

PREVENTING WATER PENETRATION IN BELOW-GRADE CONCRETE MASONRY WALLS

TEK 19-3A

Water Penetration Resistance (2001)

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INTRODUCTION

Concrete masonry has traditionally been the material of choice for foundation wall construction. State of the art waterproofing, dampproofing, and drainage systems applied to concrete masonry provide excellent protection from water penetration, ensuring protection for building contents and comfort for occupants.

Protecting below-grade walls from water entry involves installing a barrier to water and water vapor. Below grade moisture tends to migrate from the damp soil to the drier area inside the basement. An impervious barrier on the exterior wall surface can prevent moisture entry. The barrier is part of a comprehensive system to prevent water penetration, which includes proper wall construction and the installation of drains, gutters, and proper grading.

WATERPROOFING AND DAMPPROOFING

Building codes (refs. 1, 2, 4, 6, 7) typically require that basement walls be dampproofed for conditions where hydrostatic pressure will not occur, and waterproofed where hydrostatic pressures may exist. Dampproofing is appropriate where groundwater drainage is good, through granular backfill into a subsoil drainage system. Dampproofing systems include bituminous coatings, cementitious coatings, acrylic modified cement applied at a rate of 3 lb/yd² (1.6 kg/m²), and 40-mil (1013 mm) acrylic latex coatings.

Hydrostatic pressure may exist due to a high water table, or due to poorly draining backfill, such as heavy clay soils. Materials used for waterproofing are generally elastic, allowing them to span small cracks and accommodate minor movements. Waterproofing systems include 2- or 3-ply hot mopped felts, 50-mil (1270 mm) rubberized asphalt, 40-mil (1013 mm) polymer modified asphalt, 40-mil (1013 mm) polyurethane rubber, 20-mil (508 mm) vulcanized rubber, 20-mil (508 mm) thermoplastic sheets, 0.75 lb/ft² (3.7 kg/m²)

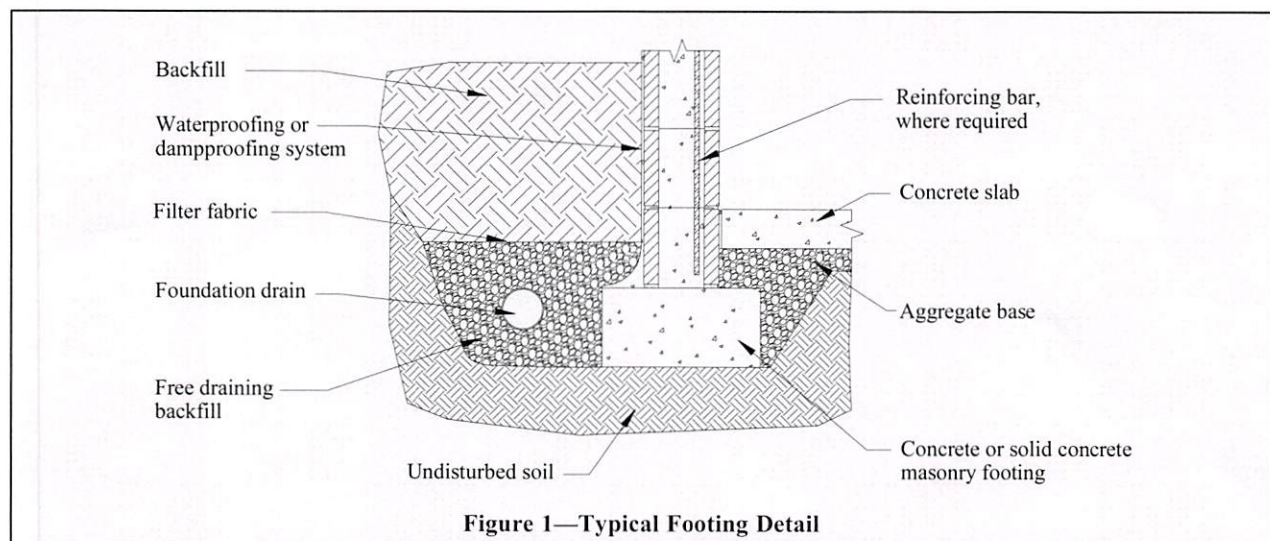
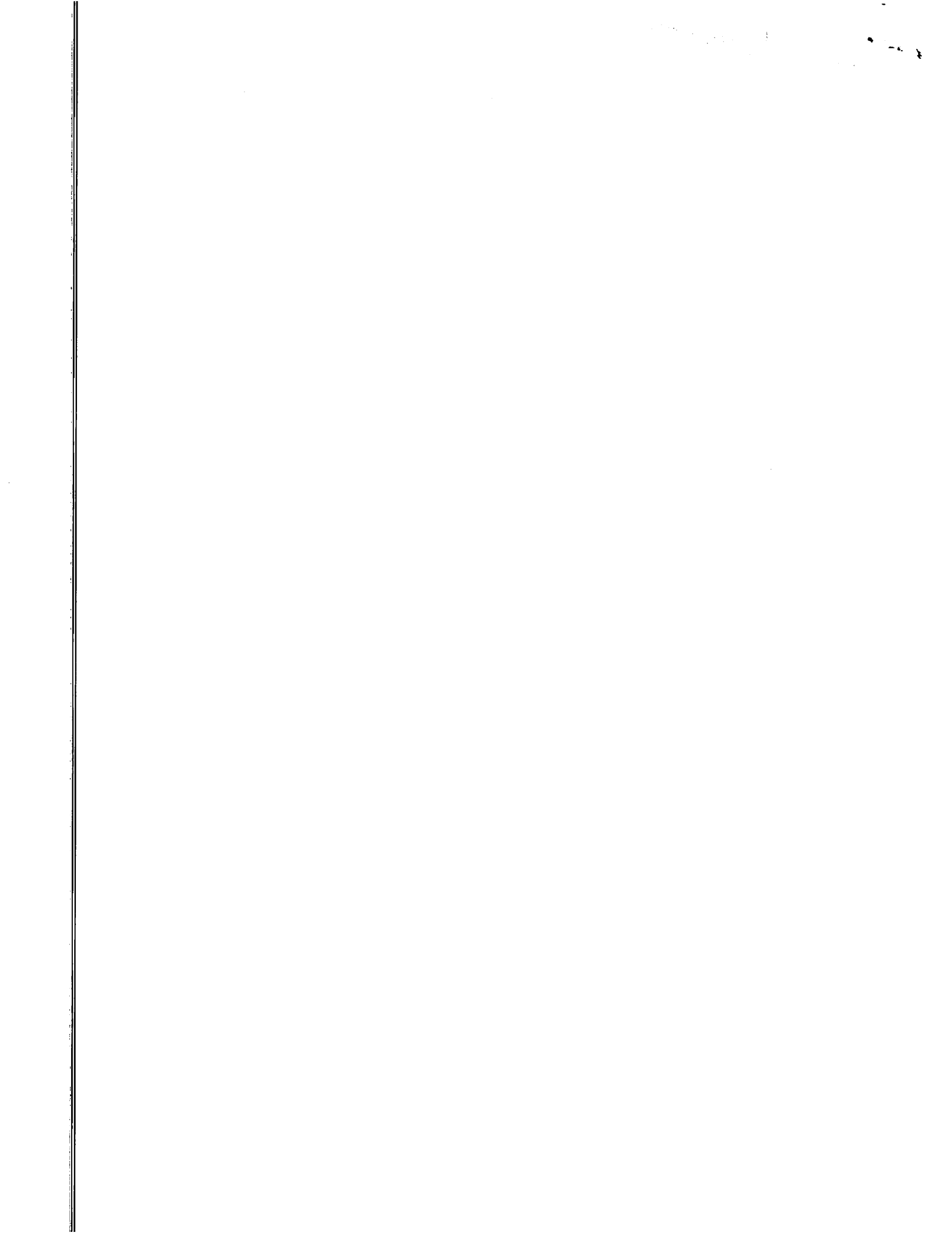


Figure 1—Typical Footing Detail



bentonite clay, and 6-mil (152 mm) polyvinyl chloride.

When choosing a waterproof or dampproof system, consideration should be given to the degree of resistance to hydrostatic head of water, absorption characteristics, elasticity, stability in moist soil, resistance to mildew and algae, impact or puncture resistance, and abrasion resistance.

WATERPROOF AND DAMPPROOF SYSTEMS

Waterproof and dampproof systems require that the barrier be continuous to prevent water penetration into voids or open seams. Similarly, the barrier is typically carried above the finished grade level to prevent water entry between the barrier and the foundation wall. Cracks exceeding 1/4 inch (6 mm) should be repaired before applying a waterproof or dampproof barrier. Repair of hairline cracks, however, is typically not required, as most barriers will either fill or span small openings. In addition, most waterproofing and dampproofing systems should be applied to clean, dry walls. In all cases, manufacturer's directions should be carefully followed for proper installation.

Particular attention should be paid to reentrant corners at garages, porches, and fireplaces and to wall penetrations. Because differential movement often occurs at these intersections, stretchable membranes are often used at these locations to span any potential cracks. Alternately, the main wall of the inhabited space can be coated prior to constructing the cross wall.

Coatings are sprayed, trowelled, or brushed onto below-grade walls, providing a continuous barrier to water entry. Coatings should be applied to clean, structurally sound walls. Walls should be brushed or washed to remove dirt, oil, efflorescence, or other materials which may reduce the bond between the coating and the wall.

Sheet membranes and panels are less dependent on workmanship and on surface preparation than coatings. Many of the membrane systems are better able to remain intact in the event of settlement or other movement of the foundation wall. Seams, terminations, and penetrations must be properly sealed.

Rubberized Asphalt Systems

A wide variety of rubberized and other polymer-modified asphalt waterproofing systems are available. Most of these are applied as sheet membranes, although some are available as liquid coatings. These systems provide a continuous barrier to water with the ability to elastically span small holes or cracks.

Rubberized asphalt sheet membranes are applied over a primer, which is used to increase adhesion of the sheet. The membrane is adhesive on one side and protected by a polyethylene film on the other. Adjacent pieces of membrane must be lapped, and the top and bottom edges sealed with mastic to provide continuous protection from water entry. After the membrane is placed on the wall, the surface is rolled with sufficient pressure to ensure adequate adhesion.

Rubberized asphalt is also available in a form that can be melted at the jobsite, then spread to completely cover

foundation walls. Liquid coatings can be applied by airless spray, roller, or brush. Both the liquid-applied and the sheets are covered with a protection board, which protects the waterproofing from construction traffic and during backfilling.

Cementitious Coating Systems

Cement-based coatings are typically trowelled onto concrete masonry walls, or brushed on using a coarse-fibered brush. The coatings sufficiently fill block pores, small cracks, and irregularities. Some cementitious coatings are modified with various polymers to increase elasticity and water penetration resistance.

Elastomeric Systems

Elastomeric materials are acrylic-based products which provide a flexible barrier to water penetration for below grade walls. Elastomerics are available as liquid coatings and as sheet membranes. The sheets are attached with adhesive, and may be reinforced with fabric to further increase tensile strength and resistance to tears and punctures. Liquid coatings can be applied by airless spray, roller, or brush.

Bentonite Panel Systems

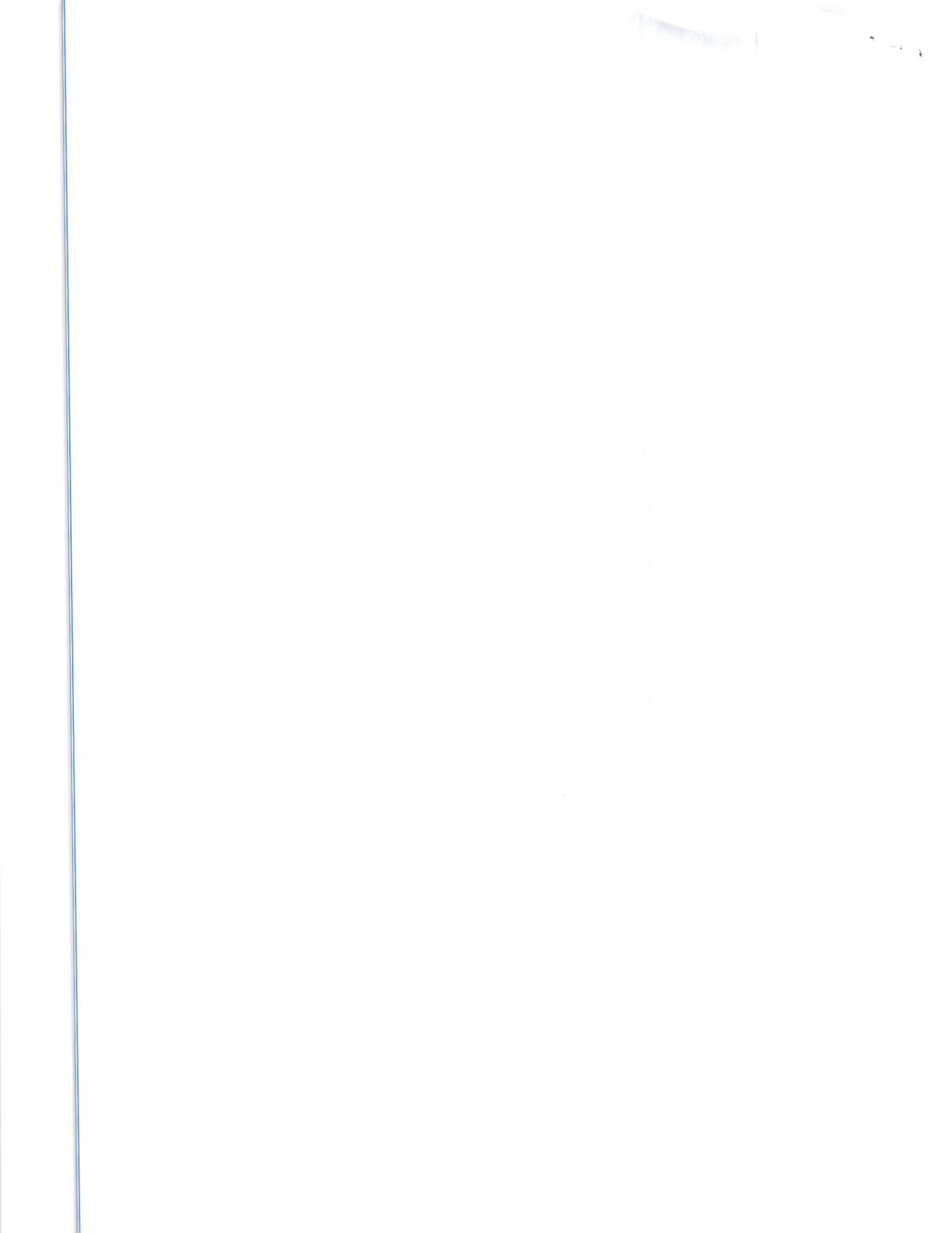
Bentonite is a mineral that swells to many times its original size when wet. Waterproofing panels incorporate dry bentonite encased in kraft paper or fabric. After installation, the bentonite swells up the first time it is exposed to water, expanding between the foundation wall and the backfill, and forming an impervious barrier. The swelling seals small cracks in the foundation wall or punctures in the panels themselves.

Bentonite panels must be protected from moisture until they are properly installed and the foundation wall has been backfilled, to prevent premature hydration.

Parging and Bituminous Coating Systems

Where drainage is good, a dampproof coating of parging with a permanent bituminous coating has proven to be satisfactory. A portland cement and sand mix (1:3.5 by volume), or Type M or S mortar may be used for the parge coat. Parging should be applied to damp (not saturated) concrete masonry in two 1/4 inch (6 mm) thick layers. The first coat should be roughened when partially set, hardened for 24 hours, and then moistened before the second coat is applied. The second coat should be trowelled to a smooth, dense surface. The parge coat should be beveled at the top to form a wash, and thickened at the bottom to form a cove between the base of the wall and the top of the footing, as shown in Figure 1.

To further increase water penetration resistance, a bituminous coating is applied over the parging. Coal tar or asphalt based bitumens are available in solvent for hot application, or in emulsions for application at ambient temperatures. These coatings can be sprayed, brushed, or trowelled onto the finish coat of parging.

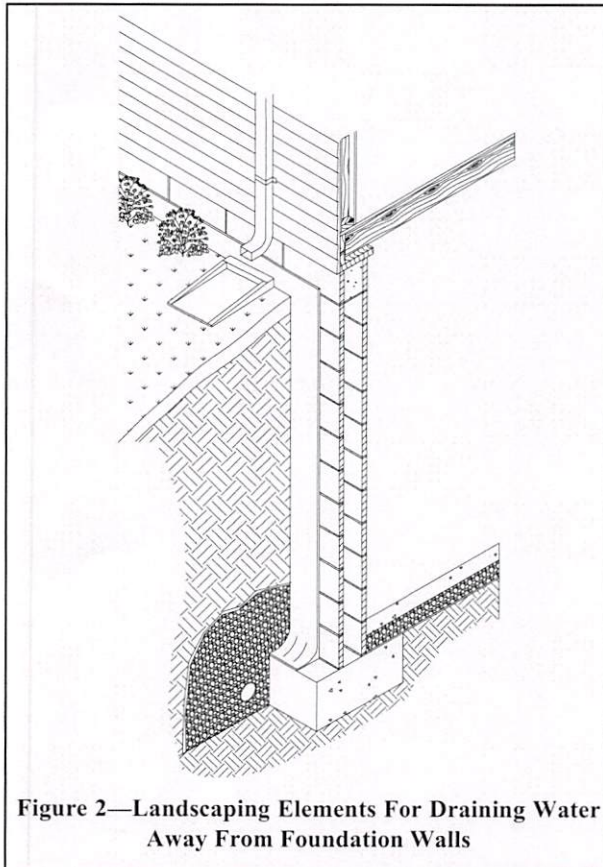


DRAINAGE

Draining water away from basement walls significantly reduces the pressure the basement wall must resist. This reduces the potential for cracking and also reduces the possibility of water penetration into the basement if there is a failure in the waterproof or dampproof system.

Perforated pipe or drain tiles laid with open joints have proven to be effective at collecting and transporting water away from foundation walls. The invert of drain pipes should be below the top of the floor slab elevation, as shown in Figure 1. The backfill drain should be connected to solid piping to carry the water to natural drainage, a storm sewer, or a sump. For adequate drainage, drains should slope at least 3/8 inch (10 mm) in 10 feet (3 m).

Drain tile and perforated pipes are typically laid in crushed stone to facilitate drainage. At least two inches (51 mm) of washed gravel or free draining backfill (containing not more than 10% material finer than a No. 4 sieve) should be placed beneath perforated pipes. Drain tiles laid with open joints are more effective when laid on the undisturbed soil where the water begins to accumulate. At least six to twelve inches (152 to 305 mm) of the same stone should cover the drain and should extend 12 inches (305 mm) or more beyond the edge of the footing. To prevent migration of fine soils into the drains, filter fabrics are often placed over the gravel.



Drainage pipes may also be placed beneath the slab and connected to a sump. In some cases, pipes are cast in or placed on top of concrete footings at six to eight feet (1.8 to 2.4 m) on center to help drain water from the exterior side of the foundation wall.

The backfill material itself also significantly affects water drainage around the wall. The backfill material should be well-draining soil free of large stones, construction debris, organic materials, and frozen earth. Saturated soils, especially saturated clays, should generally not be used for backfill, since wet materials significantly increase the hydrostatic pressure on foundation walls. The top four to eight inches (102 to 203 mm) of backfill should be low permeability soil so rain water is absorbed into the backfill slowly.

The finished grade should be sloped away from the foundation at least six inches (152 mm) within 10 feet (3 m) from the building. If the ground naturally slopes toward the building, a shallow trench or swale can be installed to direct water runoff away from the building.

Finally, gutters and downspouts should be installed to minimize water accumulation near the foundation. Water exiting downspouts should be directed away from foundation walls using plastic drainage tubing or splash blocks. Roof overhangs, balconies, and porches also shield the soil from direct exposure to rainfall.

CONSTRUCTION

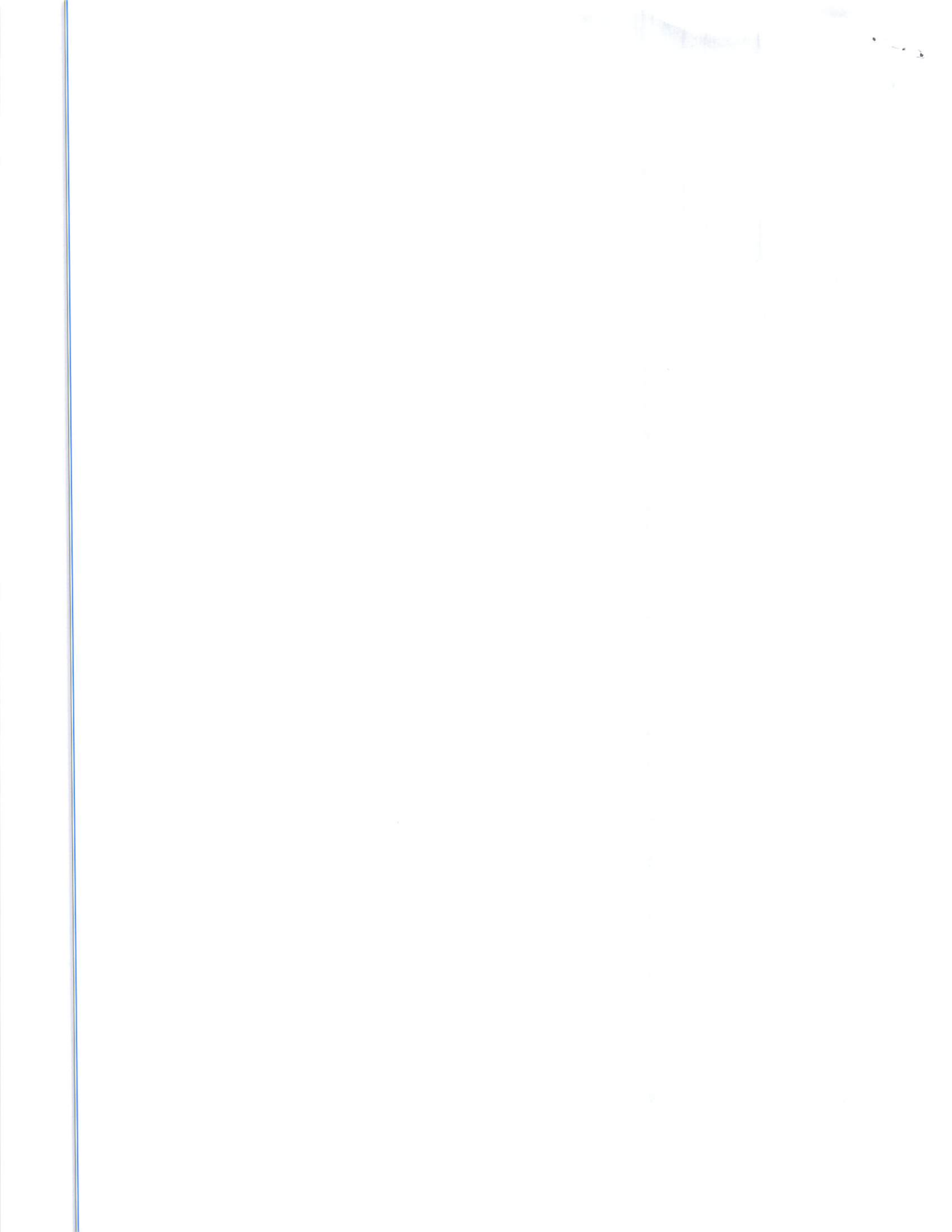
Methods of construction also impact the watertightness of foundation walls. Properly tooled mortar joints help prevent cracks from forming, and contribute to the watertightness of the finished work. Concave-shaped mortar joints are most effective for resisting water entry. Tooling the mortar compresses the surface to make it more watertight, and also reduces leakage by filling small holes and other imperfections. On the exterior face of the wall, mortar joints may be struck flush if parging will be applied.

The drainage and waterproof or dampproof system should be inspected prior to backfilling to ensure they are properly placed. Any questionable workmanship or materials should be repaired at this point, because repair is difficult and expensive after backfilling.

Backfilling methods are important, since improper backfilling can cause damage to foundation walls or to the dampproof or waterproof system. Foundation walls should either be properly braced or should have the first floor in place prior to backfilling so that the wall is supported against the soil load.

The backfill should be placed and compacted in several lifts. Care should be taken when placing backfill to avoid damaging the drainage and waterproof or dampproof systems. Heavy equipment should not be operated within about three feet (0.9 m) of foundation walls to avoid overloading the wall.

Final grade should be six to twelve inches (152 to 305 mm) below the top of the waterproof or dampproof membrane, and should slope away from the foundation



wall. In no case should the backfill be placed higher than the design grade line.

LANDSCAPING

The landscaping directly adjacent to the building impacts the amount of water absorbed by the foundation wall backfill. Particular care should be taken when automatic sprinklers are installed adjacent to foundation walls. Whenever possible, large rooting shrubs and trees should be placed 10 to 15 feet (3 to 4.6 m) away from foundation walls. Smaller shrubs should be kept at least 2 to 3 feet (0.6 to 0.9 m) from the walls. Ground covers can extend to the foundation and help prevent erosion. These elements are illustrated in Figure 2.

Parking lots, sidewalks, and driveways prevent direct absorption of water into the soil adjacent to the foundation, and should be installed to slope away from the building.

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