Technical Notes 29A - Brick in Landscape Architecture - Garden Walls
Rev [Nov. 1968] (Reissued Jan. 1999)

INTRODUCTION

The plan of a garden usually involves "leading" the sojourner through a series of spatial relationships. This can be done formally, informally or subtly, depending upon the purpose and skill of the designer. Among the tools used for this purpose are garden walls of brick. They may invite, enhance, lead, restrict, compel, separate, combine, protect, screen or prohibit; all to the purpose of the artist and his skill.

The variations and possibilities with brick garden walls approach infinity. Still among the most popular of garden wall structures is the serpentine wall. The serpentine wall is believed by some to predate recorded history. Early examples of its use in America may be found in Colonial Williamsburg, and at the University of Virginia in Charlottesville (Fig. 1) where over 160 years ago Thomas Jefferson designed and built serpentine walls.

Brick Serpentine Wall - University of Virginia

FIG. 1

MATERIALS AND WORKMANSHIP

Obviously, most garden walls will be subjected to the extremes of exposure to the elements. Rain, snow, freezing weather, heat, direct sun and combinations of these will severely test the quality of the materials, the workmanship and the design of garden walls. Consequently, the selection of materials and the workmanship are of paramount importance in constructing successful and enduring garden walls of brick.

Brick. Brick for garden walls should meet the requirements for grade SW of the ASTM Standard Specifications for Facing Brick C 216 (where exposed to view) or ASTM Standard Specifications for Building Brick C 62 (where not exposed, such as below grade), unless the brick are known to have performed satisfactorily under similar conditions of exposure.

Used or salvaged brick should not be used for garden walls unless they meet the SW requirements. Used brick generally will not meet these requirements, since they often are non-uniform in degree of burning (see *Technical Notes* 15, "Salvaged Brick").

Mortar. The recommended mortar for reinforced and non-reinforced brick garden wall construction is composed of: 1 part portland cement, 1/2 part hydrated lime and 4 - 1/2 parts sand by volume. This mortar conforms to ASTM Standard Specifications for Mortar for Unit Masonry, C 270, Type S. It is very durable and develops good bond with clay masonry units (see *Technical Notes* 8 Revised, "Portland Cement-Lime Mortars for Brick Masonry").

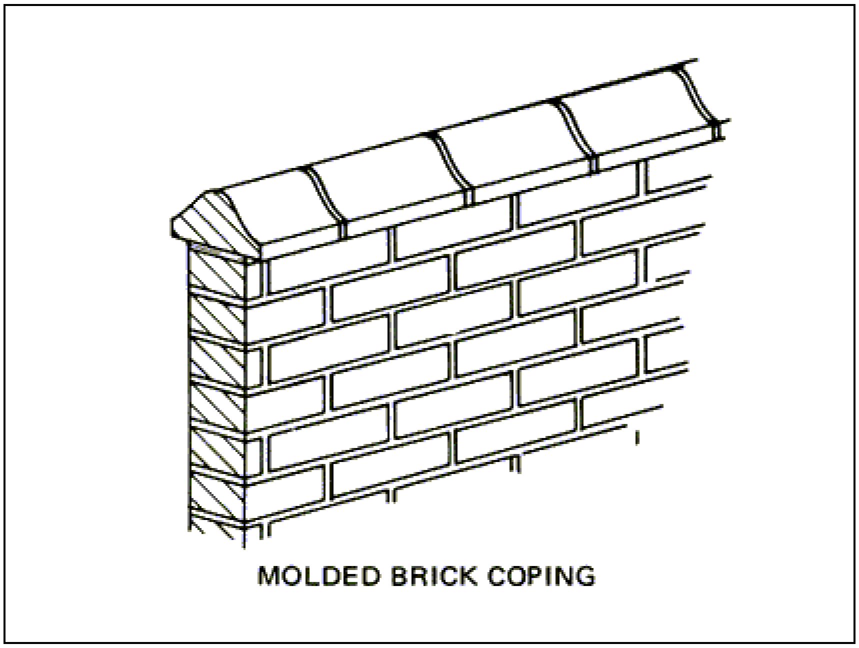
Workmanship. Workmanship on brick masonry garden walls should be that characterized by the complete filling of all head, bed and collar joints. It is sometimes erroneously supposed that workmanship of lesser quality may be tolerated in garden structures, since they are not weather barriers or enclosure walls, as in a building. Less than excellent workmanship should not be permitted. Because of the extreme exposure of garden walls, any defect may result in deterioration and perhaps ultimately in failure of the wall (see *Technical Notes* 7B Revised, "Water Resistance of Brick Masonry-Design and Detailing").

DESIGN

The most meticulous design and details may be thwarted by the selection of inappropriate materials, or by poor workmanship. The converse is also true. The use of the best possible materials and craftsmanship will not in themselves insure a successful and permanent garden wall. Much depends on the design and attention to certain critical details, such as foundations, copings and flashing.

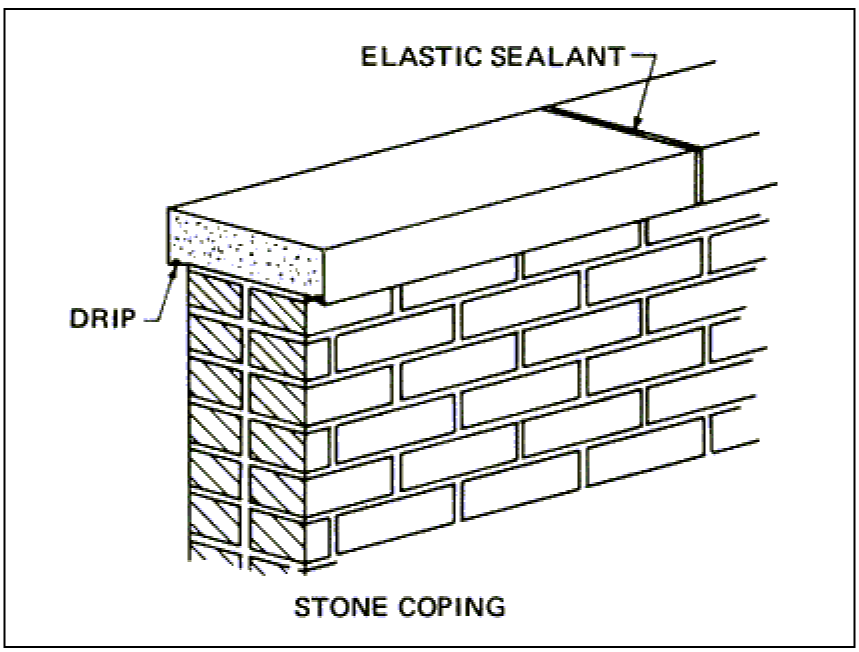
Foundations. Since garden walls generally do not carry any vertical loads other than their own weight, the footings and foundations sometimes do not receive proper attention. Foundations for garden walls should be placed in undisturbed earth at a depth below the frost line. They may be of brick or of concrete and reinforced if necessary, particularly in areas with active soils.

Copings. The appearance and character of a garden wall may be altered materially, depending on the type of cap or coping used on the top of the wall. Many materials are suitable for coping, including: natural stone, cast stone, slate, terra cotta, metals and brick. Figure 2 indicates a few suggestions for capping garden walls with various materials.



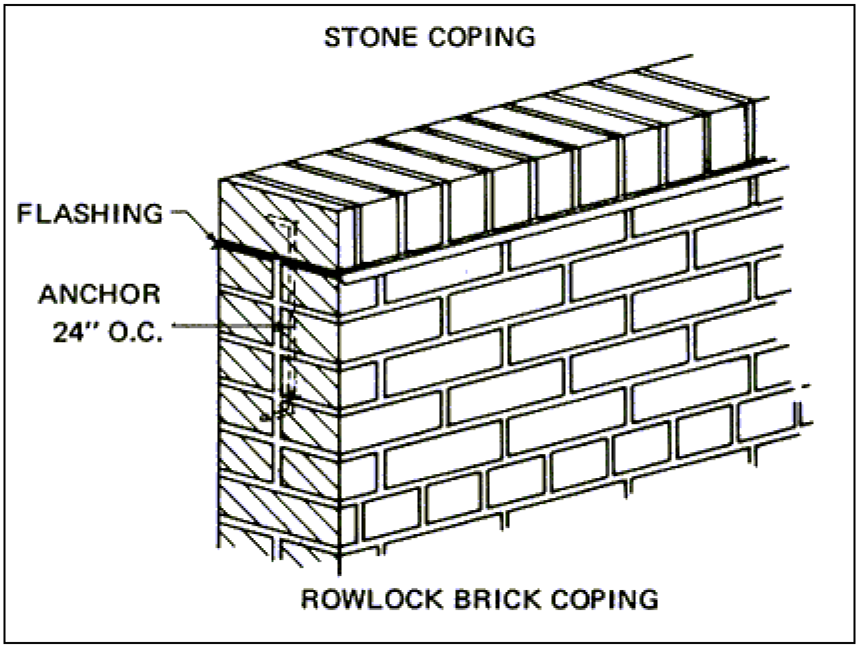
Typical Copings

FIG. 2a



Typical Copings

FIG. 2b



Typical Copings

FIG. 2c

Whichever is used, there are certain general recommendations that should be followed. The coping should project beyond the face of the brick a minimum of 1/2 in. on both sides. This projection should contain a positive drip to keep water from flowing down the face of the wall. In most cases copings should be anchored to the brick wall with metal anchors or bolts. If the coping is of material other than brick, its thermal and moisture expansion characteristics should be compared to those of the brick masonry, and provisions made for the resulting differential movements (see *Technical Notes* 18, "Differential Movement").

Flashing. In general, through-wall flashing is recommended immediately under the coping of garden walls. However, this may be tempered with good judgment, depending on several factors, such as: the type of coping used, many joints or relatively few; the climatic conditions of the area, high or low precipitation; and number of freezing and thawing cycles (see *Technical Notes* 7A Revised, "Water Resistance of Brick Masonry - Materials").

WALL TYPES

There are many types of brick garden walls with new variations constantly appearing. Perforated walls of brick are often used to complement contemporary architecture. Perforated walls can be designed in conjunction with any of the typical types which are discussed below. If perforated walls are designed, the indicated dimensional proportions and reinforcing steel requirements indicated under the specific wall types should be followed.

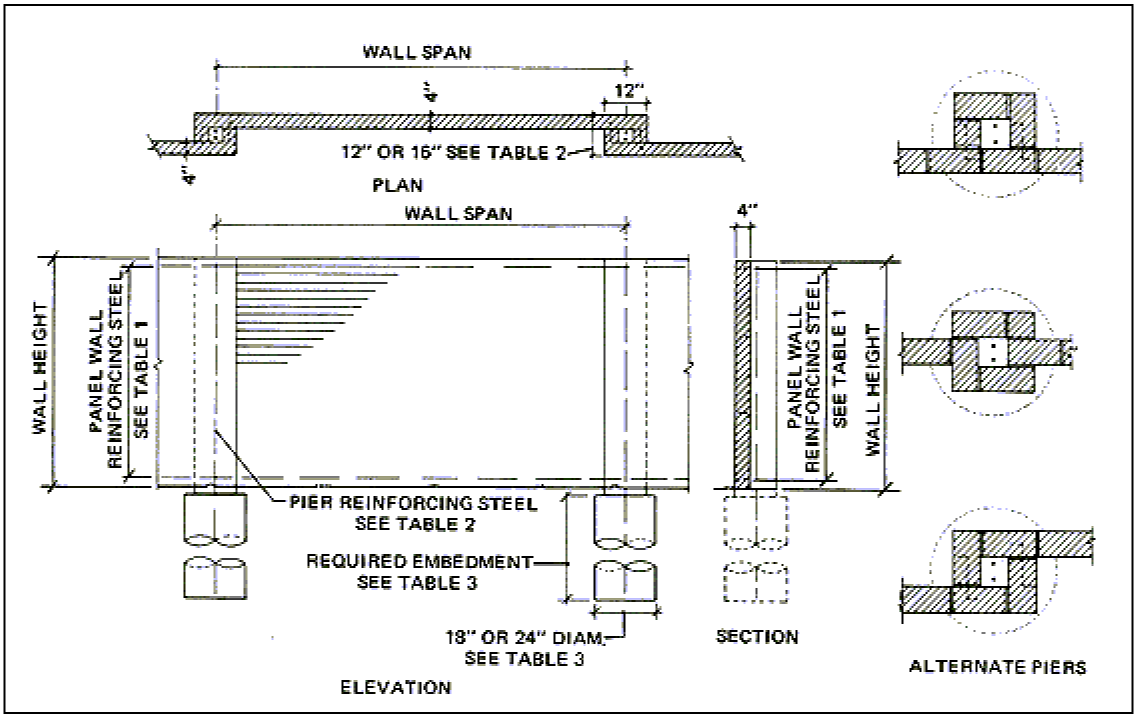
Straight Walls. This form of garden wall relies upon texture and color of the brick masonry for character. The straight garden wall must be designed with sufficient thickness to provide lateral stability. Assuming the finished grade on both sides of the wall is the same, so that no stresses result from earth pressure, it must be designed to resist wind and impact loads. For 10 - psf wind pressure, it is recommended that the height above grade (h) not exceed three-fourths of the wall thickness (t) squared $(h \le 3/4\ t^2)$ where h and t are in inches. This recommendation is based on the assumption that the overturning moment from the wind does not exceed three-fourths of the righting moment from the wall dead load, and does not depend upon bond between the foundation and the wall. If bond is assured or steel dowels are used to tie the wall to the foundation, or if greater lateral loads exist, straight walls can be designed in accordance with the *Recommended Building Code Requirements for Engineered Brick Masonry,* BIA, August 1969; or "Building Code Requirements for Reinforced Masonry", ANSI A41.2-1960 (R1970).

Pier and Panel Walls. The pier and panel wall is composed of a series of relatively thin panels, 4 in. in thickness, which are braced intermittently by masonry piers (Fig. 3). This wall is relatively easy to build and is economical due to the reduced thickness of the panels. It is also easily adapted to varying conditions of terrain.

Pier and Panel Garden Wall - Montgomery Village, Maryland

FIG. 3

Details for construction of pier and panel walls are shown in Fig. 4. Three typical design possibilities are indicated. Table 1 provides the horizontal reinforcing steel requirements for panel walls and Table 2 gives the vertical reinforcing steel for the piers. The required foundation diameter and depth of embedment are given in Table 3.



Pier and Panel Garden Wall

FIG. 4

TABLE 1
Panel Wall Reinforcing Steel

Wall Span, ft	Vertical Spacing, in.								
	Wind Load, 10 psf			Wind Load, 15 psf			Wind Load, 20 psf		
	A	B	C	A	B	C	A	B	C
8	45	30	19	30	20	12	23	15	9.5
10	29	19	12	19	13	8.0	14	10	6.0
12	20	13	8.5	13	9.0	5.5	10	7.0	4.0
14	15	10	6.5	10	6.5	4.0	7.5	5.0	3.0
16	11	7.5	5.0	7.5	5.0	3.0	6.0	4.0	2.5

Note:A= 2-No. 2 bars
B = 2 - 3/16 - in. diam. wires
C = 2 - 9 gage wires

TABLE 2
Pier Reinforcing Steel [1]

Wall Span, ft	Wind Load, 10 psf			Wind Load, 15 psf			Wind Load, 20 psf		
	Wall Height, ft			Wall Height, ft			Wall Height, ft		
	4	6	8	4	6	8	4	6	8
8	2#3	2#4	2#5	2#3	2#5	2#6	2#4	2#5	2#5
10	2#3	2#4	2#5	2#4	2#5	2#7	2#4	2#6	2#6
12	2#3	2#5	2#6	2#4	2#6	2#6	2#4	2#6	2#7
14	2#3	2#5	2#6	2#4	2#6	2#6	2#5	2#5	2#7
16	2#4	2#5	2#7	2#4	2#6	2#7	2#5	2#6	2#7

1 Within heavy lines 12 by 16-in. pier required. All other values obtained with 12 by 12-in. pier (see Fig. 4).

TABLE 3
Required Embedment for Pier Foundation[1]

Wall Span, ft	Wind Load, 10 psf			Wind Load, 15 psf			Wind Load, 20 psf		
	Wall Height, ft			Wall Height, ft			Wall Height, ft		
	4	6	8	4	6	8	4	6	8
8	2' - 0"	2' - 3"	2'- 9"	2' - 3"	2' - 6"	3' - 0"	2' - 3"	2' - 9"	3' - 0'
10	2' - 0"	2' - 6"	2' - 9"	2' - 3"	2' - 9"	3' - 3"	2' - 6"	3' - 0"	3' - 3"
12	2' - 3"	2' - 6"	3' - 0"	2' - 3"	3' - 0"	3' - 3"	2' - 6"	3' - 3"	3' - 6"
14	2' - 3"	2' - 9"	3' - 0"	2' - 6"	3' - 0"	3' - 3"	2' - 9"	3' - 3"	3' - 9"
16	2' - 3"	2' - 9"	3' - 0"	2' - 6"	3' - 3"	3' - 6"	2' - 9"	3' - 3"	4' - 0'

1Within heavy lines 23-in. diam. foundation required. All other values obtained with 18-in. diam. foundation (see Fig. 4).

The reinforced brick masonry piers and panels are designed with an allowable flexural compressive stress for brick masonry of 725 psi and an allowable tensile stress for reinforcing steel of 20,000 psi for No. 2 and larger bars (min. yield strength 40,000 psi) and 24,000 psi for 3/16 -in. diam. and 9 gage wire (min. yield strength 60,000 psi). The ratio of modulus of elasticity of the steel to that of the masonry (n) is assumed to be 13. The design is in compliance with the *Recommended Building Code Requirements for Engineered Brick Masonry,* BIA, August 1969, and "Building Code Requirements for Reinforced Masonry", ANSI A41.2-1960 (R1970). One of these standards should be used to determine the required brick compressive strength. The pier foundation diameter and required embedment below grade are based upon an average allowable soil pressure of 3000 psf. If poorer soil exists at the site, a further investigation of the foundation is necessary.

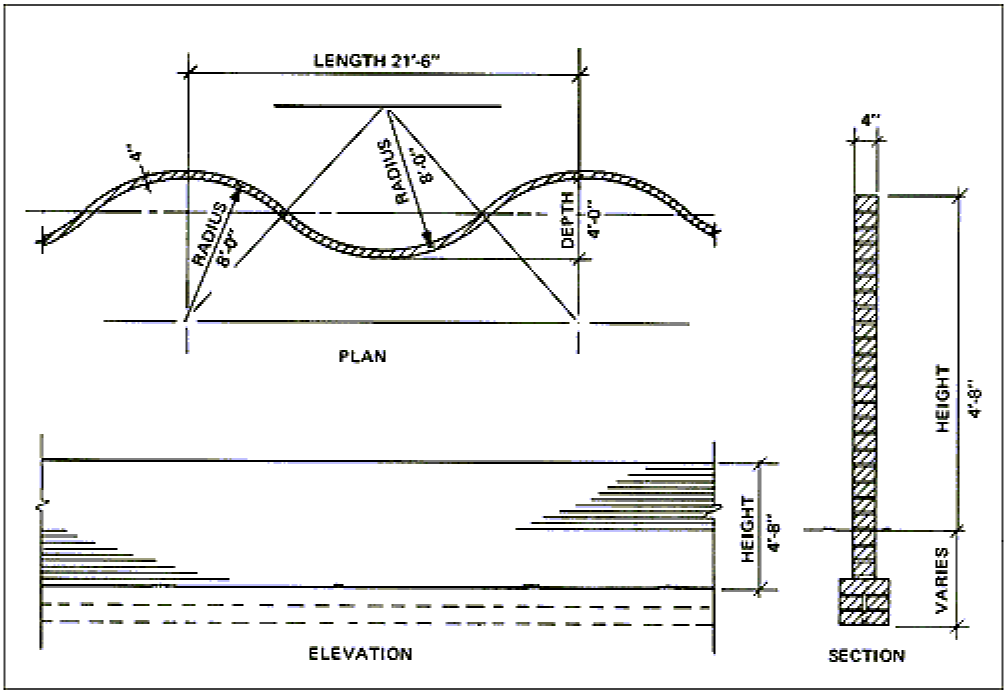
The reinforcing steel requirements vary with the wind load, the wall height and the wall span. The two vertical pier bars are placed 2 in. apart in the 12 by 12 - in. piers and 6 in. apart in the 12 by 16 - in. piers, one bar toward each face. These bars are to be continuous from the bottom of the foundation to the top of the brick masonry pier. If spliced, for ease of construction, they must be lapped at least 30 bar diameters. The panel wall reinforcement consists of two bars or wires spaced not less than 2 in. apart in the mortar joint at a vertical spacing not to exceed the dimensions given in Table 1. Individual bars or wires, or prefabricated joint reinforcement may be used. It is also required that the panel wall reinforcement be continuous throughout the length of the wall. Where spliced, it should be lapped 16 in.

Construction of these panel walls is simple, since foundations are required only under the piers. These may be constructed by drilling or digging holes with the diameter given in Table 3.

The foundations should be placed in undisturbed earth and extend below the frost line, but not less than the required embedment given in Table 3. The masons build the brick panel walls between the piers with a temporary 2 by 4 - in. wood form under the first course of brickwork. The 2 by 4 - in. forms are removed after the wall has cured at least seven days. The same mortar used to lay the brick may be used to grout the vertical reinforcing steel in the pier, if sufficient water is added so that it flows readily and completely surrounds the steel.

Serpentine Walls. This ingenious technique of garden wall construction has been used for several hundred years. The serpentine shape provides lateral strength to the wall so that it normally can be built only 4 in. in thickness without additional lateral support. Since the serpentine wall depends on its shape for lateral strength, it is important that the degree of curvature be sufficient. The following general rule is based upon the performance of many successful serpentine walls. The radius of curvature of a 4 - in. wall should be no more than twice the height of the wall above finished grade, and the depth of curvature should be no less than 1/2 of the height. Figure 5 provides details of a typical serpentine garden wall.

The general rule stated below is limited in application to minor garden walls.



A Typical Serpentine Garden Wall

FIG. 5