

**DESIGN GUIDE MD #2**

**CIRCULAR CONCRETE STORAGE FACILITIES  
FOR STORAGE OF ANIMAL WASTE**

CONSTRUCTION DETAILS  
AND SPECIFICATIONS



*Maryland*

*Revised - December 2004*



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# **SECTION I**

## **GENERAL**

This design guide is a technical resource prepared by the Maryland NRCS Engineering staff and is intended for use by the NRCS in Maryland and its partners. The circular concrete storage facility designs contained in this design guide replace all existing prequalified circular concrete designs previously issued. These new prequalified designs are to be used as part of a site-specific design. Designs previously submitted by outside vendors and concurred in for use in Maryland are not affected by this design guide and may still be used. These prequalified designs are contained in Design Guide #7. Construction drawings for walls of various heights and diameters are included, as well as other appropriate construction details and specifications.

Section II contains the construction specifications to be used as part of the site-specific design. These construction specifications are to be used for all the circular concrete storage facilities. Add site specific construction specifications as needed.

Section III contains wall and footing construction details for circular concrete storage facilities without ramps. Wall heights vary from 8 feet to 14 feet with available diameters up to 120 feet.

Section IV contains wall, footing, and ramp construction details for circular storage facilities with notched walls and ramps. Wall heights vary from 8 feet to 12 feet with available diameters up to 120 feet.

Section V contains construction details for loading and unloading pads and other details specific to circular storage facilities.

Occasionally there may be a need to construct a circular storage facility with a wall height less than 8 feet. Minor adjustments will be needed in the design. Contact the local NRCS engineer for the needed changes.

To aid in the design process, the drawings and specifications are available in AutoCAD format at the Maryland NRCS State Office and the Frederick Staff Office. No changes are allowed on these details without prior approval from the NRCS engineering staff.

## **DESIGN**

The design procedure is based on *Circular Concrete Tanks Without Prestressing* (1993) developed by the Portland Cement Associations (PCA) and complies with the *Building Code Requirements for Structural Concrete*, ACI-318. A minimum soil bearing capacity of 2000 psf is required for construction of a circular concrete storage facility.

The storage facilities may be constructed above ground with minimal or completely in ground with backfill to the top of the storage facility. Backfill cannot vary more than 3 feet around the entire structure. For example, if on one side of the storage facility is a barnyard that is at the same elevation as the top of the storage facility, requiring backfill to the top of the wall, the backfill at any point around the storage facility cannot be lower than 3 feet below the top of the storage facility.

The storage facility walls are not designed for large loads that are applied by farm equipment or trucks when they are adjacent to them. Vehicular traffic and hauling equipment are to be kept away from the wall a distance equal to the wall height. Small farm tractors, mowing

equipment, livestock and other equipment exerting loads less than 100 PSF are acceptable adjacent to the facility wall without the use of a concrete pad. When it is necessary to have large equipment next to the storage facility wall for loading and unloading of the facility, or for similar needs, a concrete pad is required. The concrete pad will sit on top of the storage facility, but **will not** be attached with steel reinforcement. See the construction details in Section V for loading and unloading pads.

## FLOOR STEEL REQUIREMENTS

The Maryland Conservation Practice Standard, code 313, Waste Storage Facility requires the required area of such reinforcing steel shall be based on subgrade drag theory as discussed in industry guidelines such as American Concrete Institute, ACI 360, 'Design of Slabs-on-Grade'." Required steel is shown in the Table below.

CONCRETE STORAGE FACILITIES		
MAXIMUM FLOOR DIMENSION	REQUIRED STEEL FOR 5" THICK FLOOR W/ GRAVEL SUBGRADE	
	$A_s$	EXAMPLE
$\leq 60'$	0.058	6x6-#6 gage, or 6x6-W2.9xW2.9, or #3 bar @ 18 inch
$>60' \leq 100'$	0.126	4x4-#4 gage, 4x4-W4xW4, or #4 @ 18"
$>100' \leq 160'$	0.190	#4 @ 12"
$>160' \leq 200'$	0.230	#4 @ 10" or #5 bar @ 16"

## WALL EXTENSIONS

A kicker wall, extension of the wall above the design top of the storage facility, may be used on circular storage facilities that **do not** have a notched wall. The notched wall referenced here is for the use of a ramp as shown in Section IV Circular Storage Facilities with Ramps and does not apply to loading and loading pads as shown on drawings CT-2D. The following applies:

The wall extension may be used on all unnotched circular storage facilities shown. The length of the wall extension shall not exceed one-third the circumference of the circular storage facility and the height of the wall extension above the design top of the storage facility shall not exceed 4 feet. The change in height shall be made by stepping the wall 2 feet vertically in a horizontal run of 8 feet, or sloped at a constant slope no steeper than 4 horizontal to 1 vertical.

Farm tractors, manure hauling equipment or livestock shall not be allowed within 16 feet of the wall extension without the use of bridge (loading and unloading pad) detail shown in Section V. The equipment on the bridge pad shall be limited to 7000 lbs. The horizontal reinforcing steel for the wall extension shall meet the same size and spacing as that shown for the upper 1-foot section of the circular storage facility wall design. In areas where the wall extension is 2 feet or less in height, the vertical steel shall be the same size and spacing as that shown on the circular storage

facility wall design. In areas where the wall extension is between 2 feet and 4 feet in height, the vertical reinforcing steel shall be the same size at one half the spacing as that shown on the circular storage facility wall design.

## **SAFETY**

Open-top storage facilities that are built inground are a potential hazard for people and animals. Provide fencing using chain link, woven wire or equal. The fence should be a minimum of 5 feet tall. The fence systems previously listed are not adequate protection for most farm equipment. In areas where farm equipment will work adjacent to the storage facilities, fencing, rails, or gates designed for this purpose are recommended. Landowners and users are to be informed of the differences and decisions made by the landowner recorded in the Agricultural Waste Management System Plan. Place warning signs around all storage facilities to alert users of potential danger.

## **DRAINAGE**

The circular concrete storage facilities are not designed to withstand hydrostatic pressure. The concrete floors will begin to yield when hydrostatic pressure under the facility reaches as little as 7 inches. Storage facilities that are constructed inground either fully or in part require subsurface drainage around the facility. Where practical, the subsurface drain tubing should be constructed with a gravity flow outlet to daylight. In areas where a gravity outlet is not possible, monitoring wells with sump pumps may be used to control groundwater. Divert all clean surface runoff away from the storage facility to reduce surface water infiltration around the storage facility.

Areas that are prone to flooding will present additional design restrictions. Contact the local NRCS engineer before considering constructing a storage facility in a flood prone area.

Discuss all options regarding surface drainage, subsurface drain, groundwater monitoring and flooding potential with the landowner, and record decisions made in the Agricultural Waste Management System Plan.

## **MATERIALS**

Fiber reinforcement may be added to help reduce hairline cracks that develop while the concrete is curing. The fibers do not prevent the development of larger shrinkage cracks that may occur with expansion and contraction of the concrete and when loads are applied. Once the concrete has cured, the fiber reinforcement no longer provides any structural reinforcement to the concrete. Fiber reinforcement cannot be used to replace steel reinforcement. Fiber reinforcement may be added in addition to steel reinforcement.

## **NOTCHED WALLS FOR RAMPS**

The increased usage of sand or ground limestone for bedding has increased the need for liquid storage facilities that have ramp access for the removal of solids accumulations. Traditionally, free standing walls or earthen facilities have been utilized to meet this need. As an alternative, some states in the Northeast have constructed circular concrete storage facilities with a notched wall and ramp. The addition of the notch in the wall and ramp decrease the efficiency of the circular design. This necessitates the need for changes in the wall and footing designs, as well as construction details for the notch and ramp. Construction details for the wall, footing, wall notch,

and ramp are shown in Section IV. An NRCS engineer must approve all site-specific designs for notched tank designs. In addition, the following also applies:

The width of the notch in the wall shall be limited to 16 feet wide and the depth of the notch shall not exceed 50% of the wall height. A notched wall and a kicker wall (extension of the wall height above the design top) **cannot** be used on the same tank.

The ramp must be adequately reinforced to bridge across the width of the backfill trench at the notch. See construction details shown in Section IV. The ramp shall have a slope no steeper than 6:1. Ramp slopes steeper than 10:1 shall be for occasional cleanout of sludge material only and requires the use of four wheel drive cleanout equipment. Cables may also be needed for access into the storage facility on steep ramps. Ramps that are to be used for regular cleanout shall have a slope no steeper than 10:1. Landowner shall be informed of the differences and their decisions recorded in the Agricultural Waste Management System Plan.

The landowner/operator must understand that the addition of the ramp will decrease the efficiency of the pump to agitate the manure. It will, however, add the benefit of access into the storage facility. The landowner must be clearly informed of the options that are available and their decisions recorded in the Agricultural Waste Management System Plan.

## **COMPARISON OF LIMITATIONS FOR ROUND TANK DESIGNS**

### **MD #2 Design Guide**

1. Kicker wall **can** be added.
2. Uneven backfill option **cannot** be added.
3. Ramps **can** be added for 8' 10' and 12' deep tanks as shown in the guide.
4. Ramps **cannot** be installed in conjunction with a kicker wall.
5. Tank diameters up to 120 feet and tank depth up 14 feet are available.

### **Concurred Drawings (Pre qualified Designs)**

1. Ramps **cannot** be added.
2. A kicker wall **can** be added on even backfill designs if shown in the general notes.
3. Uneven backfill designs are available from some vendors.
4. Tank depths of 16 feet are available from some vendors.
5. Tank diameters of 140 feet are available from some vendors.

## **DECISION RECORDING**

There are many design options available that will affect the operation and management of the waste storage facility. Many decisions are made when talking with a landowner, while standing in a barnyard or dairy parlor. Decisions are never recorded or are recorded on the CPA-6 and never discussed again, that is, until there is a problem. Recording of decisions is an important part of the design process. The Agricultural Waste Management System Plan is the only opportunity that the landowner will have to review the decisions that are made. It is important that all decisions made are recorded in the CPA-6 and the Agricultural Waste Management System Plan and that the plans be carefully reviewed with the landowner.

# ROUND TANK LIMITATIONS

<p style="text-align: center;"><u>EVEN BACKFILL</u></p> <p style="text-align: center;">APPROPRIATE DESIGNS 1. DESIGN GUIDE MD #2 2. PREQUALIFIED DRAWINGS</p>	<p style="text-align: center;"><u>TANK WITH KICKER WALL</u></p> <p style="text-align: center;">APPROPRIATE DESIGNS DESIGN GUIDE MD#2 PREQUALIFIED DRAWINGS WITH KICKER WALL</p>
<p style="text-align: center;"><u>UNEVEN BACKFILL</u></p> <p style="text-align: center;">APPROPRIATE DESIGNS 1. PREQUALIFIED DRAWINGS WITH SPECIFICATIONS BY PE</p>	<p style="text-align: center;"><u>TANK WITH KICKER WALL AND UNEVEN BACKFILL</u></p> <p style="text-align: center;">APPROPRIATE DESIGNS NONE</p>
<p style="text-align: center;"><u>TANK WITH RAMP</u></p> <p style="text-align: center;">APPROPRIATE DESIGNS 1. DESIGN GUIDE MD #2</p>	<p style="text-align: center;"><u>TANK WITH RAMP AND KICKER WALL</u></p> <p style="text-align: center;">APPROPRIATE DESIGNS NONE</p>
<p style="text-align: center;"><u>TANK WITH RAMP</u></p> <p style="text-align: center;">APPROPRIATE DESIGNS NONE</p>	<p style="text-align: center;"><u>TANK WITH RAMP AND KICKER WALL</u></p> <p style="text-align: center;">APPROPRIATE DESIGNS NONE</p>

NOTE: SEE ALL REFERENCED DESIGNS FOR DETAILS AND ALLOWABLE DIMENSIONS

1) PREQUALIFIED DRAWINGS – MOST UP TO 16’  
SEE DRAWINGS FOR ALLOWABLE DIMENSIONS



## **SECTION II**

### **CONCRETE CONSTRUCTION SPECIFICATIONS**

**Revised 8/04**

1. All materials and construction shall be in accordance with applicable NRCS Practice Standards and ACI-318.
2. Any changes in the plans or specifications must be approved by the design approver prior to being made. Changes are to be reviewed by the landowner for concurrence.
3. Concrete shall have Type IA or IIA cement, 28-day compressive strength of 4,000 psi, 5% air entrainment and a slump of 3 to 5 inches. Air entrainment admixtures shall conform to ASTM C-260.
4. Reinforcing steel shall conform to ASTM-A-615, Grade 60 steel. All reinforcing material shall be free of dirt, loose rust, scale, oil, paint or other coatings. The steel shall be accurately placed into position, as shown on the plans, and securely restrained and blocked into position prior to placement of concrete. Insertion of steel into fresh concrete is not permitted. Reinforcement steel shall have a minimum of 2 inches of concrete cover against all forms and 3 inches against soil, unless otherwise shown on the plans. Ring steel shall have a minimum overlap of 24 inches. All other reinforcement steel splices shall overlap a minimum of 18 inches. Welded wire fabric shall conform to ASTM-A-185 and overlap a minimum of 6 inches. The welding of reinforcing steel is not permitted.
5. Waterstop will be used as shown on the plans and at all cold and construction joints.
6. Plasticizing or plasticizing and retarding admixtures may be used and shall conform to ASTM C-1017.
7. Concrete forms shall have sufficient strength and rigidity to hold the concrete to withstand the necessary pressure, tamping and vibration without deflection from the prescribed lines. They shall be mortar-tight and constructed so that they can be removed without hammering or prying against the concrete. The inside of the forms shall be oiled with a non-staining mineral oil or thoroughly wet before concrete is placed. Forms may be removed 24 hours after the placement of concrete.
8. Metal ties or anchorages shall be full dimension. Nominal size wall ties are not permitted. Wall tie ends must be broken off and patched with a concrete epoxy or polymer cement. Patching is required on both the inside and outside of concrete structures.
9. Concrete shall be delivered to the site and discharged completely into the forms within 90 minutes after the truck leaves the plant. This time shall be reduced to 45 minutes when the atmospheric temperature is over 90<sup>0</sup> F. The concrete shall be maintained at a temperature below 90<sup>0</sup> F during mixing, conveying and placement. Set retarding admixtures may be used to increase mixing time. Water reducing and/or retarding admixtures shall conform to ASTM C-494 Types A, B, D, F or G.
10. All concrete for walls shall be consolidated with internal type mechanical vibrators or by rodding. Concrete shall be placed in horizontal lifts not greater than 2 feet. Concrete shall not have a vertical drop greater than 5 feet. An elephant trunk, chute, or similar means shall be used when applicable to minimize the vertical drop. Vibration shall be supplemented by spading and hand tamping as necessary to insure smooth and dense concrete along form surfaces, in corners, and around embedded items.

11. Concrete shall not be placed when the daily minimum atmospheric temperature is less than 40<sup>0</sup> F unless facilities are provided to prevent the concrete from freezing. The concrete shall be protected from freezing for a minimum of 7 days or the concrete shall be kept at a temperature of 55<sup>0</sup> F for a minimum of 3 days. The use of accelerators or antifreeze compounds will not be allowed.
12. Concrete shall be protected from drying for the curing period after the placement of the concrete. Moisture may be applied by spraying or sprinkling as necessary to prevent the concrete from drying. Concrete shall not be exposed to freezing during the curing period. Curing compounds may be used in lieu of the application of moisture. Curing compounds shall conform to ASTM C-309, type 2.
13. Defective concrete, honeycombed areas, voids left by the removal of tie rods, ridges on all concrete surfaces permanently exposed to view or exposed to water, shall be repaired immediately after the removal of forms. All voids shall be reamed and completely filled with quickset, non-shrink hydraulic cement, concrete epoxy or polymer cement. Voids left by wall ties shall be patched with a concrete epoxy or polymer cement.
14. Concrete top surfaces shall be screeded, troweled and broom finished unless otherwise approved.
15. Walls may be backfilled 7 days after the placement of concrete.
16. Fill material under concrete shall be accomplished by placing maximum 8-inch lifts (before compaction). The lifts shall be compacted by the traversing of the entire surface by not less than one track of the equipment or by a minimum of four complete passes with a sheepsfoot, vibratory, or rubber tire roller.  
  
Compaction around structures (i.e. around pipes, adjacent to walls, etc.) shall be accomplished by placing fill in maximum 4inch lifts and compacting by means of hand tampers or other manually directed compaction equipment.  
  
The technician shall determine if the moisture content is suitable for fill placement. The contractor shall make adjustments as directed by the technician. The method of compaction shall be approved prior to placement of fill material.
17. The backfill behind walls shall conform to the grades shown on the plans. When placing uncompacted fill provide an additional foot of fill to allow for settlement.
18. Subsurface drainage must be provided as shown on the plans. Drain tubing must meet the requirements of ASTM F405 Heavy Duty.

## **SECTION III**

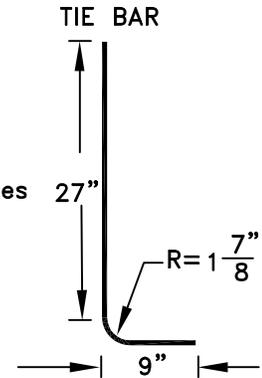
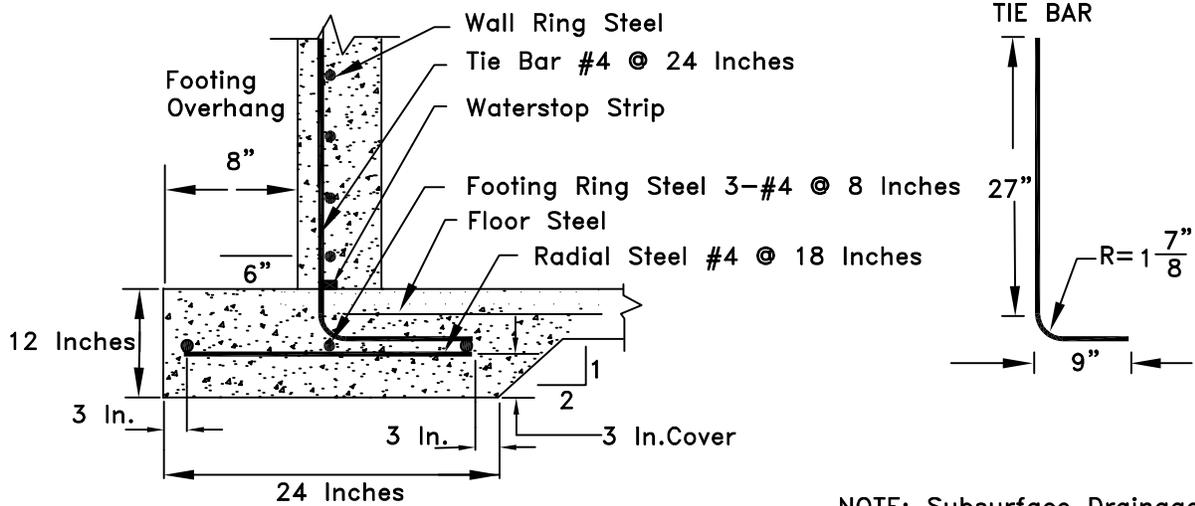
### **Construction Drawings for Circular Storage Facilities without Ramps**

#### Naming Conventions

CT-8-75	CT represents Circular Tank. 8 represents the wall height. 75 represents the maximum tank diameter.
NCT-8-120	NCT represents Notched Circular Tank. 8 represents the wall height. 120 represents the maximum tank diameter.
CT-1D	CT represents Circular Tank. 1 represents the first set of details. D represents details.

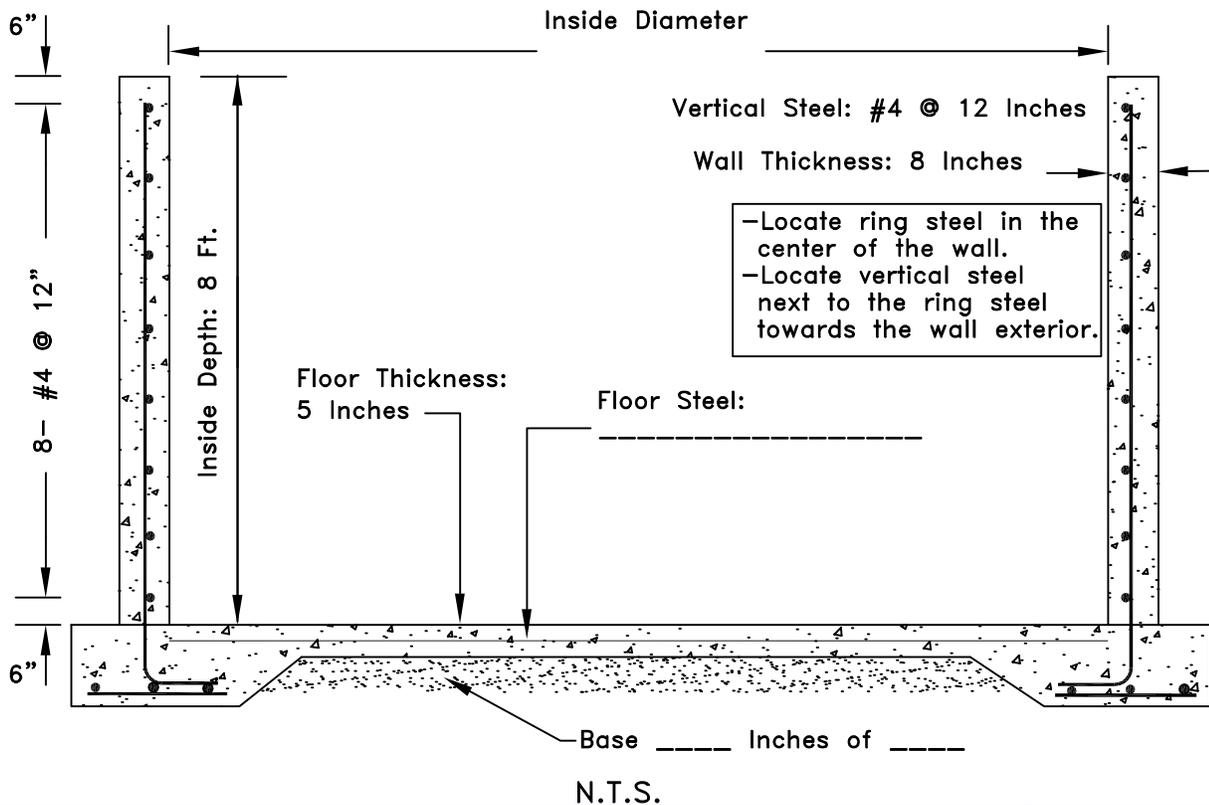


**FOOTING DESIGN**



NOTE: Subsurface Drainage must be provided around the storage facility.

**WALL DESIGN**



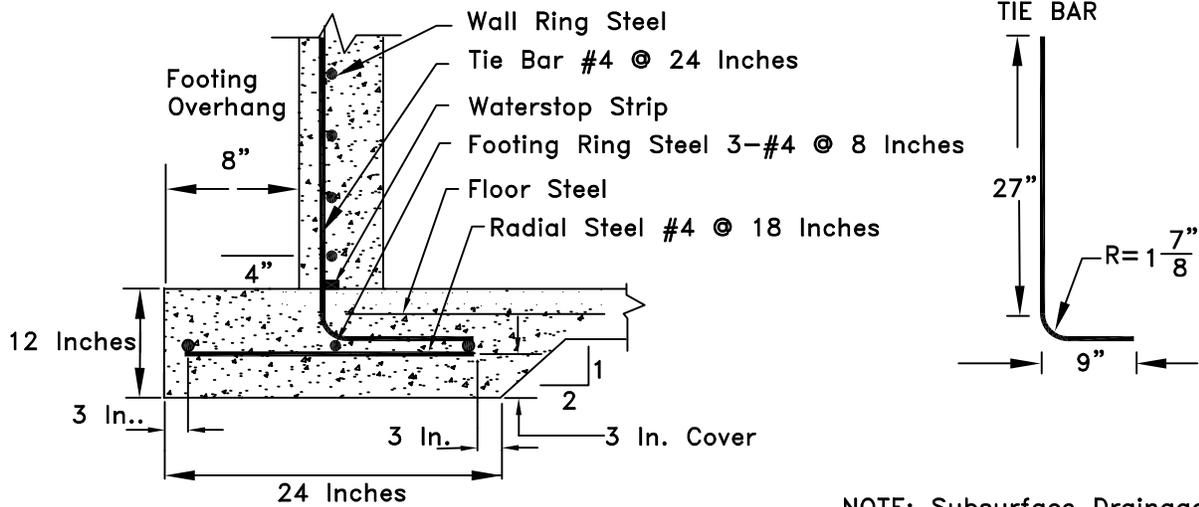
- Locate ring steel in the center of the wall.
- Locate vertical steel next to the ring steel towards the wall exterior.



CIRCULAR CONCRETE STORAGE FACILITY  
8' DEEP 75' OR LESS IN DIAMETER

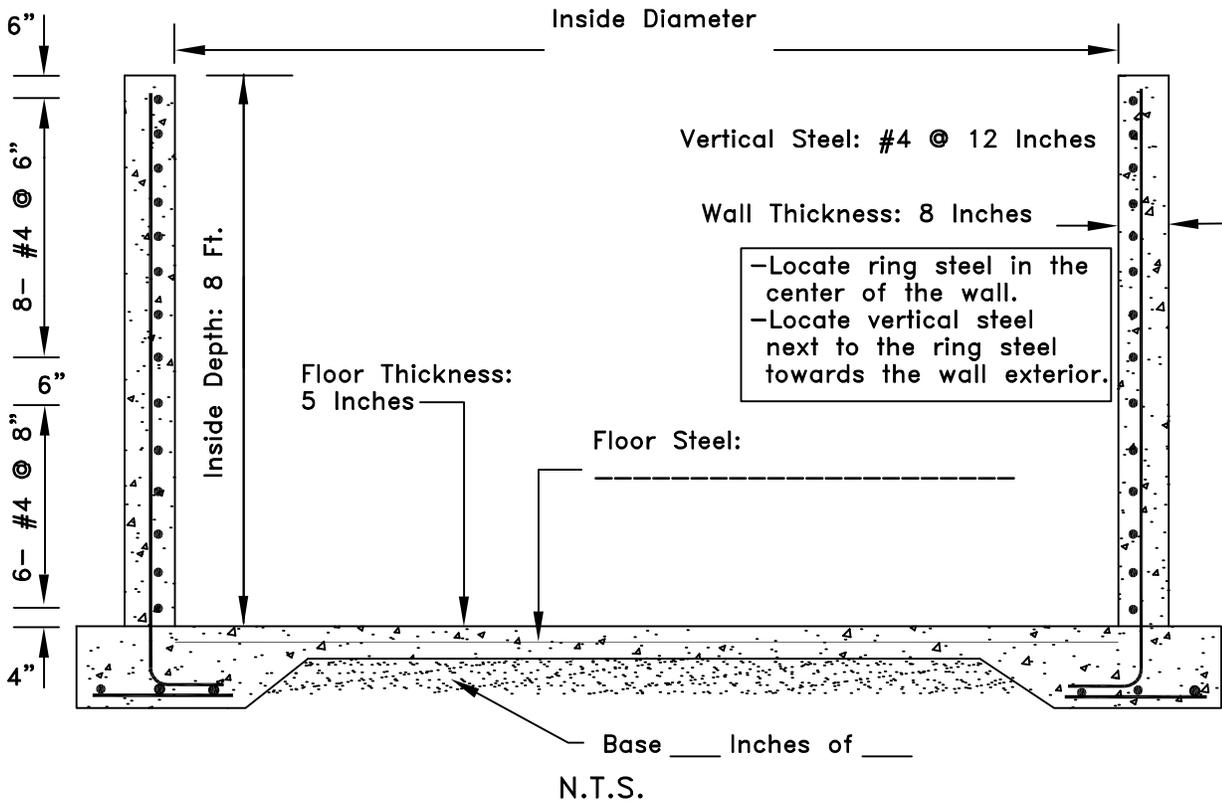
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**FOOTING DESIGN**



NOTE: Subsurface Drainage must be provided around the storage facility.

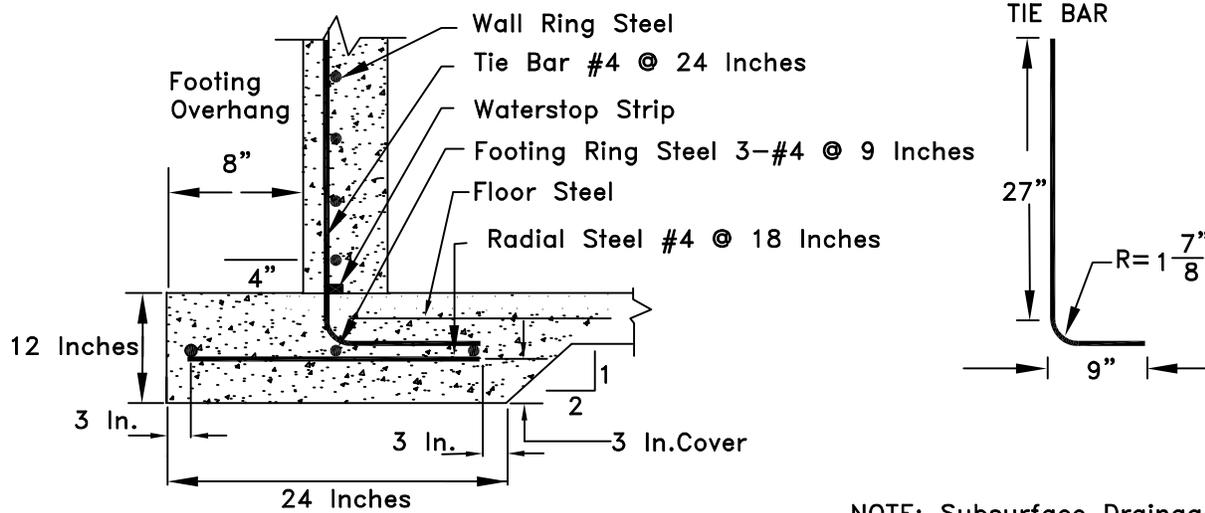
**WALL DESIGN**



CIRCULAR CONCRETE STORAGE FACILITY  
8' DEEP 76' TO 120' IN DIAMETER

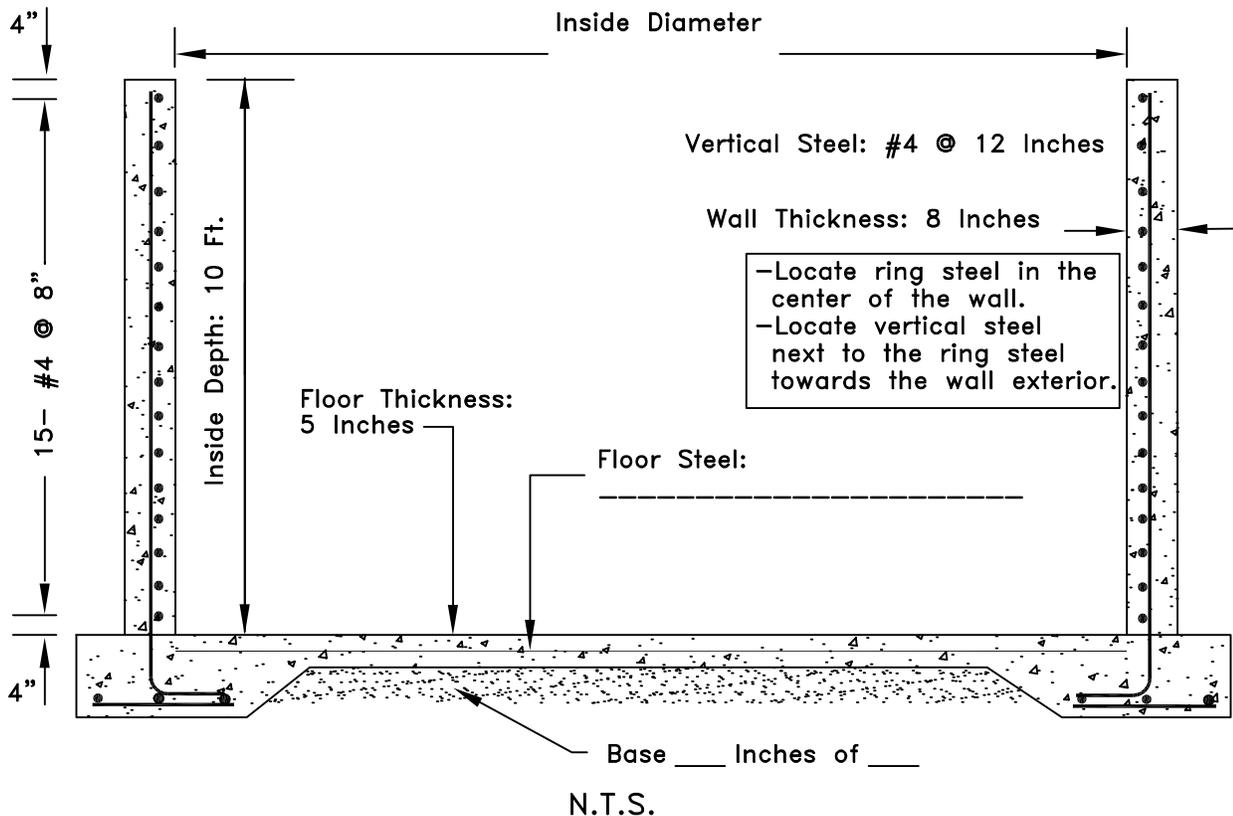
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## FOOTING DESIGN



NOTE: Subsurface Drainage must be provided around the storage facility.

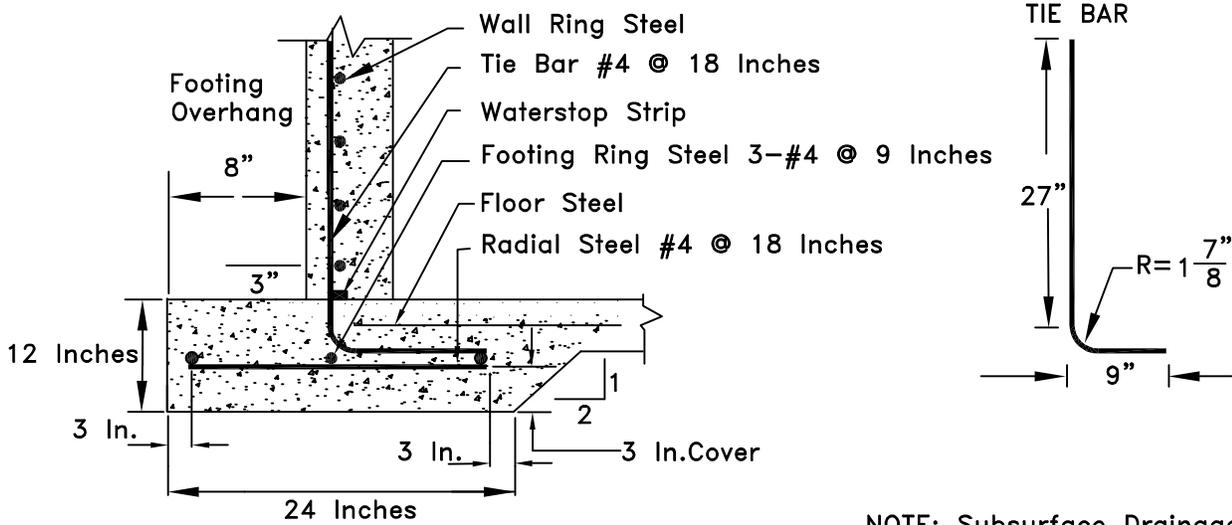
## WALL DESIGN



CIRCULAR CONCRETE STORAGE FACILITY  
10' DEEP 75' OR LESS IN DIAMETER

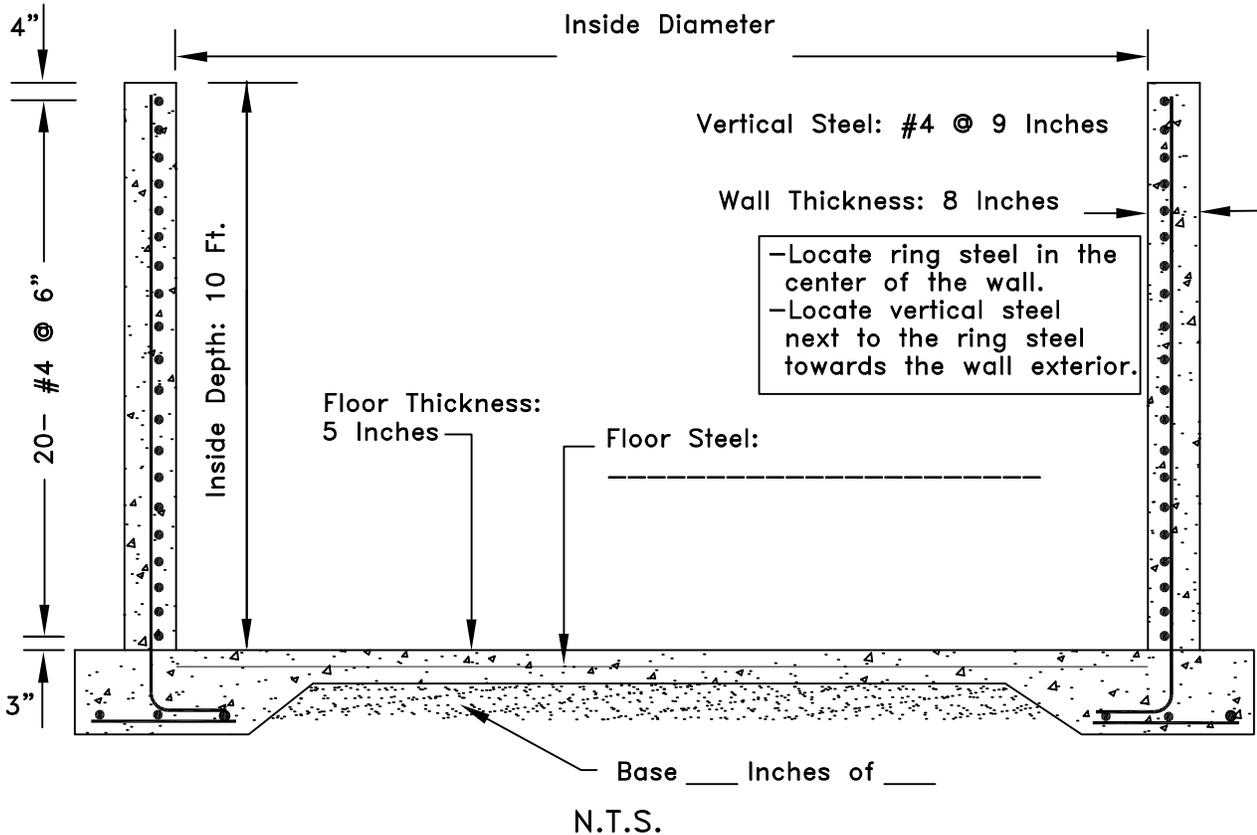
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**FOOTING DESIGN**



NOTE: Subsurface Drainage must be provided around the storage facility.

**WALL DESIGN**



CIRCULAR CONCRETE STORAGE FACILITY  
10' DEEP 76' TO 120' IN DIAMETER

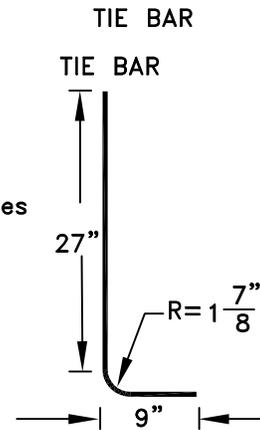
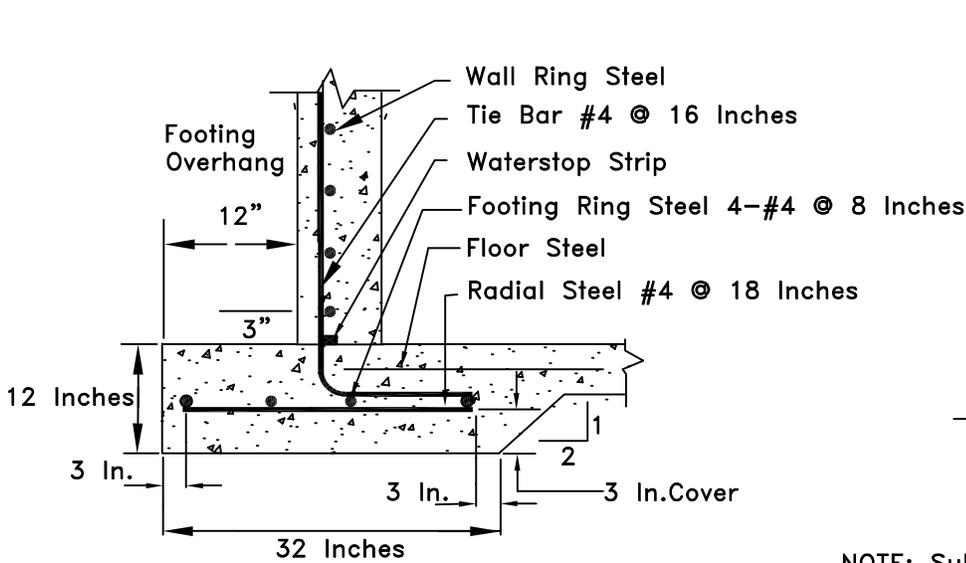
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EVEN BACKFILL: MAXIMUM 3' VARIANCE

GRADE 60 STEEL

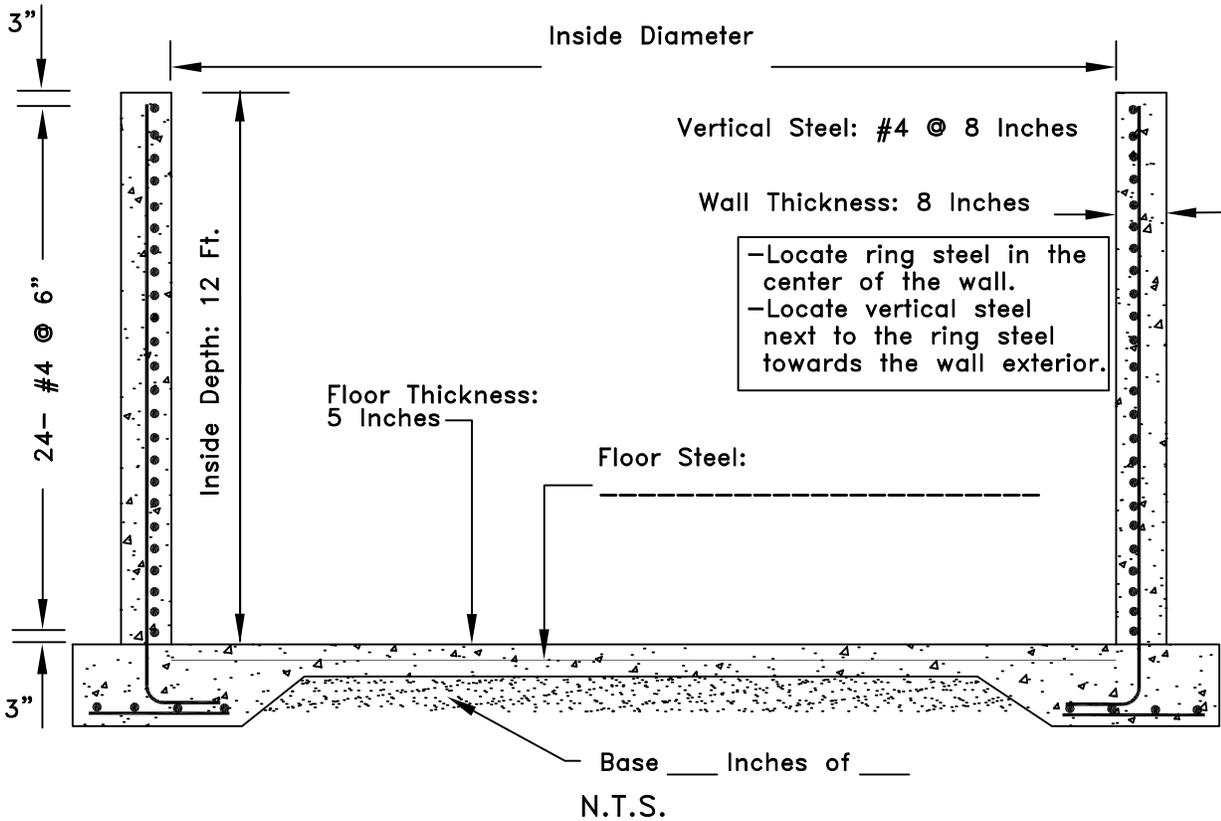
TYPE I CEMENT, 4,000 PSI CONCRETE W/5% AIR

FOOTING DESIGN



NOTE: Subsurface Drainage must be provided around the storage facility.

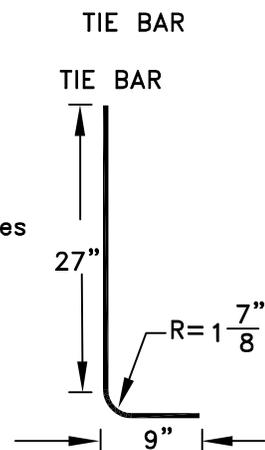
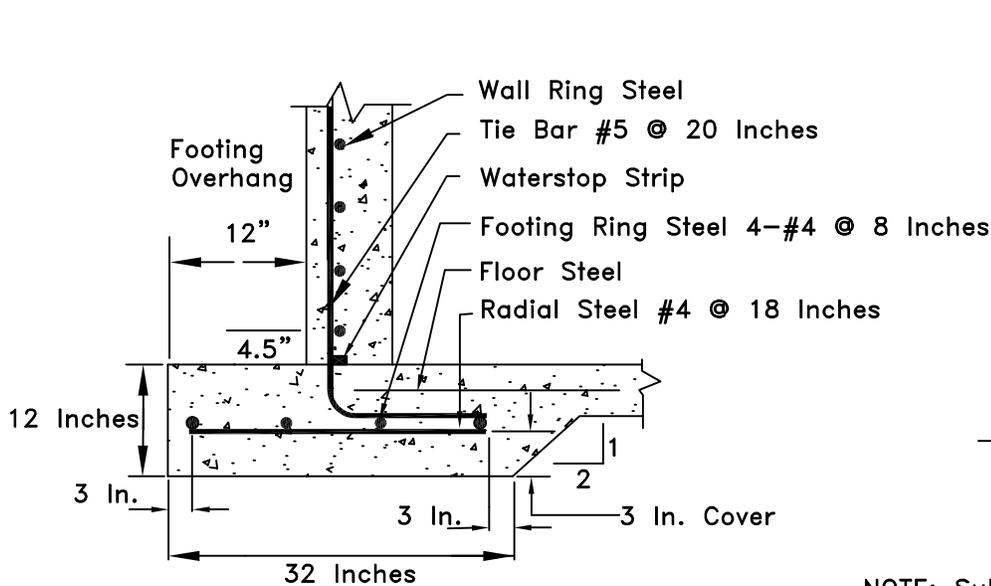
WALL DESIGN



CIRCULAR CONCRETE STORAGE FACILITY  
12' DEEP 90' OR LESS IN DIAMETER

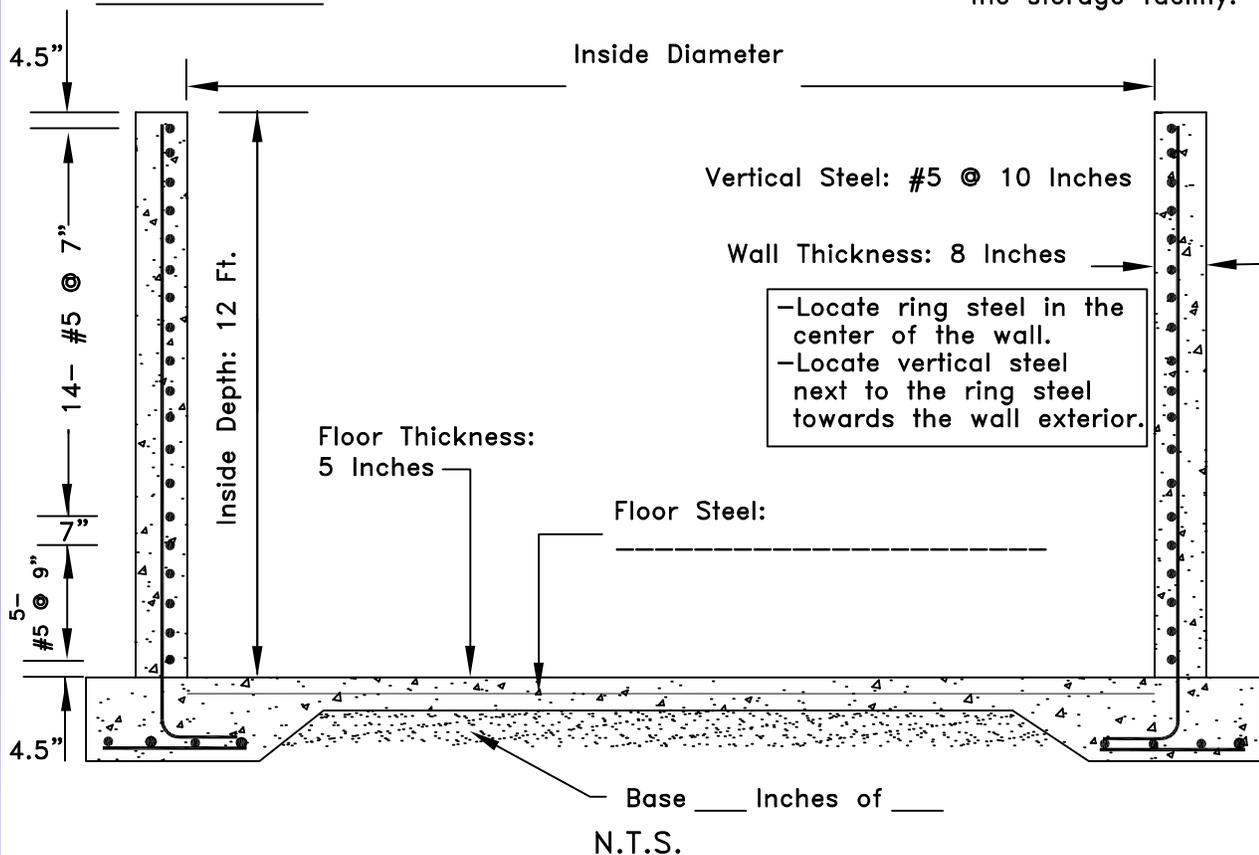
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# FOOTING DESIGN



NOTE: Subsurface Drainage must be provided around the storage facility.

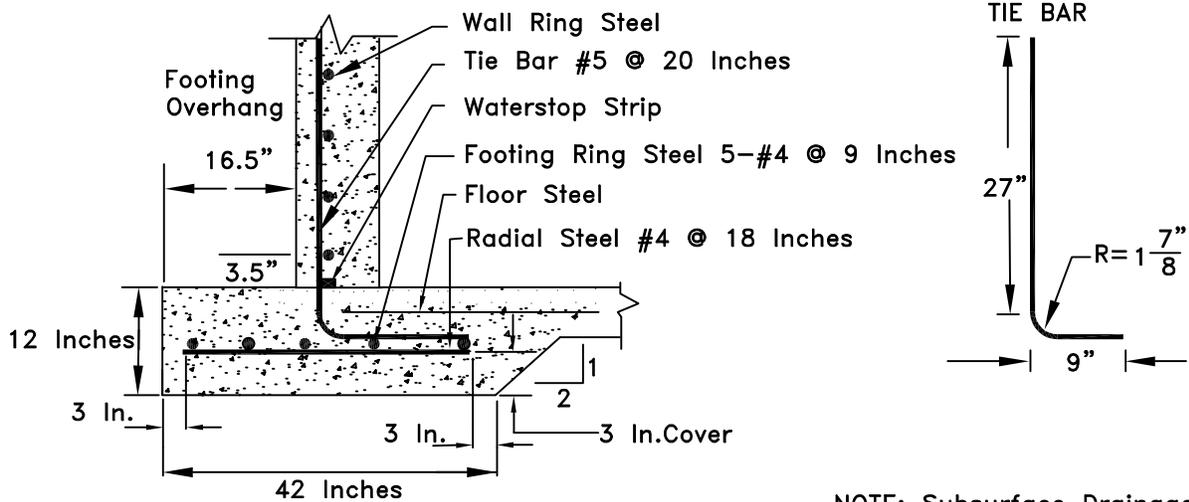
# WALL DESIGN



CIRCULAR CONCRETE STORAGE FACILITY  
 12' DEEP 91' TO 120' IN DIAMETER

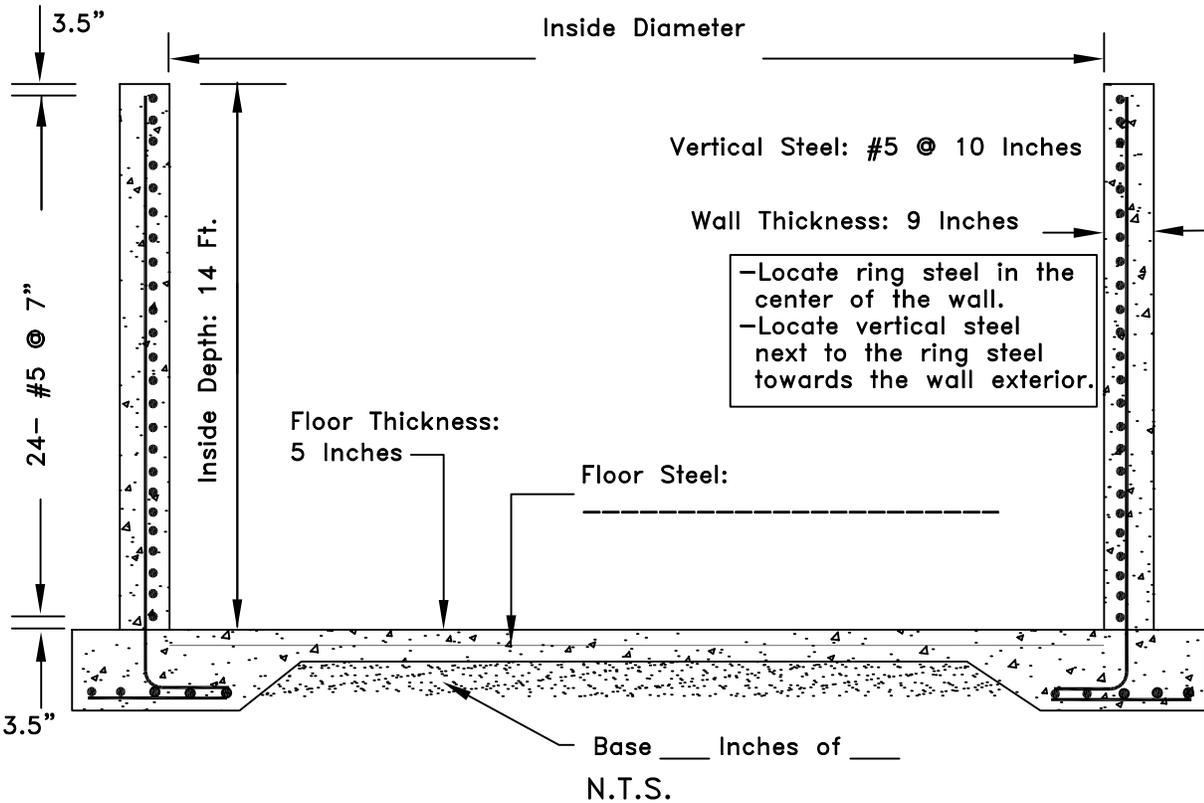
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**FOOTING DESIGN**



NOTE: Subsurface Drainage must be provided around the storage facility.

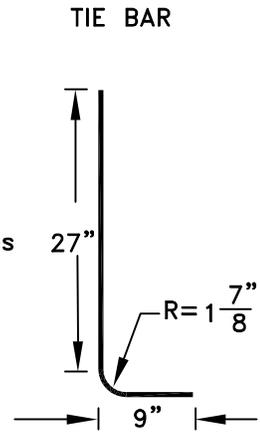
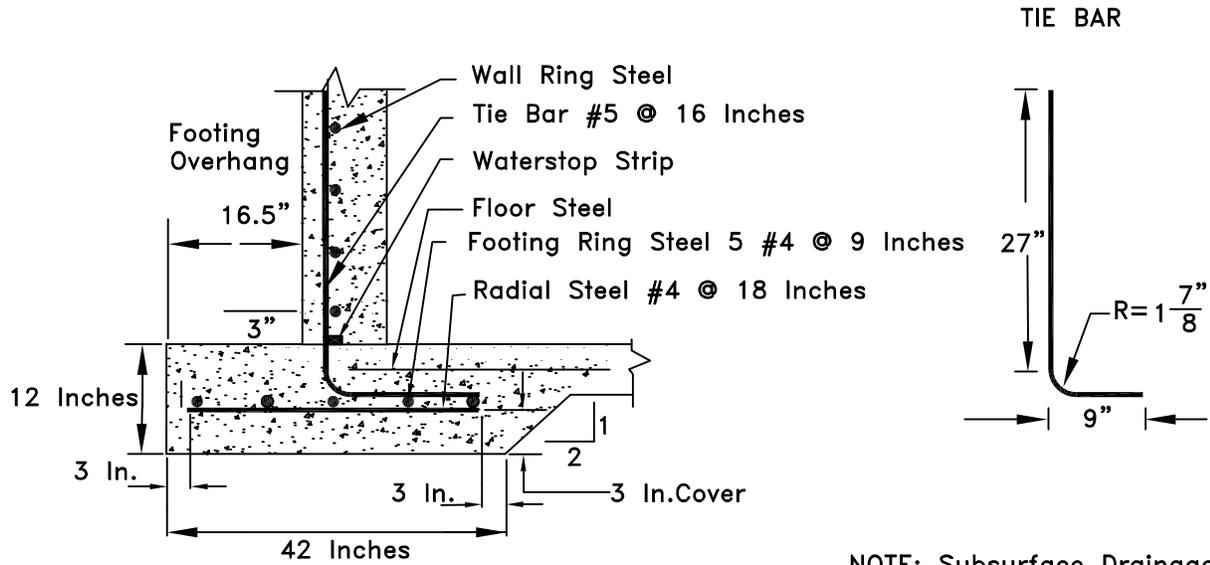
**WALL DESIGN**



CIRCULAR CONCRETE STORAGE FACILITY  
14' DEEP 90' OR LESS IN DIAMETER

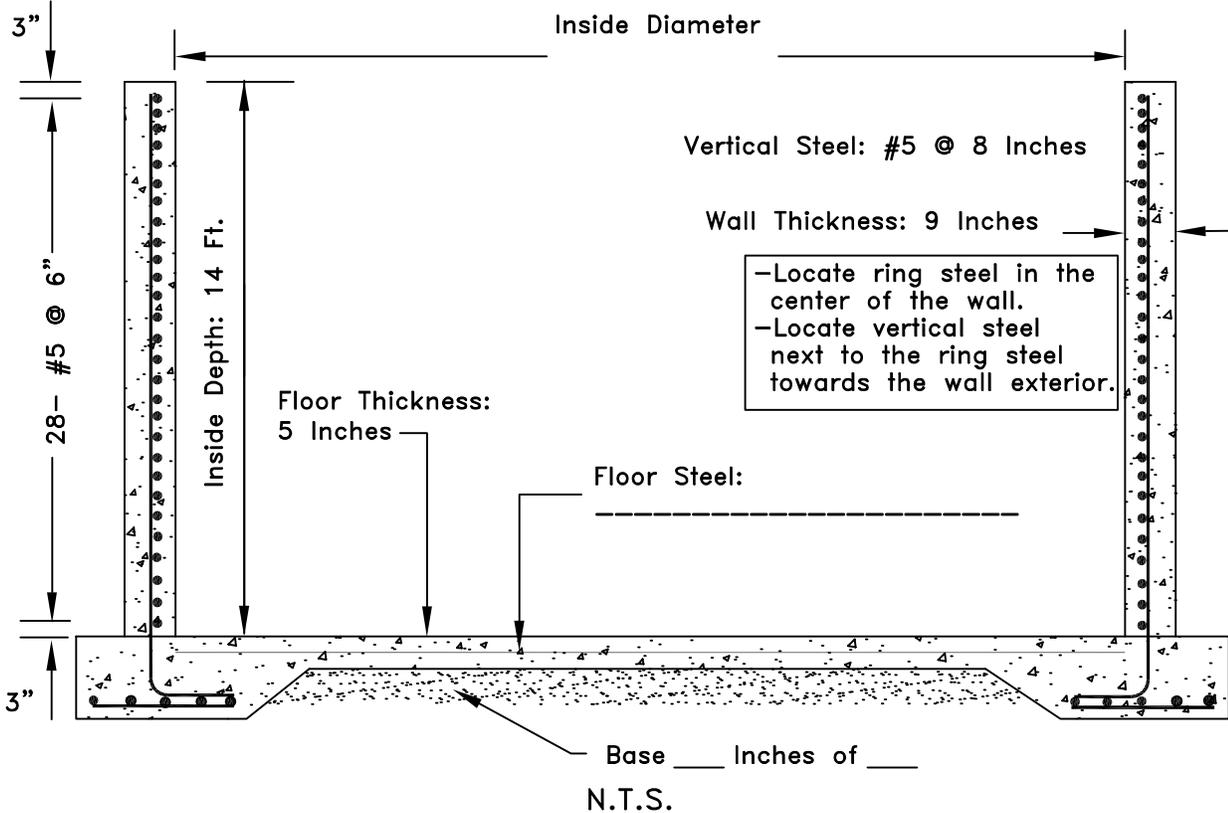
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**FOOTING DESIGN**



NOTE: Subsurface Drainage must be provided around the storage facility.

**WALL DESIGN**



CIRCULAR CONCRETE STORAGE FACILITY  
14' DEEP 91' TO 120' IN DIAMETER

ISSUE DATE: 12/04  
DRAWING NO. CT-14-120

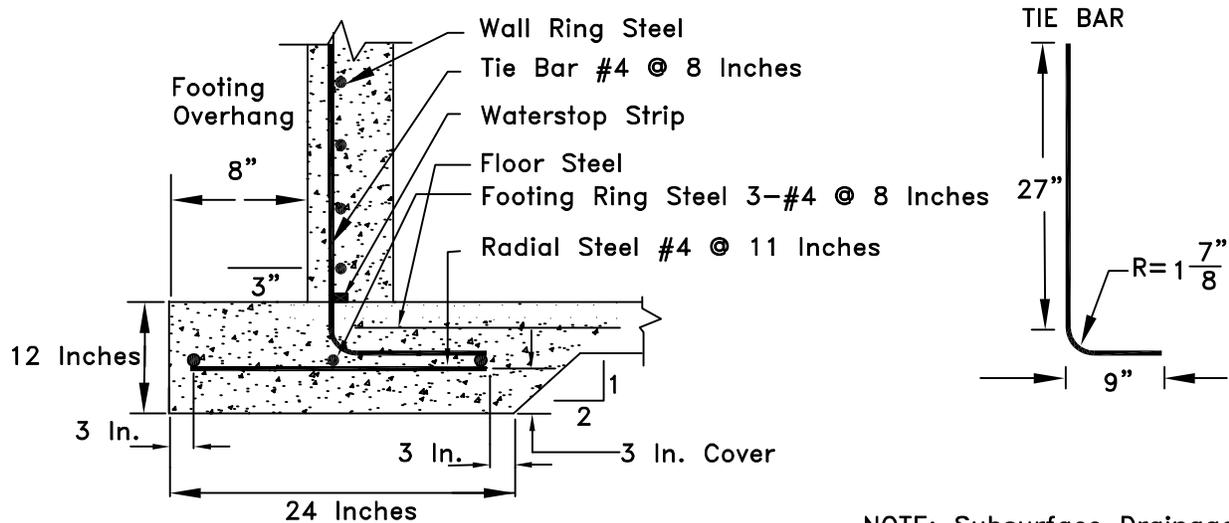
## **SECTION IV**

### **Construction Drawings for Circular Storage Facilities with Ramps**

#### Naming Conventions

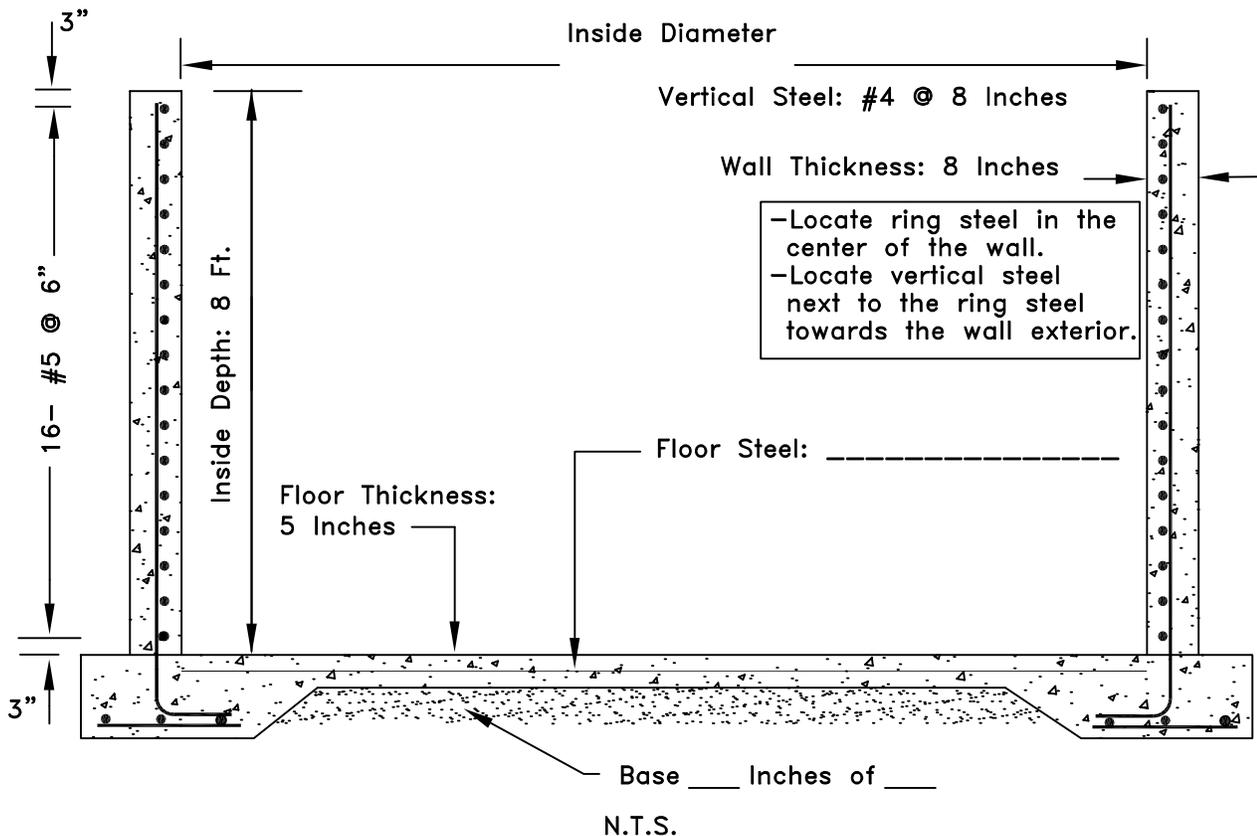
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## FOOTING DESIGN



NOTE: Subsurface Drainage must be provided around the storage facility.

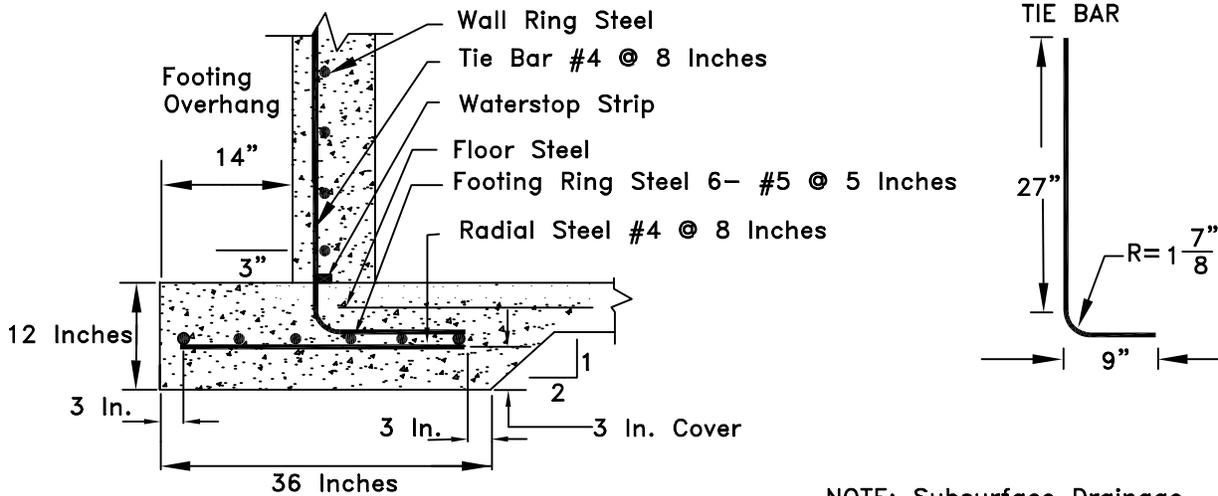
## WALL DESIGN



CIRCULAR CONCRETE STORAGE FACILITY  
FOR USE WITH NOTCHED WALL AND RAMP  
8' DEEP 120' OR LESS IN DIAMETER

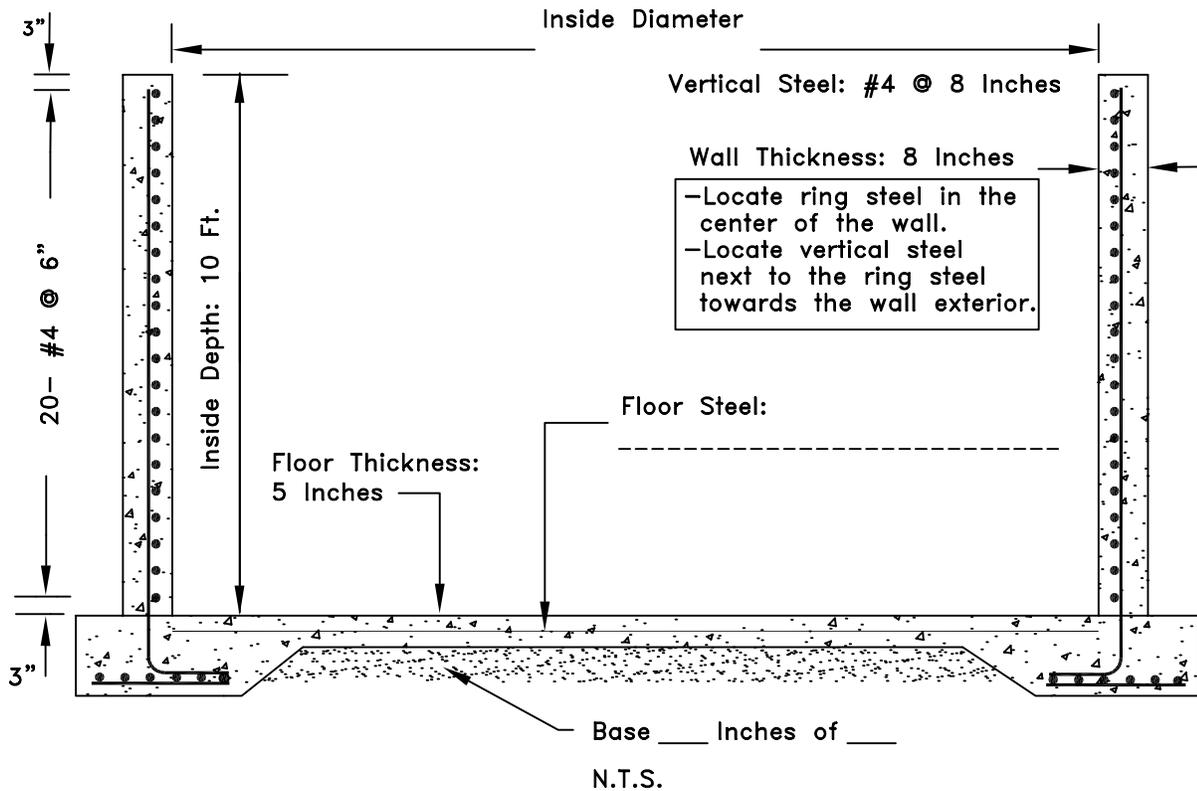
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DRAWING NO. NCT-8-120

**FOOTING DESIGN**



NOTE: Subsurface Drainage must be provided around the storage facility.

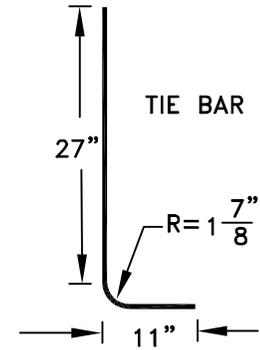
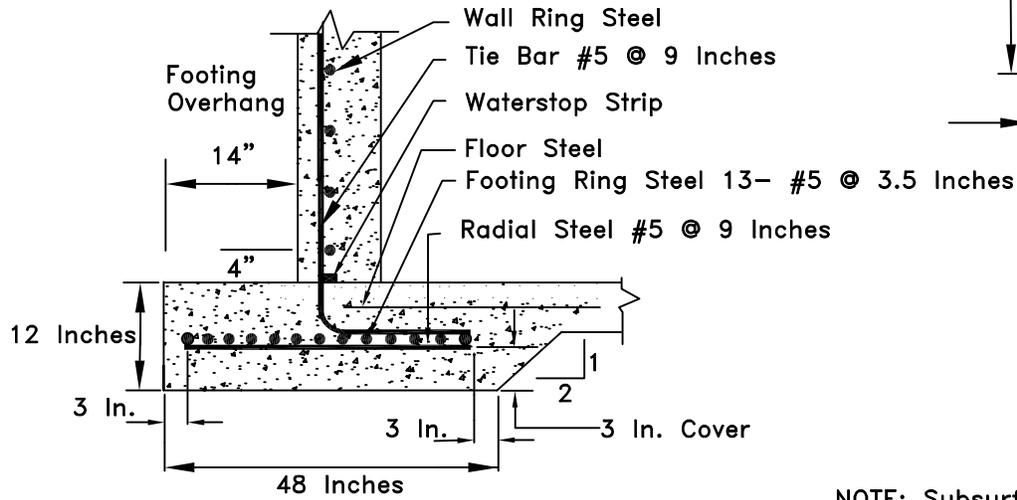
**WALL DESIGN**



CIRCULAR CONCRETE STORAGE FACILITY  
FOR USE WITH NOTCHED WALL AND RAMP  
10' DEEP 120' OR LESS IN DIAMETER

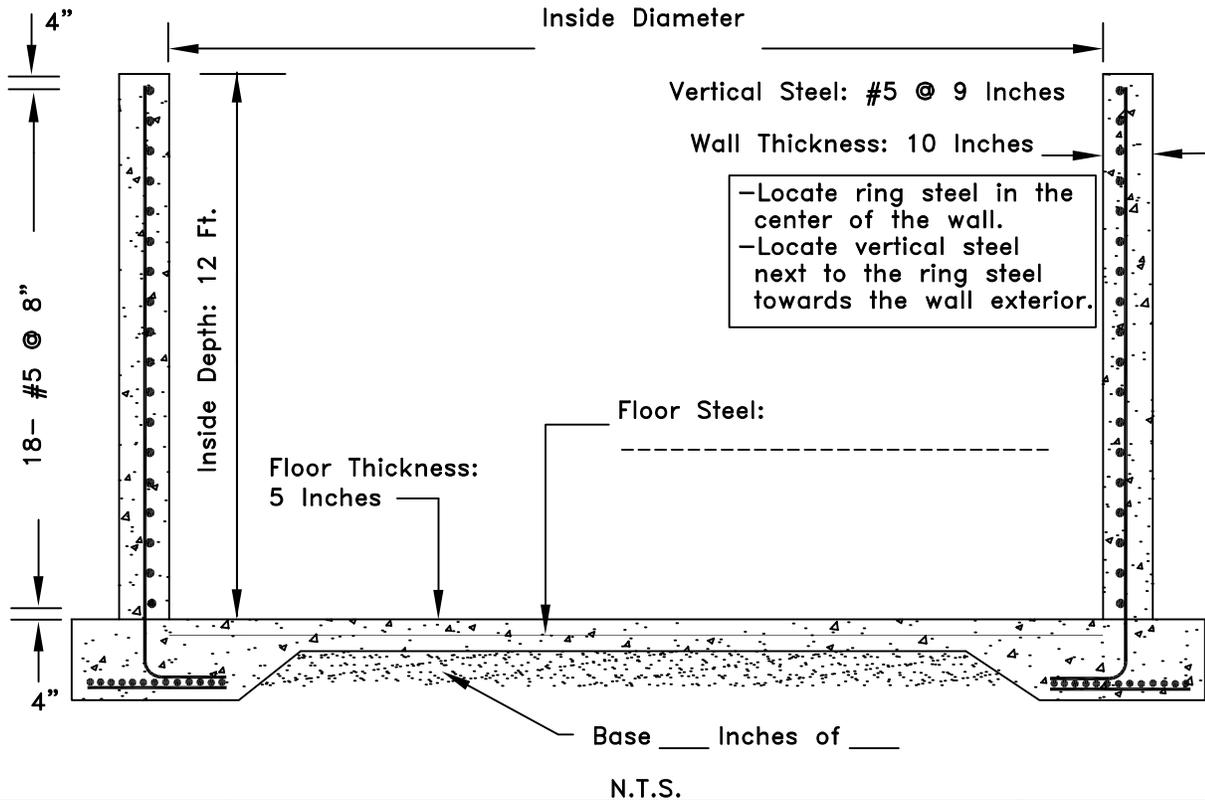
ISSUE DATE: 12/04  
DRAWING NO. NCT-10-120

**FOOTING DESIGN**



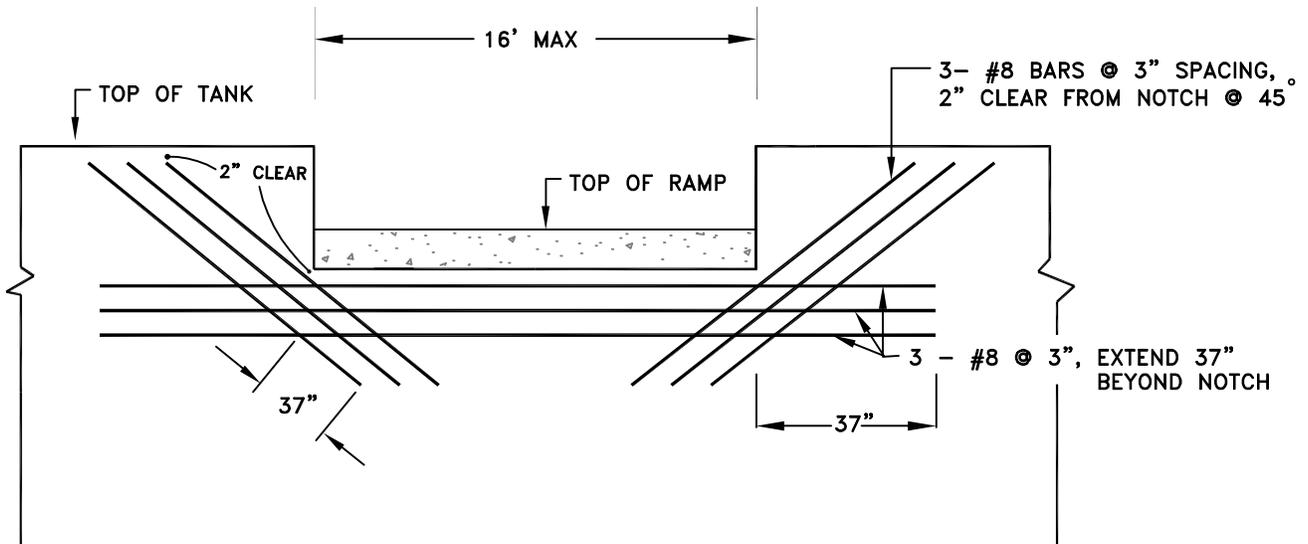
NOTE: Subsurface Drainage must be provided around the storage facility.

**WALL DESIGN**



CIRCULAR CONCRETE STORAGE FACILITY  
FOR USE WITH NOTCHED WALL AND RAMP  
12' DEEP 120' OR LESS IN DIAMETER

ISSUE DATE: 12/04  
DRAWING NO. NCT-12-120



STEEL REINFORCEMENT AROUND NOTCH

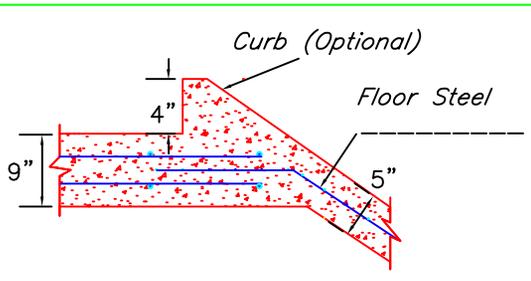
N.T.S.



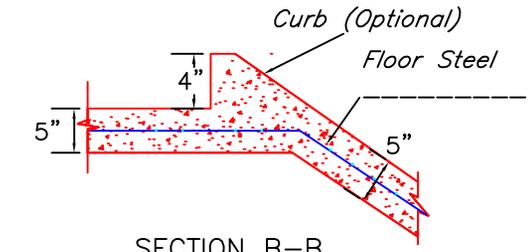
ACCESS RAMP THRU NOTCHED  
CIRCULAR STORAGE FACILITY  
DETAILS

ISSUE DATE: 12/04  
DRAWING NO. NCT 1D

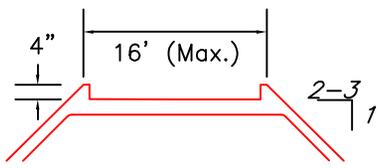




SECTION A-A

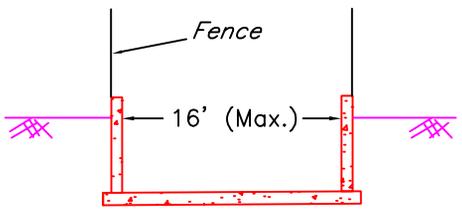


SECTION B-B  
RAMP CURB DETAIL



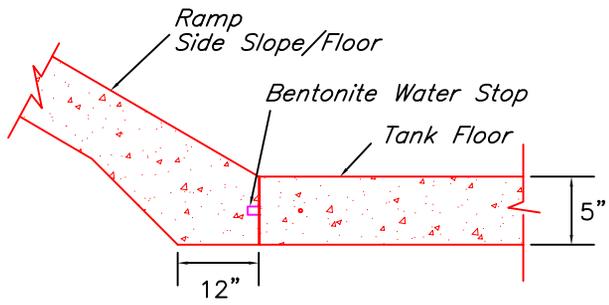
Ramp side slopes shall be 5" thick, perpendicular to slope. 4" curb is optional.

SECTION C-C

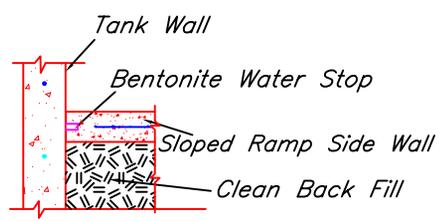
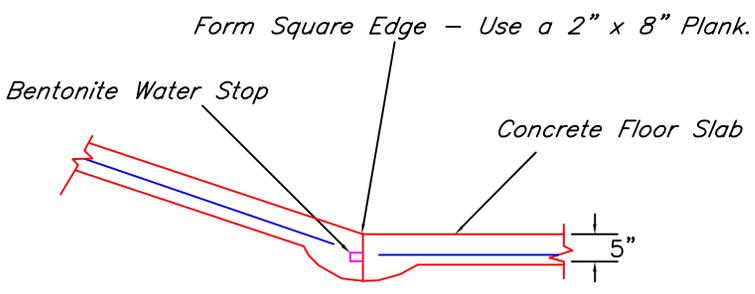


SECTION D-D

Section F-F: Inside Ramp Side Slope To Tank Floor



Section G-G: Elevation @ Floor & Ramp



SECTION E-E

N.T.S.

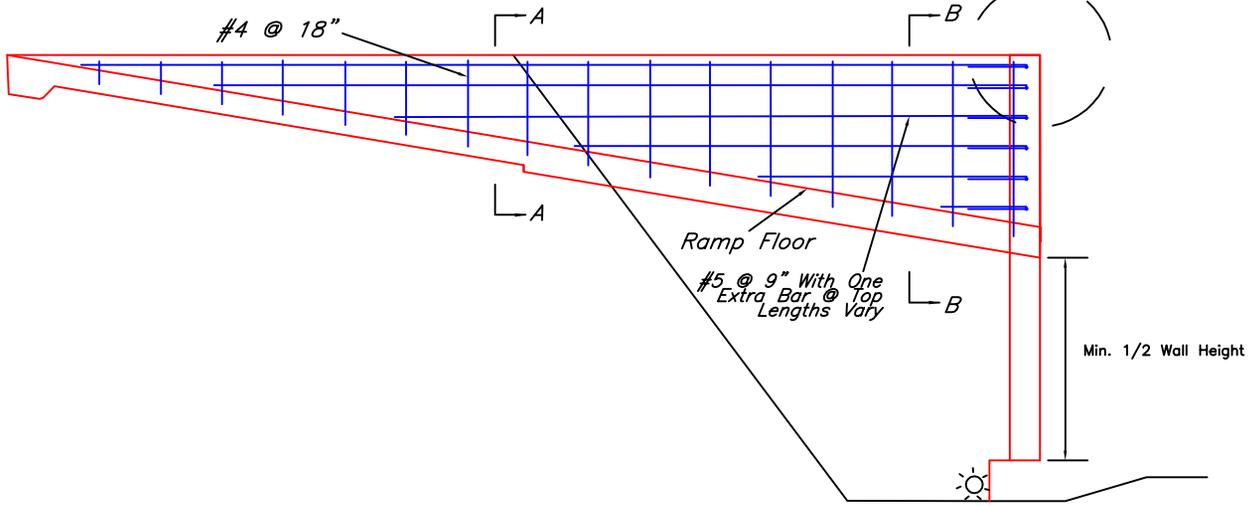


NOTCHED CIRCULAR STORAGE FACILITY  
RAMP WALL- SECTIONS & DETAILS

ISSUE DATE: 12/04  
DRAWING NO. NCT 3D

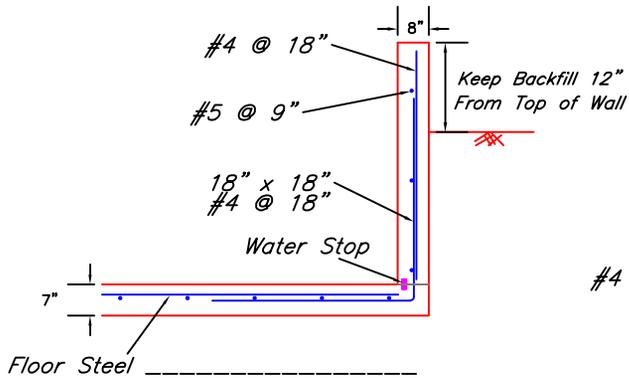
ACCESS RAMP THROUGH NOTCHED TANK – ELEVATION VIEW OF RAMP

See Inset: Top View of Wall Joint

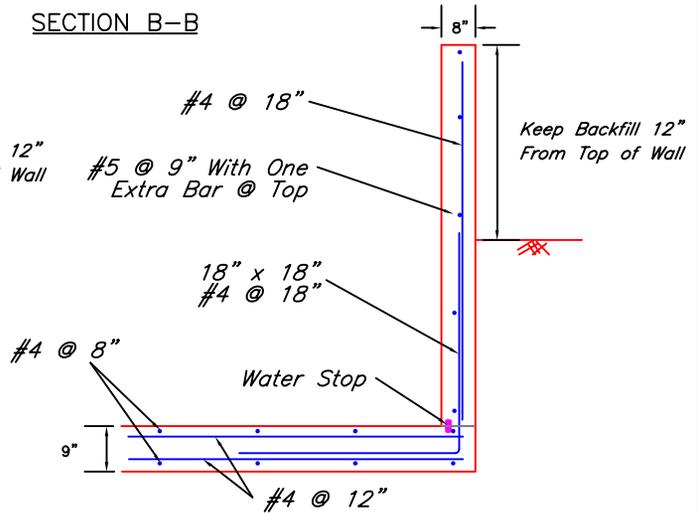


SECTION A-A

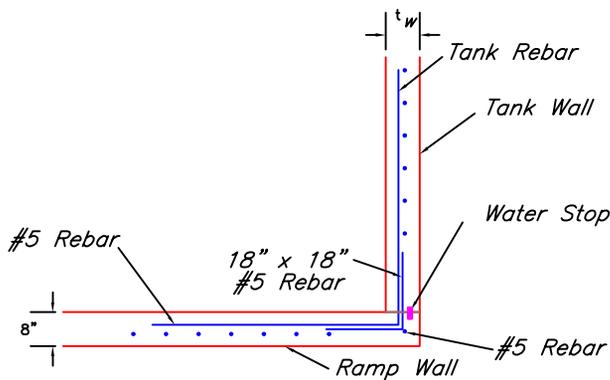
Note: Cut Vertical #4's to Fit Wall Height



SECTION B-B



TOP VIEW OF WALL JOINT



NOTCHED CIRCULAR STORAGE FACILITY  
RAMP ELEVATION VIEW & DETAILS  
N.T.S.

ISSUE DATE: 12/04  
DRAWING NO. NCT 4D

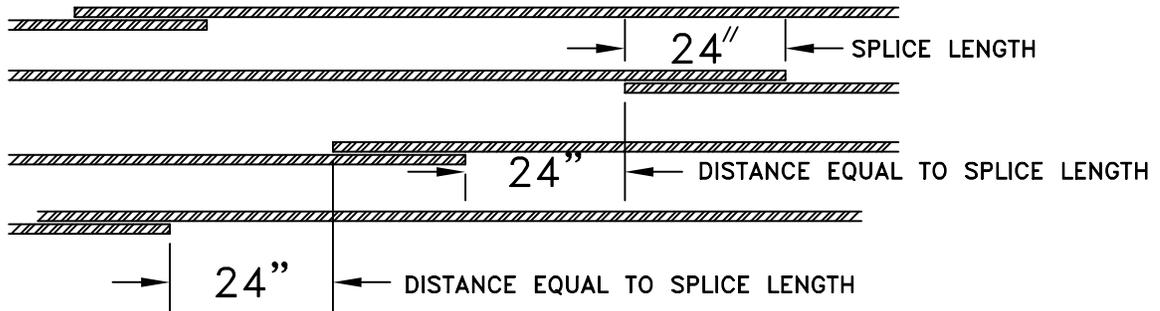
## **SECTION V**

### **Construction Details for all Circular Concrete Storage Facilities**

#### Naming Conventions

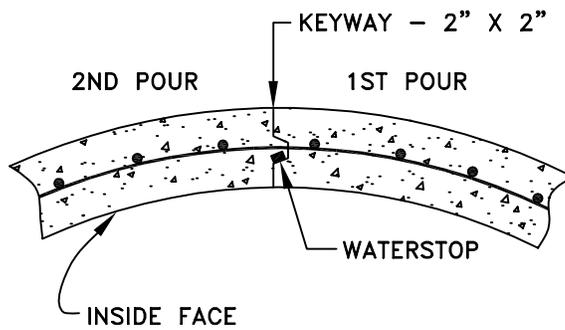
CT-8-75	CT represents Circular Tank. 8 represents the wall height. 75 represents the maximum tank diameter.
NCT-8-120	NCT represents Notched Circular Tank. 8 represents the wall height. 120 represents the maximum tank diameter.
CT-1D	CT represents Circular Tank. 1 represents the first set of details. D represents details.





SPLICING DETAIL FOR WALL AND FOOTING RING STEEL

N.T.S.



VERTICAL WALL JOINT

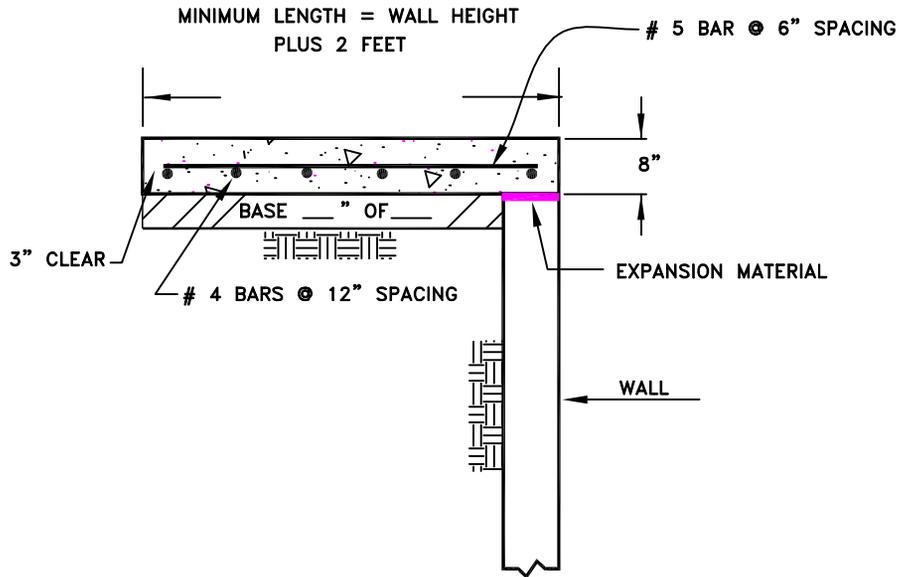
N.T.S.

N.T.S.

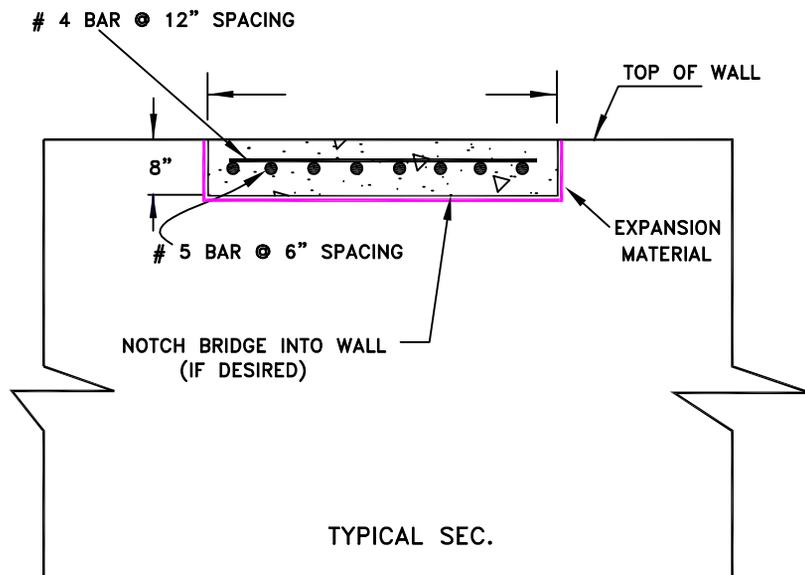


CIRCULAR CONCRETE STORAGE FACILITY  
DETAILS

ISSUE DATE: 12/04  
DRAWING NO. CT-1D



TYPICAL SEC.



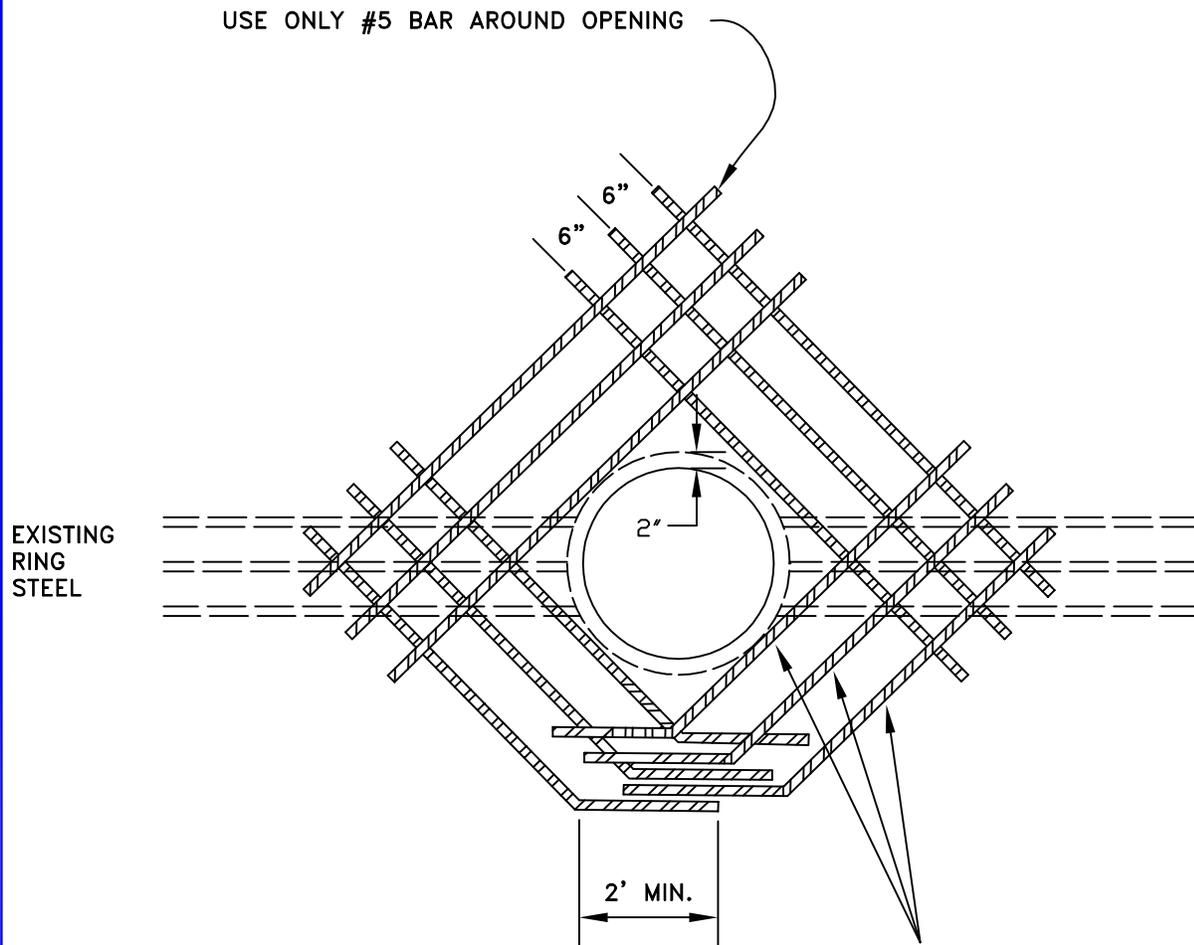
TYPICAL SEC.

N.T.S.



BRIDGE DETAIL FOR CIRCULAR TANKS  
(LOADING AND UNLOADING PADS)

ISSUE DATE: 12/04  
DRAWING NO. CT-2D



NOTE: WHEN THE PIPE IS BEING INSTALLED WITHIN 12" OF THE FLOOR, REMOVE THE BOTTOM REBAR. WHEN THE PIPE IS GREATER THAN 3' ABOVE FLOOR, BOTTOM BARS DO NOT NEED TO BE BENT.

**NOTES:**

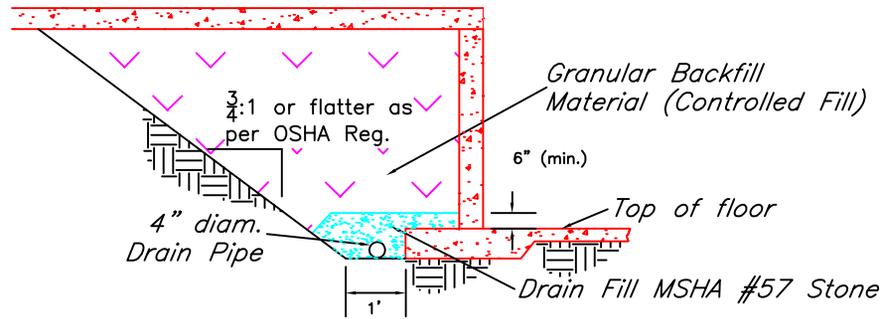
1. CUT ALL VERTICAL AND RING STEEL 2 INCHES FROM OPENING.
2. FOR EACH RING STEEL BAR INTERRUPTED BY THE OPENING, INSTALL ONE #5 BAR AROUND EACH SIDE OF THE OPENING. A MINIMUM OF 2 - #5 BARS ARE TO BE USED ALONG EACH SIDE.

N.T.S.



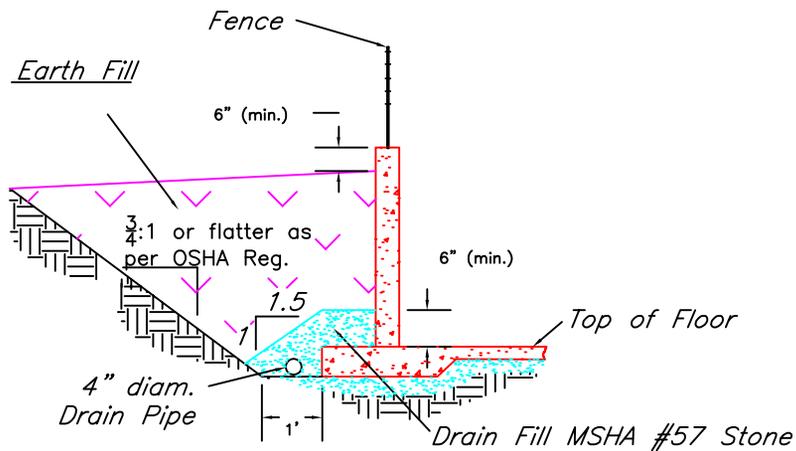
CIRCULAR CONCRETE STORAGE FACILITY  
 DETAIL OF PIPE PROTRUDING THROUGH WALL

ISSUE DATE: 12/04  
 DRAWING NO. CT-3D



Granular backfill is required under slab and shall be compacted in uniform 8-inch lifts by traversing of the entire surface with not less than one track of the equipment or by four complete passes with a manually directed vibratory roller or plate vibrator.

### WALL BACKFILL DETAIL – CONTROLLED FILL



Provide a minimum 4-inch diameter perforated drain tubing for drainage behind wall. Outlet the pipe as shown on the plan view. Place earthfill in uniform lifts. When placing uncompacted fill provide additional fill for settlement.

### WALL BACKFILL DETAIL – TYPICAL