Chapter 5. Concrete Design and Construction Details

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Concrete design involves three steps.

1. Specifying the proper concrete mix.
2. Specifying the correct design details.
3. Following correct construction practices to place the concrete.

Chapter 4 describes the specifications for concrete materials used in the mix. The following discussion describes the concrete structure design and important details of construction. Correct placement is the last key and will require experienced contractors and proper inspection.

Concrete Structural Design

Design all concrete facilities with two criteria in mind:

1. Design walls and floors to resist the potential tank loads and the hydrostatic and wheel loads that they may be subjected to. Liquid fertilizers are heavier than water and hydrostatic design loads range from to 70-100 lb/ft^3-ft of depth. The most common liquid fertilizers are 28-0-0 or UAN solution at 79 lbs/ft^3 (10.6 lbs/gal) and 10-34-0 at 85 lbs/ft^3 (11.4 lbs/gal). Check with the manufacturer for the density of specific fertilizers, or design for the highest density.

2. Design walls and floors with distributed reinforcing steel to resist cracking. This may require more reinforcing steel than the structural loads criterion.

A minimum of 4,500-psi concrete and Grade-60 reinforcing steel are required for all secondary containment structures and mixing and loading pads. Provide reinforcing support with chairs to position the reinforcing at the proper location in the slab thickness.

Reinforcing Steel

Reinforcing steel bar size and spacing is selected to control shrinkage cracking and/or to resist loads applied due to the use of the structure. A minimum of Grade-60 steel is required in all designs. Distributed steel is sized and spaced to hold together the shrinkage cracking that naturally occurs. These small, distributed shrinkage cracks usually do not penetrate the thickness of the slab or wall and still will provide a relatively impermeable liquid tight barrier. Reinforcement is also spaced to minimize crack width. Having smaller reinforcing bars spaced close together is better than having a few large reinforcing bars spaced far apart. To minimize shrinkage cracking, special effort should be made to reduce the subgrade friction.

Distributed steel can minimize the number of designed joints required in floor slabs. For example, it may be desirable for a mixing and loading pad not to have any joints. Small cracks will occur, but sufficient amounts of distributed steel hold these small distributed cracks together tightly to allow load transfer due to aggregate interlock. Distributed steel does not prevent cracking, compensate for poor subgrade preparation, or increase load carrying capacity. Distributed steel must be cut 2 inches before any designed isolation, contraction, or construction joint. A single layer of distributed reinforcing steel is commonly used in mixing and loading pads. For secondary containment floors, two layers of reinforcing steel must be used to carry the varying moments due to tank loads.

When a single layer of reinforcing is used, it must be placed above the midpoint of the slab. Reinforcing must have at least 11/2 inches of cover at top and 3 inches of cover above the soil surface. The spacing between reinforcing bars also must be large enough to allow aggregate to move between the layers. Bolsters or support accessories such as chairs should be used to support the reinforcing mat(s). Reinforcement and supports should support foot traffic of the concrete placement crew without permanent downward displacement.

Check embedment length for wall-to-floor connections. Embedment length depends on bar size and is needed to develop the tensile load of the reinforcing bar. If embedment length is insufficient, the reinforcing bar will pull out of the concrete before it can transfer the entire load the steel can handle. Table 5.1 shows the embedment length required for different size bars and 2-inch concrete cover. The minimum reinforcing cover for all reinforcing bars is 2 inches.

Table 5.1. Embedment length for 4,500 psi concrete using 60-grade steel*.

Bar size	Cross-sectional area (sq in)	Bar diameter, d (inches)	Embedment length, (inches)
4	0.20	0.500	14
5	0.31	0.625	18
6	0.44	0.750	21
7	0.60	0.875	40
8	0.79	1.000	45

* Multiply table values by 1.2 for epoxy-coated bars.

Floor Slab Design

Floors are designed as slabs on grade. The slab thickness depends on the type of loads on the floor slab. In most cases, the slab thickness is designed as an unreinforced concrete section. Reinforcing is added to control shrinkage cracking and maximize the distance between designed joints. Floor performance is influenced by:

- Uniformity of subgrade and bearing capacity
- Quality concrete
- Structural adequacy (thickness)
- Load transfer at joints
- Type and spacing of joints
- Workmanship
- Under slab treatments (vapor retarders)
- Concrete moisture content and drying rate

Secondary containment floor design

Storage tank loads control thickness for secondary containment floor slabs. See Table 5.2 for the slab thickness required for various loadings and for reinforcing steel areas for secondary containment floors with tank loading only. Reinforcing is selected to minimize crack width and reduce joints needed to control shrinkage cracking. See Table 5.3 for reinforcing schedules for secondary containment floor slabs on grade. Two layers of steel bar reinforcement are needed for secondary containment floors because tank loads induce both positive and negative bending moments in the floor.

Figure 5.1 shows the design detail for a secondary containment floor slab with two layers of reinforcing.

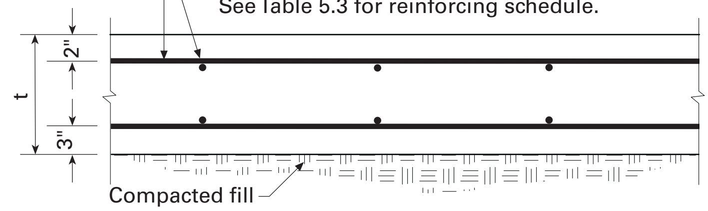

Figure 5.1. Concrete detail for secondary containment floor with two layers of reinforcing. (See table 5.2 for concrete thickness, t).

Table 5.2. Slab thickness and reinforcing steel areas for secondary containment floors with tank loading only. See Figure 5.1 for details.

Subgrade modulus	Maximum tank Height, feet	Concrete thickness, inches	Joint spacing: Less than 10'	10' to less than 20'	20' to less than 30'	30' to less than 40'	40' to less than 50'
			Steel Area (sq. in.) /ft. width of slab Grade-60 Steel				
k = 100	10	8	.400	.400	.400	.480	.576
	15	10	.620	.620	.620	.620	.720
	20	12	.880	.880	.880	.880	.880
	25	14	1.20	1.20	1.20	1.20	1.20
	30	14	1.58	1.58	1.58	1.58	1.58
k = 200	10	8	.400	.400	.400	.480	.576
	15	10	.620	.620	.620	.620	.720
	20	12	.620	.620	.620	.720	.864
	25	14	.880	.880	.880	.880	1.008
	30	14	1.20	1.20	1.20	1.20	1.20
k = 300	10	8	.400	.400	.400	.480	.576
	15	10	.620	.620	.620	.620	.720
	20	12	.620	.620	.620	.720	.864
	25	14	.620	.620	.672	.840	1.008
	30	14	.880	.880	.880	.880	1.008

Table 5.3. Reinforcing schedule for secondary containment floors with tank loading only.
Two layers of reinforcing steel. Maximum spacing 12 inches on center. Reinforcing bar size to be not less than #4. See Figure 5.1 for details.

			Joint spacing				
			Less than 10'	10' to less than 20'	20' to less than 30'	30' to less than 40'	40' to less than 50'
Subgrade modulus	Maximum tank Height, feet	Concrete thickness, inches	Reinforcing bar size and spacing 2 layers reinforcing @ maximum 12" o.c. spacing each way Grade-60 Steel				
k= 100	10	8	#4 @ 12"	#4 @ 12"	#4 @ 12"	#4 @ 10"	#4 @ 8"
	15	10	#5 @ 12"	#5 @ 12"	#5 @ 12"	#5 @ 12"	#5 @ 10"
	20	12	#6 @ 12"	#6 @ 12"	#6 @ 12"	#6 @ 12"	#6 @ 12
	25	14	#7 @ 12"	#7 @ 12"	#7 @ 12"	#7 @ 12"	#7 @ 12"
	30	14	#8 @ 12"	#8 @ 12"	#8 @ 12"	#8 @ 12"	#8 @ 12"
k= 200	10	8	#4 @ 12"	#4 @ 12"	#4 @ 12"	#4 @ 10"	#4 @ 8"
	15	10	#5 @ 12"	#5 @ 12"	#5 @ 12"	#5 @ 12"	#5 @ 10"
	20	12	#5 @ 12"	#5 @ 12"	#5 @ 12"	#5 @ 10"	#6 @ 12
	25	14	#6 @ 12"	#6 @ 12"	#6 @ 12"	#6 @ 12"	#6 @ 10"
	30	14	#7 @ 12"	#7 @ 12"	#7 @ 12"	#7 @ 12"	#7 @ 12"
k= 300	10	8	#4 @ 12"	#4 @ 12"	#4 @ 12"	#4 @ 10"	#4 @ 8"
	15	10	#5 @ 12"	#5 @ 12"	#5 @ 12"	#5 @ 12"	#5 @ 10"
	20	12	#5 @ 12"	#5 @ 12"	#5 @ 12"	#5 @ 10"	#6 @ 12
	25	14	#5 @ 12"	#5 @ 12"	#5 @ 10"	#6 @ 12"	#6 @ 10"
	30	14	#6 @ 12"	#6 @ 12"	#6 @ 12"	#6 @ 12"	#6 @ 10"

Mixing and loading floor design

Vehicle loads control floor thickness for mixing and loading pad floor slabs. The concrete slab thickness is determined based on estimated wheel and axle loadings, and soil subgrade design factors. Table 5.4 shows the thickness of concrete needed for various axle loads. Reinforcing schedules for a mixing and loading pad floor slab on grade with one layer of reinforcing are shown in Tables 5.5(alternate) and 5.6. Figures 5.2 through 5.4 show the design detail for a mixing or loading pad floor slab with one layer of reinforcing.

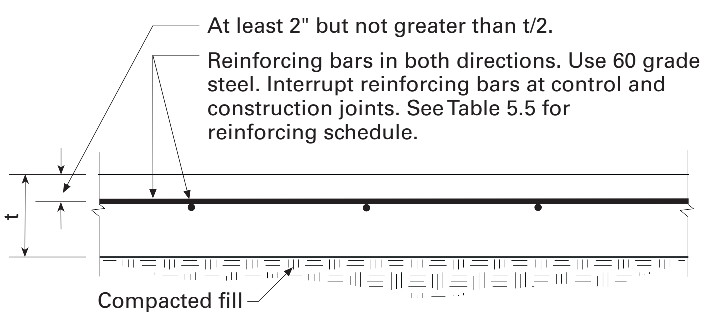

Figure 5.2. Concrete detail for mixing and loading pad floor with one layer of reinforcing. (See table 5.4 for concrete thickness, t).

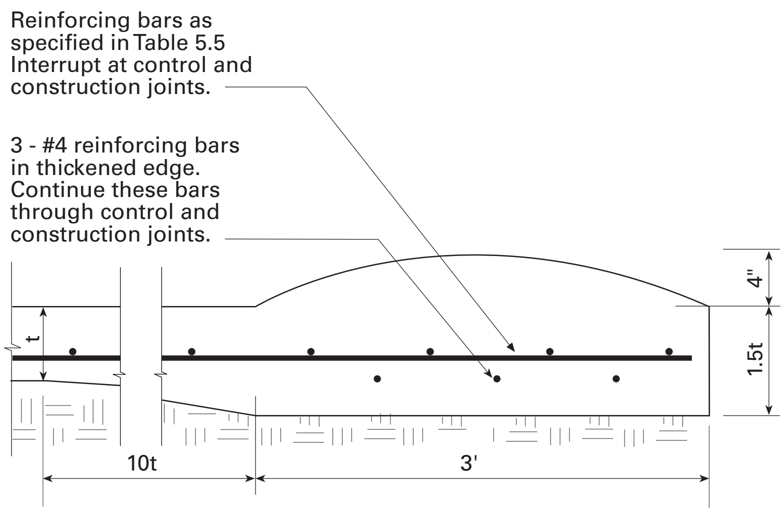

Figure 5.3. Concrete detail for mixing and loading pad floor with integral drive over curb. (See table 5.4 for concrete thickness, t).

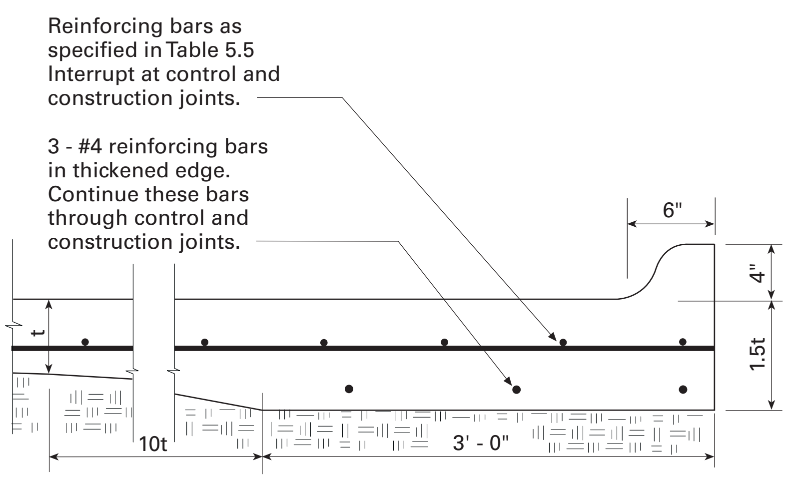

Figure 5.4. Concrete detail for mixing and loading pad floor with integral edge curb. (See table 5.4 for concrete thickness, t).

Concrete sump design

Sumps and depressions must be constructed from a monolithic pour of the concrete used in the floor of the mixing and loading pad or secondary containment structure. They are designed to be liquid tight with no joints or penetrations. The reinforcing schedule and construction detail for a sump and depression is shown in Figure 5.5.

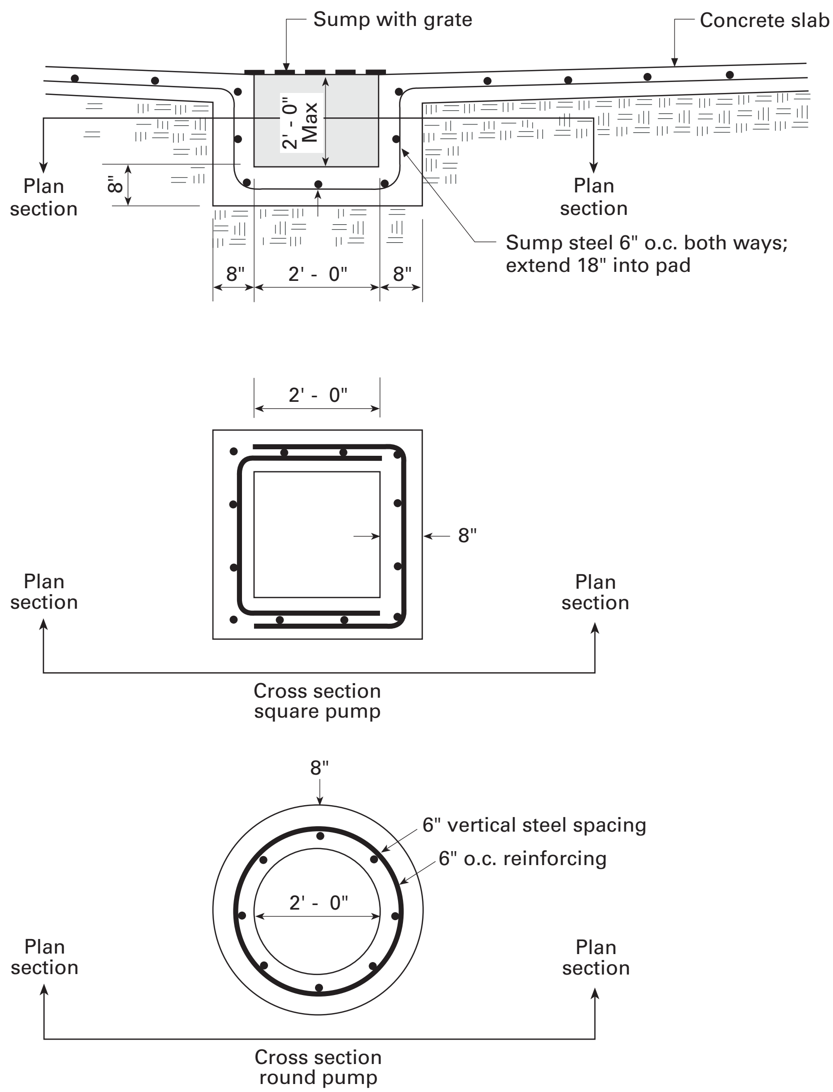

Figure 5.5. Sump or depression reinforcing schedule and design detail.

Table 5.4. Mixing and loading floor slab thickness design.

Subgrade modulus	Axle load, lbs	Slab thickness, inches: Single wheels	Slab thickness, inches: Dual wheels
k = 100 pci	10,000	6	6
	15,000	6	6
	20,000	8	7
k = 200 pci	10,000	6	6
	15,000	6	6
	20,000	8	6
k = 300 pci	10,000	6	6
	15,000	6	6
	20,000	6	6

Table 5.5. Reinforcing areas for mixing and loading pad floors with vehicle loading only. Single layer reinforcement. Maximum spacing of 12 inches on center. Reinforcing bar size to be not less than #4. See Figures 5.2 through 5.4 for detail.

Concrete thickness, inches	Joint spacing				
	Less than 10'	10' to less than 20'	20' to less than 30'	30' to less than 40'	40' to less than 50'
	Steel area (sq.in.)/ft. of slab width Grade-60 Steel.				
6	.144	.216	.288	.360	.432
7	.200	.252	.336	.420	.504
8	.200	.288	.384	.480	.576
10	.240	.360	.480	.600	.720
12	.288	.432	.576	.720	.864

Table 5.6. Reinforcing schedule for mixing and loading pad floors with one layer of reinforcing. Single layer reinforcement. Maximum spacing of 12 inches on center. Reinforcing bar size to be not less than #4. See Figures 5.2 through 5.4 for detail.

Concrete Thickness, inches	Joint spacing				
	Less than 10'	10' to less than 20'	20' to less than 30'	30' to less than 40'	40' to less than 50'
	Bar size @ spacing Single layer steel spaced each way. Grade-60 Steel.				
6	#4 @ 12"	#4 @ 11"	#4 @ 8"	#5 @ 10"	#6 @ 12"
7	#4 @ 12"	#4 @ 9"	#5 @ 11"	#6 @ 12"	#6 @ 10"
8	#4 @ 12"	#4 @ 8"	#5 @ 9"	#6 @ 11"	#6 @ 9"
10	#4 @ 10"	#5 @ 10"	#6 @ 11"	#7 @ 12"	#7 @ 10"
12	#4 @ 8"	#5 @ 8"	#6 @9"	#7 @ 10"	#8 @ 11"

Secondary containment wall design

Most secondary containment walls are designed on top of a slab on grade to provide an easy and practical way of creating a liquid tight joint between the wall and the floor. Figure 5.6 shows the concrete wall detail for a wall on a floating slab on grade. Additional secondary containment wall loads might include:

- Plumbing and other equipment loads (overhead)
- Hydraulic loads (on walls)
- Storage tank anchor loads (on walls or floors)
- Wind and snow loads on building

The secondary containment wall designs here account only for a hydrostatic load. Since building loads (including wind), anchor loads, and plumbing loads can vary significantly from one site to another these loads are not accounted for in the reinforcing schedules or design details. A professional engineer must account for these additional loads in the design of the structure.

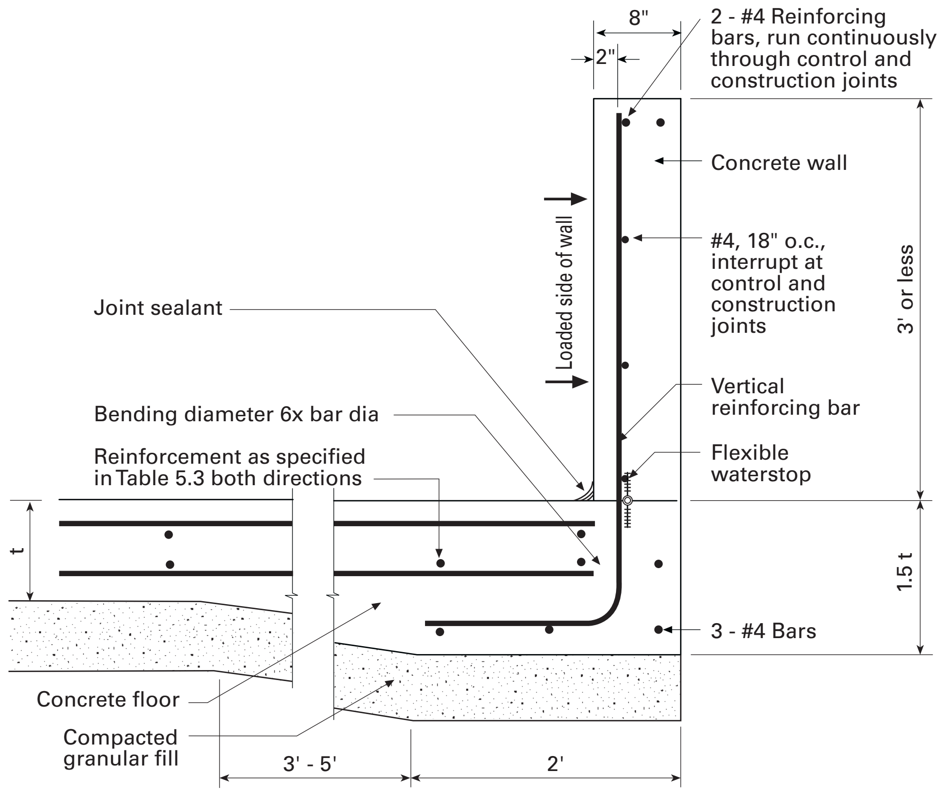

Figure 5.6. Reinforcing schedule and design detail for secondary containment wall.

Figure 5.7 shows the concrete detail for a frost wall for a synthetic liner supported by a concrete wall. When a frost wall is used as a secondary containment wall, providing a liquid tight joint between the wall and the concrete floor is more difficult.

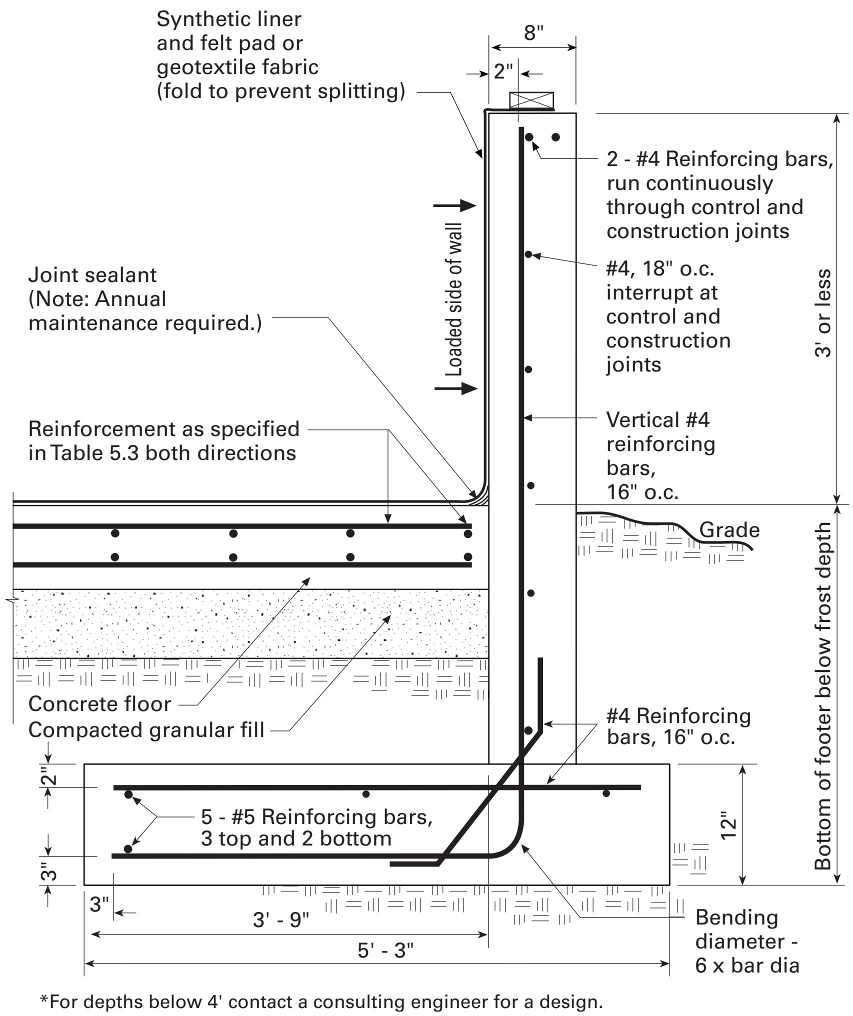

Figure 5.7. Frost wall for structural support of a synthetic liner.

Concrete Joints

Some joints in concrete construction are necessary. However, the watertight construction needed for secondary containment is enhanced when the design requires minimal joints. There are places where no joints are allowed (for example in the "no-joint zone" of a mixing loading pad). The common joints used in concrete slab and wall construction are isolation, construction, and control (contraction) joints. Figures 5.8, 5.9, and 5.10 show locations of the common joints in mixing and loading pads. Figure 5.11 shows common joint locations in secondary containment structures.

Any joints that are likely to be in contact with liquid must be designed as wet joints. Joints that are not likely to be in contact with liquid for long periods can be designed as dry joints.

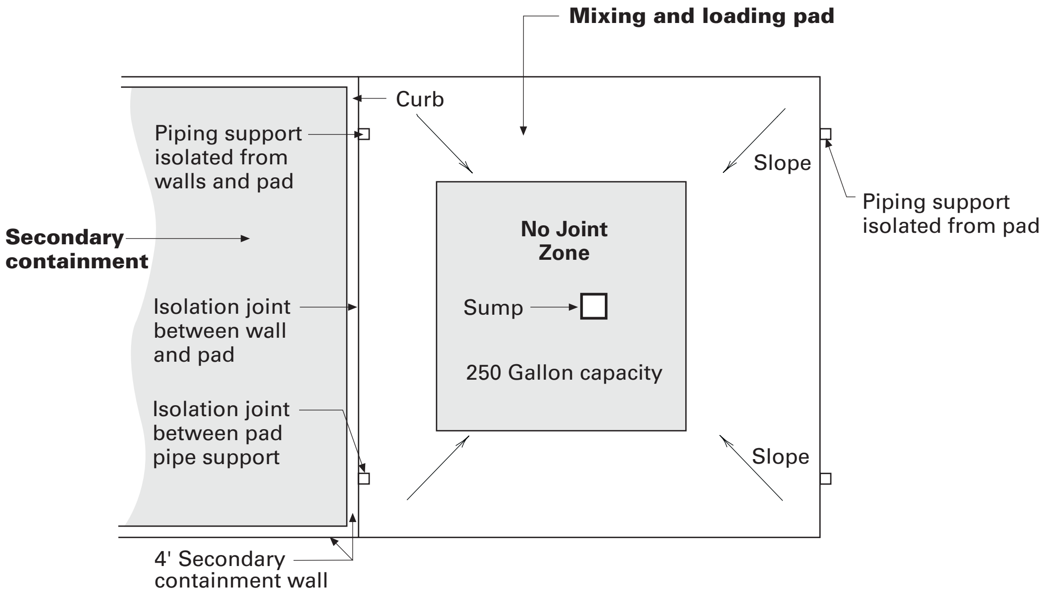

Figure 5.8. Common joints in mixing and loading pad (center sump design) Note location of piping supports.

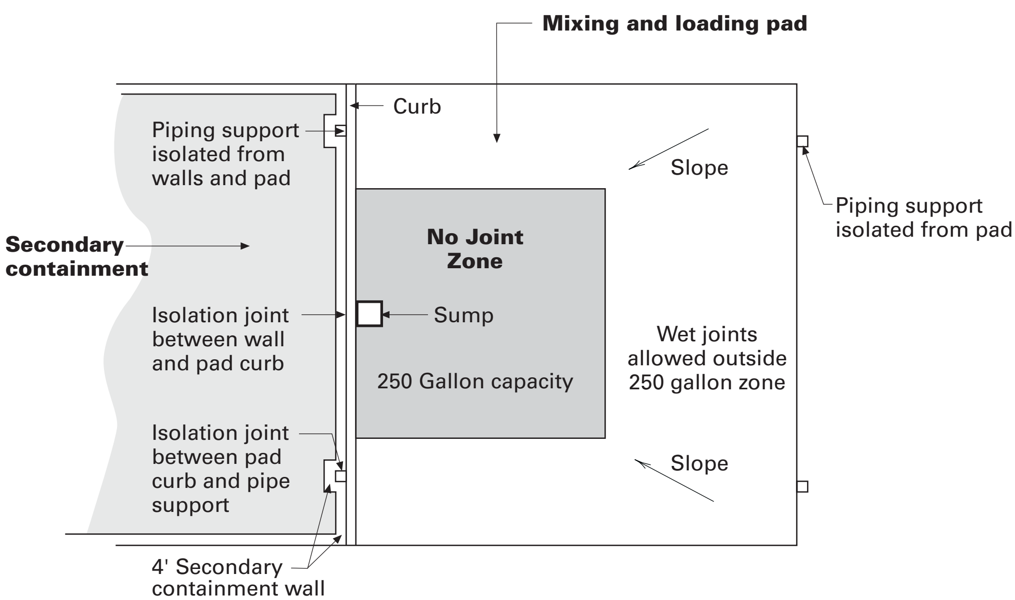

Figure 5.9. Common Joints in mixing and loading pad (side sump design). Note location of piping support outside mixing and loading pad.

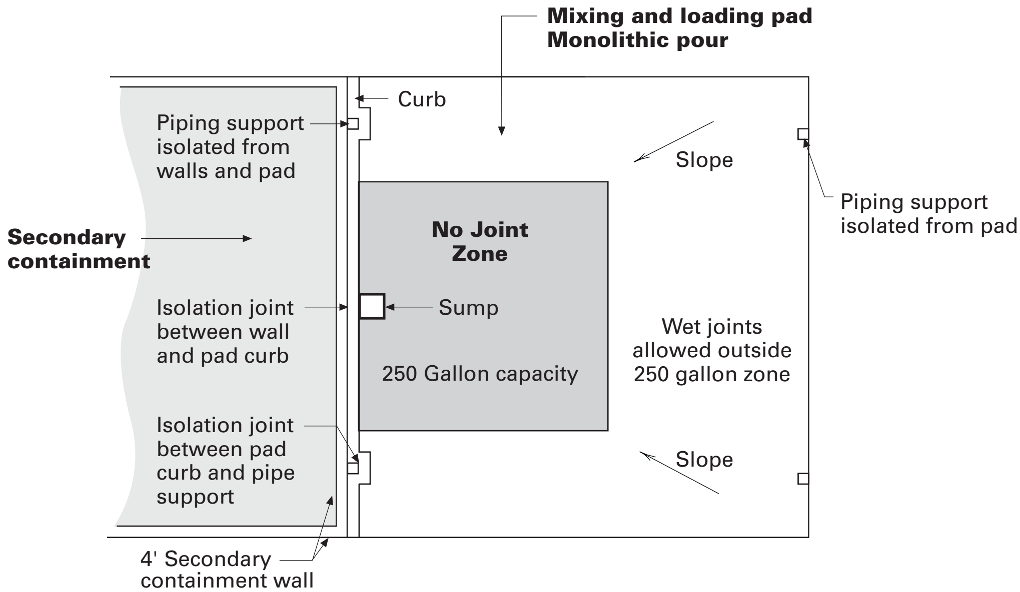

Figure 5.10. Common Joints in mixing and loading pad (side sump design). Note location of piping support outside secondary containment structure.

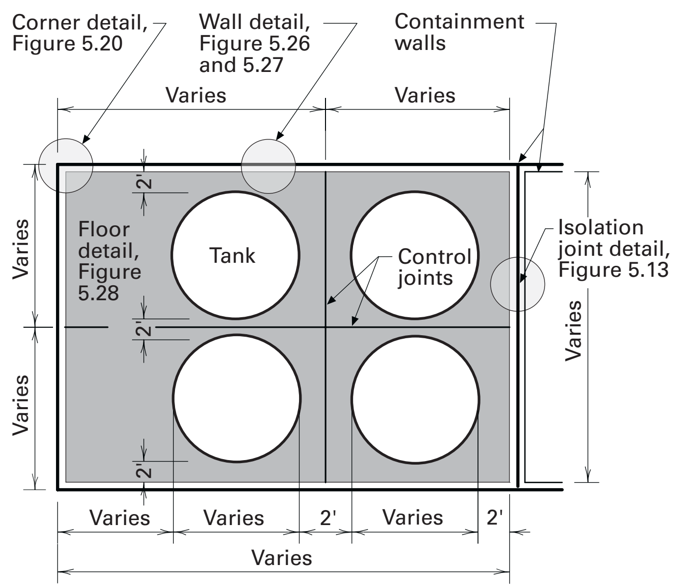

Figure 5.11. Common joints in secondary containment structure.

Dry joints

Dry joints are joints that are unlikely to have hydraulic pressure or standing liquid against the joint for any significant amount of time. They are not designed to be watertight, but will be somewhat impermeable. Any joints located at the highest elevation of a secondary containment structure that will not have fluid contact can be designed as a dry joint. For mixing and loading pads, dry joints cannot be used. Figures 5.8 through 5.11 show the areas where no joints would be allowed and where wet joints would be allowed. Table 5.7 shows where different joints are required, allowed, or recommended. For example a secondary containment structure under a roof, the floor joints can be considered dry joints, but wet joints are recommended. For a mixing and loading pad, no joints would be allowed within the "no-joint zone" (wetted perimeter), and any joints outside the wetted perimeter would be required to be wet joints.

Wet joints

Wet joints are defined as a joint that is likely to have standing fluid or hydraulic pressure against the joint for a significant amount of time. (See Figures 5.8, 5.9, and 5.10). These joints must be designed as watertight joints, which usually require the incorporation of a waterstop or other joint treatment into the joint design. Table 5.7 shows where different joints are required, allowed, or recommended. For example, joints that are located in an unroofed secondary containment floor are likely to have fluid contact and must be designed as wet joints. For mixing and loading pads, no joints are allowed within the 15- x 15-foot area surrounding the sump or lowest elevation that will contain 250 gallons. All other joints outside the "no-joint zone" (wetted perimeter) should be designed as a wet joint.

Waterstops

Flexible waterstops are used in control and construction joints to prevent water leakage in wet joints. A waterstop is a long thin flexible barrier against water leakage that spans across a floor joint, wall joint, or wall-to-floor junction. Materials chosen must be resistant to the pesticides and fertilizers to be encountered. Common waterstop shapes are dumbbell with center bulb; ribbed with center bulb and split ribbed (See Figure 5.12). The center bulb must be positioned at the joint line. Some waterstops can be placed on the subbase before concrete is placed which simplifies construction of the joint. There are also retrofit waterstop designs that allow a wet joint to be installed between existing concrete and new concrete. The waterstop must also be thick enough to withstand folding over during concrete placement. Waterstops made from PVC is not allowed for pesticide secondary containment structures or mixing and loading pads. PE (polyethylene) and Rubber (thermoplastic elastomeric) (cross linked) may be better materials for areas in contact with pesticide materials.

Table 5.7. Joint requirements depending on use in mixing and loading pad and secondary containment structure with or without a roof.
[1]No-joint zone represents the floor area within the 250-gallon capacity. See Figures 5.8 and Figure 5.9 for a definition of a no-joint zone.

Operational Use	Roof over Facility	No Roof over Facility
Mixing and Loading Pad		
• Inside "No-joint zone"[1]	No Joints Allowed	No Joints Allowed
• Outside "No-joint zone"[1]	Wet Joints Required	Wet Joints Required
• Curb and Floor Joint (Within the Required Capacity)	Wet Joints Required	Wet Joints Required
• Curb or Wall (Outside the Required Capacity)	Dry Joints Allowed Wet Joints Recommended	Dry Joints Allowed Wet Joints Recommended
Secondary Containment		
• Floor	Dry Joints Allowed Wet Joints Recommended	Wet Joints Required
• Wall	Dry Joints Allowed Wet Joints Recommended	Dry Joints Allowed Wet Joints Recommended

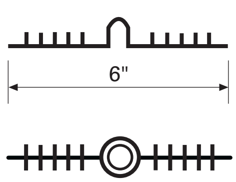

Figure 5.12. Typical waterstops available.

The formwork around waterstops must be tight fitting so a leakage path for the cement mortar does not exist. Concrete must be carefully placed and consolidated to avoid shifting of the waterstop. Position waterstops correctly; locate accurately and firmly brace or lash to reinforcement to prevent movement during placing of the concrete.

Isolation joints

Isolation joints permit horizontal and vertical differential movement at adjoining parts of the structure. (See Figures 5.8, 5.9, and 5.10.) Isolation joints may be needed at the joint between floors and walls or where column foundations and floor slabs adjoin. Isolation joints must be designed as dry joints since they would be difficult to design as a wet joint with a waterstop that could allow movement. An isolation joint detail is shown in Figure 5.13. Isolation joints can only be used at the highest elevation of a fluid retaining structure to protect it from being in contact with standing fluid or under a hydraulic pressure. If the joint is in fluid contact, it must be designed as a wet joint.

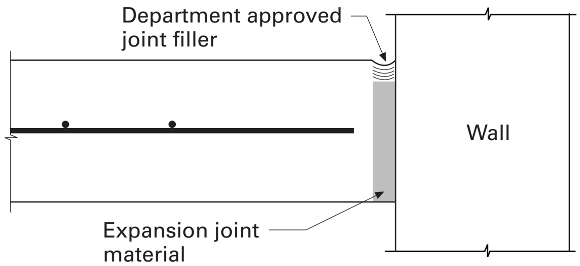

Figure 5.13. Isolation joint.

Construction joints

Construction joints are stopping places in the process of construction. They are usually designed as contraction joints or isolation joints depending on their location. Figure 5.14. A keyway is placed in the form in the first concrete placement and is removed before the next day's concrete placement.

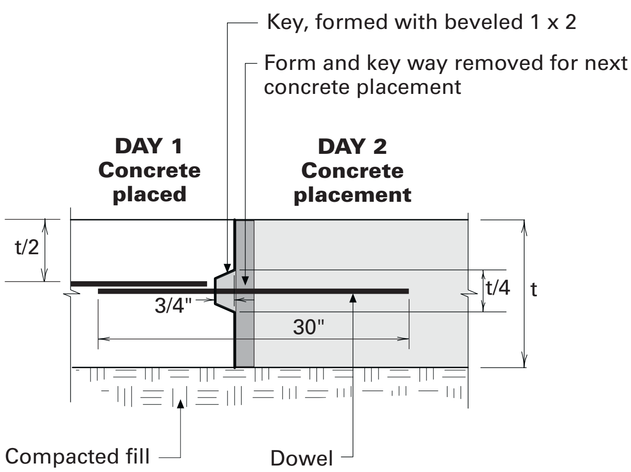

Figure 5.14. Construction joint.

Control (contraction) joints

Designed control joints relieve the shrinkage stress that occurs as the concrete hydrates and drying shrinkage occurs. Placement of control joints is based on the subgrade drag theory, which depends on how much the subbase friction restrains the concrete from moving. A crack will form when the internal stress is higher than the tensile stress of the concrete.

Control (contraction) joints provide (See Figure 5.11) movement in the plane of the slab or wall and induce a controlled crack at a selected location. This movement is due to the natural shrinkage and drying contraction that occurs as the concrete cures and dries out. Figure 5.15 shows a detail of a control joint. Control joints must be constructed to transfer perpendicular loads across the joint by aggregate interlock or if necessary by dowels.

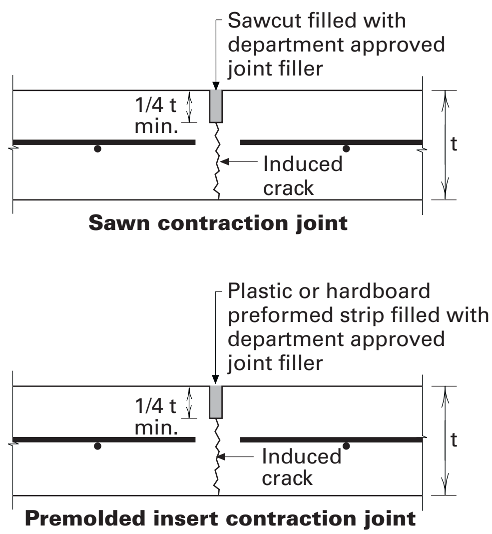

Figure 5.15. Control (contraction) joint.

Control joints can be formed by tooling during the placing of the concrete or sawed into the concrete. Sawed control joints must be sawed within the first 24 hours after the concrete has been poured and preferably within the first 12 hours. The joint becomes a weak section of concrete. Reinforcing must be interrupted (cut) at any designed control joint to promote the crack to occur at the weakened section. It is much easier to caulk or seal a straight, wide joint (1/8- to1/4-inch thick) than a random crack that may develop in unjointed concrete. Joints are usually much larger than cracks and will hold grouts and sealers much better. A control joint in the floor must extend 25 percent of the way through the slab. The line of weakness will concentrate cracking, but still allow the transfer of loads between slab sections through the interlocking aggregates. Locate floor and wall control joints in line with each other. Fill the control joints with a sealant to prevent leakage. Contact the DATCP to identify which joint sealers are approved for use in Wisconsin.

When contraction joints are placed farther apart than 20 feet, dowels must be used to transfer loads. Aggregate interlock will be lost as joint spacing increases and the resulting cracks widen. Interrupt the reinforcing steel at control joints, and place 30-inch long #4 reinforcing bar dowels through the joint every 30 inches along the joint. See Figures 5.21 and 5.22. Control joints must be located in accessible areas, e.g. not under a tank, so the crack can be monitored, and sealant can be easily applied, repaired, or replaced.

A design option for additional load transfer at joints is to thicken the edge of a slab under the designed joint. Thicken the slab at joints to 125 percent of the adjacent thickness, and taper from the thinner section to the thicker section at a slope of no more than 1:10.

Contraction (control) joints in walls are spaced according to the reinforcing specifications in Table 5.8. A control joint in a wall must extend 30 percent of the way through the wall, and half the reinforcing at the joint must be cut to promote a crack at that location.

Maximizing Joint Spacing

A high percentage of distributed steel in the concrete section can increase the distance between contraction (control) joints to a larger distance than what is normally suggested. This is based on ACI 350, which provides guidance on a more liquid tight construction. ACI 350 requires two to three times the amount of steel to increase the spacing of joints as compared to ACI 318 minimum temperature and shrinkage steel. The relationship between control joint spacing and reinforcing needed is shown in Table 5.8. Following the reinforcing suggestions could result in minimizing joints in secondary containment floor areas where liquid is likely to be in contact with the concrete surface.

Table 5.8. Minimum shrinkage and temperature reinforcement.
Spacing of reinforcing not to exceed 12 inches on center. Reinforcing bar size not to be less than #4 Imperial (13 soft metric).

Length between movement joints (feet)	Requirements Steel Area/Concrete Area Ratio
	Grade-60
less than 30	.003
30 to less than 40	.004
40 and greater	.005

Temperature and shrinkage steel recommendations according to ACI 318 require joints at a much closer spacing. Spacing of contraction joints for floor slabs with minimal temperature shrinkage steel are shown in Table 5.9. Joints at this spacing cannot be placed where liquid tight construction is desired (for example on the mixing and loading pad in the no-joint zone). For dry fertilizer loading pads smaller joint spacing following Table 5.5 may be adequate.

Table 5.9.* Spacing of contraction joints in feet.**

Slab thickness, in.	Maximum-size aggregate less than 3/4 in.	Maximum-size aggregate 3/4 in. or larger
6	12	15
7	14	18***
8	16***	20***
9	18***	23***
10	20***	25***

*Table adapted from Table 6-1b, page 55, Concrete Floors On Grade
**Spacings are appropriate for slump between 4 inches and 6 inches. If the concrete cools at an early age, shorter spacings may be needed to control random cracking. A temperature difference of only 10 degrees F may be critical. For slump less than 4 inches, join spacing can be increased by 20%
***When spacings exceed 15 feet, load transfer by aggregate interlock decreases markedly.

Wall-to-floor construction details

Figures 5.16 through 5.19 show details of joints used at an exterior or interior curb or wall for secondary containment. If a wet joint is required to provide a liquid tight joint, a waterstop must be used in the design. If no waterstop is integral to the joint, these details are considered a dry joint and are not liquid tight. Figure 5.20 shows how reinforcing is brought around a corner to minimize stress concentrations at a change in direction of the wall.

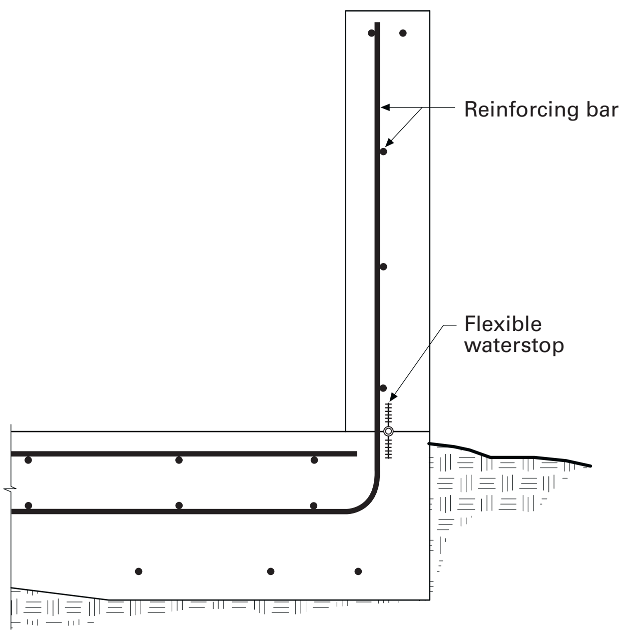

Figure 5.16. Wall-to-floor joint (wet joint).

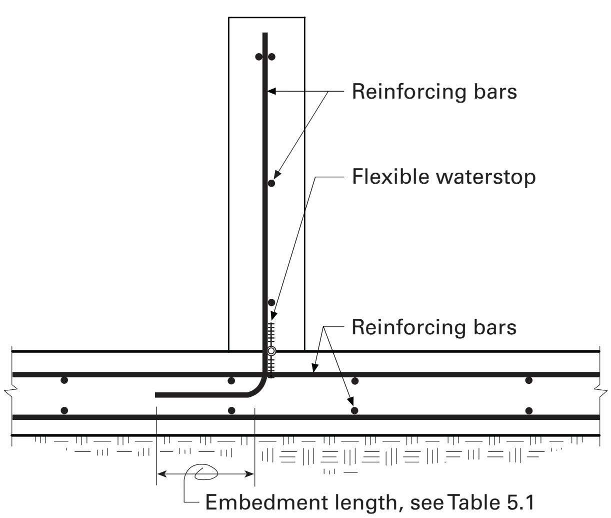

Figure 5.17. Interior wall-to-floor joint (wet joint).

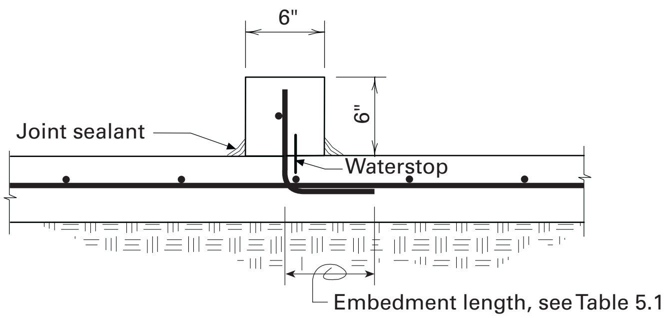

Figure 5.18. Interior curb-to-floor joint (wet joint).

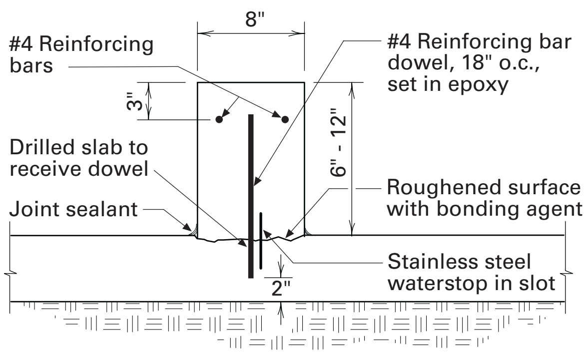

Figure 5.19. Retrofit curb-to-floor joint (dry or wet joint).

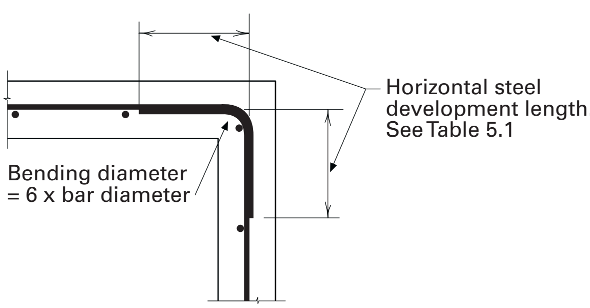

Figure 5.20. Reinforcing detail of a wall corner.

Floor slab construction details

Floor control joint details are shown in Figures 5.21 through 5.22. Although minimizing joints in the floor slab may be desirable, joints may need to be installed in a slab to maintain a more impermeable barrier. If the joints can be placed to minimize the exposure to standing water, it is more economical to design a dry joint. When it is necessary to have a joint in contact with liquid (on mixing and loading pads or outside secondary containment structures), the joint must incorporate a waterstop and be designed as a wet joint. Although it is desirable to place the floor slab in a continuous concrete placing, it may be necessary to stop construction. Figures 5.23 through 5.25 show wet and dry construction joints for floor slabs.

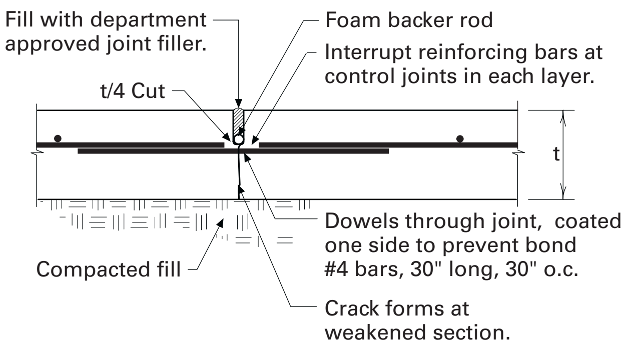

Figure 5.21. Floor sawn control joint with joint filler (dry joint).

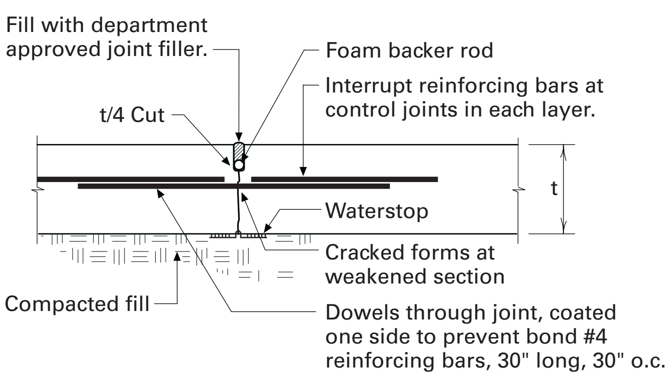

Figure 5.22. Floor sawn control joint with waterstop at bottom (wet joint).

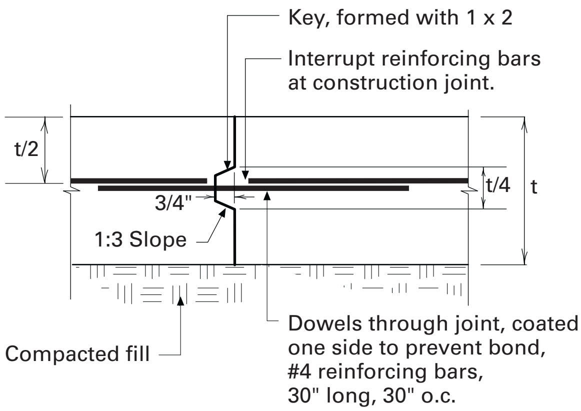

Figure 5.23. Floor construction joint (dry joint).

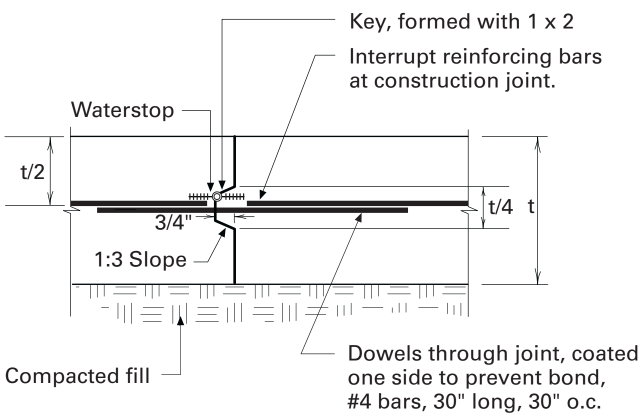

Figure 5.24. Floor construction joint with waterstop at midpoint (wet joint).

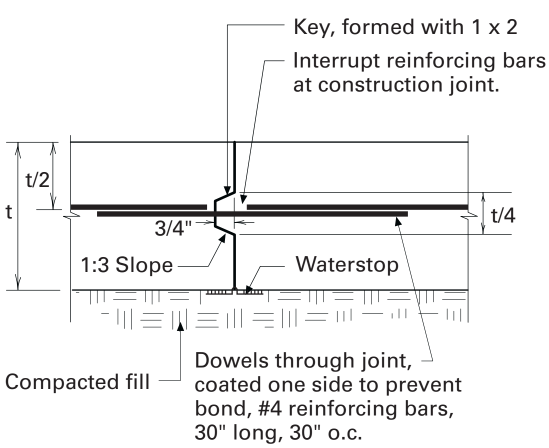

Figure 5.25. Floor construction joint with waterstop at bottom (wet joint).

Wall construction details

Wall and floor joints must be designed integral to each other. A wall joint must be placed in a wall to match any floor joint designed into the slab. If this procedure is not followed, the floor crack will likely reflect into the wall and propagate into a diagonal or random wall crack. Figures 5.26 through 5.29 show wall control joints and wall construction joints.

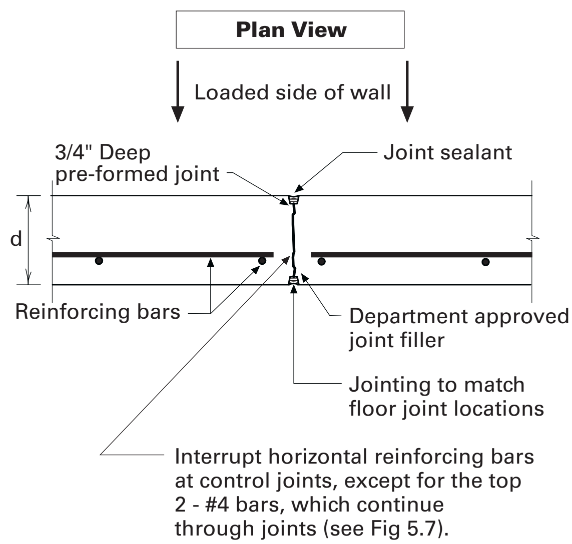

Figure 5.26. Wall sawn or formed control joint with joint filler (dry joint).

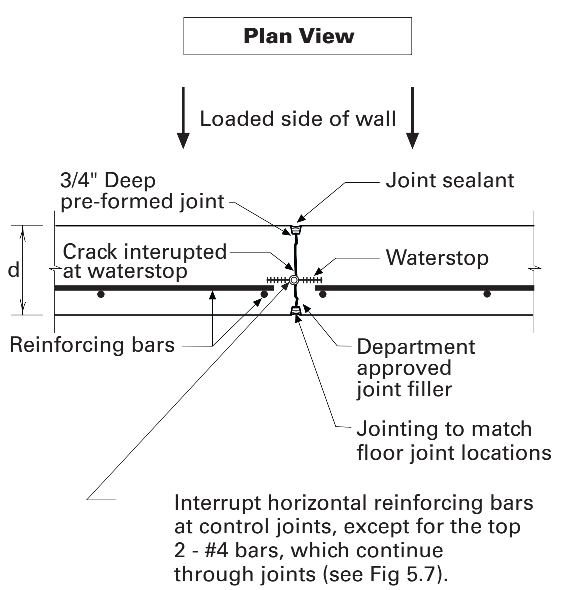

Figure 5.27. Wall sawn or formed control joint with waterstop at midpoint of wall (wet joint).

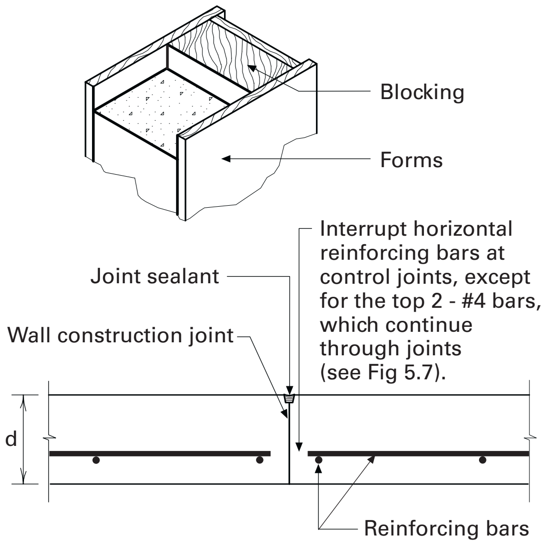

Figure 5.28. Wall construction joint (dry joint).

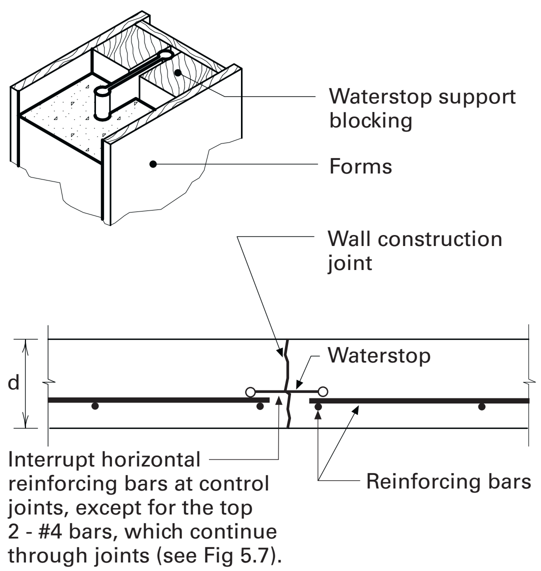

Figure 5.29. Wall construction joint with waterstop at midpoint of wall (wet joint).

Floor isolation joint detail

A floor joint between a mixing and loading pad and an adjoining concrete surface or structure will most likely be an isolation joint. It must be located at the highest elevation of the secondary containment so it is not likely to have fluid contact. The thickened edges at the joint help transfer load to and from the two separate concrete pours. Figure 5.30 shows an isolation joint detail.

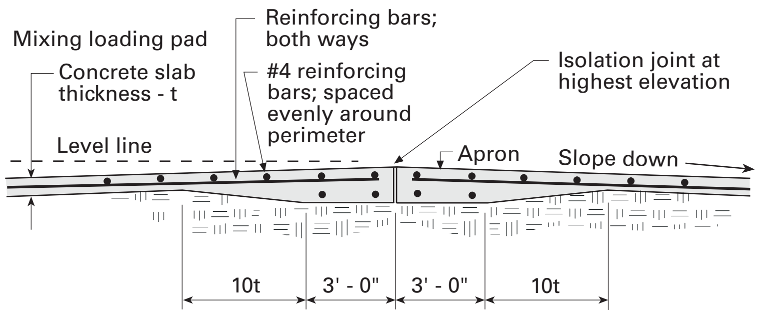

Figure 5.30. Floor Isolation joint (dry joint).