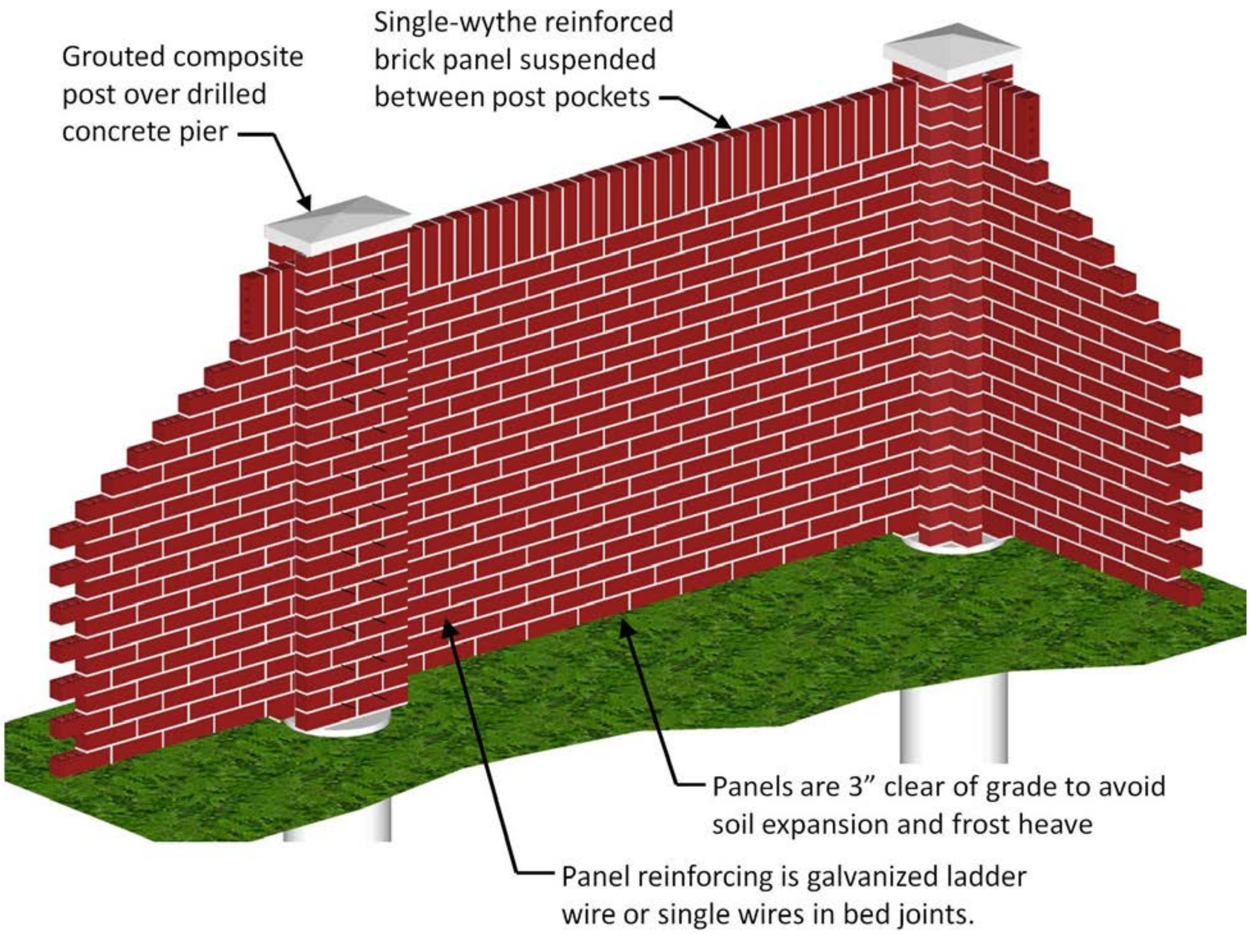
TECHNICAL SERVICES DIGEST APRIL 2014

SINGLE-WYTHE BRICK FENCES

This digest contains information and suggested details on single-wythe brick fences, including details that we recommend be included. There is also a design chart showing calculated horizontal reinforcing spacing for various wind load and span conditions, and a chart that shows minimum embedment of piers in soil with at least 3,000 psf bearing pressure. These are for use by engineers to determine design reinforcement and pier size and depth for local wind conditions and soil properties.



Construction:
Single-wythe brick fences contain three major elements:

1. Drilled concrete piers
2. Reinforced brick composite posts with slots to receive panels
3. Single-wythe brick panels reinforced to resist wind loads

Why You Need a Geotechnical Report

A building situated on compressible soil may present serious problems. The "Leaning" Tower of Pisa, is perhaps the most famous example. What happened there was not expected. As the soil compressed unevenly, the building began to tilt. Because there were no geotechnical engineers when that building was designed and constructed, the soil was not tested, and the builders relied on the condition of soil near the surface to make their decisions about the foundation.

Although there have been similar problems with buildings in recent times, it's now possible to minimize potential soil problems by commissioning a geotechnical report of the site. The report contains recommendations for design and construction on the site. A geotechnical report tells you what the subsurface conditions are and how to deal with them. The report includes a description of soil and rock; logs of borings; groundwater conditions; soil and rock conditions; changed conditions; and drainage and subsurface interpretation.

Without a subsurface evaluation, there can be problems with building performance because of soil bearing limitations.

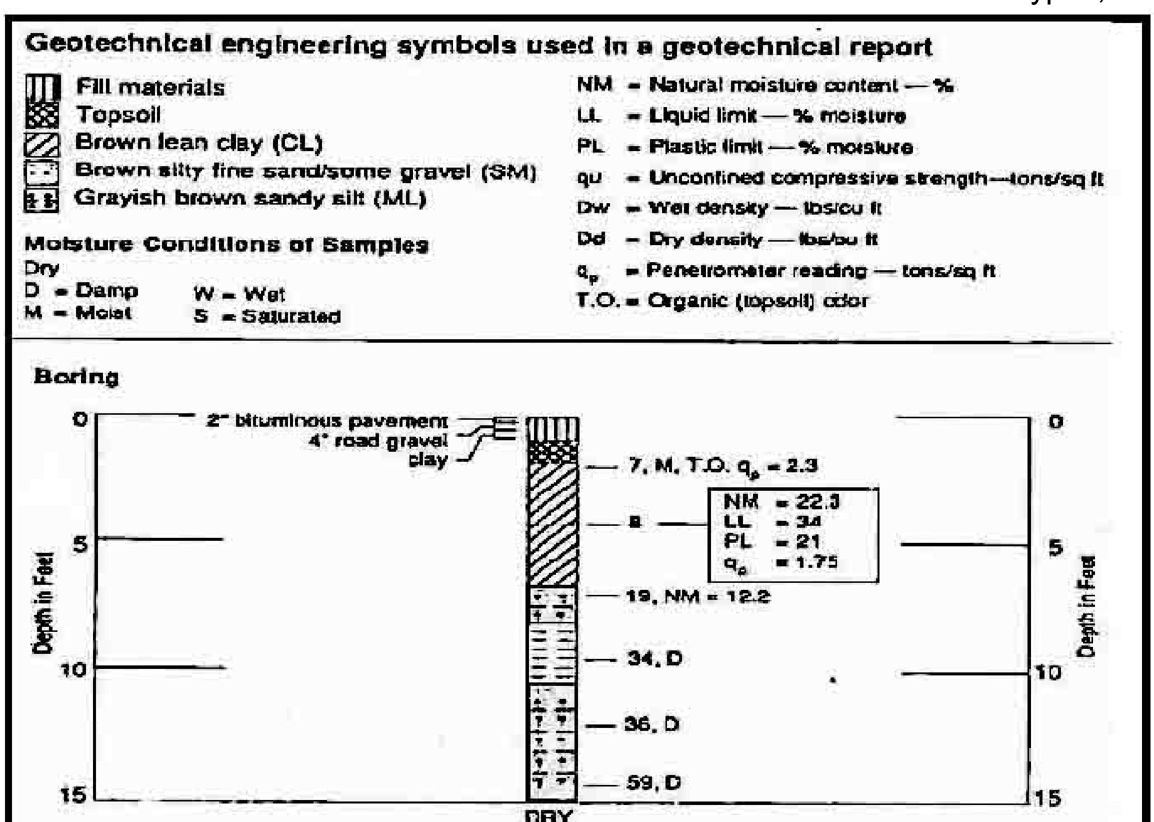
Subsurface conditions are often perplexing. Soils are an unknown on any site. There can be a wide variation of soil characteristics over a short distance. While surface conditions of adjacent sites might appear to be identical, the subsurface conditions can vary greatly. Groundwater levels, and soil composition may be very different in two adjacent sites.

Subsurface conditions can be explored through borings, seismic wave velocity of the soil, or electric resistivity, which measures the electric resistance of the soil. When sampling through borings. the soil you pull out is tested for type, deformation, and strength.

Geotechnical engineers classify soils into three main types, sand, silt and clay, based on the size of particles. There are also organics such as peat, Most soils are combinations of these, such as silty clays or sandy silts.

Both the water table and the soil type are important because soils react with water. In general, the higher the water content, the less the strength and the more compressible the soil.

In his report, the geotechnical engineer examines the soil types, and re commends bearing pressures and the type of foundation that is most appropriate for the site and the building type. It also explains settlement characteristics and gives guidance on design of pavement, retaining walls, waterproofing, and any precautions that should be taken during construction.



Subsurface conditions at the borehole. Refer to the legend for symbol definitions.

1. Piers are simply holes drilled to the depth require to resist overturning wind loads and filled with concrete. A single reinforcing bar on centerline is all that is required for reinforcing.
   a. No cage is required, because the concrete without shear reinforcing has ample capacity to resist shear loads from wind.
   b. Holes can be drilled and immediately filled with concrete.
   c. The reinforcing bar is vibrated into place with a rebar vibrator to assure continuous bond with no voids.
2. Posts are composite beams cantilevered from the tops of piers. The single bar in the pier extends to the top of the post, providing adequate reinforcing, and serving as a convenient marker for the center of post and pier.
   a. A brick face is built on either side of a composite grout pour.
   b. Wire reinforcing ties the two faces together and a temporary form blocks out pockets to receive the panels.
   c. When faces are complete and forms are in place, coarse grout is poured to make a composite reinforced brick post.
   d. Center reinforcing bar size is to be determined by your engineer to resist bending created by wind force on the panels carried by the posts.
3. Panels are designed to span horizontally between the posts.
   a. Panels consist of a single wythe or layer of brick that is reinforced with ladder wire or other reinforcement in the bed mortar joints between brick courses.
   b. Wire size and spacing is dictated by wind loads, or rarely seismic loads.
   c. Vertical load stresses in the panel are only about one percent of the wind load stresses, so they can be safely neglected.

Materials:

1. Concrete for drilled piers shall be 3,000 psi normal weight 3/4" maximum aggregate size poured at 3” to 4” slump.
2. Pier and post reinforcing bars shall be ASTM A615 Grade 60 sized to resist wind loads on post.
3. Brick shall be ASTM C216 or C652, grade SW cored brick. Special precautions must be taken for used brick or uncored brick, to assure adequate bond. Cap wall with either solid brick or a soldier course.
4. Grout shall be ASTM C476 coarse grout 2,500 psi (f’c) poured at 8 1/2” to 10 1/2” slump.
5. Piers and posts shall have vertical reinforcing extending from 3” above the bottom of drilled pier to 3” below top of brick post. A typical design with 10’-0 post spacing might have (1) #7 vertical reinforcing bar in the post and drilled piers. Have your engineer verify each design you use.

6. Wire joint reinforcing shall have minimum yield strength of 80,000 psi and be hot-dip galvanized or stainless. Use 9 ga x 1 1/4" or 3/16" x 1 1/4" ladder wire joint reinforcing for 3" nominal brick. This type is specially made to reinforce King-size brick and still keep the required 5/8" cover from the face of wall.
7. Tie wires in piers shall be 3/16" dia. galvanized or stainless ladder wire cut to 16" lengths.
8. Mortar: We recommend Type S portland cement and lime mortar or Type S Mortar Cement. Masonry cement has no required bond strength, but good results have been achieved with some quality masonry cement mortars.

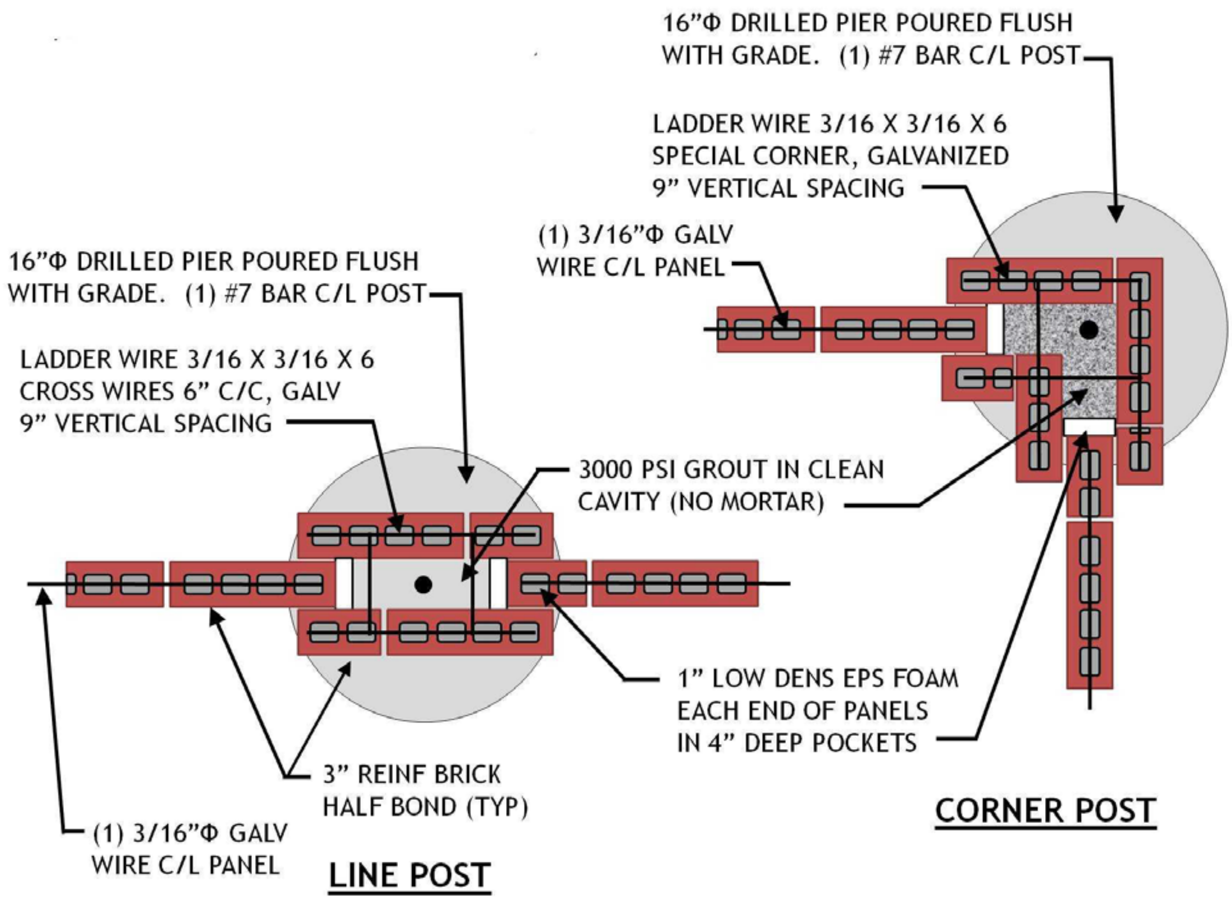
Building the fence:

1. Excellent workmanship is required to build a single-wythe brick fence that will last.
2. Post spacing shall not exceed 12'-0" c/c unless designed by a professional engineer.
3. Drill piers at precise locations shown on plans only after utilities have been clearly located and marked.
4. Fill piers with concrete and vibrate in center reinforcing true and plumb to locate the exact center of post.
5. Build post faces of brick with specified ties between faces. Clean all mortar from grout space between post faces.
6. Form pockets and seats for panels with wood formwork and embedded foam expansion strips.
7. Pour grout between forms and brick faces. Vibrate grout. Vibrate again after five minutes. Rebar vibrator used for pier pour is preferred.
8. Provide expansion joints at each end of each panel in the post pocket. A 1/2" thick expanded styrene foam strip has proved adequately compressible to allow for brick expansion and for panel movements caused by expansive soils. Wall caps must also have expansion material at posts and must not be mortared in tight to the posts.
9. Build panels on temporary forms 3" above grade between posts.
10. If a mow strip is used, it shall not be anchored to the piers or posts in any way, and must be at least 3 inches below the bottom of panel.
11. Joint reinforcing shall be placed after mortar for the bed joint is strung for each course and tapped into the mortar for full embedment. Maintain 5/8" cover from each face of brick with reinforcing accurately centered on panel.
12. The next course of brick shall be placed as soon as possible after stringing bed joint mortar. All brick in next course shall be place within 5 minutes of stringing bed joint mortar on the course below. If mortar begins to stiffen, good bond with the brick will not be achieved.
13. Joint tooling on both faces to a concave profile shall be done when mortar is thumb-print hard.
14. Clean mortar gobs from wall as work progresses.
15. Cap the tops of all panels and posts with a water-resistant cap of concrete or brick set in mortar to prevent water for getting into panel or post brickwork.
16. Anchor soldier course to panel brick with 9 ga galvanized wire ties at 30" c.c.
17. Do not splice joint reinforcing. Order joint reinforcing cut to 4" less than panel length.

18. Place joint reinforcing above the first course and add an extra layer of reinforcing at the top of wall, if a soldier cap is used. This will allow for the 10” soldier with no course reinforcing.
19. Care must be exercised in laying brick to insure full head joints and bed joints. Keep mortar wet enough to bond fully with brick.
20. High IRA (hot) brick must be pre-wet to assure good bond.
21. Build brick piers around vertical reinforcing, placing wire ties where shown on drawings to tie brick into grouted core. Leave channel for fence panel and place expansion joint material and bond breakers in channel as shown on drawings.
22. Lay first course of wall panels without bed joint, but with full head joints on temporary forms to be removed in 3 days minimum.
23. Lay remaining courses and reinforcing to finish wall panels.
24. Use extra care laying cap course. Completely fill all head joints and exposed cores.
25. Tool joints when thumb-print hard to reduce water leaks into the wall.

Building Tips

- Determine fence height and number of piers needed.
- For best economy use 10 to12 ft c/c post spacing.
- Place a post at every corner or turn in the fence and then space line posts between them.
- Diameter and depth of drilled piers for posts depends on wind load, wall height, post spacing, soil properties, frost depth and expansive soil conditions.
- Table 7 of NCMA TEK 14-15A (1997) is attached and may be used to size piers in soil with at least 3000 psi allowable bearing pressure, as determined by a soils engineer.
- For poorer soils, consult a licensed professional engineer experienced in drilled pier designs.



POST DETAILS

KING SIZE BRICK (2-3/4"), 4400 PSI[1] MINIMUM

Clear Panel Span[2]	WIND PRESSURE				
	15 psf	20 psf	25 psf	30 psf	35 psf
	Maximum Vertical Spacing for 9 ga. x 1¼" Ladder Wire				
7.0 ft	14.2	10.6	8.4	7.0	5.9
8.0 ft	10.8	8.0	6.4	5.3	4.5
9.0 ft	8.5	6.3	5.0	4.1	3.6
10.0 ft	6.8	5.1	4.0	3.4	6.8
11.0 ft	5.6	4.3	3.3		
	Maximum Vertical Spacing for 3/16" x 1¼" Ladder Wire				
7.0 ft	22.8	17.0	13.4	11.1	9.5
8.0 ft	17.1	12.8	10.2	8.4	7.2
9.0 ft	13.5	10.1	8.0	6.6	5.7
10.0 ft	10.9	8.1	6.4	5.3	4.5
11.0 ft	8.9	6.7	5.3	4.4	3.7

Disclaimer –
This chart has been prepared in keeping with the present state of the art of masonry design. Care has been taken to ensure that all data and information furnished are as accurate as possible. Acme Brick Company is not responsible for the use or interpretation or for any errors or omissions that may have occurred. Have your own engineer verify these data.

[1] Brick with higher compression strength may be used, but spans are limited by reinforcing steel, so benefits are negligible.
[2] Add width of post for total spacing center to center of posts.

Excerpt from NCMA-TEK 14-15A (1997)

Table 7—Required Minimum Embedment for Pier Foundation

Wall Span, feet (m)	(A = 16" pier dia; B = 20" pier dia; C = 24" pier dia; D = 30" pier dia; E = 36" pier dia) Wall height, ft (m)							
	6 (1.83)	8 (2.44)	10 (3.05)	12 (3.66)	14 (4.27)	16 (4.88)	18 (5.49)	20 (6.10)
	w = 10 psf (479 Pa)							
10 (3.05)	4'-6"[A]	5'-0"[A]	5'-6"[A]	6'-6"[A]	7'-0"[A]	7'-6"[A]	8'-0"[A]	8'-6"[A]
12 (3.66)	4'-6"[A]	5'-6"[A]	6'-0"[A]	7'-0"[A]	7-6"[A]	8'-0"[A]	8'-6"[A]	9'-0"[A]
14 (4.27)	5'-0"[A]	6'-0"[A]	6'-6"[A]	7'-6"[A]	8'-0"[A]	8'-6"[A]	9'-0"[A]	10'-0"[A]
16 (1.88)	5'-0"[A]	6'-0"[A]	7'-0"[A]	7'-6"[A]	8'-6"[A]	9'-0"[A]	9'-6"[A]	10'-6" [A]
18 (5.49)	5'-0"[A]	6'-6"[A]	7'-0"[A]	8'-0"[A]	8'-6"[A]	9'-6"[A]	10'-0"[A]	11'-0"[A]
20 (6.10)	5'-6"[A]	6'-6"[A]	7'-6"[A]	8'-6"[A]	9'-0"[A]	10'-0"[A]	10'-6"[A]	11'-0"[A]
Wall Span, feet (m)	w =15 psf (718 Pa)							
10 (3.05)	5'-0"[A]	6'-0"[A]	6'-6"[A]	7'-6"[A]	8'-0"[A]	9'-0"[A]	9'-6"[A]	10'-0"[A]
12 (3.66)	5'-6"[A]	6'-6"[A]	7'-0"[A]	8'-0"[A]	8'-6"[A]	9'-6"[A]	10'-0"[A]	11'-0"[A]
14 (4.27)	6'-0"[A]	7'-0"[A]	7'-6"[A]	8'-6"[A]	9'-6"[A]	10'-0"[A]	11'-0"[A]	11'-6"[A]
16 (1.88)	6'-0"[A]	7'-0"[A]	8'-0"[A]	9'-0"[A]	10'-0"[A]	10'-6"[A]	11'-6"[A]	12'-0"[A]
18 (5.49)	6'-6"[A]	7'-6"[A]	8'-6"[A]	9'-6"[A]	10'-6"[A]	11'-0"[A]	12'-0"[A]	11'-6"[B]
20 (6.10)	6'-6"[A]	8'-0"[A]	9'-0"[A]	10'-0"[A]	10'-6"[A]	11'-6"[A]	11'-6"[B]	12'-0"[D]
Wall Span, feet (m)	w = 20 psf (958 Pa) Wall height, ft (m)							
10 (3.05)	5'-6"[A]	6'-6"[A]	7'-6"[A]	8'-6"[A]	9'-0"[A]	10'-0"[A]	10'-6"[A]	11'-0"[A]
12 (3.66)	6'-0"[A]	7'-0"[A]	8'-0"[A]	9'-0"[A]	10'-0"[A]	10'-6"[A]	11'-6"[A]	12'-0"[A]
14 (4.27)	6'-6"[A]	7'-6"[A]	8'-6"[A]	9'-6"[A]	10'-6"[A]	11'-6"[A]	12'-0"[A]	11'-6"[B]
16 (1.88)	7'-0"[A]	8'-0"[A]	9'-0"[A]	10'-0"[A]	11'-0"[A]	12'-0"[A]	11'-6"[B]	11'-6"[C]
18 (5.49)	7'-0"[A]	8'-6"[A]	9'-6"[A]	10'-6"[A]	11'-6"[A]	11'-6"[B]	12'-0"[B]	12'-0"[C]
20 (6.10)	7'-6"[A]	9'-0"[A]	10'-0"[A]	11'-0"[A]	12'-0"[A]	12'-0"[B]	12'-0"[C]	11'-6"[D]
Wall Span, feet (m)	w = 25 psf (1197 Pa) Wall height, ft (m)							
10 (3.05)	6'-0"[A]	7'-0"[A]	8'-0"[A]	9'-0"[A]	10'-0"[A]	11'-0"[A]	11'-6"[A]	12'-0"[A]
12 (3.66)	6'-6"[A]	8'-0"[A]	9'-0"[A]	10'-0"[A]	10'-6"[A]	11'-6"[A]	11'-6"[B]	12'-0"[B]
14 (4.27)	7'-0"[A]	8'-6"[A]	9'-6"[A]	10'-6"[A]	11'-6"[A]	11'-6"[B]	12'-0"[B]	12'-0"[C]
16 (1.88)	7'-6"[A]	9'-0"[A]	10'-0"[A]	11'-0"[A]	12'-0"[A]	12'-0"[B]	12'-0"[C]	11'-6"[D]
18 (5.49)	8'-0"[A]	9'-0"[A]	10'-6"[A]	11'-6"[A]	11'-6"[B]	11'-6"[C]	11'-6"[D]	12'-0"[D]
20 (6.10)	8'-0"[A]	9'-6"[A]	11'-0"[A]	12'-0"[A]	12'-0"[B]	12'-0"[C]	12'-0"[D]	11'-6"[E]

Notes:

1. Pier reinforcing shall be designed to resist moments and shears from the masonry piers above.
2. Required depth of embedment was calculated using the following formula with an allowable lateral soil-bearing pressure of 300 psf per foot of embedment, increased by 1/3 for load combinations including wind or seismic (ref. 5) (p = 390 psf/ft):

$$d = \frac{A}{2}\left(1 + \sqrt{1 + 4.36h/A}\right)$$

where: $A = 2.34/(S_1 b)$ b = diameter of the foundation pier, ft d = depth of embedment, ft

h = distance from the ground surface to the point of application of P (one half height of wall), ft

P = applied lateral force, lb

S_1 = allowable lateral soil-bearing pressure based on a depth of one third the depth of embedment, psf