Brickwork Design Profile

REVISED 1/98

Masonry Construction Recommendations

Good Design Practice

Good masonry construction requires attention to certain details to 1) prevent water penetration and 2) avoid cracks in the masonry.

Avoiding Water Penetration

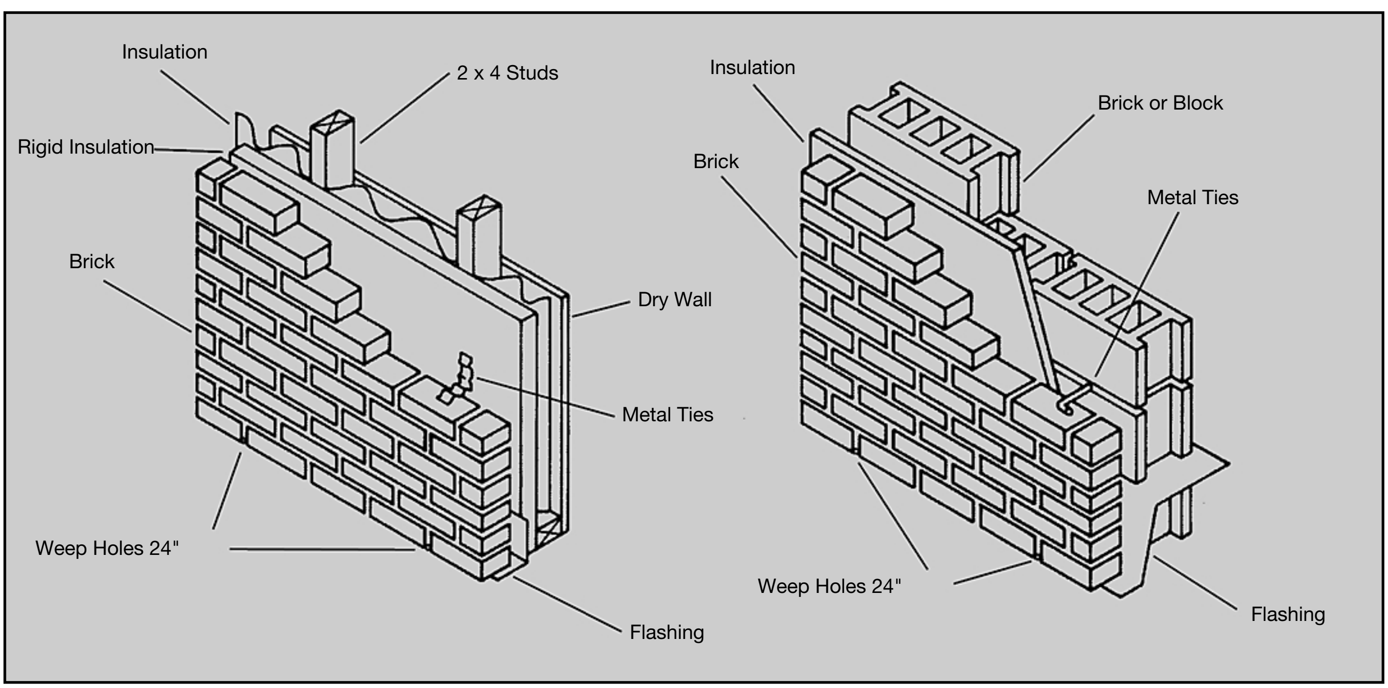
There are two design philosophies for limiting water penetration: The Barrier Wall system and the Drainage Wall system. Barrier Walls are multi-wythe walls. They are usually at least eight inches thick and are often twelve or sixteen or twenty-four inches (six brick wythes) thick. The mass of masonry is so great that rains rarely last so long that water saturates the entire wall and passes through it. Barrier walls are rarely used today because of their great weight and the cost in material, labor, time, and lost floor space. Drainage Walls are single wythe walls (veneers) forming the skin of the building. There is an air space between the back of the brick veneer and the back-up system which prevents water from reaching the back-up material. Flashings and weepholes are parts of the system and serve to collect and eject water from the air space. Today, most brick masonry is constructed as a veneer which is part of a drainage wall system.

The Air Space

The air space, a gap between the brick veneer and the back-up, does not allow water to reach the back-up. Water runs down the back of the veneer until it hits a flashing, where the water is conducted to the weepholes. The air space must be kept clear of mortar or a drainage wall system will not work properly. It has been found that it is easier to keep wider air spaces free of mortar. Air spaces for walls with steel stud back-up should be two inches wide; for reinforced concrete and concrete block back-up, one and one-half inches wide; and for wood stud back-up, one inch wide. While filling the bottom of the air space with pea gravel keeps the weepholes free of mortar, it also raises the top of any mortar droppings. Proprietary systems are generally more effective.

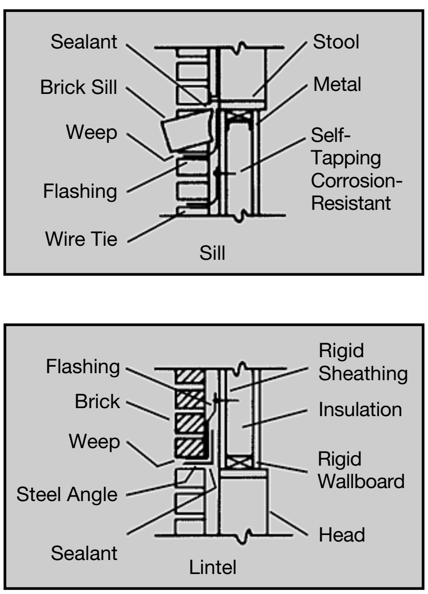
Flashings

Flashings are flexible membranes that are impervious to water. Traditionally, copper and lead were used. Soft stainless steel is excellent, as is lead-coated copper. Most flashings used today are plastics. Do not use pvc (polyvinyl chloride), polyethylene, or building felts for flashings. EPDM works well, as do bitumen polymers and other composites, including sheets of very thin copper protected by Mylar, kraft paper, and impregnated papers. Many flashing manufacturers recommend that



flashings be held back from the face of the wall about one-half inch. Do not do this! Water can run around the end of the flashing and back into the wall. Instead, either extend the flashing beyond the face of the wall and then cut it flush or use small stainless steel flashing extensions for the exposed portions of the flashing. Through-wall flashings should be used:

1) Above grade at the bases of walls.
2) At the bottom of each air space. Flashings should be used at each shelf angle and, in buildings where the floors are concrete plank bearing on concrete masonry, at each floor level.
3) Under and behind all window, door, and louver sills.
4) Over all window, door, louver, and other openings except when the openings are completely protected by broad over-hangs.



Typical Lintel and Sill Details

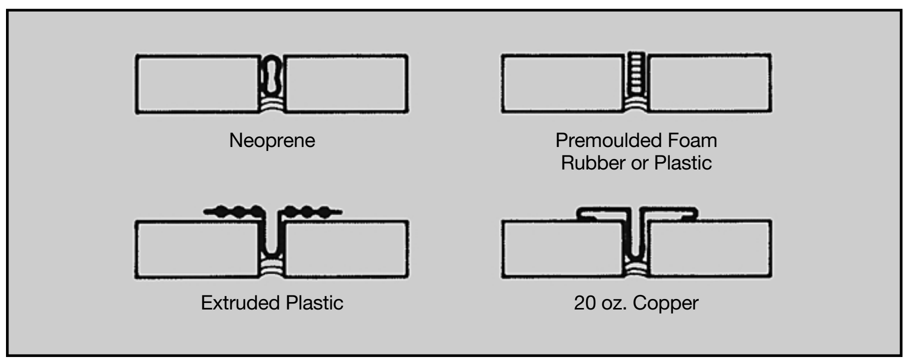
5) At spandrels in skeleton-frame structures.
6) At the bases of exterior and interior wythes of parapet walls.
7) Under masonry copings and caps. Unless the coping is impervious with watertight joints, place a flashing in the mortar bed beneath all copings.
8) Above bay windows and above the lower roof between stepped roofs.
9) In chimneys, under caps and at the roof line.

Remember:

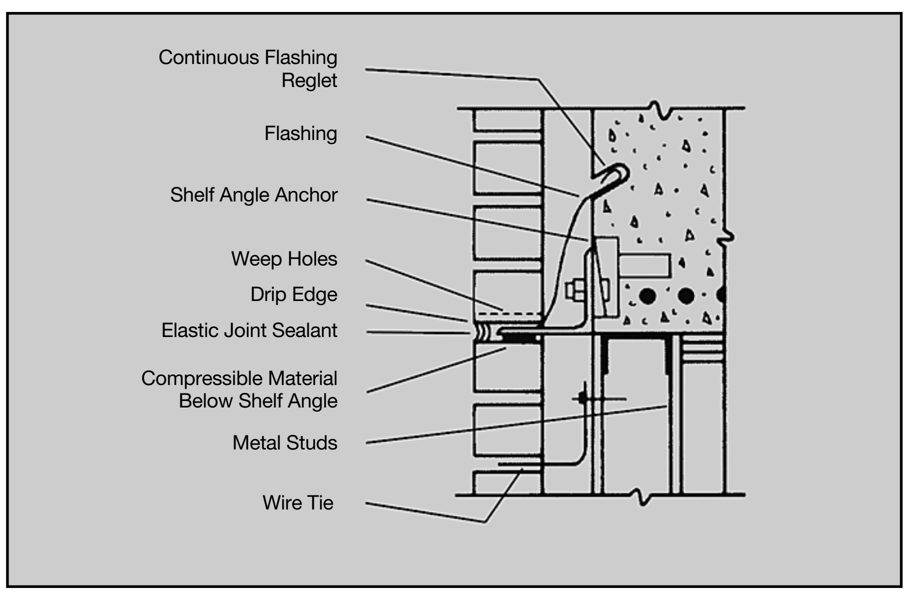
1) The design and installation of base and counter flashings at roofs are very important since the building envelope is not continuous where roofs meet walls.
2) Concrete, masonry, and steel supports should be free of projections that might puncture flashings.
3) Do not allow window installers to shoot fasteners through lintels or shelf angles.
4) To prevent the loss of bond, through-wall flashings should be placed on a thin bed of mortar with another thin bed laid on top.
5) Seams in flashings must be completely bonded to prevent water penetration. These seams occur not only at splices, but when corners are constructed. Copper and stainless steel flashings can be soldered, but slip joints are required at intervals to permit expansion. Plastic and membrane flashings should be bonded with the materials recommended by the flashing manufacturer. Aluminum cannot be soldered.
6) Although through-wall flashings do not affect the compressive strength of a wall they can reduce bending and shear strength. If a flashing is placed directly upon a masonry unit without a mortar bed, the flexural strength of the wall is nil at this point. Due to friction, shear strength may be relatively unaffected.

Weep Holes

Weep holes must be installed above each flashing to permit any water which may have accumulated to drain to the outside. Weep holes must be placed in the head joints directly above the flashing. Keep weep holes free of mortar and other debris. The best weepholes are open head joints. Open head joints should be spaced twenty-four inches



Movement Joint Fillers



Horizontal Movement Joint at Shelf Angle

on centers. Stainless steel wool, preformed louvers, and multi-celled fillers can be placed in open head joint weepholes. When wicks of cotton sash cord are used, the weep holes should be spaced sixteen inches on centers. Do not use round plastic tubes.

Rising Damp

Rising damp is moisture that is drawn upward from foundations or masonry courses below grade by capillary action. Rising damp can be prevented by installing damp checks. Damp checks are metal or plastic-coated metal flashings installed in the bed joints about six inches above the grade line. Install weep holes in the head joints immediately above the damp check. Air spaces below the lowest flashing in any wall should be filled with grout. Damp checks must extend beyond the faces of walls.

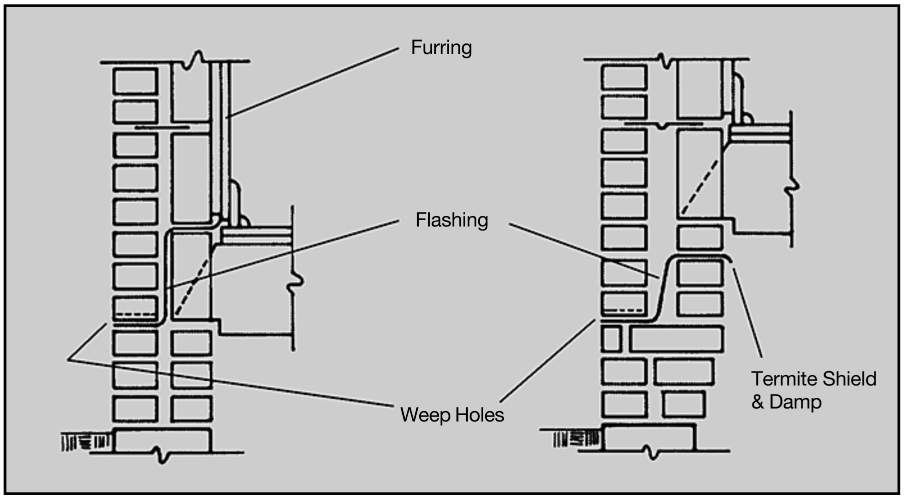
The lowest flashing in a drainage wall can serve as a damp check. The amount of water reaching foundations (and thus the likelihood of rising damp) is greatly reduced if the ground slopes away from the walls. Drain tile installed at the bottom of the footings will carry away any water that may accumulate at the outside of the foundations.

Planter boxes or similar areas are particularly vulnerable to the effects of water because they retain moisture throughout the year and are subject to repeated freeze-thaw cycles. The soil inside of planters should be drained with large, through-wall weep holes.

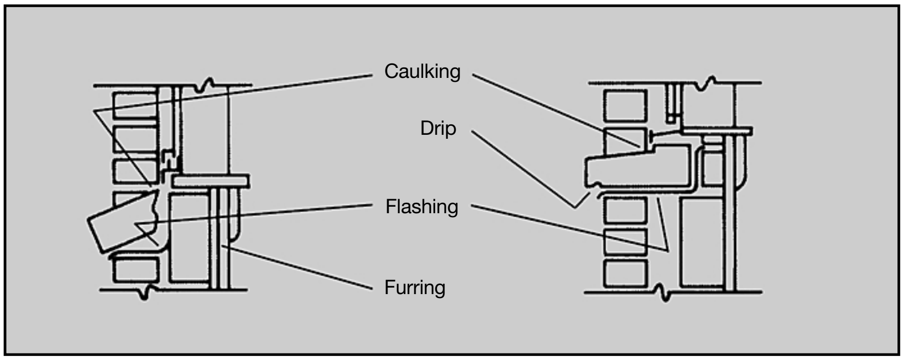
In drainage walls, where there is no basement and the bottom of the cavity is above ground level, through-wall flashings should be placed in the outer wythe six inches above the bottom of the air space and extend upward in the cavity several brick courses to return into the inner wythe below the bottom of the first floor joists. Fill the air space below this flashing with grout. In areas where termite protection is required, the flashing should project at least two inches past the inside face of the wall.

Sills

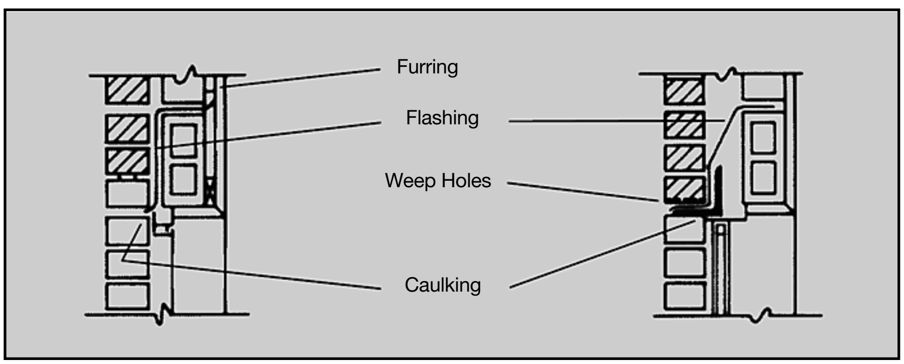
Unless made of one piece of an impervious material, all sills should be set on a flashing formed to fit under and in back of the sill. Ends of flashings should extend beyond the jamb lines and be turned up at least one inch into the wall to form end dams. Put a movement joint at one or both ends of all sills.



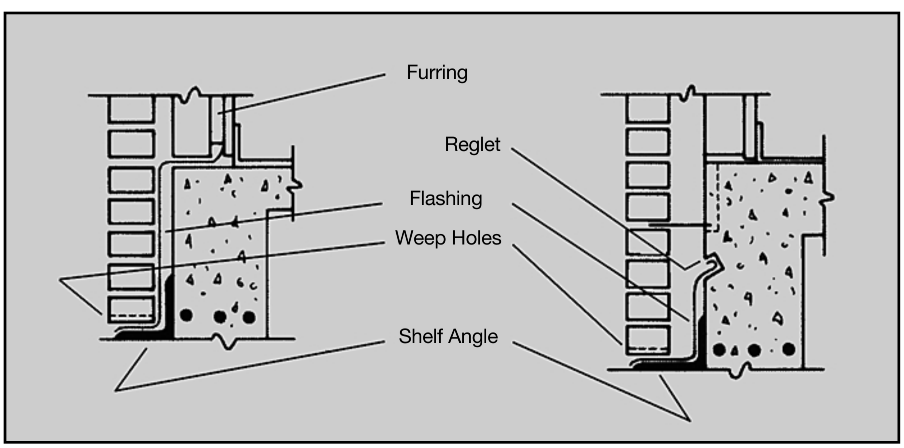
Flashing at the Bases of Masonry Walls



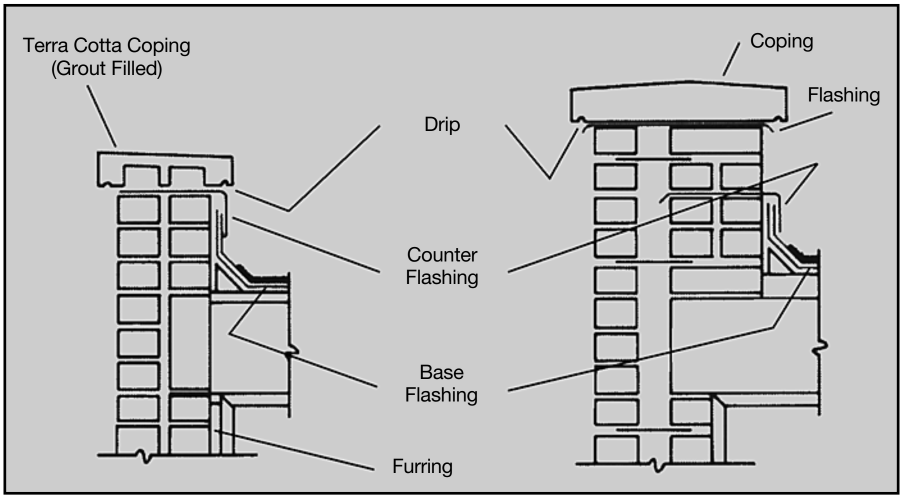
Flashing at Window Sills



Flashing Heads of Openings



Spandrel Flashing



Flashing Copings of Parapet Walls

Lintels

Flashings on lintels also serve to protect the lintel from water. The flashing should at least be extended to the ends of the lintel and be turned up into the first head joint at or beyond each end of the lintel to form end dams.

Projections and Recesses

Projections and recesses should have a top slope for drainage and, if possible, a drip recess to keep the water away from the wall surface below.
Do not allow recessed bricks to encroach on the air space. Special shapes can be used to create full bearing behind a projected brick. When a coated brick is being used, exposed beds must be finished to match the faces of the bricks.

Copings

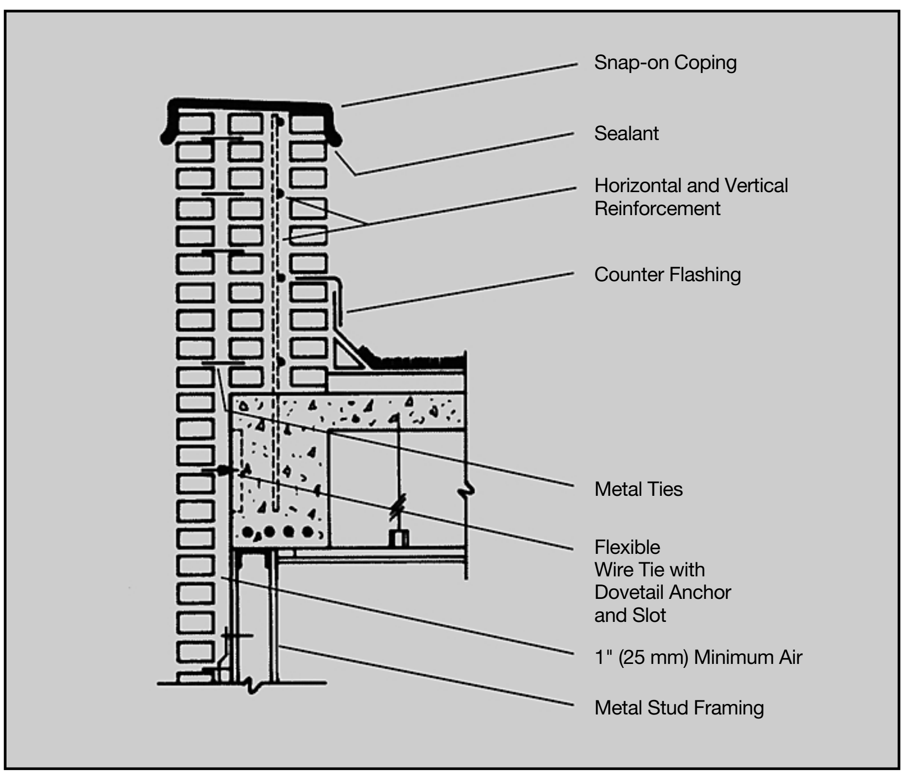
Copings are used to protect a parapet wall from water. Single-slope copings are preferred. Copings can be masonry or metal. The exposed portions of a coping are often required to match the color and texture of the wall material. Remember, though, that it is difficult to manufacture brick copings that are more than twelve inches wide. Stone and cast stone copings and metal caps can be made in almost any width. Copings are made with a smooth top surface to carry off water and should be installed with a one inch wide overhang on at least on one side, preferably at the low side. The overhang should have a drip notch. Metal, metal composite, or plastic flashings should be used under masonry copings and at parapet through-wall cap, counter and base flashings. Ideally, coping flashings should be placed between a mortar bed about 1/4 inch thick on top of the parapet wall and another, similar, mortar bed laid on top of the flashing. Since the flashing lessens the bond, masonry copings should be fastened with corrosion-resistant pins and the flashing sealed around this penetration. Unless there are drip notches in the copings, flashings under copings should project not less than 1/4 inch on the exterior and inside surfaces of the wall and be bent down at a 45° angle. If metal composite or plastic flashings are used, stainless steel flashing extensions can be installed. Metal copings must extend down the both faces of the parapet at least four inches to prevent water from blowing up under the coping. Metal copings should be fabricated with water-tight joints between adjacent sections of coping.

Avoiding Cracks in Brickwork

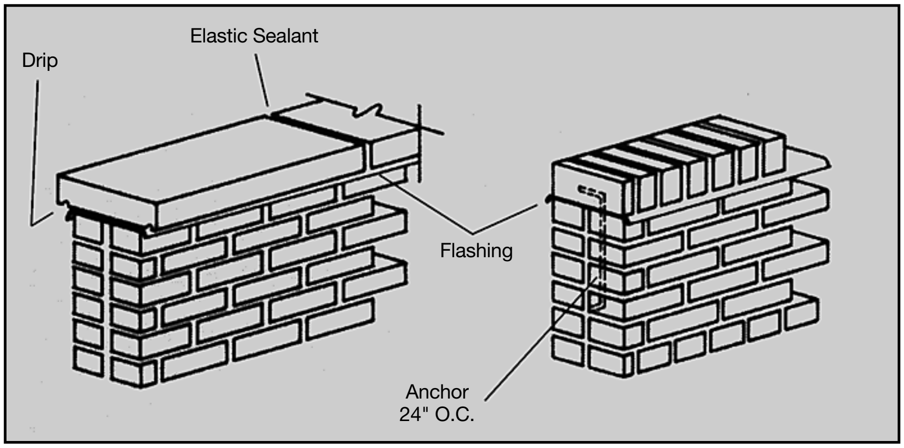
Any building material which is exposed to extremes of temperature, moisture, sunlight, or applied forces can fail. In the case of masonry, the expression of this failure is cracks in the veneer. These failures can be prevented if movement joints are incorporated into the construction.

Movement Joints

Movement joints are spaces left in the structure that allow movement to occur without damaging any part of the structure. Movement joints are detailed to prevent cracks at inside and outside corners of buildings, offsets (pilasters and chimneys), punched windows, and changes in cross-section of the masonry. Movement joints are also detailed to accommodate differential movements due to differing support conditions, differing forces on adjacent elements, and differential movement of related parts of the structure (veneers and building



Reinforced Parapet Wall



Stone Coping **Brick Coping**

frames). Movement joints are placed both parallel and perpendicular to the ground. The number, position, and location of movement joints are determined by analyzing each building design for potential movement. An explanation of this procedure is found in BIA Tech Note 18A, "Design and Location of Expansion Joints." Equation 2 of Tech Note 18A is important when the distance between joints is determined. Although certain combinations of materials, environment, exposure, width of movement joints and sealant materials may allow joints in veneer walls to be as much as forty feet apart, a much more common distance is twenty-five feet. Sometimes, however, conditions may require expansion joints as close as fifteen feet apart. Equation 2 must always be considered before locating movement joints.

Parapets

In parapets, the distance between movement joints should be one-half the distance found with Equation 2. In no instance should movement joints be farther than fifteen feet from a corner.

Corners

For aesthetic reasons, movement joints are rarely place at outside corners. They are usually detailed two to ten feet from the corner, often at window jambs in buildings with shelf angles. The distance between movement joints on either side of an outside corner must not exceed the distance calculated in Equation 2. At inside corners, place movement joints parallel to the longer wall.

Shelf Angles

Horizontal relieving joints should be placed directly below steel shelf angles. The widths of these joints are determined with Equation 2. Where uniform bed joint width is desirable, lipped bricks are recommended. Relieving joints are particularly important in taller structures and in structures with concrete frames. Building codes usually dictate placement of shelf angles, often requiring them at each floor level. Where the exterior wythe of a masonry wall is supported on shelf angles, insure proper anchorage and shimming of the steel angles so that they cannot rotate and induce highly concentrated stresses in the masonry. Shelf angles should be designed so that the total of all deflections (x, y, and z) is less than 1/16 inch.

Lintels

Generally, deflection of lintels is limited to 1/3 inch or L / 720, whichever is less. All lintels should have a minimum bearing of at least 8 inches at each end, but the actual required length and area is a function of the capacity of the masonry, the applied load and the deflection at the end supports. Very long lintels should be placed on bearing pads to avoid pinching of the masonry at the jamb. Do not run movement joints along the bearing surfaces of lintels. Do not place vertical movement joints at the ends of lintels. Movement joints should be located well away from the ends of lintels. Do not use lipped bricks with lintels.

Sealants

Sealants must be supported on a backer rod. Some sealants may require that the masonry be primed before the sealant can be installed. Typically, polyurethanes work better with clay masonry than silicones.

Good Construction Practices

Protection of Work

Protect masonry materials from water, mud, dirt, over-spray, and other construction operations by storing them covered and off of the ground.
If possible, Portland cement and lime should be stored under roof. During construction, all masonry work should be kept dry by covering it at the end of each day or shut-down period.
A water resistant covering should hang over the walls at least 2 feet (60.96 cm) on each side of the wall and should be carefully secured against displacement by wind.

Weather Extremes

During construction, masonry must be protected during both hot weather and cold weather. Consult BIA Tech Note 1, "All Weather Construction" for details.

Mortar Types

Mortars must conform to the requirements of ASTM C 270, "Mortar for Unit Masonry," or Brick Institute of America M1-88, "Standard Specification for Portland Cement-Lime Mortar for Brick Masonry." All mortars should contain only Portland cement, hydrated lime, mineral oxide pigments, sand, and water. See Brickwork Design Profile 4p1, "Glen-Gery Color Mortar Blend." Additives must be used with great care. Never use accelerators containing calcium chloride. The following mortar types are recommended for use with exterior brick masonry construction in accordance with job requirements:

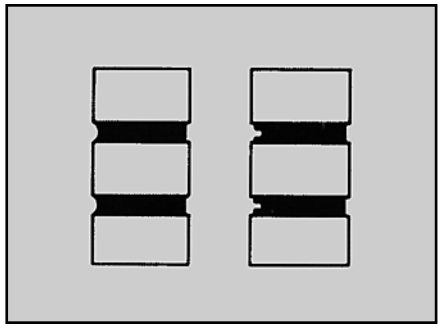
Type N – A medium strength mortar with the greatest resistance to water penetration, Type N mortars are the first choice for general use in exposed masonry above grade.

Type S – Tests indicate that the tensile bond strength between brick and Type S mortar approaches the maximum obtainable with cement-lime mortars. The highest water penetration resistance achievable with low-IRA bricks (< 5 grams) occurs with Type S mortars. Type S mortar is used when wind loads are high, story heights are great, or if the back-up system is flexible.

Type M – Stronger and somewhat more durable than other mortar types. Generally not recommended for exposed vertical work because it is difficult to use and has much poorer water penetration resistance than Types N and S. Type M mortar should not be used to construct brick veneers. Type M mortar is excellent for mortared brick paving.

Mortar Joints

Mortar in exterior brick masonry should be tooled to a concave, vee or grapevine profile. This tooling compresses the mortar, creates a dense surface and provides a good bond between the



mortar and units. Do not use struck or raked joints in exterior brick masonry. The most important factor in the construction of dry masonry walls is the proper filling of the mortar joints. Poorly filled joints result in voids and separation cracks through which water may enter, particularly when there are wind-driven rains. Bed joints must be solid and only slightly furrowed, if at all. Head joints must be full.

Cleaning

Brush down the work to remove mortar smears and snots each time the scaffolding is moved and at the end of each shift. Consult the brick manufacturer for recommendations about cleaning methods and chemicals. Some bricks cannot be cleaned and great care must be taken during laying. Refer to Brickwork Design Profile 4t1, "Cleaning New Brickwork." For further information contact Glen-Gery Brick at:

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