

## Index 425-001

### Supplementary Details for Manholes and Inlets

#### ORIGINATION

**Date:** November 1, 2019

**Name:** Rick Jenkins

**Phone:** (850) 414-4355

**Email:** Rick.Jenkins@dot.state.fl.us

#### COMMENTARY

Reorganized Index, Added additional Sheets.

Sheet 1: General Notes and Overview

Sheet 2: Manhole Frames and Tops

Sheet 3: Inlet Locking Grates, Subgrade and Base Temporary Drains, and Pipe to Structure Filter Fabric Wrap

Sheet 4: Drainage Structure Inlet, Sump Bottom, Wall Reinforcement Splice Details, and Typical Slab to Wall Details

Sheet 5: Construction Joints and Minimum Box Riser Segment Dimensions

Sheet 6: Skewed Pipe in Rectangular Structures

Sheet 7: Miscellaneous Pipe Connection Details

#### COMMENTS AND RESPONSES

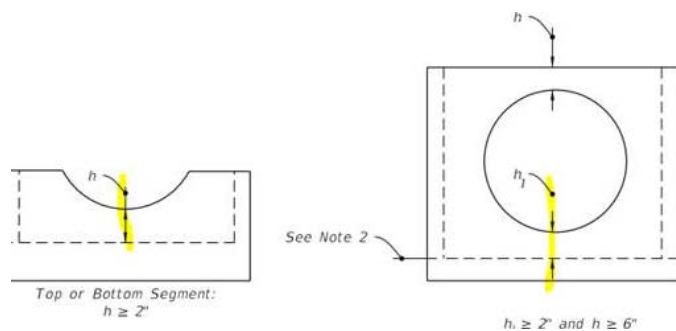
**BLACK** = Industry Review Comments    **RED** = Standard Plans Response

**Name:** Charles Samuels / Atkins

**Date:** September 2, 2020

#### **COMMENT:**

Consider placing the “h” for the Top or Bottom as it is for adjacent bottom. It is a bit confusing unless you zoom in considerably.



**RESPONSE:** Agreed

**Change to Index:** Moved dimension arrows to outside of top or bottom segment detail for clarity.

**Date:** 9-10-20

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**Name:** Anonymous

**Date:** September 16, 2020

**COMMENT:**

1. Sheet 1 & 2 Manhole Tops – Is the bottom of Type 8 Manhole round (3'-6" dia or 4' dia) per sheet 2? Or will the pre-caster need to transition a round top to a rectangular bottom, regardless of the rectangular dimension per sheet 1?
2. Sheet 1 Manhole Tops Isometric View – Suggest eliminating "or inlet" since the view is related to manhole tops only.
3. Sheet 2 Note 1 – The General Note 6 does not discuss about concrete slab. Is that the correct reference?
4. Sheet 2 Note 4 – Please consider reword to "Use construction joint options" to avoid confusion that the construction joint requirements are optional.
5. Sheet 3 Table 2 – Some inlet types were eliminated/renumbered in Index 425-030.
6. Sheet 7 Skewed Pipe – The original index limits the pipe skew to not exceed 45-degree (between pipe and CL wall opening). When the skew definition is switched, the sub-title also need to be switched with  $\leq$  sign. Furthermore, Section A-A would need an elliptical opening when it exceeds the maximum degree on Table 4.
7. Will the old General Note 7 be moved to SPI?

**RESPONSE:**

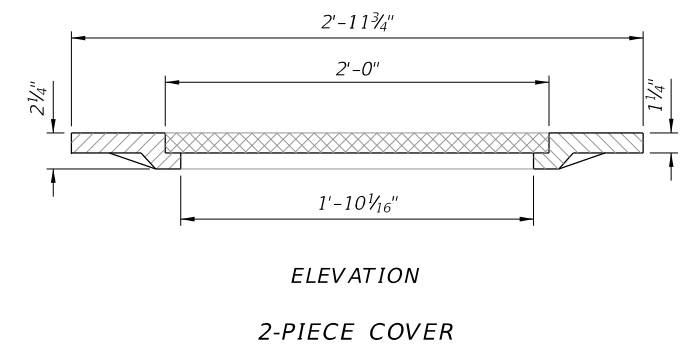
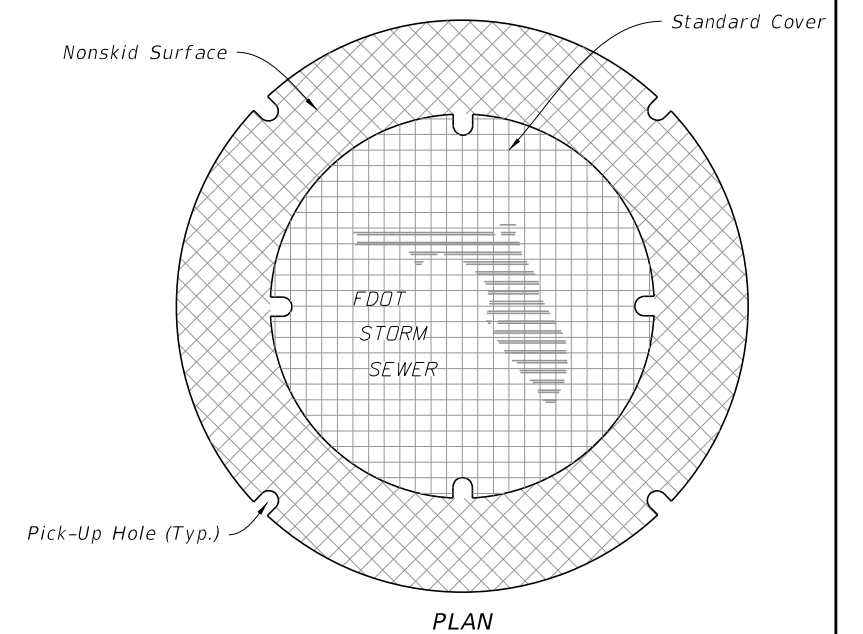
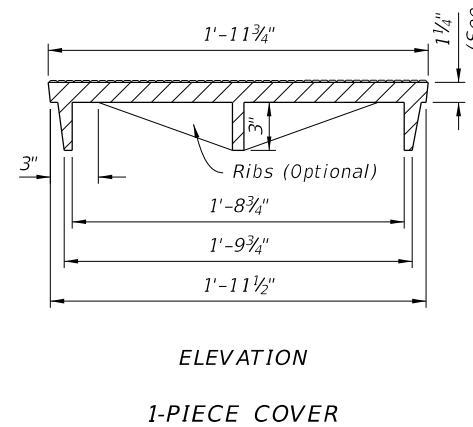
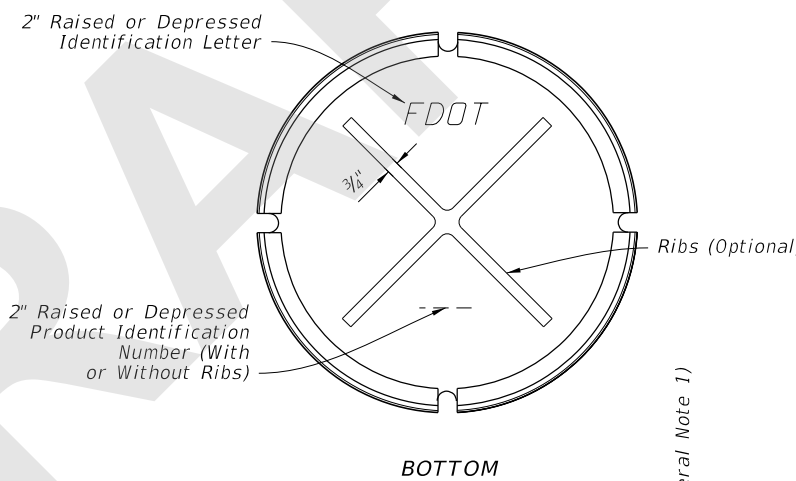
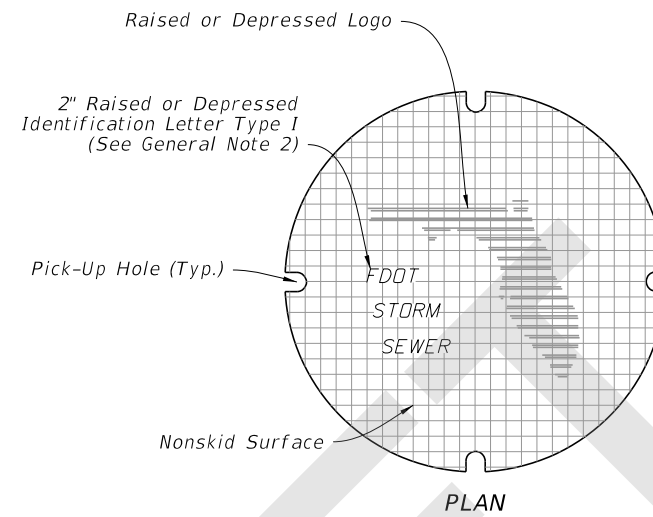
1. These isometric views are for visual purposes only. The Type 8 Manhole can have a round or square bottom as specified on sheet 2 of the Index.
2. Agree. **The reference to Inlets in the Manhole Tops Details will be deleted from Sheet 1.**
3. Agree. **This is a left-over reference and will be deleted from index.**
4. Agree. **The note will be updated to clarify.**
5. Agree. **Table was updated to remove old references to Index 425-030.**
6. Section A-A applies to both cast in place and precast, while Table 4 applies to precast. The Note under Table 4 also states that the table is for precast structures, larger skews are possible for cast-in-place and elliptical pipe openings when approved by the Engineer. **We will add a note on sheet 7 to send the user to Table 4.**
7. Yes

**Change to Index:** See **bold** text in responses above.

**Date:** 9-18-20

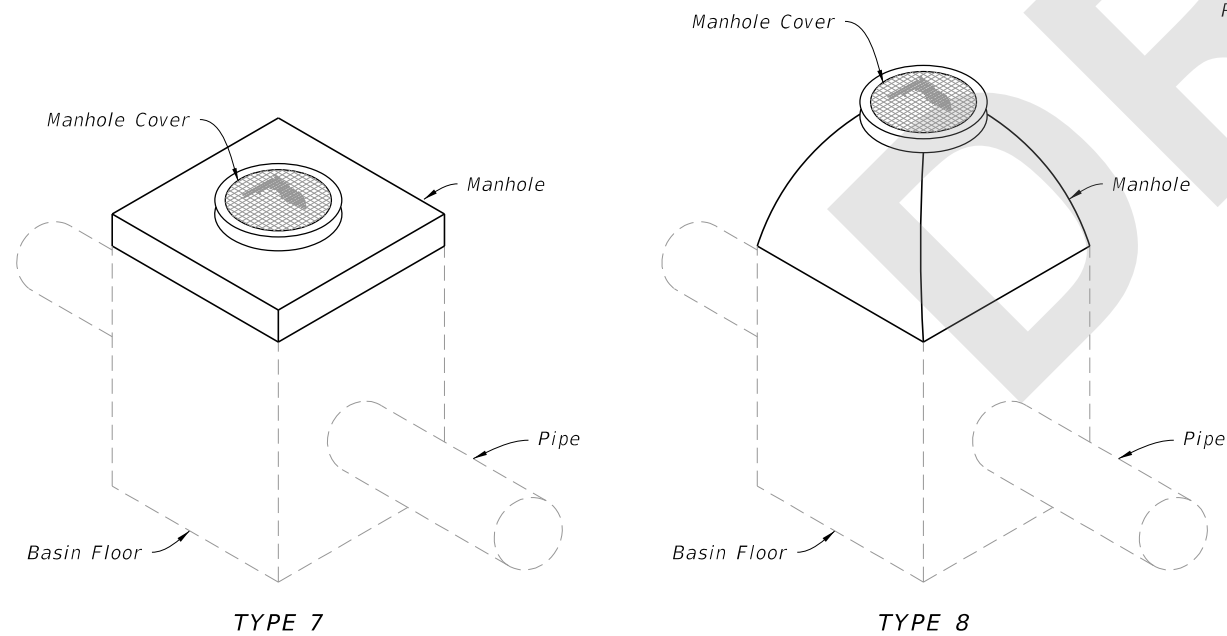
**GENERAL NOTES:**

1. Use a 1-piece cover, unless the 2-piece cover is called for in the Plans, except at inlets and manholes with sump bottoms. Use the 2-piece cover when the sump depth exceeds 2', unless otherwise noted.
2. Include "Adjustable" on the cover for Type I manhole adjustable frames.
3. For square or rectangular precast drainage structures, use either deformed or smooth WWR meeting the requirements of Specification 931. WWR must be continuous around the box and lapped in accordance with Option 1 or 3 as shown in the Wall Reinforcing Splice Details.
4. Lap splice horizontal steel in the walls of rectangular structures in accordance with Option 1, 2 or 3 as shown in the Wall Reinforcing Splice Details.
5. Welding of splices and laps is permitted. Use AASHTO M259 requirements and restrictions on welds.
6. Rebar straight end embedment of peripheral reinforcement may be used in lieu of ACI standard hooks for top and bottom slabs, except when hooks are specifically called for in the Plans.
7. Precast opening for pipe must be the pipe OD plus 6" ( $\pm 2"$  tolerance). Use mortar to seal the pipe into the opening of such a mix that shrinkage will not cause leakage into or out of the structure. Dry-pack mortar may be used to seal openings less than 2½" wide.



**TABLE OF CONTENTS:**

| Sheet | Description   |
|-------|---|
| 1     | General Notes, Contents, Manhole Top Overview, and Manhole Covers   |
| 2     | Manhole Frames and Manhole Tops   |
| 3     | Inlet Locking Grates, Subgrade and Base Temporary Drains, and Pipe to Structure Filter Fabric Wrap        |
| 4     | Drainage Structure Invert, Sump Bottom, Wall Reinforcing Splice Details, and Typical Slab to Wall Details |
| 5     | Precast Option and Equivalent Reinforcement substitution  |
| 6     | Construction Joints and Minimum Box Riser Segment Dimensions  |
| 7     | Skewed Pipe in Rectangular Structures   |
| 8     | Miscellaneous Pipe Connection Details   |



MANHOLE TOPS

MANHOLE COVERS

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| LAST REVISION | DESCRIPTION: |
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FY 2021-22  
STANDARD PLANS

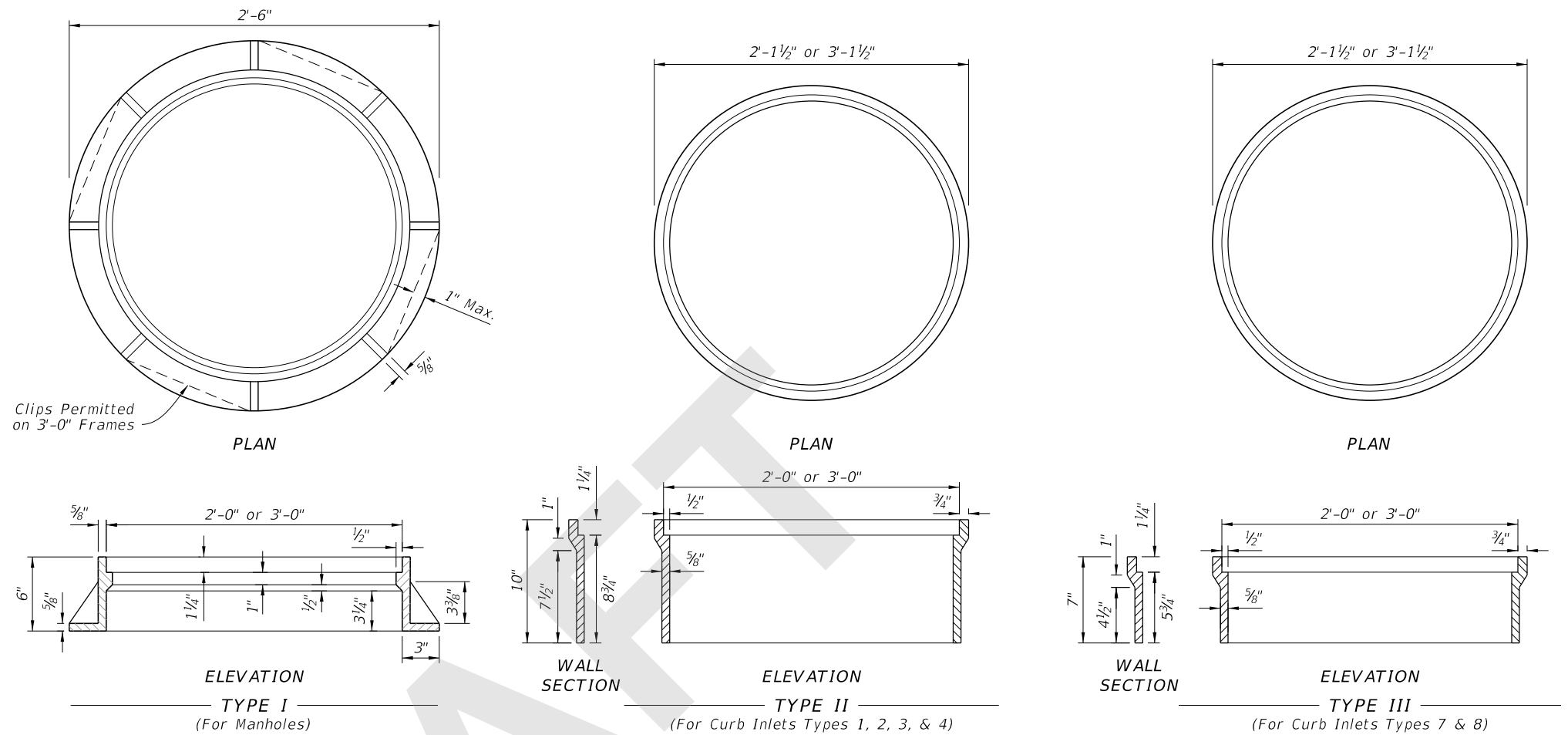
SUPPLEMENTARY DETAILS  
FOR DRAINAGE STRUCTURES

INDEX  
425-001

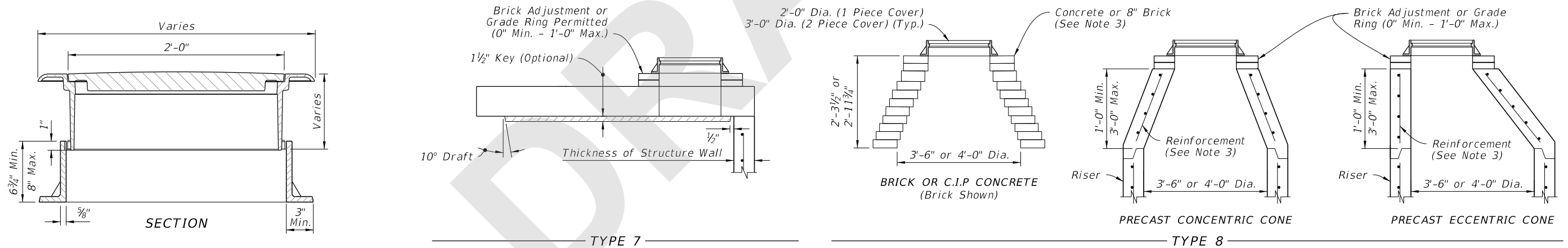
SHEET  
1 of 8

| Frame Type | 2'-0" OPENING |              | 3'-0" OPENING |                      |                       |       |
|------------|---------------|--------------|---------------|----------------------|-----------------------|-------|
|            | Frame         | Cover (Std.) | Frame         | 2-Piece Cover Inside | 2-Piece Cover Outside | Total |
| I          | 155           | 190          | 220           | 190                  | 220                   | 410   |
| II         | 145           | 190          | 255           | 190                  | 220                   | 410   |
| III        | 90            | 190          | 180           | 190                  | 220                   | 410   |

**NOTE:**  
Frame Type I in Table 1, includes Adjustable frames.

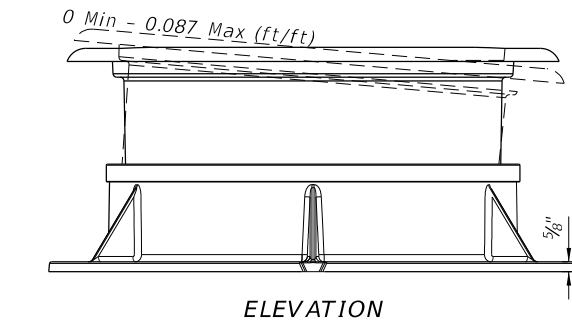


**MANHOLE FRAMES**



**NOTES:**

1. Use Class II concrete for Manhole top Type 7 slabs.
2. Manhole top Type 7 slabs may be of cast-in-place or precast construction. The optional key is for precast tops and in lieu of dowels. Omit frame and slab openings when top is used over a junction box.
3. Manhole top Type 8 may be of cast-in-place, precast concrete construction, or brick construction. For concrete construction, use the same concrete and steel reinforcement as the supporting wall unit. An eccentric cone may be used.
4. Use construction joint options, as shown on Sheet 6 to secure manhole tops to structures.
5. Frames may be adjusted to a maximum 12" height with brick or precast ASTM C478 grade rings.
6. Manhole top Type 8 may be substituted for a Type 7, if the minimum dimensions are not reduced.
7. Manhole top Type 7 may be substituted for Type 8, if the minimum thickness (h) above pipe opening cannot be maintained with Type 8.



**TYPE I ADJUSTABLE FRAME**

**MANHOLE TOPS**

**MANHOLE FRAMES AND MANHOLE TOPS**

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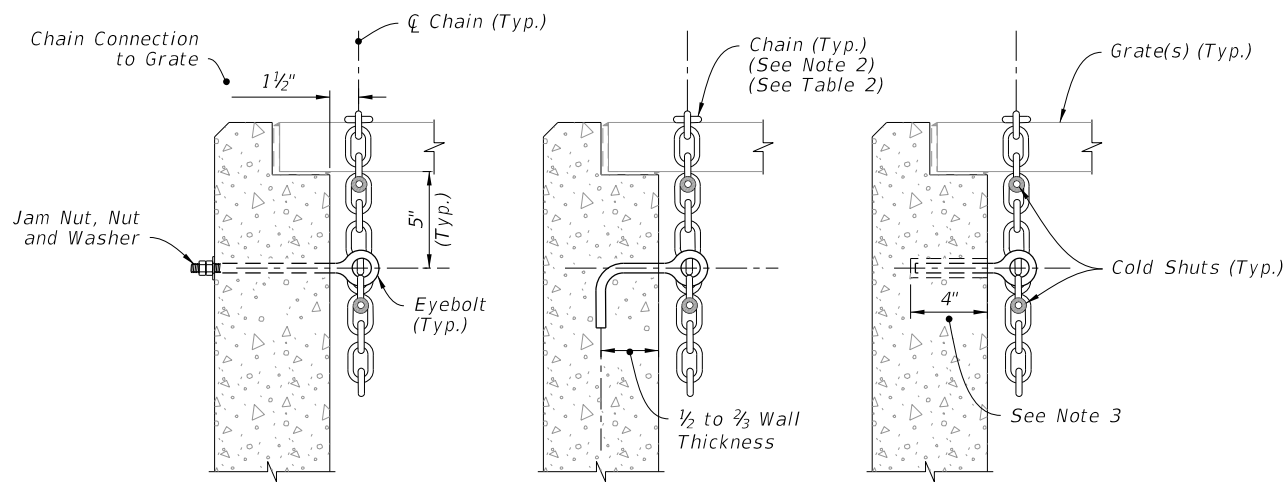


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THRU-BOLT

J-TYPE

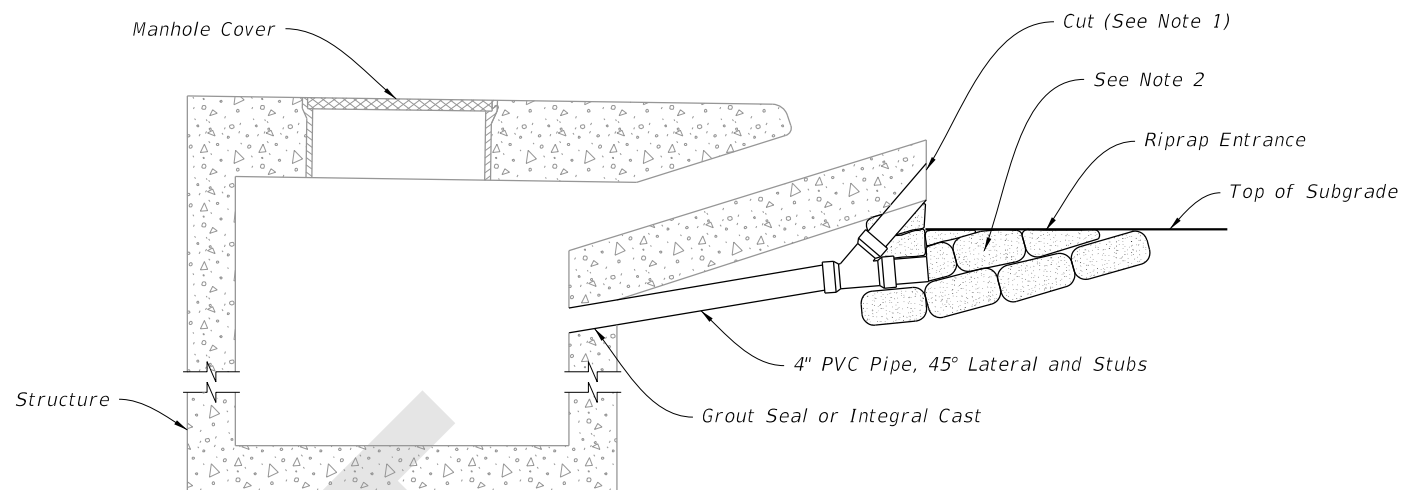
ADHESIVE BONDED ANCHOR

NOTES:

1. Install either a 1/2" Ø x 1" Diameter Threaded Straight (Thru-Bolt), a J-Type, or an adhesive Bonded Anchor Eyebolt.
2. Install a 3/16" Chain and 3/16" Cold Shuts. When chaining two grates together provide adequate loop for easy handling.
3. Install adhesive bonded anchor option with a minimum of 4" embedment, and in accordance with Specification 416.

TABLE 2  
EYEBOLT AND CHAIN REQUIREMENTS

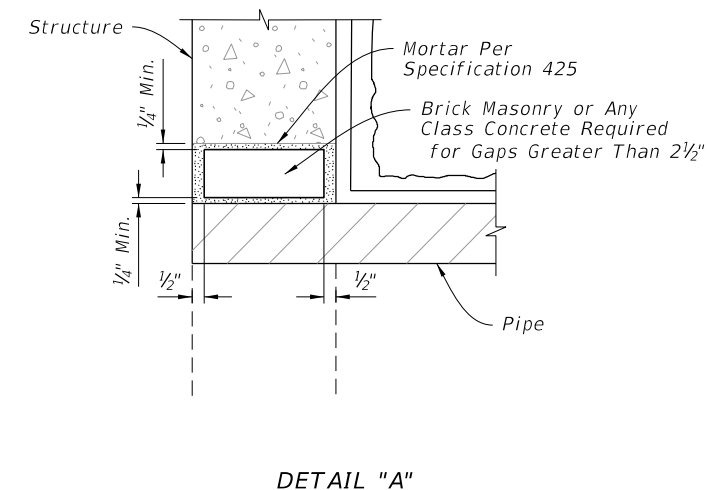
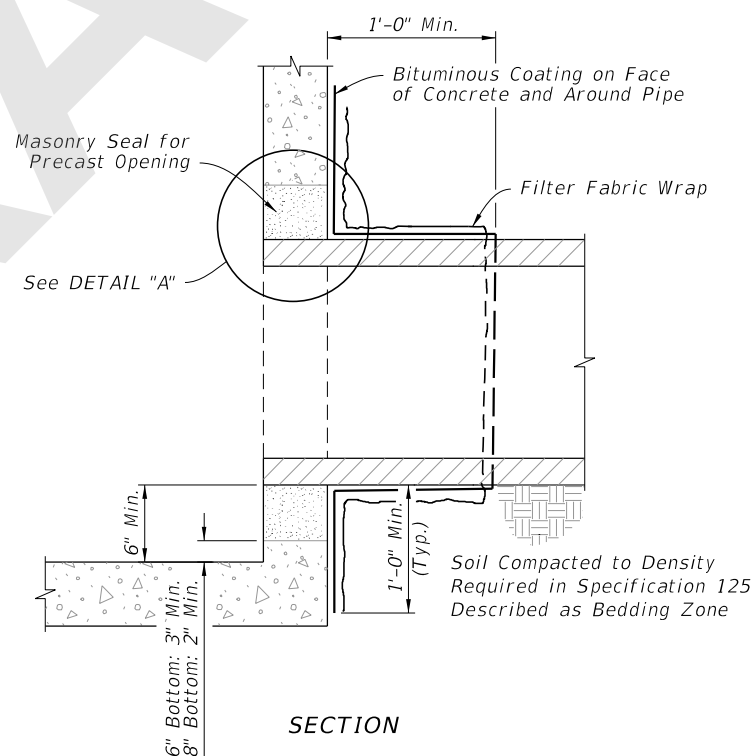
| Index Number | Inlet Type | Eye-Bolts | Length of Chain | Handling & Remarks                                 |
|--------------|------------|-----------|-----------------|--|
| 425-030      | 1          | 1         | 4'-0"           | Slide & Spin                                       |
|              | 2          | 2         | 2 @ 4'-0"       | Slide & Spin                                       |
| 425-031      | N/A        | 1         | 3'-8"           | Slide or Slide & Spin                              |
| 425-032      | N/A        | 1         | 4'-0"           | Slide & Spin                                       |
| 425-040      | S          | 1         | 4'-0"           | Slide & Spin                                       |
| 425-041      | V          | 1         | 4'-0"           | Slide & Spin                                       |
| 425-050      | A          | 1         | 3'-0"           | Slide  |
| 425-051      | B          | 1         | 5'-0"           | Slide & Spin                                       |
|              | C          | 1         | 2'-6"           | Slide & Spin                                       |
|              | D          | 1         | 2'-6"           | Slide & Spin                                       |
|              | E          | 2         | 2 @ 2'-6"       | Slide & Spin                                       |
| 425-052      | H          | 2         | 2 @ 2'-6"       | Flip Ctr. Grate and Slide & Spin Single Free Grate |
|              |            |           | 1 or 2 @ 1'-6"  | Center Grate(s) Chained to One End Grate           |
|              | F          | 1         | 3'-6"           | Flip or Slide & Spin                               |
| 425-053      | G          | 1         | 6'-0"           | Slide  |
|              |            |           | 2'-0"           | Lifting Loop                                       |
| 425-054      | J          | 1         | 4'-0"           | Slide & Spin                                       |



NOTES:

1. Bevel cut upper stub to match forming for apron face. Capping or plugging of upper stub is not required. Remove friable base material at stub opening to permit covering of opening with structural course material.
2. Remove riprap, cement PVC cap on lower stub, and place compacted fill in entrance prior to placing base material.

SUBGRADE AND BASE TEMPORARY DRAINS



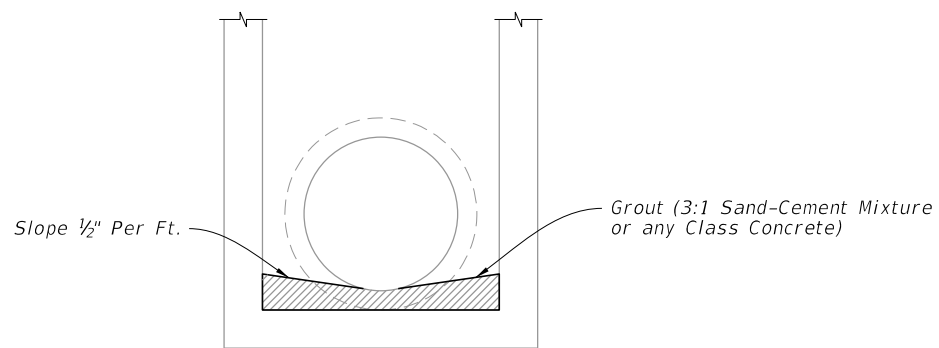
LOCKING GRATES TO INLETS

PIPE TO STRUCTURE FILTER FABRIC WRAP

LOCKING GRATES, SUBGRADE AND BASE TEMPORARY DRAINS, AND PIPE TO STRUCTURE FILTER FABRIC WRAP

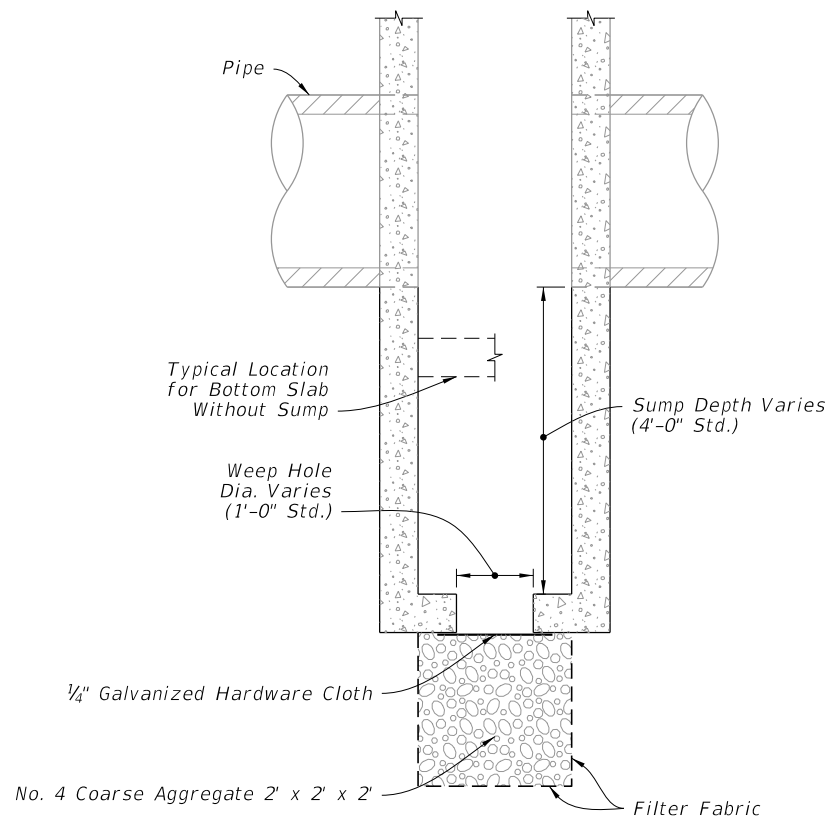
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| LAST REVISION<br>11/01/20 | DESCRIPTION: |  | FY 2021-22<br>STANDARD PLANS | SUPPLEMENTARY DETAILS<br>FOR DRAINAGE STRUCTURES | INDEX<br>425-001 | SHEET<br>3 of 8 |
|                           |              |  |                              |  |                  |                 |



NOTE: For all structures unless excluded by special detail.

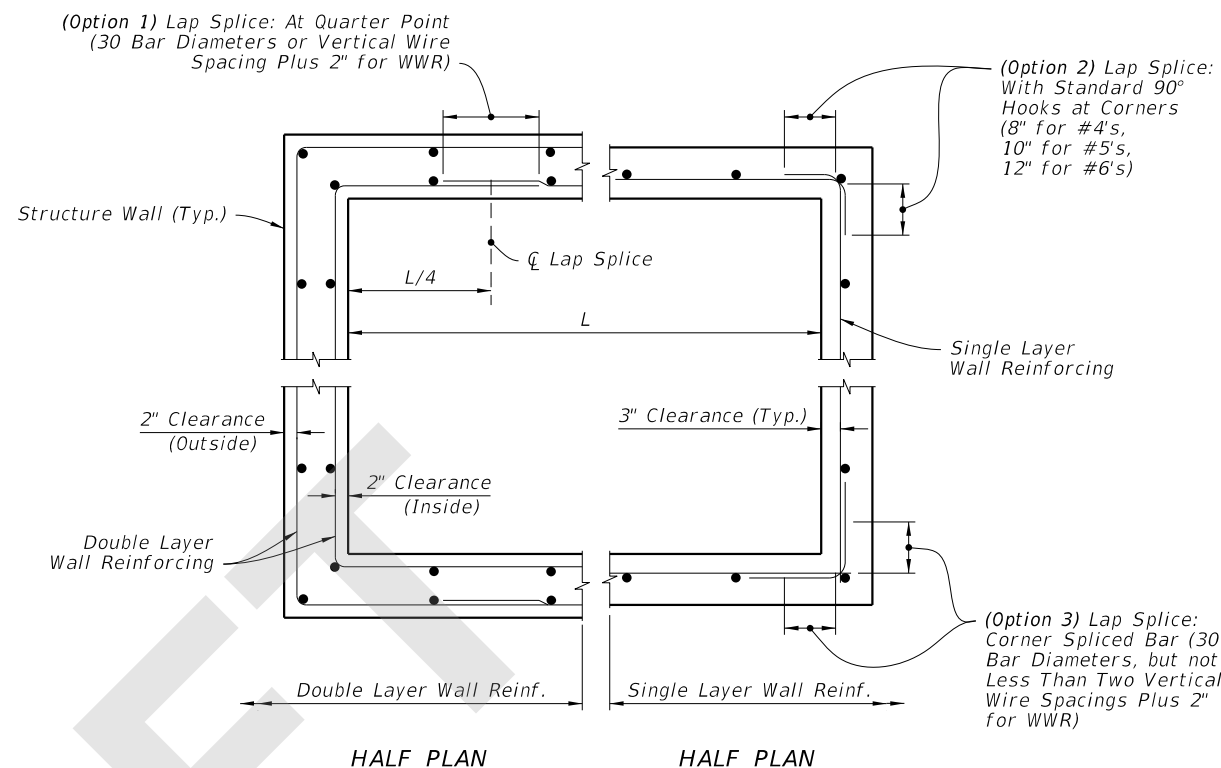
**DRAINAGE STRUCTURE INVERT**



**NOTES:**

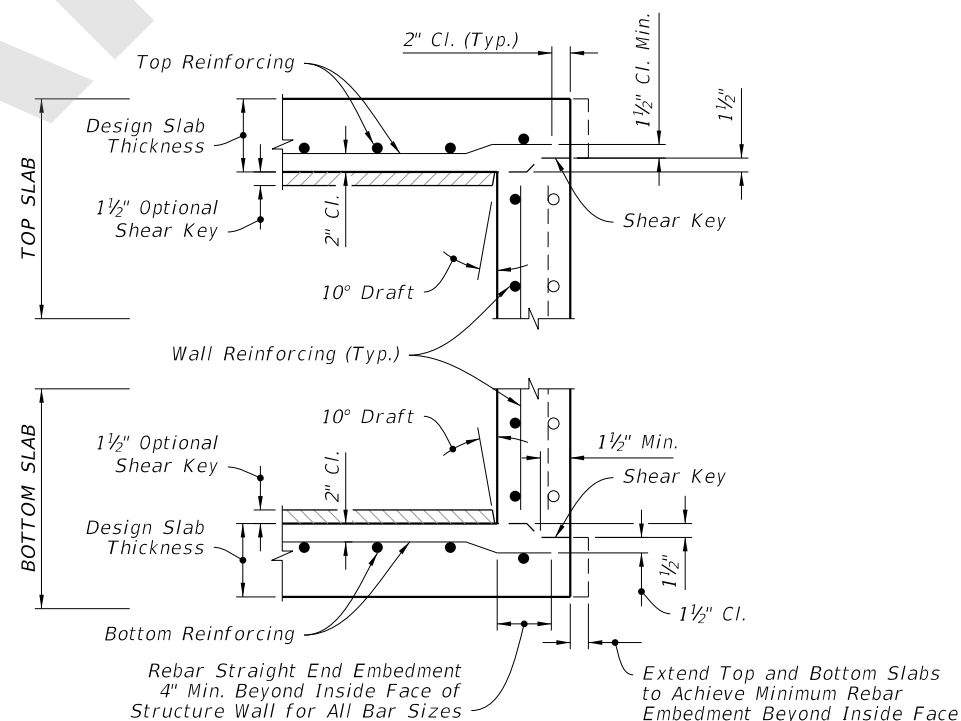
1. Construct sumps in inlets and manholes connecting to French Drains unless excluded in the Plans.
2. Construct sumps only where called for in the Plans at all other locations.
3. Construct weep holes in sump bottom only where called for in the Plans.

**SUMP BOTTOM**



**HALF PLAN HALF PLAN**

**WALL REINFORCING SPLICE DETAILS**



**NOTES:**

1. See Sheet 6 for optional construction joints.
2. Bend bars as required to maintain cover.

**TYPICAL SLAB TO WALL DETAILS (PRECAST STRUCTURE SHOWN)**

**DRAINAGE STRUCTURE INVERT, SUMP BOTTOM, WALL REINFORCING SPLICE DETAILS, AND TYPICAL SLAB TO WALL DETAILS**

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**EXAMPLE TABLE OF EQUIVALENT STEEL AREA**

| SCHEDULE  | GRADE 60 REINFORCING BAR                           |                                  | EQUIVALENT GRADE 40 REINFORCING BAR                |                                  | EQUIVALENT 65 KSI SMOOTH WELDED WIRE REINFORCEMENT          |                                  | EQUIVALENT 70 KSI DEFORMED WELDED WIRE REINFORCEMENT        |                                  |
|-----------|--|----------------------------------|--|----------------------------------|---|----------------------------------|---|----------------------------------|
|           | Bar Size & Spacing                                 | Steel Area (in <sup>2</sup> /ft) | Bar Size & Spacing                                 | Steel Area (in <sup>2</sup> /ft) | Style Designation   | Steel Area (in <sup>2</sup> /ft) | Style Designation   | Steel Area (in <sup>2</sup> /ft) |
| A         | #3 @ 6½" Ctrs.<br>#4 @ 12" Ctrs.                   | 0.20                             | #3 @ 4½" Ctrs.<br>#4 @ 8" Ctrs.<br>#5 @ 12" Ctrs.  | 0.30                             | 3"x3"-W4.6xW4.6<br>4"x4"-W6.2xW6.2<br>6"x6"-W9.2xW9.2       | 0.1846                           | 3"x3"-D4.3xD4.3<br>4"x4"-D5.7xD5.7<br>6"x6"-D8.6xD8.6       | 0.1714                           |
| B         | #3 @ 5½" Ctrs.<br>#4 @ 10" Ctrs.                   | 0.24                             | #3 @ 3½" Ctrs.<br>#4 @ 6½" Ctrs.<br>#5 @ 10" Ctrs. | 0.36                             | 3"x3"-W5.5xW5.5<br>4"x4"-W7.4xW7.4<br>6"x6"-W11.1xW11.1     | 0.2215                           | 3"x3"-D5.1xD5.1<br>4"x4"-D6.9xD6.9<br>6"x6"-D10.3xD10.3     | 0.2057                           |
| Special 1 | #3 @ 5" Ctrs.<br>#4 @ 9" Ctrs.                     | 0.267                            | #3 @ 3" Ctrs.<br>#4 @ 6" Ctrs.<br>#5 @ 9" Ctrs.    | 0.40                             | 3"x3"-W6.2xW6.2<br>4"x4"-W8.2xW8.2<br>6"x6"-W12.3xW12.3     | 0.2465                           | 3"x3"-D5.7xD5.7<br>4"x4"-D7.6xD7.6<br>6"x6"-D11.4xD11.4     | 0.2289                           |
| C         | #3 @ 3½" Ctrs.<br>#4 @ 6½" Ctrs.<br>#5 @ 10" Ctrs. | 0.37                             | #4 @ 4" Ctrs.<br>#5 @ 6½" Ctrs.<br>#6 @ 9½" Ctrs.  | 0.555                            | 3"x3"-W8.5xW8.5<br>4"x4"-W11.4xW11.4<br>6"x6"-W17.1xW17.1   | 0.3415                           | 3"x3"-D7.9xD7.9<br>4"x4"-D10.6xD10.6<br>6"x6"-D15.9xD15.9   | 0.3171                           |
| D         | #4 @ 4½" Ctrs.<br>#5 @ 7" Ctrs.<br>#6 @ 10" Ctrs.  | 0.53                             | #4 @ 3" Ctrs.<br>#5 @ 4½" Ctrs.<br>#6 @ 6½" Ctrs.  | 0.795                            | 3"x3"-W12.2xW12.2<br>4"x4"-W16.3xW16.3<br>6"x6"-W24.5xW24.5 | 0.4892                           | 3"x3"-D11.4xD11.4<br>4"x4"-D15.1xD15.1<br>6"x6"-D22.7xD22.7 | 0.4543                           |
| E         | #4 @ 3" Ctrs.<br>#5 @ 5" Ctrs.<br>#6 @ 7" Ctrs.    | 0.73                             | #5 @ 3½" Ctrs.<br>#6 @ 4½" Ctrs.<br>#7 @ 6½" Ctrs. | 1.095                            | 3"x3"-W16.8xW16.8<br>4"x4"-W22.5xW22.5<br>6"x6"-W33.7xW33.7 | 0.6738                           | 3"x3"-D15.6xD15.6<br>4"x4"-D20.9xD20.9<br>6"x6"-D31.3xD31.3 | 0.6257                           |
| F         | #5 @ 3½" Ctrs.<br>#6 @ 5" Ctrs.<br>#7 @ 7" Ctrs.   | 1.06                             | #6 @ 3" Ctrs.<br>#7 @ 4½" Ctrs.<br>#8 @ 6" Ctrs.   | 1.59                             | 3"x3"-W24.5xW24.5<br>4"x4"-W32.6xW32.6<br>6"x6"-W48.9xW48.9 | 0.9785                           | 3"x3"-D22.7xD22.7<br>4"x4"-D30.3xD30.3<br>6"x6"-D45.4xD45.4 | 0.9086                           |
| Special 2 | #5 @ 3" Ctrs.<br>#6 @ 4" Ctrs.<br>#7 @ 5½" Ctrs.   | 1.24                             | #7 @ 4" Ctrs.<br>#8 @ 5" Ctrs.                     | 1.86                             | 3"x3"-W28.6xW28.6<br>4"x4"-W38.2xW38.2<br>6"x6"-W57.2xW57.2 | 1.1446                           | 3"x3"-D26.6xD26.6<br>4"x4"-D35.4xD35.4<br>6"x6"-D53.1xD53.1 | 1.0629                           |
| G         | #6 @ 3½" Ctrs.<br>#7 @ 5" Ctrs.                    | 1.46                             | #7 @ 3" Ctrs.<br>#8 @ 4" Ctrs.                     | 2.19                             | 3"x3"-W33.7xW33.7<br>4"x4"-W44.9xW44.9                      | 1.3477                           | 3"x3"-D31.3xD31.3<br>4"x4"-D41.7xD41.7                      | 1.2514                           |

**NOTES:**

1. See inlet indexes for optional precast inlet construction details up to depths of 15'.
2. Interior dimensions of an Alt. "B" Bottom may be adjusted to reflect these inlet interior dimensions when precast units are used in conjunction with Alt. "B" Structure Bottoms, Index 425-010.
3. Use concrete meeting the requirements of ASTM C478 or Class IV for precast structures with 6" wall or slab thickness.
4. Reinforcement may be deformed bar reinforcement or welded wire reinforcement. Bar reinforcement other than 60 ksi may be used, however only two grades are recognized: Grade 40 and Grade 60. Smooth welded wire reinforcement will be recognized as having a design strength of 65 ksi and deformed welded wire reinforcement will be recognized as having a design strength of 70 ksi. The area of reinforcement required may be adjusted in accordance with the Equivalent Steel Area Table provided. Use the following equations to determine the steel area and spacing for bars not otherwise specified:

Grade 40 Steel Area =  $A_{s40} = 60/40 \times A_{s60}$

Smooth Welded Wire Reinforcement Steel Area =  $A_{s65} = 60/65 \times A_{s60}$

Deformed Welded Wire Reinforcement Steel Area =  $A_{s70} = 60/70 \times A_{s60}$

When a reduced area of reinforcement is provided, any maximum bar spacing shown must also be reduced as determined by the following equations, unless otherwise shown:

Max. Grade 40 Bar Spacing = Grade 60 Bar Spacing

Max. Smooth Welded Wire Spacing = Grade 60 Bar Spacing x 0.86

Max. Deformed Welded Wire Spacing = Grade 60 Bar Spacing x 0.74


When an increased area of reinforcing is provided, the maximum bar spacing may be increased by the squared ration of increased steel area, but not to exceed 12":

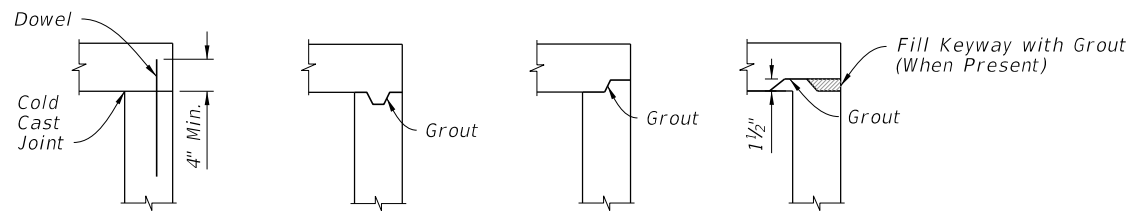
Max. Bar Spacing Provided  $\leq$  Max. Bar Spacing Required  $\times \left( \frac{\text{Steel Area Provided}}{\text{Min. Steel Area Required}} \right)^2$

Use wire no smaller than than W3.1 or D4.0, or larger and with spacing 8" or less. Use bar reinforcement displaying the minimum yield designation grade mark, or either the number 60 or one (1) grade mark line to be acceptable at the higher value. Use maximum bar spacing no greater than two (2) times the slab thickness with a maximum spacing of 12" or three (3) times the wall thickness, with a maximum spacing of 18" for vertical bars and 12" for horizontal bars. Wires smaller than W3.1 or D4.0 may be used in the walls of ASTM C 478 round structure bottoms and round risers.

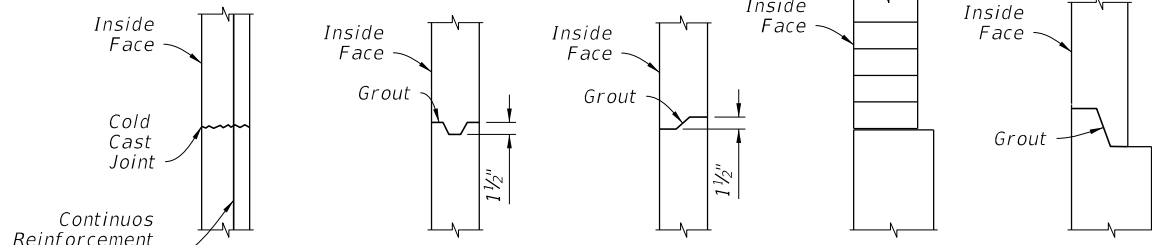
5. Fiber-reinforced concrete may be substituted for conventional steel reinforcement in accordance with the Structures Design Guidelines. Submit shop drawings corresponding to an approved fiber-reinforced concrete mix design for approval to the State Drainage Engineer.

**PRECAST OPTION AND EQUIVALENT REINFORCEMENT SUBSTITUTION**

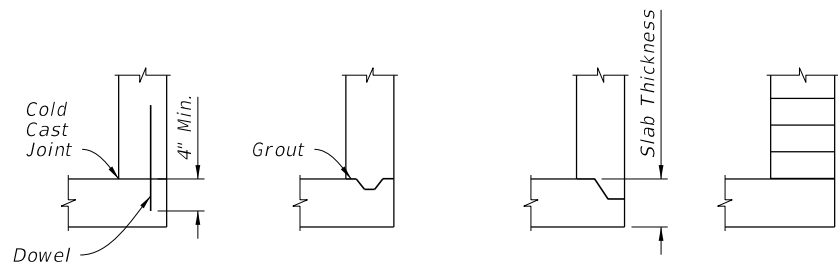
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TOP SLABS TO WALL JOINTS



WALL JOINTS

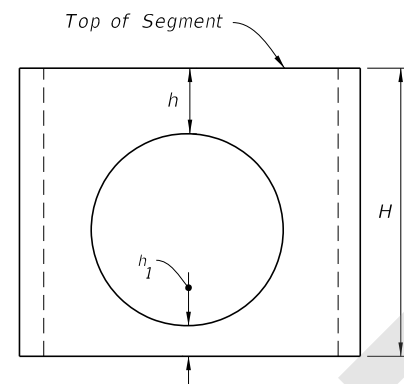


BOTTOM SLAB TO WALL JOINTS

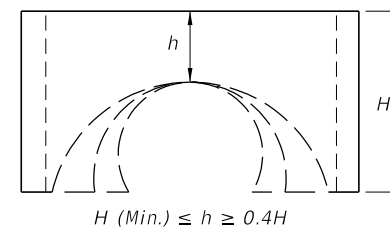
**NOTES:**

1. One or more types of joints may be used in a single structure, except brick wall structure. Brick wall construction is permitted on circular units only.
2. All grouted joints are to have a maximum thickness of 1".
3. Keyways are to be a minimum of 1 1/2" deep.
4. Joint dowels are to be #4 bars, 12" long with a minimum of 6 bars per joint approximately evenly spaced for circular structures or at maximum 12" spacing for rectangular structures. Bars may be either Adhesive Bonded Dowels in accordance with Specification 416, or placed approximately 6" into fresh concrete leaving the remainder to extend into the secondary cast. Welded wire reinforcement may be substituted for the dowel bar in accordance with the equivalent steel area table on Sheet 5.
5. Minimum cover on dowel reinforcing bars is 2" to outside face of structure.
6. Seal joints between wall segments and between wall segments and top or bottom slabs with preformed plastic gasket material in accordance with Specification 430 or non-shrink grout in accordance with Specification 934.
7. Insert products approved by the Engineer may be used in lieu of dowel embedment.

CONSTRUCTION JOINT OPTIONS

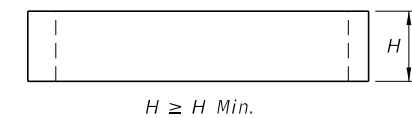


When  $6" \leq h_1 < 0.75H$  (Min.)  
 Then (Reqd.)  $h_1 \geq 0.75H$  (Min.)



**NOTES:**

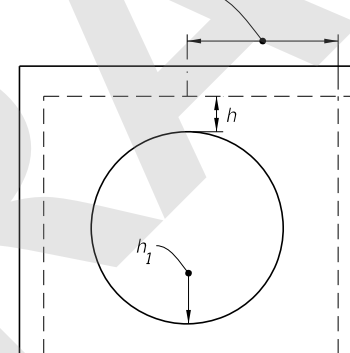
1. Segments may be inverted. Opening for pipe is the pipe OD plus 6" (± 2" tolerance).
2. If h can not be attained, then a top or bottom slab must be attached to the segment as shown below.



| H (min.) | Box or Riser Diameter |
|----------|-----------------------|
| 1'-0"    | 3'-6" & 4'-0"         |
| 1'-6"    | 5'-0" & 6'-0"         |
| 2'-0"    | >6'-0"                |

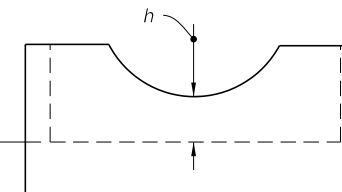
RISER SEGMENTS OTHER THAN DOWEL

Riser or Inlet Opening (Location Varies)



$h \geq \text{zero}$  and  $h_1 \geq 6"$

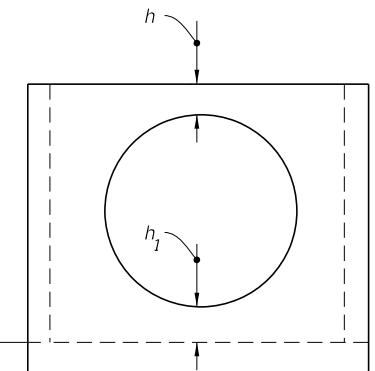
See Note 2



Top or Bottom Segment:  
 $h \geq 2"$

See Note 2

See Note 2



$h_1 \geq 2"$  and  $h \geq 6"$

**NOTES:**

1. h may be less than 6" when approved by the Engineer, but not for inlet segments at finish grade elevation.
2. Dowel construction joint or monolithic cast only.

SEGMENTS FOR SLAB TO WALL DOWEL CONSTRUCTION JOINTS OR MONOLITHIC CAST

MINIMUM BOX AND RISER SEGMENT DIMENSIONS

CONSTRUCTION JOINT OPTIONS AND MINIMUM BOX AND RISER SEGMENT DIMENSIONS

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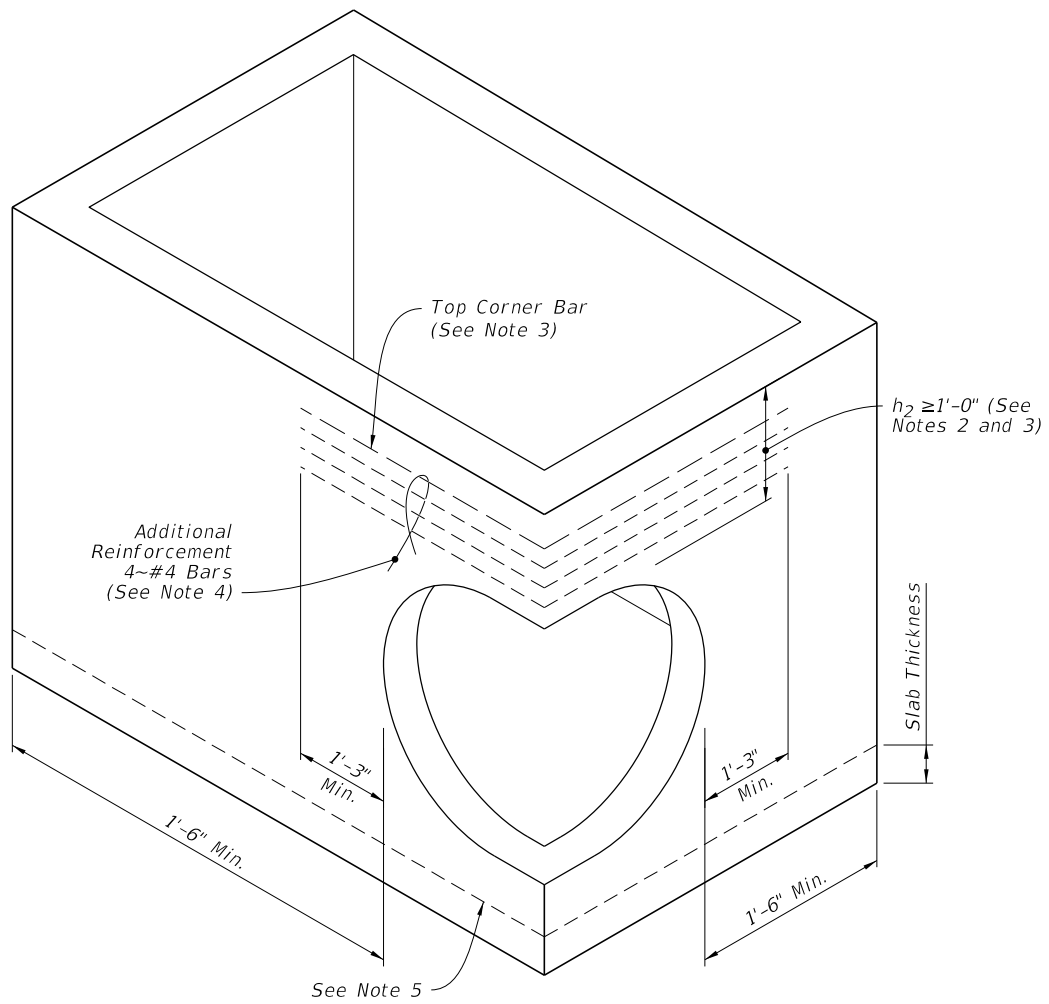
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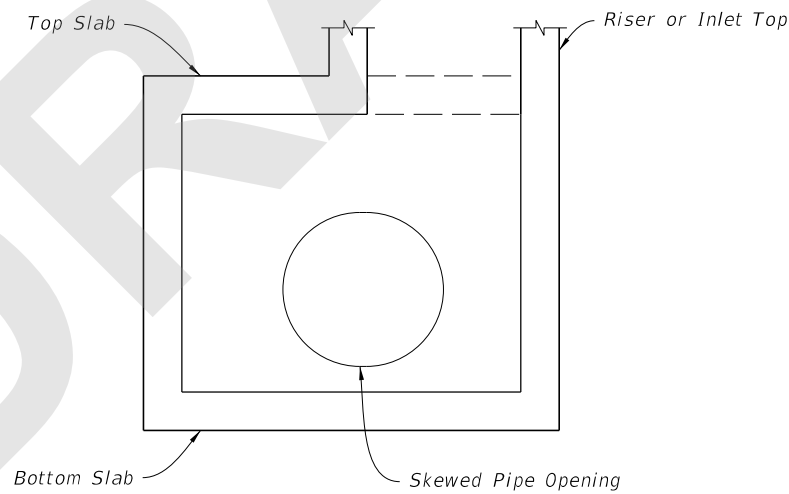
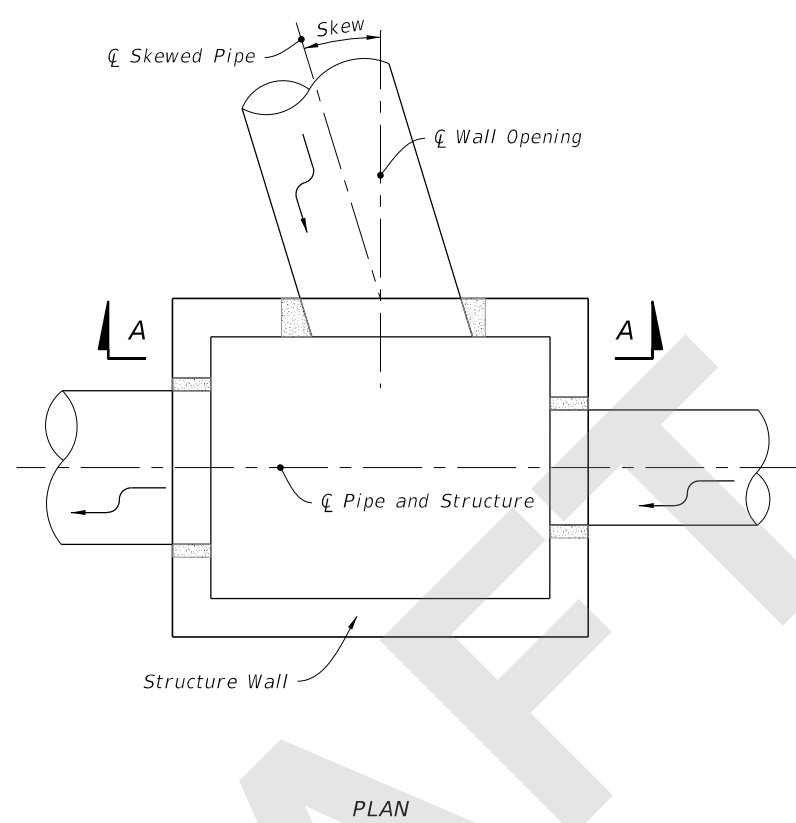




**NOTES:**

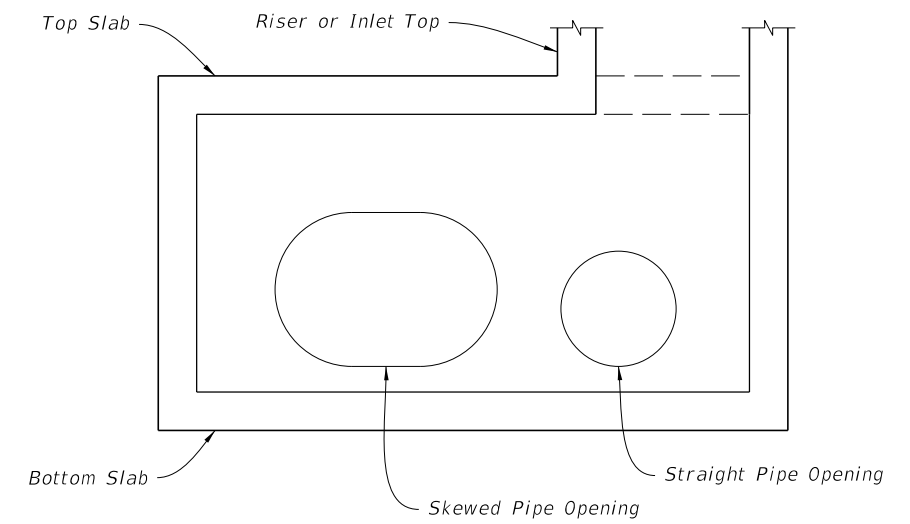
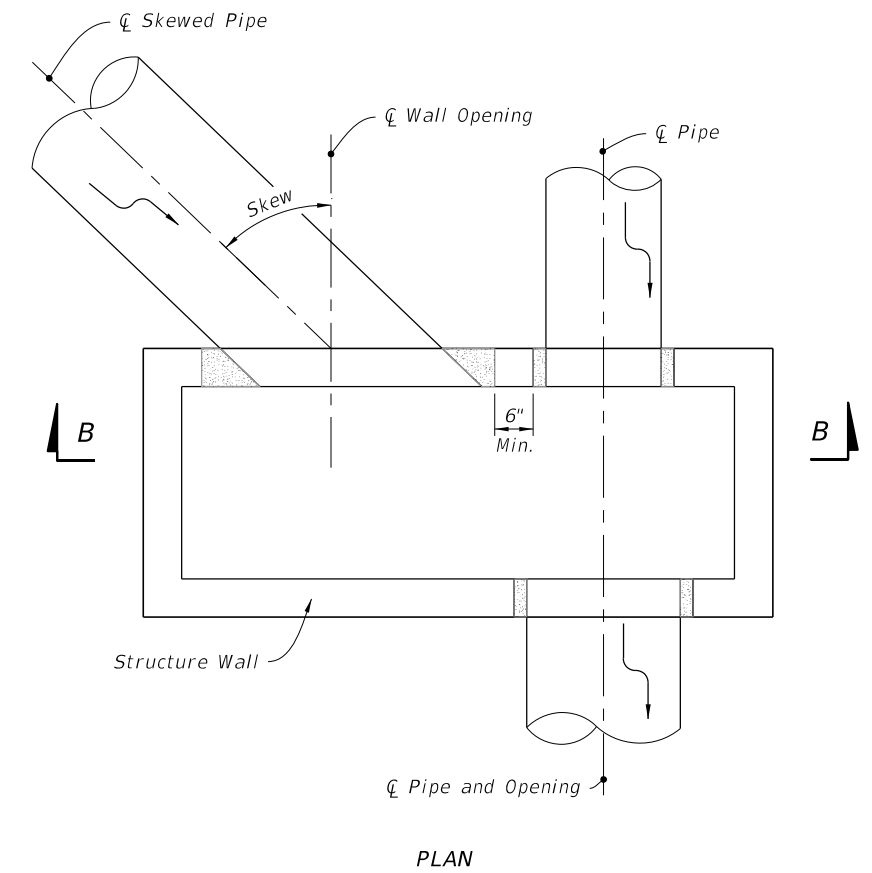
1. Submit Shop Drawings of corner openings for approval by the Engineer.
2.  $h_2$  may be less than 1'-0" when a minimum 1'-0" deep segment, 8" slab or curb inlet is provided above the corner opening.
3. For inlet segments at finish grade elevation, substitute a #8 Bar for the top corner bar when  $1'-0" \leq h_2 < 2'-0"$ .
4. Install bars continuously around corner and evenly spaced. Tie additional reinforcement to the outside of vertical wall reinforcement.
5. Dowel construction joint or monolithically cast wall and slabs.

PIPE OPENING AT CORNER



SECTION A-A

SKEWS  $\leq 45^\circ$   
(Not Centered)



SECTION B-B

SKEWS  $> 45^\circ$   
(Not Centered)

SKewed PIPE IN RECTANGULAR STRUCTURES

(See Table 4 on Sheet 8)

**SKewed PIPE IN RECTANGULAR STRUCTURES**

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|               |          |          |              |
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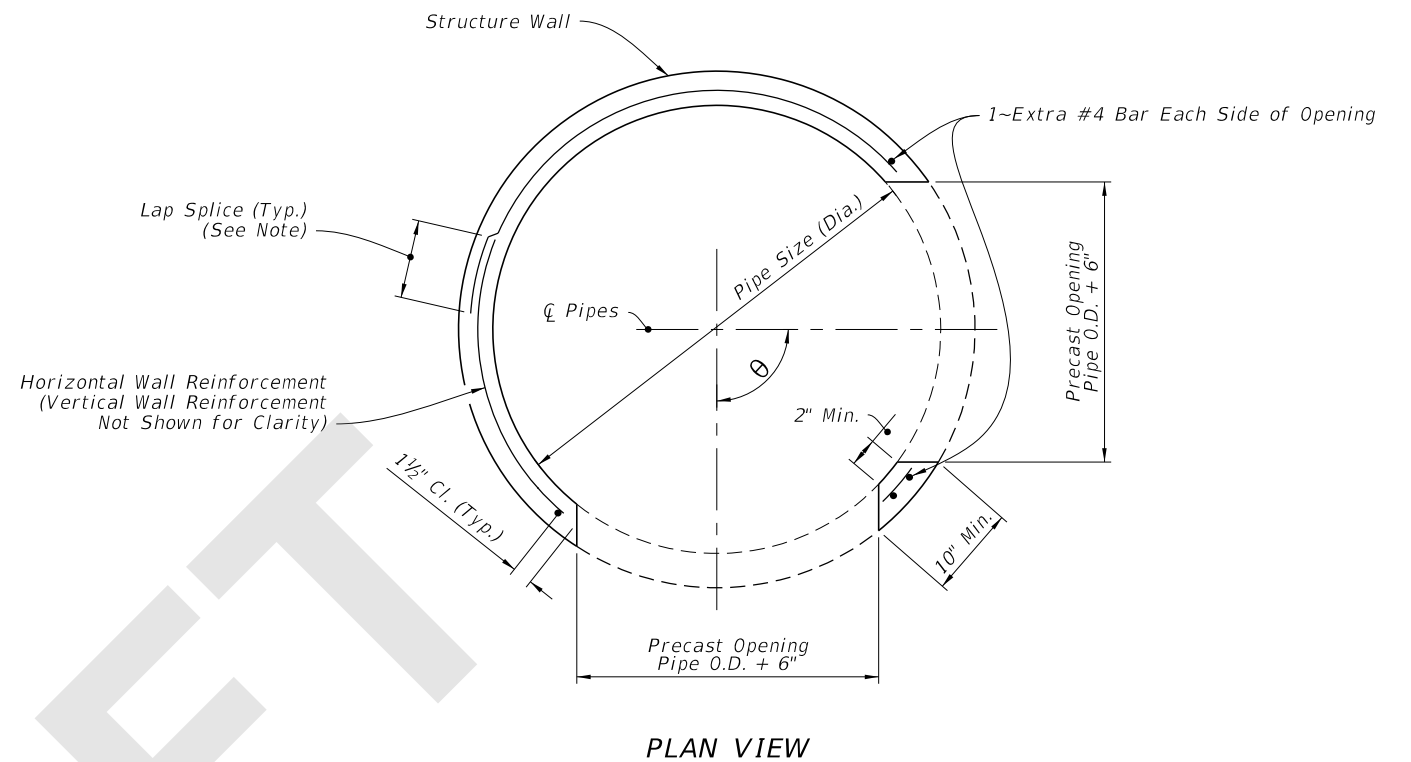
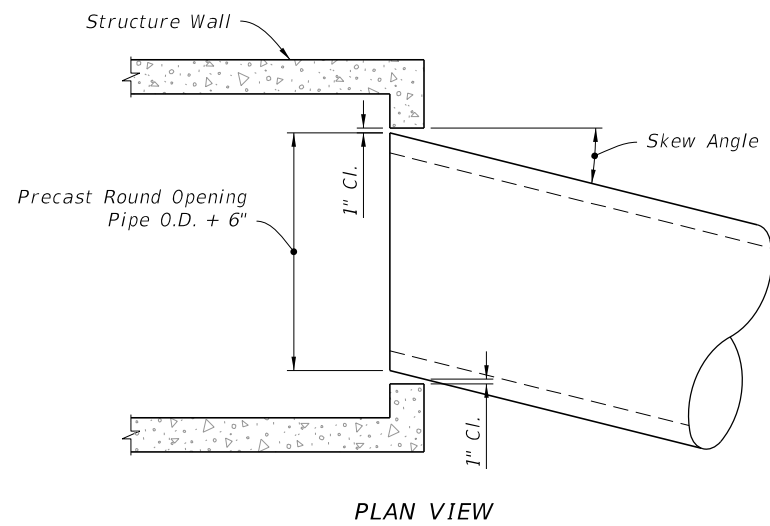


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**TABLE 4 - MAXIMUM PIPE SKEW FOR PRECAST ROUND OPENINGS**

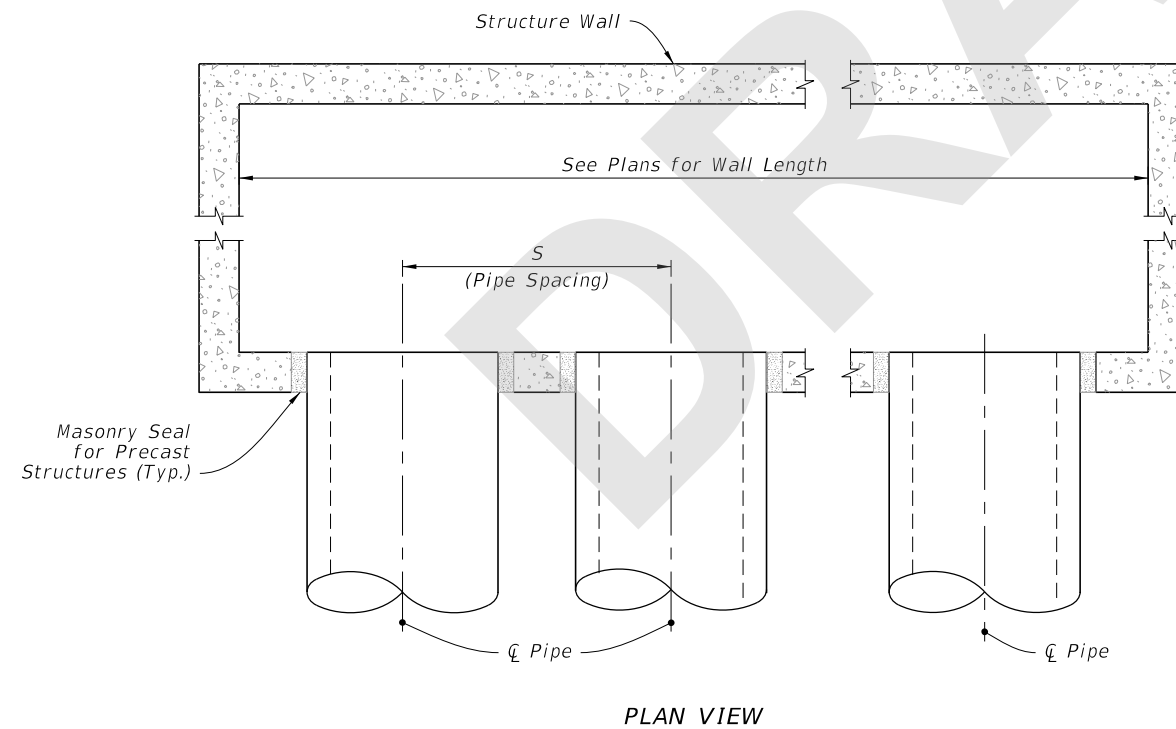
|                    | WALL THICKNESS | PIPE SIZE |     |     |     |     |     |     |     |     |     |     |     |  |
|--------------------|----------------|-----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
|                    |                | 18"       | 24" | 30" | 36" | 42" | 48" | 54" | 60" | 66" | 72" | 78" | 84" |  |
| MAXIMUM SKEW ANGLE | 8"             | 19°       | 17° | 16° | 16° | 15° | 14° | 14° | 13° | 13° | 13° | 12° | 12° |  |
|                    | 6"             | 21°       | 20° | 18° | 17° | 17° | 16° | 15° | 15° | 14° | 14° | 13° | 13° |  |

**NOTE:**  
 These values are based on 2" clearance for precast structures. Larger skews are possible for Cast-In-Place Structures or elliptical pipe openings when approved by the Engineer.

**NOTE:**  
 Lap splice: 20 bar diameter for deformed wire or bar, but not less than vertical wire spacing plus 2" for WWR or 40 bar diameters for smooth wire.

===== MAXIMUM PIPE SKEW FOR PRECAST ROUND OPENINGS =====

===== MULTIPLE PIPE CONNECTIONS - PRECAST ROUND STRUCTURES =====



**TABLE 5 - MINIMUM SIZES FOR MULTIPLE PARALLEL PIPE CONNECTIONS**

| PIPE SIZE | PIPE SPACING (S) |
|-----------|------------------|
| 18"       | 2'-10"           |
| 24"       | 3'-5"            |
| 30"       | 4'-3"            |
| 36"       | 5'-1"            |
| 42"       | 6'-0"            |
| 48"       | 6'-9"            |
| 54"       | 7'-8"            |
| 60"       | 8'-6"            |
| 66"       | 9'-0"            |
| 72"       | 10'-0"           |
| 78"       | 10'-9"           |
| 84"       | 11'-8"           |

===== MULTIPLE PARALLEL PIPE CONNECTIONS - RECTANGULAR STRUCTURES =====

**MISCELLANEOUS PIPE CONNECTION DETAILS**

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