Rain Resistant Architectural Concrete Masonry

Integrally colored concrete masonry is commonly used as an architectural material in the Pacific Northwest. By combining different block sizes and shapes, colors or surface treatments, architects have designed many striking buildings. The interest in architectural block led to the development of industry recommendations for rain resistance. This updated technical note addresses the design and specification of a concrete masonry wall system for the western portion of the states of Washington and Oregon where rain resistance is a major concern. Some of these recommendations may not be applicable to the more arid regions of the Northwest.

This publication focuses on weather-exposed, single-wythe concrete block walls. These walls are assumed to be coated with a clear water repellent rather than an opaque coating for aesthetic reasons. They are designed as barrier walls and reinforced and grouted to withstand the forces of wind and earthquake, making the use of internal wall flashing impractical.

The basis for these recommendations primarily comes from a series of water permeance tests conducted at the National Concrete Masonry Association (NCMA) laboratory, combined with field experience in the Pacific Northwest. The wall system described in this information was tested in accordance with an extended version of ASTM E 514-90, Standard Test Method for Water Penetration and Leakage through Masonry. The wall was subjected to a 62.5 mph wind-driven rain. Water was applied to the front face of the wall at a rate equivalent to an extreme rainfall of 5.5 inches per hour. (See Figure 1 for the configuration of the test setup.)

It should be stated here that although this wall system demonstrated excellent test performance, maximum resistance to rain penetration is achieved through the use of an opaque, elastomeric coating over concrete masonry. A masonry cavity wall is another design option. As a responsible design professional, one must prioritize the various design requirements for a given construction project before selecting the most appropriate wall system.

A rain resistant concrete masonry wall combines the elements of quality materials, proper design and specification, and good workmanship. We will discuss each of these in some detail.

Concrete Masonry Units

The concrete masonry units (CMU) shall comply with ASTM Standard C-90. They should be medium-weight units with a density of approximately 110 pounds per cubic foot. The block should contain the recommended amount of an approved integral water repellent admixture (IWR).

Mortar

The mortar proportions should be selected to produce a workable mortar and one that provides optimum bond strength. Long-term bond strength is one of the most important variables effecting the water resistance of a masonry wall assembly.

Mortar should be mixed with as large a proportion of lime as possible, while still meeting the structural requirements of the project. Specify mortar under the Type S alternative property requirements of ASTM Standard C-270. Use an integral water-repellent admix in the mortar that is compatible with the water repellent in the CMU. The use of factory preblended, packaged mortars may offer a higher level of quality control.
Clear Water Repellent

It is recommended that exterior walls be clear coated to aid in water resistance as well as help to keep them clean. The application of a water repellent, combined with the other items discussed in this technical note, will also help to minimize efflorescence. The more resistant to rain penetration a wall is, the less efflorescence potential it has.

A clear siloxane or a silane-siloxane blend water repellent in a non-water carrier is recommended. This type of product chemistry was found to perform best during testing at NCMA. Specifiers should provide complete information to limit substitutions of unacceptable products. This material should be specified in the masonry section.

The water repellent should be applied per the manufacturer’s recommendations. Inspection is important to ensure compliance. The applicator should have experience in applying clear masonry coatings or be approved by the water repellent manufacturer.

The combination of both a post-applied clear water repellent and an integral water repellent admixture may be considered as a “belt and suspenders” approach. However, successful design for moisture mitigation considers each of these components, and provides for redundancy of protection. The clear water repellent provides surface protection while the integral admix provides internal water migration protection to the wall assembly.

Design

Proper design and detailing of masonry wall systems is important from all aspects of performance. When focusing on water resistance, details at the top and base of the wall are critical.

Parapet wall flashing and coping is one area that is often times not detailed properly. Parapets are exposed to extreme wind-driven rain conditions and can be a primary location of water entry into a building. Figure 2 illustrates the recommended detail at parapet walls. Note that the recommendation is to extend the sheet metal cap three inches over the face of the masonry unit, not to only have three-inch legs on the metal cap. Refer to the Sheet Metal and Air Conditioning Contractors Association literature for proper design of sheet metal, including laps and weather-tight installation.

The waterproofing membrane extends to the top outside edge of the masonry wall and down the exterior face past the wood plate. On the parapet wall interior face, the membrane is continuous, extending down to counterflash the base flashing, eliminating the cost and maintenance of a metal reglet and counterflashing.

The top course of block at the parapet should have a smooth face texture, even if the wall is constructed of split-face or split-ribbed block. This will permit a complete seal at the juncture of the block and metal cap.

At the base of the wall it is preferable to start the concrete masonry coursing at an elevation below the interior floor height. This can be done by stepping the foundation, using a CMU stem wall or other method. Base flashing is a design option to consider. It is typically not very effective in heavily reinforced masonry wall construction. The structural engineer should always be consulted prior to specifying base flashing.

Other design items for consideration to improve water penetration resistance include:

- adding an overhang or corbel at the top of wall (Figure 3)
- avoiding ledges in the wall plane (unless flashed or coated, Figure 4)
- utilizing control joints and horizontal reinforcement to minimize wall cracking
- specifying open-end block (check availability with local block producers)
- adding other finish materials on the exterior of the CMU (e.g. rigid insulation and stucco)
- specifying pan flashing with integral weeps in partial-grouted walls
- placing an air barrier on the interior of the wall (more information follows)

Figure 2. Parapet Wall Detail

Figure 3. An overhang at the roof line helps protect the top of the wall from rain exposure
Additional materials applied to the CMU wall interior may help performance in certain critical situations by adding another layer of protection against water penetration. The application of air barrier materials for this purpose is worth considering, especially since many energy codes now require air barriers for improved energy efficiency. (It should be noted that solid-grouted block walls and partial-grouted, coated CMU walls can also serve as air barriers). NWCMA investigated the water resistant performance of a few air barrier materials applied to CMU walls using the ASTM E-1105 test procedure\(^3\). The tested materials performed well and provide redundancy to the single-wythe wall system.

**Construction Practices**

All block walls should be laid with full mortar coverage on horizontal and vertical face shells. Block should be laid using a “double butter” technique for spreading mortar head joints. As shown in *Figure 5* this practice provides for a mortar to mortar contact as two block are laid together in the wall. Hairline cracking in the head joint is avoided.

All mortar joints should be tooled concave with a rounded or “V” jointer when thumbprint hard. The forming of these concave tooled joints densifies the mortar at the surface and seals the joint. (See *Figure 6*). Mortar joints should be double struck and tooled on both sides of the wall.

Concave and “V” joints direct water away from the building interior, unlike raked joints which create a ledge for water collection. Brush or flush mortar joints which are common when laying split ribbed concrete block do not provide the same degree of weather protection as a tooled joint.

Both partial and solid-grouted walls were tested and performed well under certain conditions. Solid-grouting can be beneficial for exterior walls exposed to severe wind-driven rain conditions. Severity of exposure varies considerably due to factors such as roof overhang, site location, orientation, etc.

**Concave Joint** - Most common joint used. Tooling works the mortar into the joint to produce a good weather joint. Pattern is emphasized.

**“V” Joint** - Tooling compacts the mortar tight and provides a good weather joint. Used to emphasize joints.

Although the test walls were constructed without a grout admixture, the use of superplasticizers or shrinkage compensating admixtures can be advantageous\(^4\). Approval of the building official is required prior to using a grout admixture.

During inclement weather, tops of unfinished walls must be covered at the end of the work day. The cover should extend two feet down both sides of the masonry and be securely held in place. After completion of the walls, immediately install the wall cap to prevent excessive amounts of water from directly entering the masonry.

**Cleaning**

Architectural concrete masonry should be left clean at the completion of the project. Cleaning procedures should be included in the project specification. The masonry wall should be kept clean as it is constructed by standard procedures using a brush and water. High pressure water cleaning or light abrasive blast cleaning can also be effective. Contact your concrete block supplier, cleaning product manufacturer, or mason contractor for additional cleaning information.

---

3This research is reported in NWCMA project report No. 2013BB.

4National Concrete Masonry Association Technical Note, Number 9-4 provides additional grout information.
Whatever cleaning methods are utilized, care should be taken to avoid impairing the water resistance of the mortar joints. Discoloring of the concrete masonry units should also be prevented. This can be difficult to do with smooth-colored block.

**Do not** use muriatic acid to clean architectural concrete masonry. Use masonry cleaners developed specifically for concrete masonry walls. It is advisable to test clean a small, inconspicuous location before proceeding with cleaning the entire wall.

**General**

It is recommended that a jobsite mock-up panel be constructed prior to the pre-installation meeting. The size of the mock-up panel should be specified (minimum 4 x 4 feet) along with any critical details to be included. The panel should represent completed masonry work including the specified sealer application and cleaning procedures. The specification should designate the accepted mock-up as the project standard.

A pre-installation meeting is recommended prior to beginning construction of architectural concrete masonry wall systems. The architect, general contractor, mason contractor and concrete masonry unit supplier should be present. Any questions concerning the masonry work should be discussed at this time. Everyone should be made aware of the importance of working together and their role in constructing a successful concrete masonry building.

The information presented in this technical note provides the industry’s current recommendations on this subject based upon completed laboratory testing and actual field experience. Specific product information from the testing is available upon request. In the future, modifications to this information may be made as masonry material innovations occur and/or additional testing is completed.

This information is intended for the use of professional personnel competent to evaluate the significance of limitations of the reported findings and recommendations, and who will accept responsibility for the application of the material.

For further information on how to put concrete masonry to work for you contact:

**Basalite Concrete Products, LLC**  
www.basalite.com

**Central Pre-Mix Concrete Products Co.**  
www.centralpremix.com

**Eastside Masonry Products**  
www.eastsidemasonry.com

**Mutual Materials Co.**  
www.mutualmaterials.com

**Western Materials**  
www.westernmaterials.com

**White Block Co.**  
www.whiteblockcompany.com

**Willamette Graystone, Inc.**  
www.willamettegraystone.com