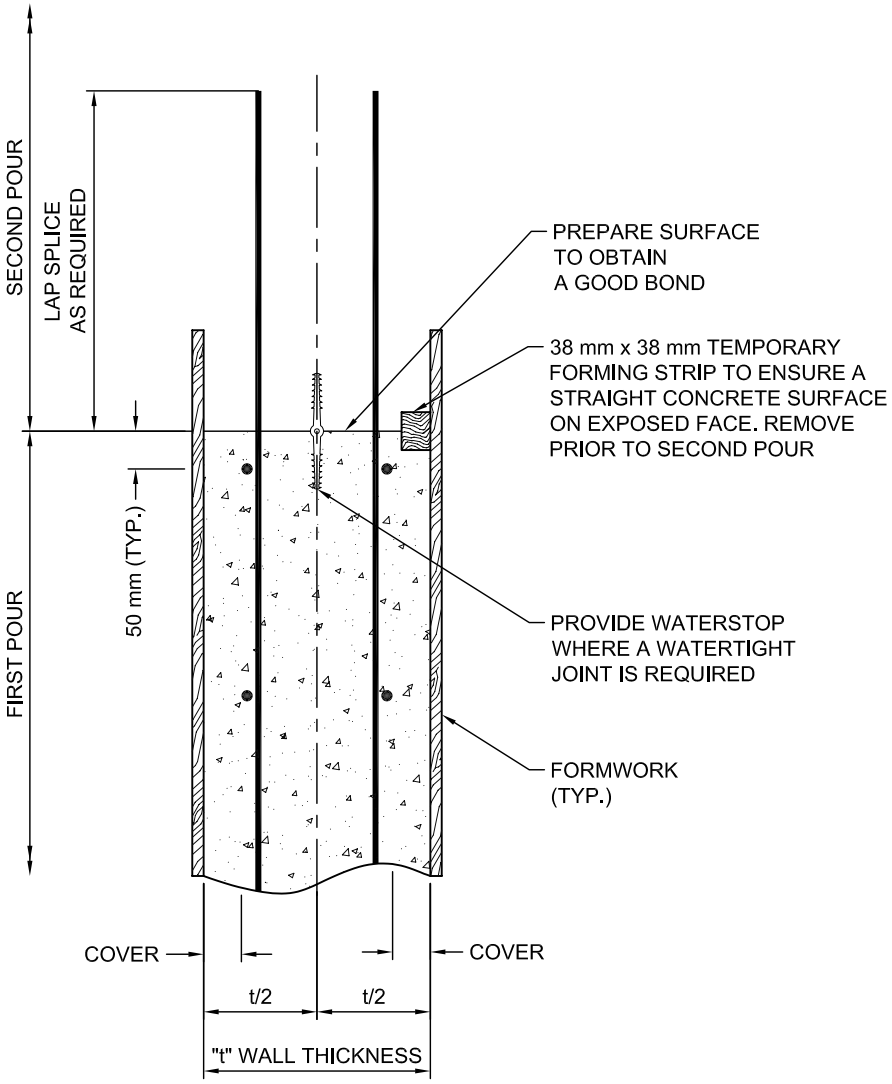


WALL

10-2 Jan 07/2005 - 10:36am Jesse Llorca

ALBERTA TRANSPORTATION CIVIL PROJECTS BRANCH **ALBERTA ENVIRONMENT** WATER MANAGEMENT OPERATIONS	WATER CONTROL STRUCTURES - SELECTED DESIGN GUIDELINES **TYPICAL HORIZONTAL CONSTRUCTION JOINT**	
	DATE: November 2004	CAD FILE: 99008A10-2.dwg
		FIGURE No.: 10-2

A flat-shaped waterstop is ordinarily provided wherever a watertight construction joint is required. This includes construction joints which will be subjected to significant hydrostatic pressure differentials such as in wet wells and conduits for low level outlet structures or portions of structures located within the seepage reduction zone.

For horizontal construction joints, shear keys are not used because they tend to trap dirt, debris, and water (ice).

10.3 Contraction Joints

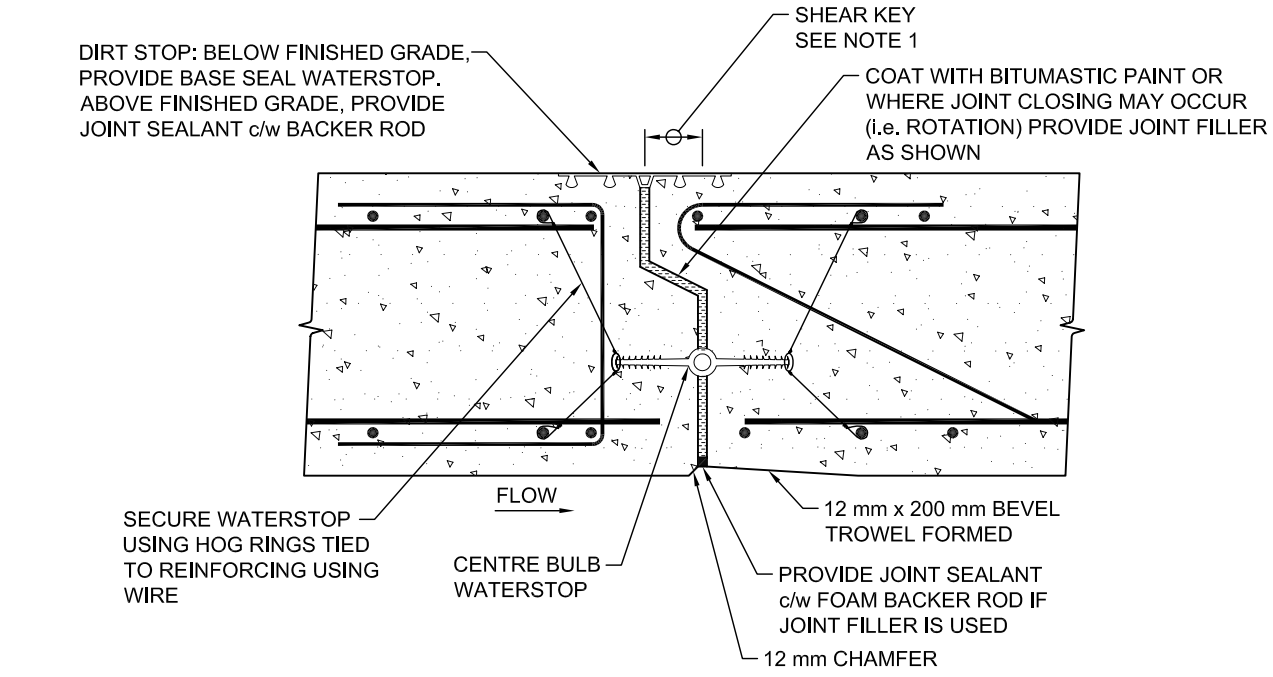
Contraction joints are normally incorporated at regular spacing to provide for the volumetric shrinkage within a structure, and to accommodate minor contraction/expansion movements between components.

These joints are usually designed so that tensile stresses cannot be transferred across the joint. As a result, the reinforcing steel does not extend across the joint and a bond-breaking compound (e.g. bitumastic paint) is normally applied to the concrete surface on the previously completed side of the joint. The coat of bitumastic paint should normally be thin to avoid sagging which can cause stress concentrations and spalling if, and when, the joint closes. A centre bulb waterstop is usually incorporated to make the joint watertight. Shear keys or dowels may be provided to prevent any differential displacement that may result in harmful abrupt offsets, particularly along water passages. Shear keys are preferred over shear dowels because the dowels are more likely to cause stress concentrations that can cause concrete spalling, and are also susceptible to corrosion. Where shear dowels are proposed, the use of smooth galvanized or stainless steel bars should be considered.

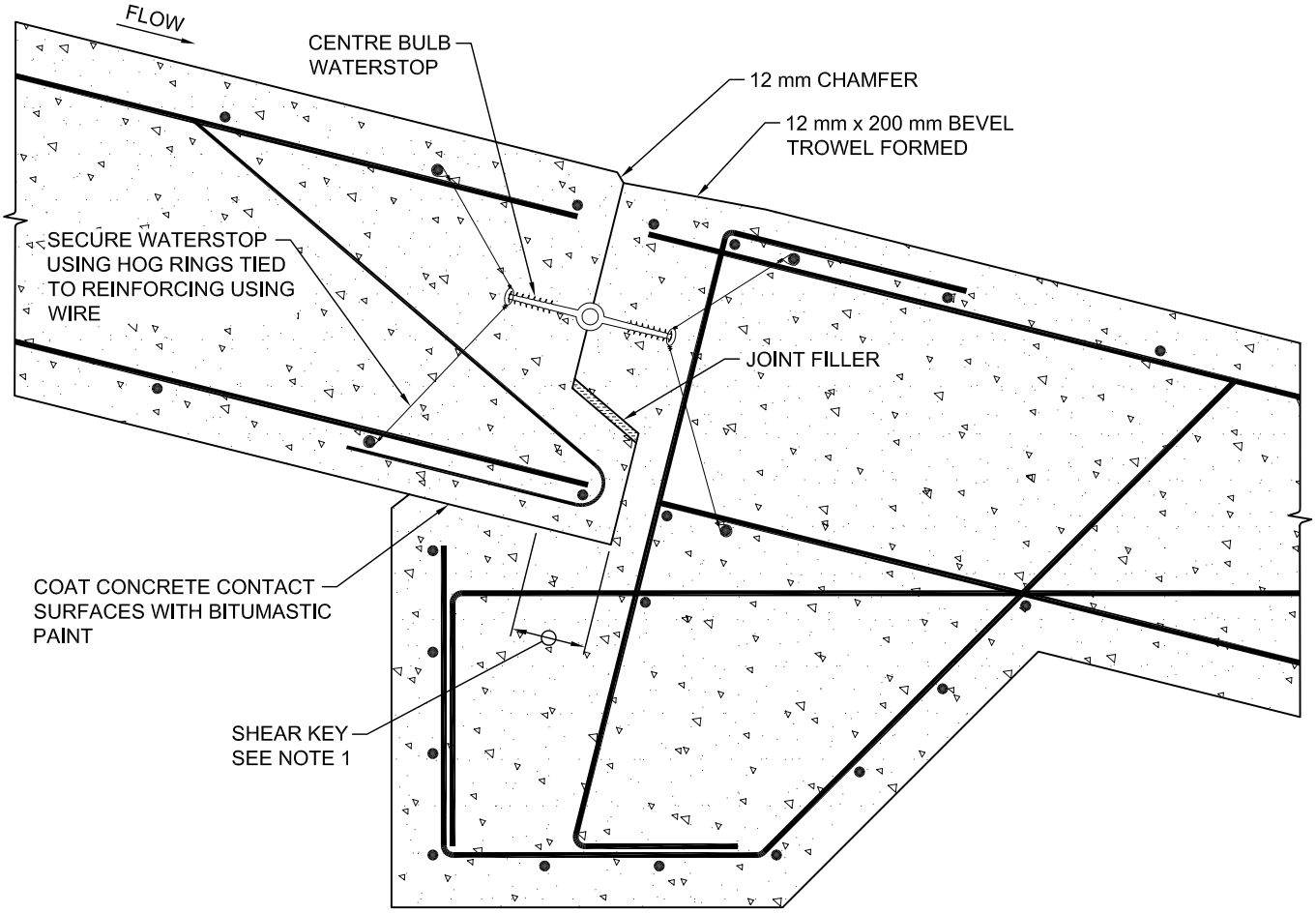
Details of typical wall and slab contraction joints for a larger chute-type structure are shown on Figure 10-3. For the wall, joint filler as shown on Figure 10-3 can be used instead of bitumastic paint in cases where joint rotation may occur. Similar provisions for joint rotation can also be made in the slab as shown on Figure 10-4; however, the joint filler should not extend for the full contact area between adjacent slabs, especially where the potential for downhill creep exists.

The two-way shear key arrangement shown on Figure 10-3, which prevents the upstream slab/wall from moving upward/inward relative to the downstream one, may be appropriate in some instances, but not all. For thinner slabs on smaller structures, the provision of a one-way key (i.e. ledge) that prevents displacement of the downstream slab into the flow is commonly used, whereas for thinner walls, the shear key is eliminated.

In order to establish the appropriate spacing of contraction joints for a particular structure, the benefits of using a wider joint spacing to reduce the number of joints versus the additional temperature and shrinkage reinforcement that may be required, and the increased potential for additional and/or wider cracks to develop, should be considered. For conduits, a maximum spacing of 9 m has generally been used (refer to Section 13.6), and for chutes (except for continuous chute



TYPICAL CONTRACTION JOINT - WALL



TYPICAL CONTRACTION JOINT - SLAB

NOTE:

1. FOR THINNER SLABS, TO AVOID THE RISK OF FAILING THE CONCRETE INTO THE WATERSTOP, CONSIDERATION SHOULD BE GIVEN TO EITHER a) OMISSION OF THE SHEAR KEY OR b) LOCAL THICKENING OF THE SLAB.

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	DATE: November 2004	CAD FILE: 99008A10-3.dwg
		FIGURE No.: 10-3

slabs), a maximum spacing of around 18 m (i.e. slope length) has generally been employed. It is noted that reinforcing steel is typically manufactured to a maximum length of 18 m, therefore using the above joint spacing would also reduce the number of splices and amount of material wastage that would occur.

10.4 Expansion Joints

Expansion joints are normally provided at strategic locations within a structure, including the interface between different structure elements, to permit expansion/contraction and articulation to occur.

These joints are designed so that tensile stresses cannot be transferred across the joint. This is accomplished by making the reinforcing steel discontinuous (does not extend across the joint), and incorporating a joint filler material which also serves as a concrete bond breaker.

Joint filler material, a centre bulb or tear web waterstop, cover plates, joint sealant, and dirt stop are generally used at the expansion joint. A two-way shear key arrangement is also incorporated to prevent any differential displacement that may result in harmful abrupt offsets, particularly along water passages. For thinner slabs and walls on smaller structures, the same approach as noted in Section 10.3 is commonly used. Typical expansion joint details are illustrated on Figures 10-4 and 10-5.

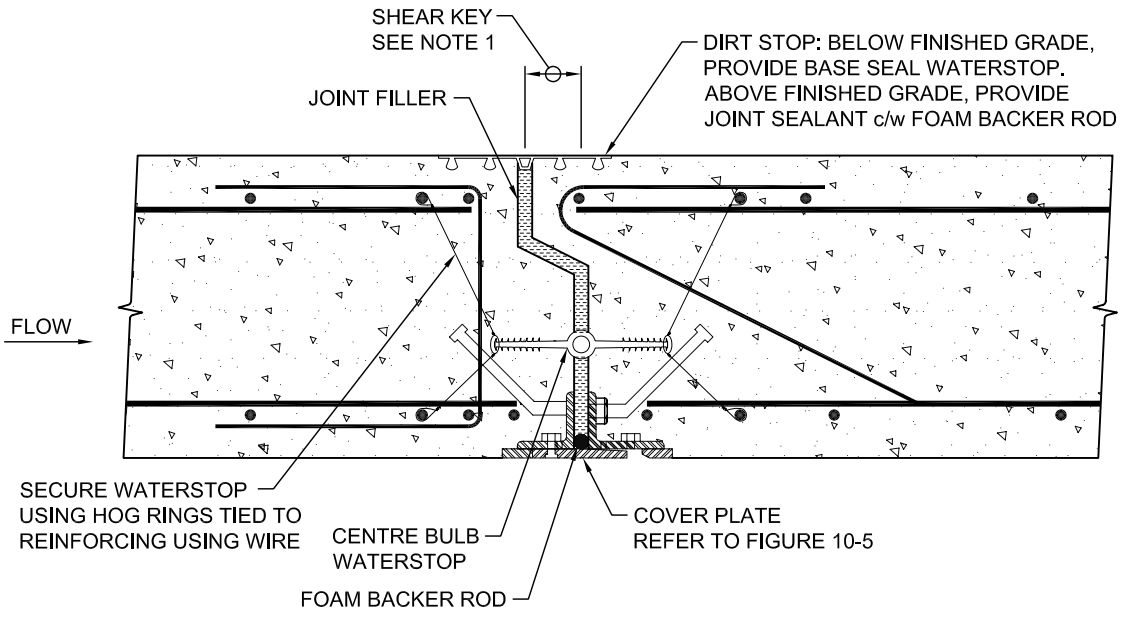
The location, width, and details of the expansion joints will be influenced by the following factors:

- The type, direction, and magnitude of movements expected (longitudinal, transverse, rotation, etc);
- Flow velocities and the potential for cavitation;
- Performance limitations of the joint filler, sealant, and waterstop materials; and
- In the case of a chute slab, whether it is designed as a jointed slab or a continuous slab as noted in Sections 12.6.3 and 12.6.4, respectively.

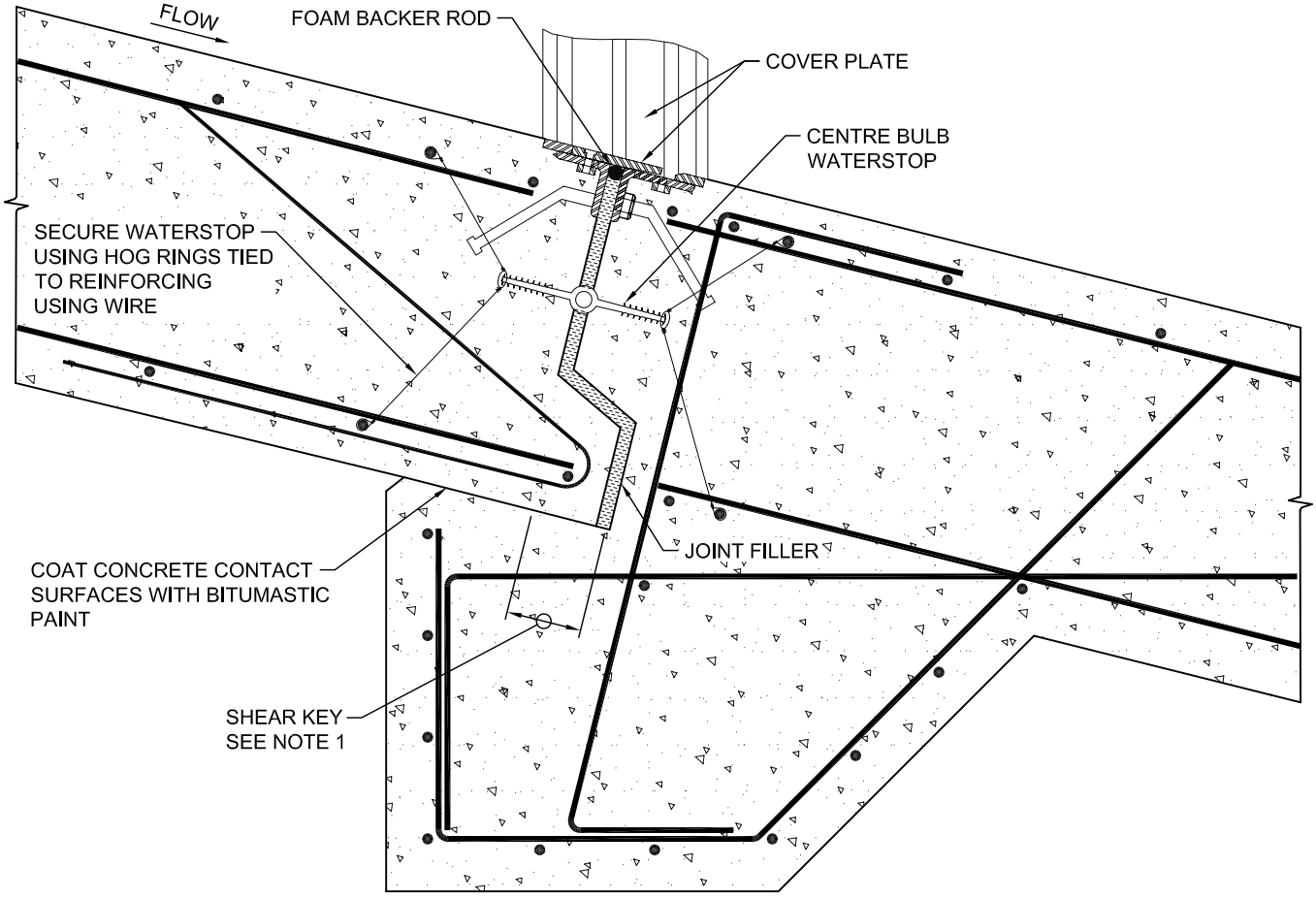
10.5 Closure Sections

Closure sections can be used to:

- Allow movements between two structure elements for an extended period.
- Allow movements due to shrinkage and temperature effects during the cement hydration process.



TYPICAL EXPANSION JOINT - WALL



TYPICAL EXPANSION JOINT - SLAB

NOTE:

1. FOR THINNER SLABS, TO AVOID THE RISK OF FAILING THE CONCRETE INTO THE WATERSTOP, CONSIDERATION SHOULD BE GIVEN TO EITHER a) OMISSION OF THE SHEAR KEY OR b) LOCAL THICKENING OF THE SLAB.

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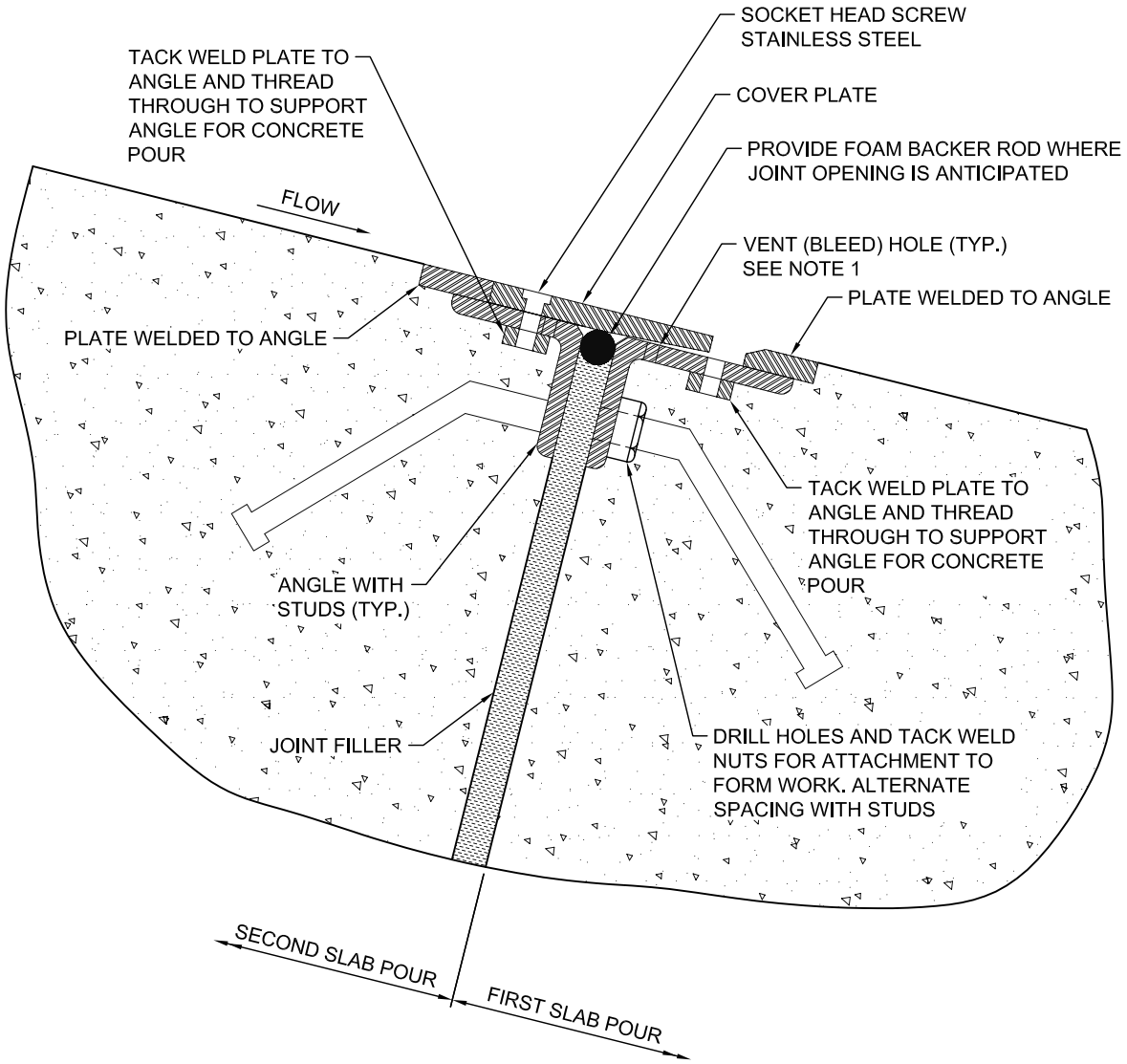
	DATE: November 2004	CAD FILE: 99008A10-4.dwg
		FIGURE No.: 10-4



NOTE:

1. THE DIAMETER AND SPACING OF VENT HOLES WILL MAINLY BE DEPENDENT ON THE SIZE OF THE ANGLE AND SLOPE OF THE SLAB. LARGER DIAMETER HOLES ALLOWS MORE AIR TO ESCAPE AND FACILITATES INSPECTION BUT SMALLER HOLES CAN FACILITATE GROUT INJECTION, IF REQUIRED, TO FILL ANY REMAINING VOIDS.

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TYPICAL COVER PLATE ARRANGEMENT

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In general, a closure section consists of a narrow, full width section of the structure that is not completed until later or toward the end of concrete construction. Construction and/or expansion joints are typically provided to separate the closure section from the rest of the structure. In cases where construction joints are provided on both sides of the closure section (i.e. closure section is being used to reduce shrinkage and temperature effects), consideration should be given to the use of a lap splice to eliminate the development of stresses in the reinforcing steel prior to the closure being poured.

The width of the closure section should be kept as narrow as possible (i.e. minimum required for a lap splice or for construction), particularly when it is restrained (construction joints at both ends), in order to limit shrinkage and temperature effects.

Temporary covers or bulkheads may be required at the closure sections to allow temporary operation, protect embedded items, keep debris out, provide access, and permit backfill placement (wall sections).

An example of a closure section provided within a chute spillway is discussed in Section 12.6.4, and within an outlet conduit in Section 13.6.