MSDS

SECTION I
MATERIAL IDENTIFICATION AND USE

Material Name: Designer Stone

Manufacturer's/Supplier's Name:
Shouldice Designer Stone Ltd.

Address: 281227 Shouldice Block Road
Shallow Lake, Ontario N0H 2K0

Telephone: 1-800-265-3174

Chemical Family: Portland Cement Product

Chemical Formula: Mixture Cementitious Material Aggregates and Water

Trade Name: Masonry Veneer

Material Use: Construction Materials

SECTION II
HAZARDOUS INGREDIENTS OF MATERIAL

Designer Stone is a mixture of inert gravel or rock, sand, Portland cement and water. It may also contain chemical admixtures and / or granulated slag and or iron oxide colour, which have no effect on the hazards associated with the use of the product. The chemical reaction is complete in Designer Stone.

SECTION III
PHYSICAL DATA FOR MATERIAL

Odour and Appearance: odourless, grey unless coloured
Freezing Point: (0° C)
Solubility in Water: 0.1%

SECTION IV
FIRE AND EXPLOSION HAZARD OF MATERIAL

Not applicable.

SECTION V
REACTIVITY DATA

Not applicable.

SECTION VI
TOXICOLOGICAL PROPERTIES OF MATERIAL

Hardened or "Set" Concrete

Sawing or other demolition techniques may result in exposure to dust, which may contain hazardous ingredients of the products as follows:

(I) Portland Cement and Portlandite

Toxicological Properties: The hazardous ingredients when in contact with water produce calcium hydroxide, with an alkalinity level of pH12 to pH13. This level of alkalinity can cause skin and eye irritation.

Route of Entry: Skin contact, eye contact, inhalation and ingestion.

Effects of Acute Exposure: Cement and wet cement mixtures can dry skin, cause alkali burns and irritate the eyes and the upper respiratory tract. Ingestion can cause inflammation of the throat.

Effects of Chronic Exposure: Cement dust can cause inflammation of the tissue lining the interior of the nose and the cornea (white) of the eye. Hypersensitive people may develop allergic dermatitis.

(II) Quartz ($SiO2$)

Route of Entry: Skin contact, eye contact, and inhalation.

Effects of Acute Exposure: Exposure to dust may irritate respiratory system, eyes and skin.

Effects of Chronic Exposure: (1) Chronic exposure to respirable dust levels exceeding exposure limits has caused pneumoconiosis.

(2) Chronic exposure to respirable sand and gravel dust containing quartz at levels exceeding exposure limits has caused silicosis, a serious and progressive pneumoconiosis which can be disabling, and in extreme instances, lead to death. Symptoms may appear at any time, even years after exposure have ceased. Symptoms of silicosis may include shortness of breath, difficulty in breathing, coughing, diminished chest expansion, reduction of lung volume and heart enlargement and/or failure. The only reliable method of detecting silicosis is through chest x-ray. Silicosis may aggravate other chronic pulmonary conditions and may increase the risk of pulmonary tuberculosis infection. Smoking aggravates the effects of silica exposure.

SECTION VII
PREVENTATIVE MEASURES

Personal Equipment: Use gloves, boots and clothing to prevent skin contact. Wear safety glasses or goggles to prevent contact with eyes. Wear an approved respirator if exposed to dust from hardened concrete when sawing or using other demolition.

Engineering Controls (Specify): Provide ventilation when sawing or using other demolition techniques to reduce dust concentrations.

Waste Disposal: At approved landfill or waste disposal sites in accordance with local regulations.

Handling Procedures & Equipment: As Above.

Storage Requirements: Not Applicable.

Special Shipping Information: Not Applicable.

SECTION VIII
FIRST AID MEASURES

Wash exposed areas of body with soap and water; irrigate eyes with large amounts of water; consult a physician in case of severe exposure.

SECTION IX
PREPARATION DATE OF MSDS JANUARY/2013

The information contained on the Material Safety Data Sheet is based on hazard information from sources considered technically reliable and has been prepared in good faith in accordance with available information. No warranty, express or implied, is made and the supplier will not be liable for any damages, losses, injuries or consequential damages which may result from the use of or reliance on any information contained herein.

1e.14 Anchored Veneer Support

ACI 530/ASCE 5/TMS 402 Support Requirements for Anchored Masonry Veneer

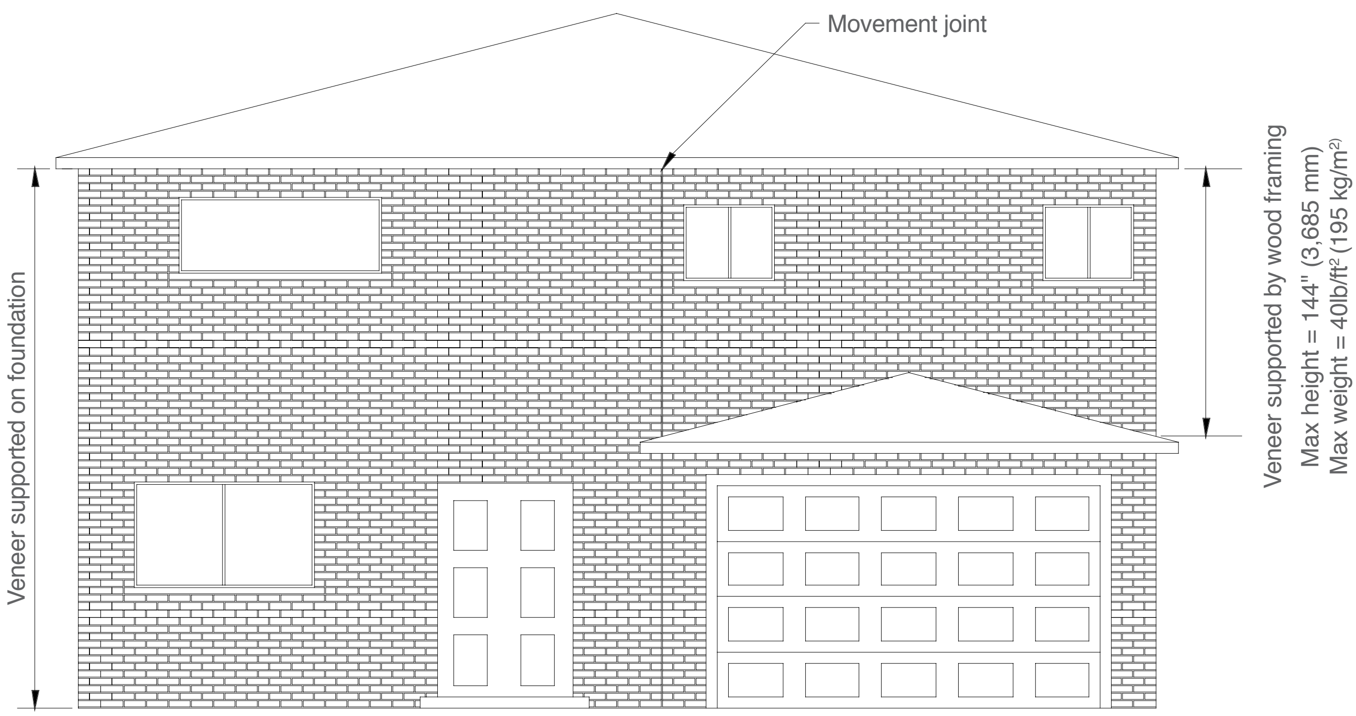
In accordance with the prescriptive detailing requirements of the Building Code Requirements for Masonry Structures (Ref. 1.8), the weight of anchored veneer is to be vertically supported by noncombustible structural supports. When combustible supports are used, the following limitations are to apply:

- Anchored veneer supported vertically by preservative treated wood foundations is not to exceed a height of 18 feet (5,486 mm) above the support.
- Interior anchored veneer may be supported on wood construction when the installed weight is not more than 40 lb/ft (195 kg/m).
- Exterior anchored veneer may be supported on wood construction if the installed weight is 40 lb/ft (195 kg/m) or less and the height is not more than 12 feet (3,658 mm). (Note that concrete masonry veneer 4 inches (102 mm) or less in nominal thickness and 130 lb/ft (2110 kg/m) or less in density has an installed weight of less than 40 lb/ft).

Anchored veneer supported by lintels, floors, wood construction, or other spanning elements not continuously supported shall be designed such that the deflection is limited to l/600 or 0.3 inches (7.6 mm), whichever is less.

Anchored veneer with a backing of wood framing shall not exceed a height of 30 feet (9,144 mm) (38 feet (11,582 mm) at gables). Veneer with a backing of cold-formed steel framing may exceed these heights if the weight of the veneer is supported by noncombustible construction at each story above these height limits. There are no prescriptive height limitations for veneer with concrete or masonry backing.

Unless pressure treated wood suitable for contact with masonry is used, veneer must be designed and detailed so that it is not in direct contact with wood or other similar material susceptible to moisture damage. When different sections of a veneer assemblage are supported by wood construction and by the foundation, respectively, a movement joint must be placed between each section to isolate the differential movement that may occur between each region.



1e.15 Anchored Veneer Anchors

ACI 530/ASCE 5/TMS 402 Anchor Requirements for Anchored Masonry Veneer

The following types of anchors are permitted under the prescriptive requirements of the Building Code Requirements for Masonry Structures (Ref. 1.8) for anchored masonry veneer.

Corrugated Sheet Metal Anchors: Corrugated sheet metal anchors, used with wood backup, are required to be at least 7/8 inches (22 mm) wide, have a base metal thickness of at least 0.03 inches (0.76 mm), and have corrugations with a wavelength of 0.3 to 0.5 inches (7.6 to 13 mm) and an amplitude of 0.06 to 0.10 inches (1.5 to 2.5 mm).

Sheet Metal Anchors: Sheet metal anchors, used with wood backup, shall be at least 7/8 inches (22 mm) wide, have a base metal thickness of at least 0.06 inches (1.5 mm) and shall have corrugations as given above for corrugated sheet metal anchors or be bent, notched or punched to provide equivalent performance.

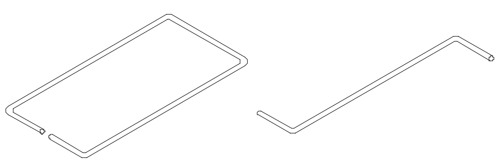
Wire Anchors: Wire anchors, used with wood or masonry backup, shall be at least W1.7 (MW 11) wire and have ends bent to form an extension from the bend at least 2 inches (51 mm) long. Note that for multiwythe walls designed for composite action, "Z" ties are not permitted for the use with hollow masonry units.

Joint Reinforcement Anchors: Ladder-type or tab-type joint reinforcement is permitted for use with masonry backup if the cross wires used to anchor the masonry veneer are at least W1.7 (MW 11) wire and the wires are spaced no further than 16 inches (406 mm) on center. Cross wires shall be welded to longitudinal wires, which shall be at least wire size W1.7 (MW 11).

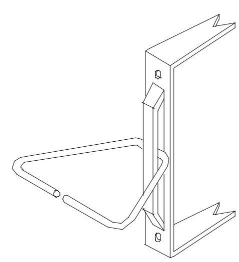
Adjustable Anchors: Sheet metal and wire components of adjustable anchors shall conform to the requirements for corrugated sheet metal anchors, sheet metal anchors or wire anchors. Adjustable anchors with joint reinforcement shall also meet the requirements for joint reinforcement anchors. Adjustable anchors must also comply with the following requirements (refer to Figure 4A.1 for further guidance):

- The maximum clearance between connecting parts of the tie shall be 1/16 inches (1.6 mm).
- Adjustable anchors shall be detailed to prevent disengagement.
- Pintle anchors shall have at least two pintle legs of wire size W 2.8 (MW 18) each and shall have an offset not exceeding 1 1/4 inches (32 mm).

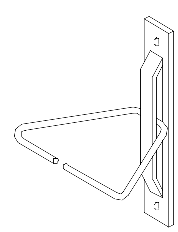
Other veneer anchors are permitted when their performance is equivalent to the above.



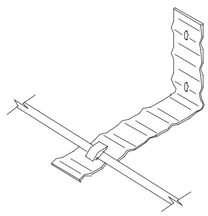
Wire anchors



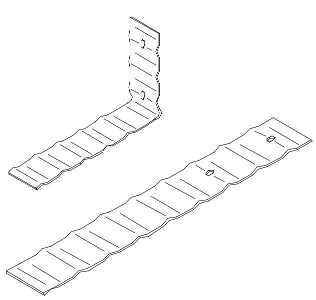
Base and vee anchor with prongs



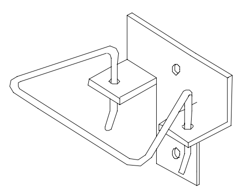
Base and vee anchor



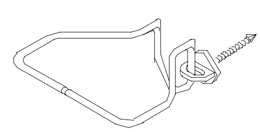
Currugated anchor with wire



Currugated anchors



Eye and pintle anchor (See Figure 4E.1)



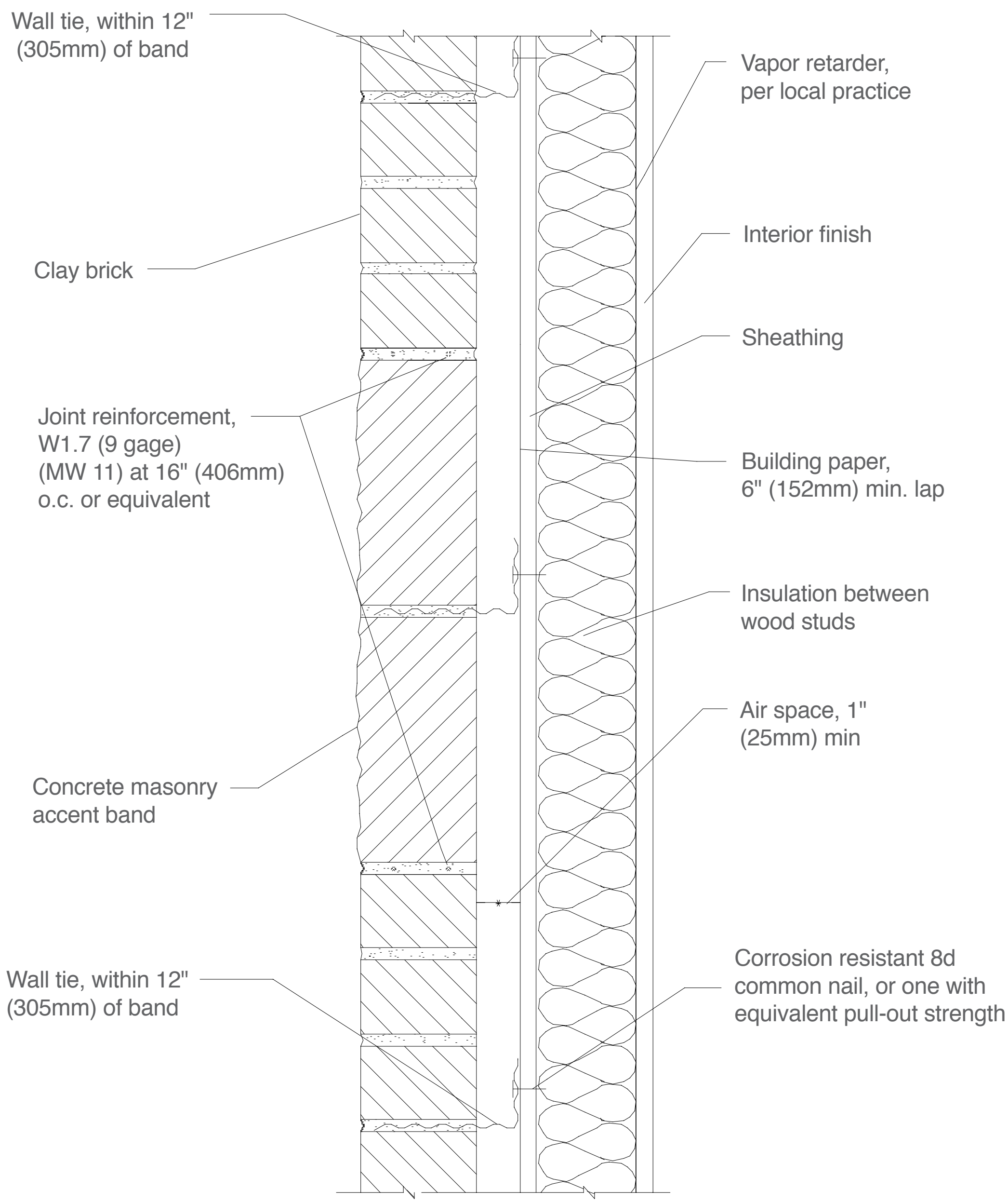
Wire and screw anchor

9d.3 CM Band Over Wood Framing

Concrete Masonry Band in Clay Brick Veneer Over Wood Framing Backup

When concrete masonry banding is used over a wood framing backup, it is imperative that joint reinforcement be used in the concrete masonry band, even if it is not used in the surrounding clay brick masonry. See also the notes to Figure 9D.1.

A 1" (25 mm) air space between wythes is considered appropriate if special precautions are taken to keep the air space clean (such as beveling the mortar bed away from the cavity or carefully pulling a piece of wood up the cavity to collect mortar droppings as veneer construction proceeds). Otherwise, a 2 inch (51 mm) air space is preferred. Proprietary drainage products can be used to create a drainage cavity, which takes the place of the clear air space.



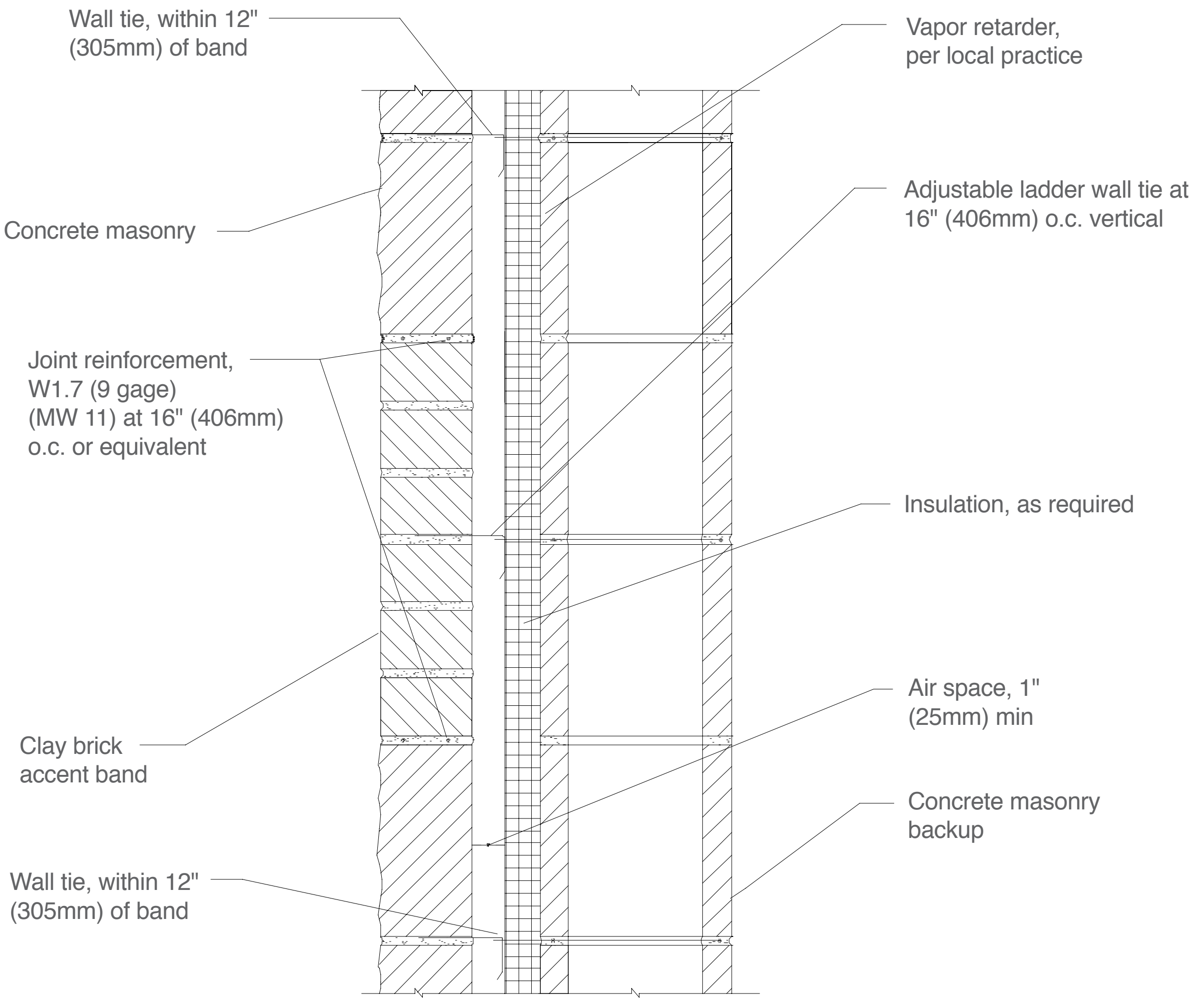
Clay Brick Band in CM Veneer

Multi-Course Clay Brick Band in Concrete Masonry Veneer

The recommendations to control differential movement for clay brick masonry bands in concrete masonry are very similar to those for a concrete masonry band in clay brick veneer: joint reinforcement above and below the band and wall ties within the band. Seismic clip-type wall ties are recommended, as they provide an adjustable wall tie and joint reinforcement in one assembly.

With this construction, it is imperative that the veneer control joint not contain mortar as it goes through the clay brick band. Mortar in this joint will restrict brick expansion, reducing the movement joint's effectiveness. Note that although control joints in structural masonry walls must permit free longitudinal movement while resisting lateral or out-of-plane shear loads, veneers are laterally supported by the backup and do not require a shear key.

A 1" (25 mm) air space between wythes is considered appropriate if special precautions are taken to keep the air space clean (such as by beveling the mortar bed away from the cavity or drawing a piece of wood up the cavity to collect mortar droppings). Otherwise, a 2 inch (51 mm) air space is preferred. Proprietary insulating drainage products can be used without the need for a clear air space.



(a) Section

19-4A Flashing Strategies

Introduction

The primary role of flashing is to intercept the flow of moisture through masonry and direct it to the exterior of the structure. Due to the abundant sources of moisture and the potentially detrimental effects it can have, the choice of flashing material, and the design and construction of flashing details, can often be as key to the performance of a masonry structure as that of the structural system.

The type of flashing material to be used is governed by both environmental and design/build considerations. Environmental considerations include such factors as the physical state of moisture present (liquid, solid, or vapor), air movement, and temperature extremes as well as temperature differentials. Design/build considerations include the selection of the proper type of flashing material, location of the flashing, structural, and installation details. Drawings for flashing details, often the only method of communicating the necessary information between the designer and contractor, should be comprehensive and show sufficient detail for the proper interpretation and installation of flashing systems. TEK 19-5A Flashing Details for Concrete Masonry Walls (ref. 3) includes such details.

Although flashing is the primary focus of this TEK, it should be understood that the role of vapor retarders, air barriers, and insulation are also important elements to consider for any wall design as the performance of the entire system can be dependent on the design of its individual components.

Effect Of Moisture On Masonry

The damage caused to a masonry structure (or its contents) due to the infiltration of moisture can take many forms, depending on the source and the physical state of the water. For example, in the liquid state, water penetrating to the interior of a building may cause considerable damage to its contents. In some extreme cases, water trapped within the masonry may freeze, inducing spalling and cracking of the masonry units or mortar. Alternatively, water vapor can lead to condensation inside the cores and on the surfaces of masonry if the dew point temperature is reached. During cold weather, below 28°F (-2°C), water vapor can accumulate on a cold surface and from frost or increase the quantity of ice within the masonry.

Although it is commonly thought that moisture problems stem only from the external environment, this is not always the case. For example, in some instances it is possible for the humidity of interior air to cause water damage to the exterior of a structure. This damage may appear in the form of water stains, ravelled mortar joints, spalled surfaces, or efflorescence.

Design Considerations

Water Movement

In the design of any structure, the presence and movement of water in any of its three forms needs to be considered. Significant forces that influence water movement include wind pressure, gravity, and moisture absorption by the material. Dynamic wind pressure on the surface of an exposed wall can drive exterior moisture (in the form of rain or irrigation water) into the masonry. Gravity, which is always present, draws the free water vertically downward, while the absorptive characteristics of the masonry can cause moisture migration in any direction by capillary action.

It should also be recognized that these forces do not act independently of one another. For example, wind-driven rain may enter masonry through cracks at the interface between mortar and units and migrate downward through the wall due to the force of gravity, or it may be transferred horizontally through the wall either by pressure or by flowing across the webs of the units or mortar bridges. Wind-driven rain can also be absorbed by masonry units and carried from the exterior surface to the interior surface by capillary action. Additionally, ground water may be drawn upward by the wicking action of units placed on porous foundations or by contact with moist soil.

Designers should never assume that any material is capable of rendering a wall totally impervious to water penetration. Surface treatments, designed to reduce the quantity of water entering a masonry structure, are helpful in this regard but should not be considered as a sole means of protection. Available as clear and opaque compounds, the effectiveness of surface treatments depends on their composition and compatibility with the masonry. They also do not reduce the movement by capillary action (wicking) of any water that does penetrate the masonry face through cracks or defects in the mortar/masonry. The use of integral water repellent admixtures in concrete masonry units and mortars can also reduce the amount of water entering the masonry. In addition, they inhibit water penetrating the masonry face from wicking to the back face of the wall. Proper selection and application of surface treatments and integral water repellents can greatly enhance the water resistant properties of masonry, but they should not be considered as substitutes for flashing. See TEKs 19-1 and 19-2A (refs. 8 and 2) for more information on water repellents for concrete masonry.

Flashing Location

The proper design of masonry for resistance to water penetration includes consideration of the various types of wall construction such as single wythe, cavity, veneer, etc. During the design phase it should be understood that all exterior masonry walls may be subjected to some degree of water penetration and/or water vapor movement during its design life. Flashing is recommended for all locations where moisture may potentially penetrate into a wall and where the free drainage of water is blocked. Some of these critical locations include the top of walls and parapets, at all horizontal obstructions such as over openings, beneath sills, above shelf angles, at the base of walls, and in walls at ground level to serve as a moisture retarder to reduce the amount of water wicked up into the masonry above grade.

When selecting the flashing material for a particular application, the service conditions, projected life of the structure, and past performance characteristics of the flashing materials should be reviewed. Flashing should be designed to perform satisfactorily for the design life of the building since repair or replacement can be very labor intensive and expensive.

Flashing Materials

A wide variety of flashing materials are available. The selection of the type of flashing material to use can be influenced by several factors including cost, durability, compatibility with other materials, ease of installation, aesthetic value, and performance. Table 1 summarizes some of the attributes for various flashing materials. The advantages and disadvantages of each must be weighed for each individual project to provide the most cost-effective and desirable choice.

Prefabricated flashing boots may be available for inside and outside corners and end dams. These boots eliminate the need for cutting, folding, or tucking the flashing materials at these locations. However, due to construction tolerances, some of these prefabricated items, particularly those of rigid materials, may be difficult to fit into their intended location.

Sheet Metals

Stainless steel is technically any of a large and complex group of corrosion resistant iron chromium alloys possessing excellent weather and chemical resisting properties. Preformed sections must be properly sized so that on site modification is minimized. Stainless steel flashing with a conventional annealed finish should comply with Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip, ASTM A 167 (ref. 6). Generally, Type 304 stainless steel with a minimum thickness of 0.010 in. (0.25 mm) is satisfactory. Lap sections require solder conforming to Standard Specification for Solder Metal, ASTM B 32 (60% tin and 40% lead) (ref. 5). Stainless steel drip edges used in combination with other flashing materials offer an economical compromise with a durable drip edge.

Copper is a nonferrous metal possessing good ductility and malleability characteristics. Like stainless steel, it also possesses excellent weather and chemical resistant properties. Preformed sections or sheet materials are easily modified to conform to site requirements. However, it should be cautioned that once weathered, copper flashings produce a green patina that may impart a green stain to adjacent masonry surfaces that some find objectionable.

Galvanized steel is less expensive than stainless steel but is subject to corrosive attack from salts and acids. The galvanized coating also may crack at bends, lowering the corrosion resistance. As with stainless steel, it is also difficult to form and to solder laps effectively.

Composites

Combinations of metals and plastics are supplied by some dealers. The composition and application of these combined materials should be determined before use. Composites utilizing copper are the most popular since they combine the durability and malleability of copper with the nonstaining characteristics of a protective coating. Composites containing aluminum should be avoided.

Plastics and Rubber Compounds

Plastics are categorized as polymeric materials of large molecular weight, usually polyvinyl chloride (PVC) or polyethylene. Manufacturers of plastic flashings should be consulted for documentation establishing the longevity of the plastic in a caustic environment (pH = 12.5 to 13.5), the composition of the plastic, ease of working at temperatures ranging from 20 to 100ºF (-7 to 38ºC), and ability to withstand exposure to ultraviolet light.

Ethylene Propylene Diene Monomer (EPDM) is a synthetic rubber that is used as a single ply roofing membrane as well as flashing. It has better low temperature performance than PVC and will not embrittle. It offers ultraviolet light and ozone resistance and can be left exposed.

Self-adhering, rubberized asphalt membranes consist of a composite of flexible plastic film for puncture and tear resistance combined with a rubberized asphalt adhesive layer. This material adheres to itself, requiring less effort to seal laps or corners which speeds installation. It also self-adheres to the substrate which prevents water from migrating under the flashing and is self-healing in the event of punctures. However, it should not be applied to damp, dirty, or dusty surfaces and typically has a lower installation temperature limit of 25ºF (-4ºC). Because it degrades in the presence of extended UV exposure, it should not be left exposed and requires a metal drip edge.

19-4A Flashing Strategies

Construction Practices

To perform, flashing must be designed and installed properly or it may aggravate rather than reduce water problems. Flashing should be longitudinally continuous or terminated with end dams. Longitudinally continuous requires that joints be overlapped sufficiently, 4 in. (102 mm) minimum, to prevent moisture from entering between the joints and they must be bonded (joined) together with adhesive if they are not self adhering to prevent water movement through the lap area. With metal flashings a ¼ in. (6.4 mm) gap joined and sealed with a pliable membrane helps in accommodating expansion (ref. 3).

Flashings should be secured at the top by embedment into the masonry, a reglet, or should be adhesively attached so that water cannot infiltrate or move behind the attachment. For multi-wythe construction, the flashing should project downward along the outer surface of the inner wythe and then project outward at the masonry joint, shelf angle, or lintel where it is to discharge the water. Every effort should be made to slope the flashing towards the exterior. Effectively placed mortar or sealant material can help promote this drainage. The flashing should continue beyond the exterior face of the masonry a minimum of ¼ in. (6.4 mm) and terminate with a sloped drip edge.

An additional design consideration for flashings includes ensuring that all materials are compatible. For example, contact between dissimilar metals can result in the corrosion of one or both of the metals. Additionally, the coefficients of thermal expansion for the flashing and masonry materials differ. All flashing details should be designed to accommodate the resulting differential movement.

Other recommended practices involve the use of tooled concave mortar joints to reduce water penetration through the mortar joints. Masons should be careful to ensure that mortar dropped onto the flashing is minimized. This can be accomplished by beveling the mortar on the face shells adjacent to the cavities in cavity wall construction. In addition, cavity drainage mats, gravel beds, screens, or trapezoidal drainage material (filter paper) can be used to prevent mortar droppings from collecting on the flashing, which can form dams and block weep holes. Mortar collection devices at regular intervals or filling the cells with loose fill insulation a few courses at a time as the wall is laid-up, can be effective in dispersing minor mortar droppings enough to prevent clogging.

Weep holes, the inseparable companion to flashings, should provide free movement of water out of the concrete masonry cores, collar joints, or cavities. Any construction practice that allows forming the weep holes without inhibiting water flow may be used. Cotton sash cords and partially open head joints are the most common types of weep holes. Cotton sash cords should be removed prior to putting the wall into service to provide maximum unobstructed drainage. If necessary, insects can be thwarted by inserting stainless steel wool into the openings or using plastic or metal vents.

Vents

Weep holes often serve a dual function, first for water drainage and second as vents. Vents are desirable in some masonry wall systems to help reduce the moisture content of the masonry during drying periods. Air circulation through the cores and cavities within the masonry promotes equalization of moisture content throughout the masonry. Vents are considered desirable where air is confined within masonry, such as in parapets or areas of high humidity such as natatoriums.

Maintenance

Maintenance programs should involve preserving the "as-built" design documents, records pertaining to inspections during the life of the structure, and continuing appraisal of the performance of the structure in addition to conventional repair and upkeep. Documentation of inspections, if efflorescence and water stains are observed, and logs of reported water penetration and their identified location, assist in determining proper corrective actions. Pictures with imprinted dates are suggested.

Knowledge of the wall design and construction can influence repair decisions. If flashing and weep holes were omitted during construction, it may prove effective to simply drill weep holes and vents to promote drainage and drying. Weep holes so drilled should be either at the intersection of the bed and head joints or into the cores at the bottom of the wall. Vents should be installed at the top of the wall or directly below bond beams. See TEK 8-1A Maintenance of Concrete Masonry Walls (ref. 4) for more detailed information on maintenance of concrete masonry walls.

When considering maintenance options, it is important to ensure that a masonry wall's moisture control measures are kept intact. Thus, applying sealant beads, pargings, or coatings to a wall should be carefully weighed. Weep holes and vents should be maintained in an open condition to allow evacuation of moisture.

Summary

Flashings are essential at foundations, bond beams, above and below openings, at shelf angles and at copings. Weep holes and vents reduce the moisture content of masonry walls. Proper selection of flashing materials, proper detailing, and proper installation will help ensure satisfactory performance.

References

1. The Building Envelope: Solutions to Problems, Proceedings from a national seminar series sponsored by Simpson Gumpertz & Heger Inc., 1993.

2. Design for Dry Single-Wythe Concrete Masonry Walls, TEK 19-2A, National Concrete Masonry Association, 2002.

3. Flashing Details for Concrete Masonry Walls, TEK 19-5A, National Concrete Masonry Association, 2003.

4. Maintenance of Concrete Masonry Walls, TEK 8–1A, National Concrete Masonry Association, 2002.

5. Standard Specification for Solder Metal, ASTM B 32-00, American Society for Testing and Materials, 2002.

6. Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip, ASTM A 167-99, American Society for Testing and Materials,1999.

7. Through-Wall Flashing, Engineering and Research Digest No.654, Brick Industry Association.

8. Water Repellents for Concrete Masonry Walls, TEK 19-1, National Concrete Masonry Association, 2002.

19-5A Flashing Details

Introduction

At critical locations throughout a building, moisture that manages to penetrate a wall is collected and diverted to the outside by means of flashing. The type of flashing and its installation may vary depending upon exposure conditions, opening types and locations and wall types. This TEK is a collection of typical flashing details that have proven effective over a wide geographical range. The reader is also encouraged to review the companion TEK 19-4A Flashing Strategies for Concrete Masonry Walls (ref. 3) which addresses the effect of moisture on masonry, design considerations, flashing materials, construction practices, and maintenance of flashing.

Cavity Walls

For cavity walls, as illustrated in Figure 1, the cavity ranges from a minimum of 1 in. (25 mm) to a maximum of 4 ½ in. (114 mm) wide with a minimum of a 1 in. (25 mm) clear airspace if insulation board is placed in the cavity. Cavities wider than 4 ½ in. (114 mm) are permitted only if a detailed analysis is performed on the wall ties per the Building Code Requirements of Masonry Structures (ref. 1) The 1 in. (25 mm) clear airspace works only if the mason takes precautions to insure that mortar will not bridge the airspace. Such precautions would include beveling the mortar bed away from the cavity or drawing a piece of wood up the cavity to collect mortar droppings. If precautions are not taken, it is suggested that a wider airspace be utilized, i.e. 1½ to 2 in (38 to 51 mm). Proprietary insulated drainage boards or mats are available that provide an unobstructed drainage path that eliminate the need for a clear airspace (ref. 4).

As shown in Figure 1, the flashing in a cavity wall at the intersection of the foundation should be sealed to the exterior faceshell of the backup wythe, project downward to the foundation surface, outward to the exterior face of the wall, and terminate with a sloped drip. Weep holes or open head joints should be located a maximum of 32 in. (813 mm) apart. Flashing at lintels and sills (shown in Figures 2 and 3, respectively) is very similar. Although not shown, vents can be installed in the vertical head joints at the top of masonry walls to provide natural convective air flow within the cavity to facilitate drying.

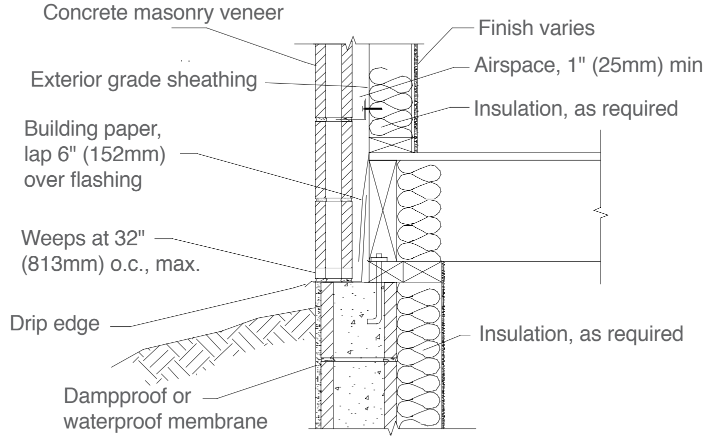


Figure 1

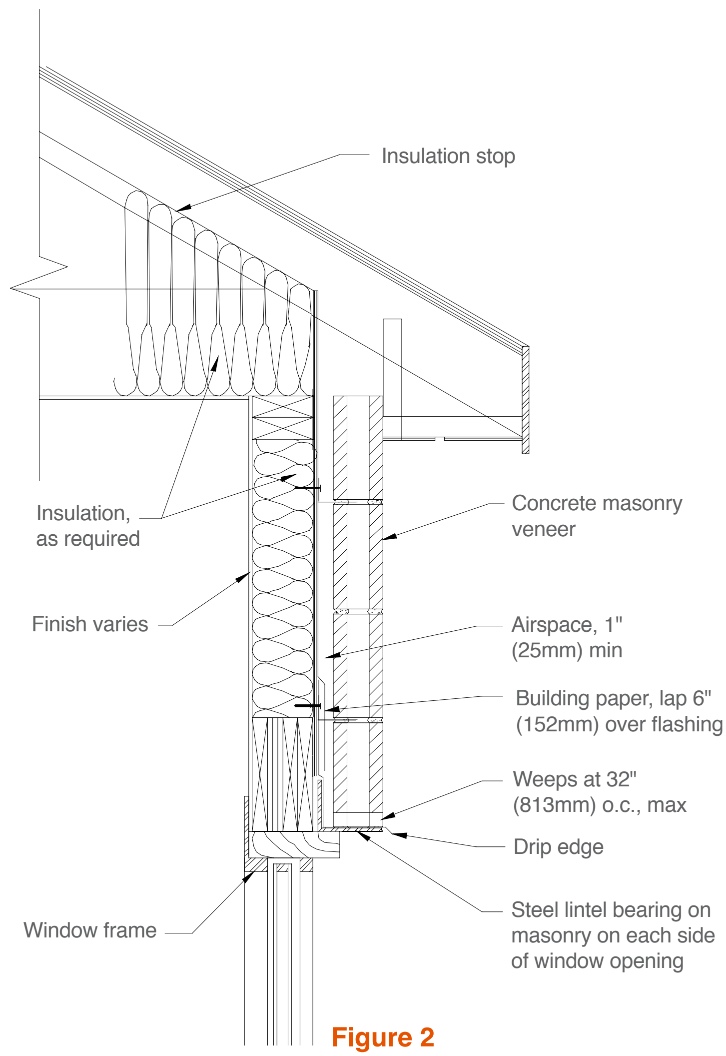


Figure 2

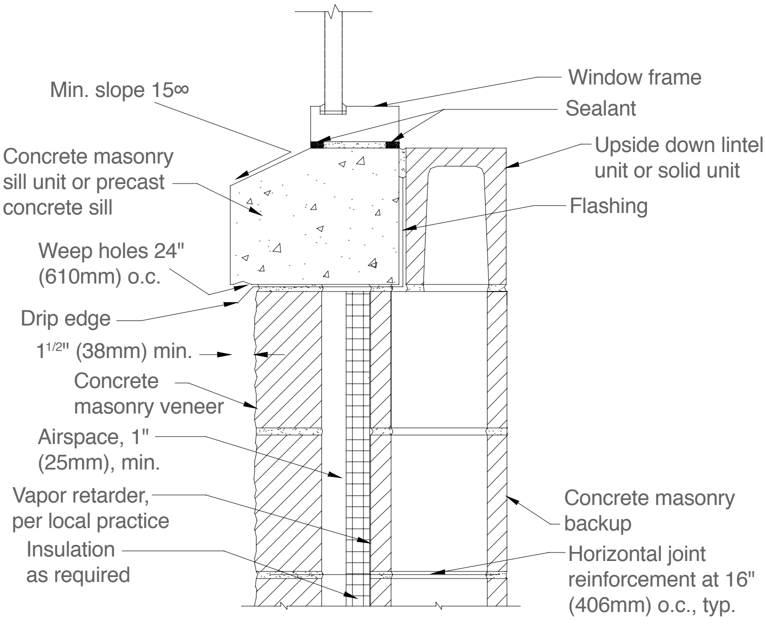


Figure 3 (b Sill)

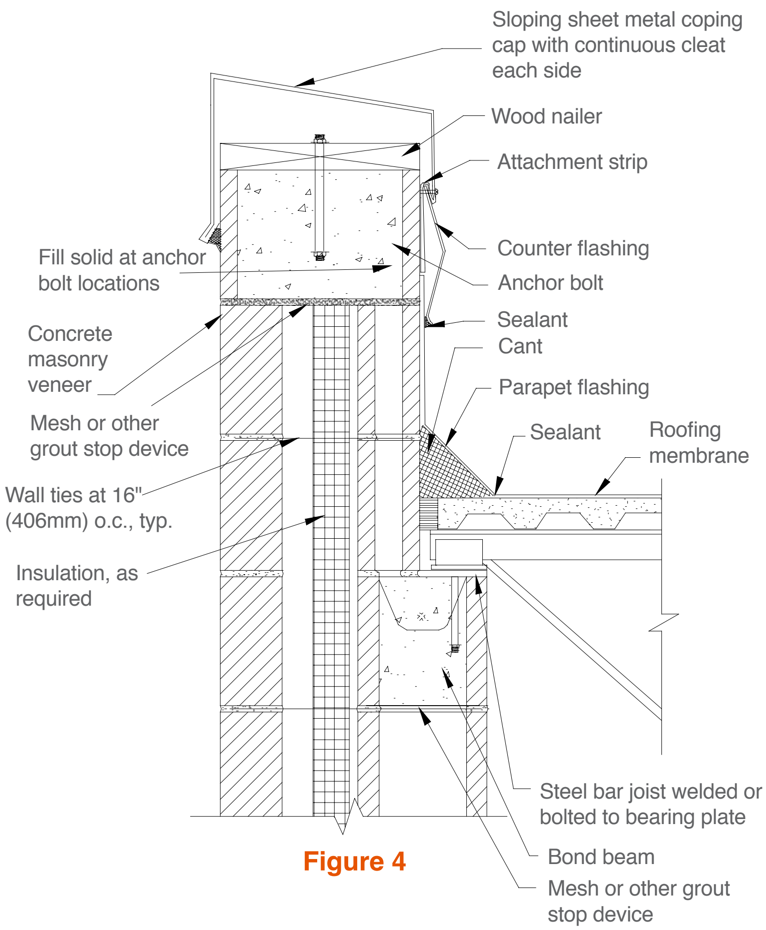


Figure 4

Flashings At Copings And Caps

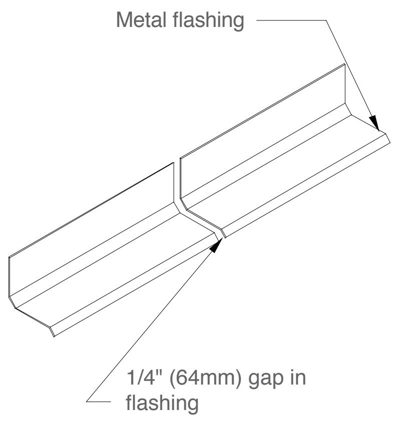
The type of flashing detail to use on low-sloped roofs will in part depend on the type of roofing membrane being used. As with any flashing detail, the materials used should result in a uniform and compatible design. For example, joining two materials with significantly different coefficients of thermal expansion (such as metal flashing and bitumen roofing membrane) can cause tearing and failure of the joint. Many roofing membranes also shrink as they age. As a result, roofing membranes extending over the top of a parapet may pull the parapet off the wall as the roofing membrane shrinks. Counter flashing provides a solution to these problems as shown in Figure 4. Counter flashing also facilitates the reroofing process by allowing easy removal and access to the flashing membrane fasteners.

During placement of the final courses of masonry in parapets, and commencing with the second course below the coping/cap location, a grout stop should be placed over cores so that grout can be placed for the positioning of anchor bolts (Figure 4).

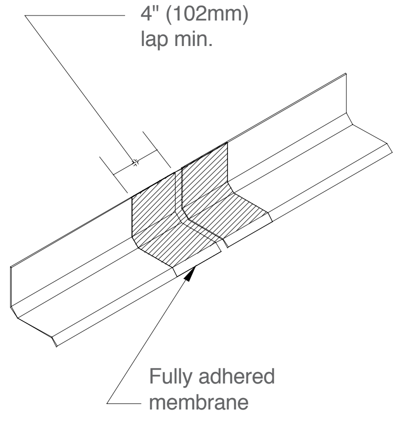
In coping installations it is imperative that penetrations of through-wall flashing be tightly sealed to prevent water infiltration. A full mortar bed is required to be placed on the through-wall flashing to allow proper positioning of coping units. Full head joints are placed between the coping units as well as properly spaced control joints. The joints between the coping units should then be raked and a joint sealant applied.

Coping units should be sized such that overhangs and a drip reveal are provided on both sides of the wall. Metal caps require wood plates for anchorage, which in turn are usually attached to the wall with anchor bolts. The cap should be sloped to prevent water from draining onto the exposed surface of the masonry and should extend at least 4 in. (102 mm) over the face of the masonry and sealed on both sides. Smooth face or uniform split face CMU should be considered for use under the cap to ensure a relatively tight fit between the masonry and cap that might be hindered by uneven CMU units such as split-face units.

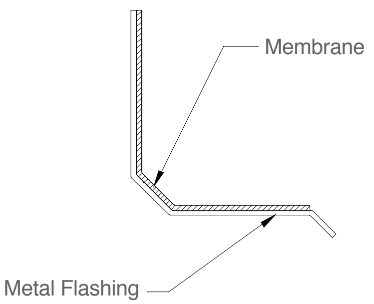
19-5A Flashing Details



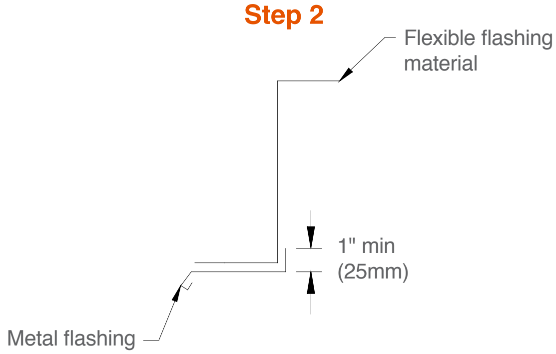
Step 1



Step 2



Splice Cross Section



Two-Piece Flashing Cross Section

Splicing Flashing

When splicing of the flashing is necessary, extra precautions are required to ensure that these discreet locations do not become sources of water penetration. Flashing should be longitudinally continuous or terminated with an end dam as shown in Figure 5. The splicing of flashing materials consisting of plastic and rubber compounds is achieved by overlapping the joint a minimum distance of 4 in. (102 mm). The lapped area is then bonded together with adhesive if the flashing material is not self-adhering.

Lap splicing of metal flashing is not recommended as it has a different coefficient of thermal expansion than that of concrete masonry. As the temperature fluctuates, the flashing material will expand and contract differently than the masonry material, which can result in sealant failure and a potential point of entry for moisture. A typical flashing splice is detailed in Figure 5. Here, the two sections of sheet metal type flashing that are to be spliced are first installed with a ¼-in. (6.4 mm) gap between them to allow for expansion of the flashing. Next, a section of pliable self-adhering membrane (such as rubberized-asphalt) or other pliable membrane set in mastic is fully bonded to the flashing at the location of the gap.

References

1. Building Code Requirements for Masonry Structures, ACI 530-02/ASCE 5-02/TMS 402-02, reported by the Masonry Standards Joint Committee, 2002.

2. Design for Dry Single-Wythe Concrete Masonry Walls, TEK 19-2A, National Concrete Masonry Association, 2001.

3. Flashing Strategies for Concrete Masonry Walls, TEK 19-4A, National Concrete Masonry Association, 2003.

4. Flashing...Tying the Loose Ends, Masonry Advisory Council, Chicago, IL, 1998

5. Generic Wall Design, Masonry Institute of Michigan, 1998.

Masonry Cement Mortars

The role of mortar in construction is to join the individual units together, resulting in masonry with the desired performance characteristics. To satisfy the Architect, Engineer, Contractor, Mason, Owner team, the mortar must possess:

In the Plastic State

Workability

The workability of plastic mortar depends on its ability to be spread easily, its ability to cling to vertical surfaces, and its resistance to flow during placement of a masonry unit.

Water Retention

This property resists rapid loss of mixing water to the air on a dry day or to an absorptive masonry unit. Rapid loss of water causes the mortar to stiffen quickly making it difficult to obtain a good bond and weather tight joints.

Consistent Rate of Hardening

Consistent rate of hardening assists the mason in laying the masonry units and in tooling the joints to the same degree of hardness. Uniform colour of masonry joints reflects proper hardening and consistent tooling times.

In the Hardened State

Bond

The term “bond” refers to a specific property that can be subdivided into: (1) extent of bond or degree of contact of the mortar with the masonry units; and (2) tensile bond strength, or force required to separate the units. A chemical and mechanical bond exists in each category.

Many variables affect bond including (1) mortar ingredients, such as type and amount of cementitious materials, water retained, and air content; (2) characteristics of the masonry units, such as surface texture, suction and moisture content; (3) workmanship, such as pressure applied to the mortar bed during placing; and (4) curing conditions, such as temperature, relative humidity and wind.

Durability

Corrosion by aggressive environments and unsound materials may contribute to the deterioration of mortar joints, the major destruction is caused by water entering the mortar and freezing. Because air-entrained mortar will withstand hundreds of freeze-thaw cycles, its use provides good protection against localized freeze-thaw damage.

Strength

Compressive strength of mortar is largely dependent on the type and quality of masonry cement used in preparing the mortar. It increases with an increase in cement content and decreases with an increase in air-entrainment, lime content and water content. Strengths should meet the property specification of ASTM C270.

Appearance

Uniformity of colour and shade of the mortar joints greatly affects the overall appearance of a masonry structure. Atmospheric conditions, admixtures, and moisture content of the masonry units are some of the factors affecting the colour and shade of mortar joints. Others are uniformity of proportions in the mortar mix, water content, and time of tooling the mortar joints.

Retempering

Fresh mortar should be prepared at the rate it is used so that its workability will remain about the same throughout the day. Mortar that has been mixed but not used immediately tends to dry out and stiffen. Loss of water by absorption and evaporation on a dry day can be reduced by wetting the mortar board and covering the mortar in the mortar box, wheelbarrow, or tub.

If necessary to restore workability, mortar may be retempered by adding water; thorough remixing is then necessary. Although small additions of water may slightly reduce the compressive strength of the mortar, the end result is acceptable. Masonry built using plastic mortar has a better bond strength than masonry built using dry, stiff mortar.

If colour mortar is used, no retempering should be permitted. Additional water may cause a significant lightening of the mortar.

Mortar Joints - Common Types

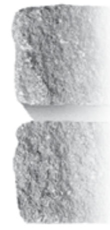
Selection of Type of Joint

Properly cured and tooled mortar joints serve two major purposes to a masonry wall; by tooling the joint, the mortar is compacted and provides a weather-resistant bond between masonry units, and by changing joints, different overall wall appearances will result.

Joints recommended for weather resistance are: concave, vee, flush, and weathered. The raked, beaded, grapevine, struck, and extruded joints are recommended where exposure to moisture is minimal or for interior work. To control the uniformity of colour of mortar joints in a wall, care should be taken to use consistent batching procedures when mixing, adequate mixing time, and most important to tool the joint after the mortar has begun to stiffen slightly. Should a joint be tooled too soon (in a wet condition) a light joint results; and conversely, if a joint is allowed to become too stiff, a dark, burned joint will result.


Concave


Raked

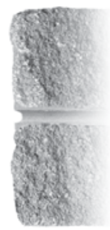

Struck

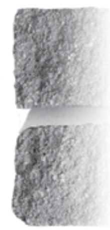

Beaded


Extruded


Flush


Vee


Grapevine


Weathered


Concave mortar joint


Flush or bagged mortar joint

9-1A Mortars for Concrete Masonry

Introduction

While mortar represents only a small proportion of the total wall area in concrete masonry construction (approximately 7 percent), its influence on the performance of a wall is significant. Mortar serves many important functions: it bonds units together into an integral structural assembly, seals joints against penetration by air and moisture, accommodates small movements within a wall, accommodates slight differences between unit sizes, and bonds to joint reinforcement, ties and anchors so that all elements perform as an assembly.

Mortar Materials

The American Society for Testing and Materials (ASTM) maintains national standards for mortars and materials commonly used in mortars, as follows:

Portland cement (ASTM C 150, ref. 4d) is a hydraulic cement (sets and hardens by chemical reaction with water) and is one of the main constituents of mortar. Types I (normal), II (moderate sulfate resistance), and III (high early strength) are permitted according to ASTM C 270 (ref. 4f). Air-entrained portland cements (IA, IIA, and IIIA) may be used as alternatives to each of these types.

Masonry cement (ASTM C 91, ref. 4b) is a hydraulic cement consisting of a mixture of portland cement or blended hydraulic cement and plasticizing materials (such as limestone, hydrated or hydraulic lime) together with other materials introduced to influence such properties as setting time, workability, water retention, and durability. Masonry cements are classified as Type M, Type S, or Type N according to ASTM C 270. In addition, Type N masonry cement can be combined with portland cement or blended hydraulic cement to produce Type S or M mortars.

Mortar cement (ASTM C 1329, ref. 4j) is a hydraulic cement similar to masonry cement, with the added requirement of a minimum bond strength requirement.

Blended hydraulic cements (ASTM C 595, ref. 4g) consist of standard portland cement or air-entrained portland cement (denoted by -A) combined through blending with such materials as blast furnace slag (S), or pozzolan (P & PM) which is usually fly ash. Types IS, IS-A, IP, IP-A, I(PM), or I(PM)-A blended cements may be used as alternatives to portland cement to produce ASTM C 270 compliant mortars. Types S or SA (slag cement) may also be used in mortars meeting the property specification requirements of ASTM C 270 (Table 2 of this TEK). Quicklime (ASTM C 5, ref. 4a) is calcined (burned-decarbonated) limestone, the major constituents of which are calcium oxide (CaO) and magnesium oxide (MgO). Quicklime must be slaked (combined chemically with water) prior to use. The resultant lime putty must be stored and allowed to hydrate for at least 24 hours before use. Consequently, quicklime is rarely used in mortar.

Hydrated lime (ASTM C 207, ref. 4e) is a dry powder obtained by treating quicklime with enough water to satisfy its chemical affinity for water. ASTM C 207 designates Type N (normal), Type S (special), and air-entraining Type NA and Type SA hydrated limes. Slaking of hydrated lime is not required, thus hydrated lime is immediately usable and much more convenient than quicklime. ASTM C 207 limits the amount of unhydrated oxides in Type S or Type SA hydrated limes, assuring the soundness of mortar made using these limes. Types N or NA lime are not typically used in mortar; however, they are permitted if shown by test or performance record to not be detrimental to the soundness of the mortar. Air-entrained limes are only permitted in mortars containing nonair-entrained cement.

Aggregates (ASTM C 144, ref. 4c) for mortar consist of either natural or manufactured sand. Manufactured sand is the product obtained by crushing stone, gravel, or air cooled blast furnace slag. It is characterized by sharp, angular shaped particles. Gradation limits are established in ASTM C 144 for both natural and manufactured sands. Aggregates which fail these gradation limits may be used, as long as the resulting mortar complies with the property specification requirements of ASTM C 270, as shown in Table 2.

Water for masonry mortar (ASTM C 270, ref. 4f) must be clean and free of deleterious amounts of acids, alkalis, or organic materials. Potability of water is not in itself a consideration, but the water obtained from drinking supply sources is considered suitable for use.

Modifiers (also sometimes called admixtures or additives) for masonry mortars (ASTM C 1384, ref. 4k) are available for various purposes. Modifiers are functionally classified as bond enhancers, workability enhancers, set accelerators, set retarders, and water repellents. Since chlorides accelerate the corrosion of steel reinforcement and accessories ASTM C 1384 stipulates that modifiers add not more than 0.15% water-soluble chloride or 0.20% acid-soluble chloride by weight of portland cement.

Similarly, the Specifications for Masonry Structures (ref. 3) limits admixtures to no more than 0.2% chloride ions. The document also limits pigments for coloring to no more than 1 to 10% by weight of cement depending upon the pigment type.

Effect of Materials on Mortar

With the diversity of materials available, masonry mortars can be formulated to produce the desired properties for most specific job requirements. Each of the individual ingredients (cement, lime, sand, water, and any modifiers present) contributes to the performance of the mortar. Portland cement provides strength and durability. Lime imparts workability, water retention, as well as some limited cementitious and autogenous healing properties. Sand acts as a filler and provides body to the mortar while helping to reduce shrinkage and control cracking. Water acts as a mixing agent, a lubricant, and is also needed for hydration of the portland cement.

The various material options alter the characteristics of the mortar in a predictable manner. Changes in cement type promote slight changes in setting characteristics, workability, color, and strength development. Use of air-entrained cement or lime generally results in decreased water demand, improved workability, increased freeze-thaw resistance, and decreased bond strength. Masonry cements, used singly or in combination with portland cement, provide mortars with excellent workability and freeze-thaw durability; however, bond strengths may be reduced. Consequently, design allowable flexural tension values vary based on mortar type and cementitious materials or lime used for unreinforced masonry (ref. 1).

Changes in sand type and gradation affect mortar properties. Natural sand gives improved workability at a lower water demand because of the spherical particle shape, while manufactured sands require additional water due to their angular shape. In general, well graded aggregates reduce segregation in a plastic mortar, which in turn inhibits bleeding and improves workability. Sands deficient in fines generally produce harsh mortars, while sands with excessive fines typically result in mortars with lower compressive strengths.

Types of Mortar

Building codes generally specify mortar types as referenced in ASTM C 270, Standard Specification for Mortar for Unit Masonry (ref. 4f). Four mortar types, M, S, N and O are included in this standard. However, Types M, S, and N are typically required by building codes. Building codes also may restrict the use of some mortars for particular applications. For example, in seismic performance categories C, D, and E (seismic zones 3 and 4), as well as for the empirical design of foundation walls, mortar Types S or M are required (ref. 1). Glass unit masonry requires Type N or S mortar (ref. 1).

Proportioning Mortar

All mortar types are governed by either of the two specifications contained in ASTM C 270: the proportion specification or the property specification. Only one of the specifications should be called for in the project documents, not both. The proportion specification (Table 1) prescribes the parts by volume of each ingredient required to provide a specific mortar type.

A combination of portland cement and lime may be used as the cementing agent in each type of mortar. Also, masonry cements or mortar cements subject to the provisions of ASTM C 91, Standard Specification For Masonry Cement, are available that meet the requirements of M, S, and N mortars with or without further addition of cement.

As an alternative, approved materials may be mixed in controlled percentages as long as the resultant mortar meets the physical requirements designated in ASTM C 270, as shown in Table 2. The aggregate ratio noted in Table 2 must be followed.

9-1A Mortars for Concrete Masonry

Table 1 ASTM C 270 Proportion Specification Requirements
(ref. 4) Proportions by volume (cementitious materials)

Mortar	Type	Portland cement or blended cement	Mortar Cement			Masonry cement			Hydrated lime or lime putty	Aggregate ratio (measured in damp, loose conditions)
			M	S	N	M	S	N	1/4	
Cement-Lime	M	1	-	-	-	-	-	-	over 1/4 to 1/2	Not less than 2 1/4 and not more than 3 times the sum of the separate volumes of cementitious materials.
	S	1	-	-	-	-	-	-	over 1/2 to 1 1/4	
	N	1	-	-	-	-	-	-	over 1 1/4 to 2 1/2	
	O	1	-	-	-	-	-	-	-	
Mortar Cement	M	1	-	-	1	-	-	-	-	
	M	-	1	-	-	-	-	-	-	
	S	1/2	-	1	-	-	-	-	-	
	S	-	-	-	-	-	-	-	-	
	N	-	-	1	-	-	-	-	-	
	O	-	-	1	-	-	-	-	-	
Masonry Cement	M	1	-	-	-	-	1	-	-	
	M	-	-	-	1	-	-	-	-	
	S	1/2	-	-	-	-	1	-	-	
	S	-	-	-	-	1	-	-	-	
	N	-	-	-	-	-	1	-	-	
	O	-	-	-	-	-	1	-	-	

Note: Two air-entraining materials should not be contained in mortar.

Conformance to the property specification of ASTM C 270 is established by testing laboratory prepared mortar during a pre-construction evaluation of the mortar proposed for the project. The laboratory then establishes proportions for mortar, based on successful tests. These proportions are then followed when preparing field mortar.

Table 2 ASTM C 270 Property Specification Requirements*(ref. 4)

Mortar	Type	Avg. compressive strength at 28 days min.psi (MPa)	Water retention, min %	Air content max %	Aggregate ratio (measured in damp, loose conditions)
Cement-Lime	M	2500 (17.2)	75	12	Not less than 2 1/4 and not more than 3 1/2 times the sum of the separate volumes of cementitious materials.
	S	1800 (12.4)	75	12	
	N	750 (5.2)	75	14**	
	O	350 (2.4)	75	14**	
Mortar Cement	M	2500 (17.2)	75	12	
	S	1800 (12.4)	75	12	
	N	750 (5.2)	75	14**	
	O	350 (2.4)	75	14**	
Masonry Cement	M	2500 (17.2)	75	18	
	S	1800 (12.4)	75	18	
	N	750 (5.2)	75	20**	
	O	350 (2.4)	75	20**	

*Laboratory prepared mortar only.

**When structural reinforcement is incorporated in cement-lime mortar, the maximum air content shall be 12%.

***When structural reinforcement is incorporated in masonry cement mortar, the maximum air content shall be 18%.

Masonry Mortar Properties

Many properties of mortar are not precisely definable in quantitative terminology because of a lack of definitive standards by which to measure them. For example, mortars can be rated on the basis of obtaining visually satisfactory mortar joints.

Depending on the particular circumstances for a given project, the criteria for mortar selection are based on design considerations, mortar properties in the plastic state or mortar properties in a hardened state. Consideration of each is necessary to achieve a desired result.

Properties of Plastic Mortar

Workability is the property of mortar characterized by the smooth plastic consistency which makes it easy to spread. This is the property of most importance to the mason. A workable mortar spreads easily under the trowel; adheres to vertical surfaces during unit handling, placement, and bedding; maintains alignment as other units are positioned; and provides a watertight, closed joint when tooled.

Once mix proportions have been established, the addition of water should be consistent with that required to improve mortar placement without sacrificing the ability to support the masonry unit. Adequate water content promotes intimate contact between the unit and mortar, which is essential for satisfactory bond. While water content has the greatest influence on the workability of a mortar, cementitious materials, aggregate gradation, and air-entrainment also contribute to a lesser degree.

Water retention of mortar is a measure of the mortar's ability to retain its plasticity when subjected to the atmosphere or the absorptive forces of a concrete masonry unit. Mortars with low water retention stiffen more quickly, making it difficult for the mason to bed and adjust the masonry unit during placement. Mortars with desired water retention characteristics allow the mason to lay a mortar bed two or three units ahead before placing subsequent units. Water retentivity is dependent on properties of the cementitious materials, sand gradation, and mortar proportions.

9-1A Mortars for Concrete Masonry

The time lapse between spreading a mortar bed and placing block should be kept to a minimum, because the workability will be reduced as water is absorbed into the block. If too much time elapses before a block is placed on a fresh mortar bed, units are less easily positioned and the bond will be reduced.

Evaporation of the mixing water from mortar may require retempering (mixing in additional water). This generally is not harmful as long as it is done prior to hydration of the mortar. To avoid the stiffening effects of hydration, mortar must be placed in final position within 21/2 hours after the original mixing (ref. 3) unless special set retarding admixtures are used.

Properties of Hardened Mortar

Properties of hardened mortar that affect the performance of the finished concrete masonry include bond, compressive strength, and durability. These properties are difficult to measure other than in laboratory or field specimens prepared under controlled conditions. However, ASTM C 1324, Standard Test Method for Examination and Analysis of Hardened Masonry Mortar, (ref. 4i) provides procedures for petrographic examination and chemical analysis for components of masonry mortar in the hardened state. A 0.35 oz. (10 g) sample is usually sufficient for both the petrographic and chemical analysis. When obtaining the sample, however, it is important to ensure that the sample is representative of the mortar in question, i.e. original mortar as opposed to pointing mortar or other mortars used on the project.

Bond is a term used to describe both the extent of contact between mortar and unit and the strength of adhesion. Bond is a function of several factors including mortar properties, unit surface characteristics, workmanship, and curing. Other factors being equal, bond strength will increase as the compressive strength of the mortar increases, although not in direct proportion. Bond may also be effectively increased through the use of properly designed mortars having water contents which provide good workability.

Compressive strength is perhaps the most commonly measured property of mortar but is perhaps the most misunderstood. Whenever compressive strength results are intended to be used to determine conformance of a mortar to the property specifications of ASTM C 270, compressive strength tests must be conducted in accordance with the laboratory procedures required by ASTM C 270. The mortar compressive test in ASTM C 780, Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry, (ref. 4h) is only to verify the consistency of materials and procedures, not to determine mortar strength (ref. 3). It contains no requirement for minimum compressive strength of field mortar and states that the strength should not be construed as being representative of the actual strength of the mortar. The reason is that the mortar strength in the wall will be much higher than the field test because of the reduced water cement ratio due absorption of mix water into the masonry units and a greatly reduced shape factor in the mortar joint versus the mortar test cube.

Durability of mortar also is an important consideration for parapets or other walls with an extreme exposure to the weather. Oversanding or overtempering can decrease durability. High strength mortars and air entrained mortars provide increased durability. For more detailed discussion on field testing of mortar see TEK 18-5, Masonry Mortar Testing (ref. 2).

References

1. Building Code Requirements for Masonry Structures, ACI 530-99/ASCE 5-99/TMS 402-99. Reported by the Masonry Standards Joint Committee, 1999.

2. Masonry Mortar Testing, TEK 18-5. NCMA, 1995.

3. Specifications for Masonry Structures, ACI 530.1-99/ASCE 6-99/TMS 602-99. Reported by the Masonry Standards Joint Committee, 1999.

4. 2001 Annual Book of ASTM Standards, American Society for Testing and Materials :

- **4a.** C 5-79 (1997), Standard Specification for Quicklime for Structural Purposes.
- **4b**. C 91-99, Standard Specification for Masonry Cement.
- **4c.** C 144-99, Standard Specification for Aggregate for Masonry Mortar.
- **4d.** C 150-00, Standard Specification for Portland Cement.
- **4e.** C 207-91(1997), Standard Specification for Hydrated Lime for Masonry Purposes.
- **4f.** C 270-00, Standard Specification for Mortar for Unit Masonry.
- **4g.** C 595-00ae1, Standard Specification for Blended Hydraulic Cements.
- **4h.** C 780-00, Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
- **4i.** C 1324-96, Standard Test Method for Examination and Analysis of Hardened Masonry Mortar.
- **4j.** C 1329-00, Standard Specification for Mortar Cement.
- **4k.** C 1384-01, Standard Specification for Admixtures for Masonry Mortars.

Cold Weather Construction

When masonry construction is carried on during periods of freezing weather, proper facilities should be available for preparing the mortar and protecting the fresh masonry work against frost damage. The most important consideration is that sufficient heat be provided to ensure hydration of the cement. After combining all ingredients, mortar temperature should be within the range of 4°C (40°F) to 49°C (120°F). Mortar temperatures in excess of 49°C (120°F) may cause excessively fast hardening with resultant loss of compressive and bond strength.

The use of an admixture to lower the freezing point of mortars during winter construction should be avoided. The quantity of such materials necessary to lower the freezing point of mortar to any appreciable degree would be so large that mortar strength and other desirable properties would be seriously impaired.

Recommendations for Cold-Weather Construction:
The following table gives requirements at various cold-weather temperatures for heating of materials and protections of construction.

Above 4°C

Normal Masonry Procedures. No heating (40°F) required. Cover walls with plastic or canvas at end of work day to prevent water entering masonry.

Below 4°C

Heat mixing water. Maintain mortar (40°F) temperatures between 4°C (40°F) and 49°C (120°F) until placed.Cover walls and materials to prevent wetting and freezing. Covers should be plastic or canvas.

Below 0°C

In addition to the above, heat the sand. Frozen (32°F) sand and frozen wet masonry units must be thawed. With wind velocities over 24 kmh (15 mph), provide windbreaks during the work day and cover walls and materials at the end of the work day to prevent wetting and freezing. Maintain masonry above 0°C (32°F) using auxiliary heat or insulated blankets for 16 hours after laying units.

Below -7°C

In addition to the above, dry masonry units (20°F) must be heated to -7°C (20°F). Provide enclosure and supply sufficient heat to maintain masonry enclosure above 0°C (32°F) for 24 hours after laying units.

Refer to NCMA Tek 3-1C All Weather Concrete and Masonry Construction or contact the Shouldice Head Office for more information.

10-1A Crack Control

Crack Control In Concrete Masonry Walls

Cracks in buildings and building materials normally result from restrained movement. This movement may originate within the material, as with volume changes due to moisture loss or acquisition, temperature expansion or contraction, may result from movements of adjacent or supporting materials, such as deflection of beams or slabs. In many cases, movement is inevitable and must be accommodated or controlled.

Designing for effective crack control requires an understanding of the sources of stress which may cause cracking. It would be a simple matter to prevent cracking if there were only one variable. However, prevention is made more difficult by the fact that cracking often results from a combination of sources.

Causes Of Cracking

There are a variety of potential causes of cracking. Understanding the cause of potential cracking allows the designer to incorporate appropriate design procedures to control it. The most common causes of cracking in concrete masonry are discussed below.

Shrinkage/Restraint

Cracking resulting from shrinkage can occur in concrete masonry walls because of drying shrinkage, temperature fluctuations, and carbonation. These cracks occur when masonry panels are restrained from moving.

Drying Shrinkage

Concrete products are composed of a matrix of aggregate particles coated by cement which bonds them together. Once the concrete sets, this cementitious-coated aggregate matrix expands with increasing moisture content and contracts (shrinks) with decreasing moisture content. Drying shrinkage is therefore a function of change in moisture content.

Although mortar, grout, and concrete masonry units are all concrete products, unit shrinkage has been shown to be the predominate indicator of the overall wall shrinkage principally due to the fact that it represents the largest portion of the wall. Therefore, the shrinkage properties of the unit alone are typically used to establish design criteria for crack control.

For an individual unit, the amount of drying shrinkage is influenced by the wetness of the unit at the time of placement as well as the characteristics and amount of cementitious materials, the type of aggregate, consolidation, and curing. Specifically, drying shrinkage is influenced in the following ways:

- walls constructed with “wet” units will experience more drying shrinkage than drier units ;
- increases in cement content increase drying shrinkage;
- aggregates that are susceptible to volume change due to moisture content will result in increased shrinkage; and units that have undergone at least one drying cycle will not undergo as much shrinkage in subsequent drying cycles (ref. 7).
- typical drying shrinkage coefficients range from 0.0002 to 0.00045 in./in. (mm/mm) or 0.24 to 0.54 in. (6.1 to 13.7 mm) in 100 ft (30.48 m).

Temperature Changes

Concrete masonry movement has been shown to be linearly proportional to temperature change. The coefficient of thermal movement normally used in design is 0.0000045 in./in./°F (0.0000081 mm/mm/°C) (ref. 2). Actual values may range from 0.0000025 to 0.0000055 in./in./°F (0.0000045 to 0.0000099 mm/mm/°C) depending mainly on the type of aggregate used in the unit. The actual change in temperature is, of course, determined by geographical location, wall exposure, and colour.

As an example, a wall constructed during 70°F (21°C) weather and subjected to a minimum temperature of 0°F (-18°C) results in a shortening of about 0.38 in. (9.7 mm) in a 100 foot (30.48 m) long wall using the 0.0000045 in./in./°F (0.0000081 mm/mm/°C) coefficient.

Carbonation

Carbonation is an irreversible reaction between cementitious materials and carbon dioxide in the atmosphere that occurs slowly over a period of several years. Since there currently is no standard test method for carbonation shrinkage, it is suggested that a value of 0.00025 in./in. (mm/mm) be used. This results in a shortening of 0.3 in. (7.6 mm) in a 100 foot (30.48 m) long wall.

Restraint

As previously mentioned, the above phenomenon produce movement in the wall. When external restraint is provided that resists this movement, the result is tension within the wall and a corresponding potential for cracking. Typically, concrete masonry walls are restrained along the bottom of the wall (mainly by the foundation) with partial restraint along the top of the wall. The ends of the typical concrete masonry wall panel may be partially restrained by pilasters or wall intersections, but this partial restraint usually does not significantly alter the wall’s cracking potential. Exceptions to the typical restraint condition include cantilevered walls which are restrained along their base, but free (unrestrained) at the top. It is conservative to base general crack control design criteria on a condition of restraint along the top and bottom of the wall.

Differential Movement

Various building materials may react differently to changes in temperature, moisture, or structural loading. Any time materials with different properties are combined in a wall system, a potential exists for cracking due to differential movement. With concrete masonry construction, two materials in particular should be considered: clay brick and structural steel.

Differential movement between clay brick and concrete masonry must be considered when the two are attached since concrete masonry has an overall tendency to shrink while clay brick masonry tends to expand. These differential movements may cause cracking, especially in composite construction and in walls that incorporate brick and block in the same wythe.

Composite walls are multi-wythe walls designed to act structurally, as a single unit in resisting applied loads. The wythes are typically bonded together using wall ties at prescribed intervals to assure adequate load transfer. When the composite wall includes a clay brick wythe bonded to a concrete masonry wythe, ladder-type joint reinforcement, or box ties are used to provide some degree of lateral movement between wythes. In addition, expansion joints are installed in the clay brick wythe to coincide with control joints in the concrete masonry wythe.

When clay brick is used as an accent band in a concrete masonry wall, or vice-versa, the differential movement of the two materials may result in cracking unless provisions are made to accommodate the movement. To reduce cracking, slip planes between the band and the surrounding wall, horizontal reinforcement or more frequent control joints or a combination thereof can be used to control cracking. See Crack Control for Concrete Brick and Other Concrete Masonry Veneers (ref. 6) for more information on these approaches.

Thermal movement differences also need to be taken into consideration when using masonry in conjunction with structural steel. In addition to differences in thermal coefficients, steel shapes typically have a much higher surface area to volume ratio and tend to react to changes in temperature more quickly. This is normally accommodated with slotted and flexible connections. Concrete Masonry Walls for Metal Buildings (ref. 5) provides more detailed information on this subject.

Excessive Deflection

As walls and beams deflect under structural loads, cracking may occur. Additionally, deflection of supporting members can induce cracks in masonry elements. To reduce the potential for cracking, the following alternatives are available:

- adding reinforcing steel into the masonry to cross the expected cracks and to limit the width of the cracks,
- limiting the deflection of members providing vertical support of unreinforced masonry to acceptable levels (less than or equal to l/600 nor more than 0.3 in. (7.6 mm) due to dead load and live load when supporting unreinforced masonry) (ref. 2), and;
- utilizing movement joints to effectively panelize the masonry so that it can articulate with the deflected shape of the supporting member.

Structural Overload

All wall systems are subject to potential cracking from externally applied design loads due to wind, soil pressure or seismic forces. Cracking due to these sources is controlled by applying appropriate structural design criteria such as allowable stress design or strength design. These criteria are discussed in detail in Allowable Stress Design of Concrete Masonry and Strength Design of Concrete Masonry (refs. 1 and 9).

Settlement

Differential settlement occurs when portions of the supporting foundation subside due to weak or improperly compacted foundation soils. Foundation settlement typically causes a stair-step crack along the mortar joints in the settled area as shown in Figure 1. Preventing settlement cracking depends on a realistic evaluation of soil bearing capacity, and on proper footing design and construction.

Footings should be placed on undisturbed native soil, unless this soil is unsuitable, weak, or soft. Unsuitable soil should be removed and replaced with compacted soil, gravel, or concrete. Similarly, tree roots, construction debris, and ice should be removed prior to placing footings. Adding reinforcement in foundations can also lessen the effects of differential settlement.

10-1A Crack Control

Crack Control Strategies

In addition to the proper design strategies discussed above for structural capacity and differential movement, the following recommendations can be applied to limit cracking in concrete masonry walls.

Material Properties

Traditionally, crack control in concrete masonry has relied on specifying concrete masonry units with a low moisture content, using horizontal reinforcement, and using control joints to accommodate movement. Prior to the 2000 edition of ASTM C 90 (ref. 8), low moisture content was specified by requiring a Type I moisture controlled unit. The intent was to provide designers an assurance of units with lower moisture content to minimize potential shrinkage cracking. However, there are several limitations to relying on moisture content alone since there are other factors that influence shrinkage which are not accounted for by specifying a Type I unit. Additionally, Type I units were not always inventoried by concrete masonry manufacturers. Most importantly, Type I units needed to be kept protected until placed in the wall, which was proven to be difficult on some projects. Because of the above problems associated with the Type I specification, ASTM removed the designations of Type I, Moisture-Controlled Units and Type II, Nonmoisture Controlled Units from the standard.

Due to removal of the unit type designations from ASTM C90, two methods of determining control joint spacings have been devised irrespective of unit type: 1). Empirical crack control criteria which is based on successful, historical performance over many years in various geographic conditions and 2). Engineered crack control criteria based on a Crack Control Coefficient (CCC) that includes the combined effects of movement due to drying shrinkage, carbonation shrinkage, and contraction due to temperature change. The first is presented in NCMA TEK 10-2B, Control Joints for Concrete Masonry Walls - Empirical Method (ref. 4) and the second in TEK 10-3 Control Joints for Concrete Masonry Walls - Alternative Engineered Method (ref. 3). The empirical method is the most commonly used method and is applicable to most conventional building types. The engineered method is generally used only when unusual conditions are encountered such as dark coloured units in climates with large temperature swings.

Control Joints

Control joints are essentially vertical separations built into the wall to reduce restraint and permit longitudinal movement. Because shrinkage cracks in concrete masonry are an aesthetic rather than a structural concern, control joints are typically only required in walls where shrinkage cracking may detract from the appearance or where water penetration may occur. TEK 10-2B (ref. 4) provides much more detailed information on control joint details, types and locations.

Reinforcement to Limit Crack Width

In addition to external restraint, reinforcement causes some internal restraint within the wall. Reinforcement responds to temperature changes with corresponding changes in length; however, reinforcement does not undergo volumetric changes due to moisture changes or carbonation. Consequently, as the wall shrinks, the reinforcement undergoes elastic shortening (strain) which results in compressive stress in the steel. Correspondingly, the surrounding masonry offsets this compression by tension. At the point when the masonry cracks and tries to open, the stress in the reinforcement turns to tension and acts to limit the width of the crack by holding it closed.

The net effect is that reinforcement controls crack width by causing a greater number (frequency) of cracks to occur. As the horizontal reinforcement ratio (cross-sectional area of horizontal steel vs. vertical cross-sectional area of masonry) increases, crack width decreases. Smaller sized reinforcement at closer spacings is more effective than larger reinforcement at wider spacings, although horizontal reinforcement at spacings up to 144 in. (3658 mm) is considered effective in controlling crack widths in some areas.

Studies have shown that reinforcement, either in the form of joint reinforcement or reinforced bond beams, effectively limits crack width in concrete masonry walls. As indicated previously, as the level of reinforcement increases and as the spacing of the reinforcement decreases, cracking becomes more uniformly distributed and crack width decreases. For this reason, a minimal amount of horizontal reinforcement.

Walls in high seismic areas with a relatively large amount of horizontal reinforcement may not require control joints, as the reinforcement alone reduces the width of shrinkage cracks to a size that can be treated effectively with water repellent coatings. Experience has shown that this can be accomplished in walls with at least 0.2% of horizontal reinforcement (ref. 3). See Table 1 for the size and spacing of reinforcement to meet this criteria.

Table 1—Maximum Spacing of Horizontal Reinforcement to Meet the Criteria As > 0.002 An[1]

Wall thickness, in (mm)	Maximum spacing of horizontal reinforcement, in. (mm) Reinforcement size		
	No. 6 (M19)	No. 5 (M16)	No. 4 (M13)
Ungrouted or partially grouted walls			
6 (152)	48 (1219)	48 (1219)	32 (813)
8 (203)	48 (1219)	40 (1016)	24 (610)
10 (254)	48 (1219)	32 (813)	16 (406)
12 (305)	48 (1219)	24 (610)	8 (203)
Fully grouted walls			
6 (152)	32 (813)	24 (610)	16 (406)
8 (203)	24 (610)	16 (406)	8 (203)
10 (254)	16 (406)	16 (406)	8 (203)
12 (305)	16 (406)	8 (203)	8 (203)

1. A_n includes cross-sectional area of grout in bond beams

References

1. Allowable Stress Design of Concrete Masonry, TEK 14-7A. National Concrete Masonry Association, 2002.

2. Building Code Requirements for Masonry Structures, ACI 530-02/ASCE 6-02/TMS 402–02. Reported by the Masonry Standards Joint Committee, 2002.

3. Control Joints for Concrete Masonry Walls - Alternative Engineered Method, TEK 10-3. National Concrete Masonry Association, 2003.

4. Control Joints for Concrete Masonry Walls - Empirical Method, TEK 10-2B. National Concrete Masonry Association, 2001.

5. Concrete Masonry Walls for Metal Buildings, TR–149. National Concrete Masonry Association, 1996.

6. Crack Control for Concrete Brick and Other Concrete Masonry Veneers, TEK 10-4. National Concrete Masonry Association, 2001.

7. Measuring Shrinkage of Concrete Block - A Comparison of Test Methods, E.L. Saxer and H.T. Toennies, Pages 988-1004, 1957.

8. Standard Specification for Loadbearing Concrete Masonry Units, ASTM C 90-03. ASTM International, 2003.

9. Strength Design of Concrete Masonry, TEK 14–7A. National Concrete Masonry Association, 2002.

10-4 Crack Control

Introduction

Concrete masonry veneer is used to provide a beautiful, economical and highly durable exterior. Concrete brick are widely used over concrete masonry, concrete frame, steel or wood structural backup. Concrete brick masonry also offers tremendous architectural versatility. The finished appearance of the wall can be altered by changing the unit size, unit or mortar colour, as well as the masonry bond pattern. A wide range of surface textures is also available, such as split face, Rock-Stone, Tex-Stone, or Tapestry. In addition, concrete brick can be used to provide a traditional clay brick appearance, while offering the flexibility available with the colours and architectural finishes of conventional concrete masonry products. Tumbled concrete brick and surface colour coatings are also available to simulate the look of antique brick.

The term "brick" historically refers to a masonry unit that can be held in the hand, although the term is often associated with fired clay masonry. Concrete masonry veneers that resemble brick are constructed using either concrete brick units or half-high concrete masonry units, as shown in Figure #1. Concrete brick units most commonly have a nominal thickness of 4 in. (102 mm), lengths of 9 3/4 or 12 in. (247 or 290 mm) and heights from 3 to 3 1/2 in. (64 to 152 mm). The specified size of a concrete brick is typically 3 5/8 x 3 x 9 3/4 in. (90 x 75 x 247 mm). They are usually laid with bed joints 3/8 in. (10 mm) thickness to provide a constructed height of 3 3/8 in. (86 mm), so that three courses of concrete brick equals one 9 3/4 in. (247 mm) high module. In many cases, additional sizes and configurations are available.

This TEK addresses crack control measures specifically developed for concrete masonry veneers to accommodate cracking resulting from internal volume change of the concrete masonry. Potential cracking resulting from externally applied loads is not covered. Further information on concrete masonry veneers is available in TEK 3-6A Concrete Masonry Veneers,

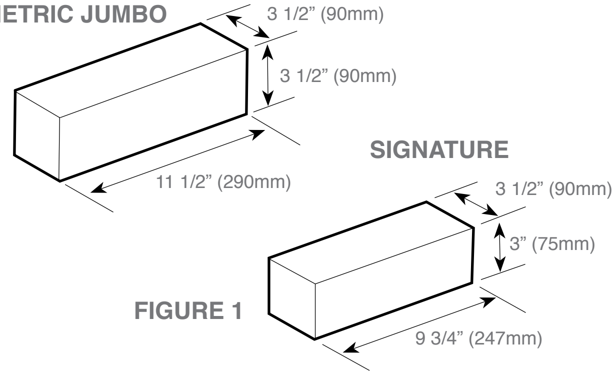


FIGURE 1

TEK 16-2A Concrete Brick Structural Design Considerations and TEK 16-3A Structural Backup Systems for Masonry Veneer (refs. 3, 4 and 5).

Concrete Brick Compared To Clay Brick

Building with concrete brick has some intrinsic differences from building with clay brick due to different material properties. One should not be substituted for the other without due consideration of these differences.

Concrete masonry walls have an overall tendency to shrink, whereas clay brick walls tend to expand. Both concrete and clay masonry may use movement joints to accommodate this movement, although the type of joint is different for clay than for concrete masonry. When control joints are required, concrete brick requires only vertical control joints whereas clay brick typically requires both vertical and horizontal expansion joints to accommodate panel expansion. In commercial construction, horizontal expansion joints are most often installed at each floor level below steel shelf angles used to support the clay brick. Concrete brick installations may include shelf angles as lintels over openings or in curtain wall construction.

Placing concrete brick units also differs from placing clay brick, because the production techniques differ between concrete and clay brick. Concrete brick have very consistent dimensional tolerances compared to clay brick. Concrete brick should not be wetted prior to placement. Concrete brick unit properties are summarized in TEK 1-1C, ASTM Specifications for Concrete Masonry Units (ref. 7).

When clay brick banding is incorporated in a concrete masonry veneer, a horizontal slip plane is used to accommodate differential movement between the two materials. See TEK 10-1A, Crack Control in Concrete Masonry Walls (ref. 11) for more information.

Crack Control Recommendations

Concrete masonry veneer units, like all concrete products, tend to decrease in volume as drying occurs. This potential shrinkage should be provided for in the design, detailing and construction to minimize shrinkage cracking. Shrinkage cracks in concrete masonry are an aesthetic, rather than structural, concern. Because veneers, by definition, are primarily aesthetic, crack control for veneers is often a high design priority.

While movement due to moisture change is the primary focus when addressing nonstructural movement in masonry walls, temperature changes can also cause reversible shrinkage and expansion. It should be noted that darker masonry units as well as those installed on southern and western exposures will experience larger daily temperature variations due to solar exposure, and hence may require more attention to adequately address wall movement.

Crack control measures for concrete masonry veneers are similar to those for other concrete masonry walls. In fact, conventional concrete masonry crack control measures, such as those in TEK 10-2B, Control Joints for Concrete Masonry Walls—Empirical Method (ref. 1), have been used successfully for concrete masonry veneers in many cases.

Crack control recommendations for concrete masonry veneers are summarized below and are described more fully in the following sections.

Crack Control Recommendations for Concrete Masonry Veneers*
· Control joints: maxumum panel length to height ratio of 1 1/2, and maximum spacing of 20 ft. (6.1m) and where stress concentration occurs
· Joint reinforcement: at 16 in. (406mm) o.c.
· Mortar: Type N
*Adust as needed to suit local conditions and exerience.

Unit Characteristics

Because the units used for veneers are often produced specifically for veneer applications, the physical properties may differ from those of larger concrete masonry units. These differences can impact how the concrete masonry veneer moves and reacts to changes in moisture content and temperature. Hence, crack control recommendations have been tailored specifically for concrete masonry veneers.

Ensuring that the concrete masonry units are relatively dry when laid and remain dry during construction will also help minimize initial drying shrinkage of the wall.

Techniques to minimize water absorption by the veneer will also help limit subsequent movement due to moisture loss. Some manufacturers have had success in reducing veneer movement by incorporating integral water repellents in the veneer units during manufacture. When used in the units and added to the mortar on site, integral water repellents help minimize water absorption.

Mortar

Using a lower compressive strength mortar helps ensure that when cracks do occur, they occur in the mortar joint rather than through the unit. Type N mortar is often specified for concrete brick veneers, because it tends to be more flexible than other mortar Types. ASTM C 270, Standard Specification for Mortar for Unit Masonry (ref. 6) recommends that Type S mortar be used in parapets, chimneys and other exposed applications.

Joint Reinforcement

Horizontal joint reinforcement effectively limits crack width by holding any cracks that form tightly together. For this reason, joint reinforcement, spaced at 16 in. (406 mm) on center, is recommended in concrete masonry veneers, although acceptable performance has been achieved without joint reinforcement in some cases.

To protect joint reinforcement from corrosion, Specification for Masonry Structures (ref. 9), requires at least 5/8 in. (16 mm) of mortar cover between the joint reinforcement and the weather-exposed face of the masonry.

When both joint reinforcement and control joints are used, the joint reinforcement should be discontinued at the control joint to avoid restricting horizontal movement at the joint.

10-4 Crack Control

Figure 2 - Example of Residential Control Joint Placement

Control Joints

Control joints are vertical separations built into the veneer and located where stress concentrations are likely to cause cracks. The joints allow unrestrained longitudinal movement, thereby relieving horizontal tensile stress that may develop due to shrinkage.

Ideally, a control joint should be located wherever masonry volume changes are likely to cause cracking. Because this can be difficult to determine in practice, the following are general guidelines for locating control joints.

For veneer panels without openings or other points of stress concentration, control joints are used to effectively divide a wall into a series of panels. In general, it is desirable to keep these panels as square as possible to minimize cracking between the control joints. When this is not possible, the panel length to height ratio should be limited to 1 1/2, with a maximum control joint spacing of 20 ft. (6.1 m). Control joint spacing should be adjusted where local experience justifies.

Whenever possible, control joints should be located where stress concentrations occur, such as: at changes in wall height or thickness; at inside corners; within 4 in. (102 mm) of outside corners; and near one or both sides of large door and window openings. Note that every opening does not necessarily require control joint(s), particularly in buildings with many small openings (see Residential Construction section, below). Note that control joints should line up with the end of the lintel, rather than be placed through the lintel, as shown in Figure 2.

Veneers are typically attached to a structural backup with adjustable ties or anchors (for tie and anchor types, design criteria and spacing requirements, see TEK 12-1A, Anchors and Ties for Masonry (ref. 8)). Ties should be placed within 12 in. (305 mm) of the control joint. When flexible ties are used, control joint locations need not align with control joints in the backup when a masonry backup wythe is used, although it is considered good practice to align them. If the veneer is rigidly bonded to a masonry backup, however, control joints should extend through the backup and veneer in the same location.

Residential Construction

Control joint recommendations for larger buildings typically call for a control joint at each window, and on both sides of the window if the window is over 6 ft (1.8 m) wide (ref. 1). However, this may be difficult to accomplish in residential construction because of the large number of relatively small openings. One strategy is to use control joints to divide the wall into panels that are no longer than they are high. Because residential buildings typically have fewer stories than commercial, this often results in closer control joint spacings than are common in commercial buildings.

Figure 2 shows a residential facade with recommended control joint locations. As an alternative to the right-hand joint shown in Figure 2, a control joint could be placed through or to one side of the garage door. Horizontal joint reinforcement placed at 16 in. (406 mm) o.c. will help compensate for not placing control joints at every window opening.

In residential construction, veneers are most often supported by wood frame construction (see Figure 3). Detailed requirements for masonry veneer over wood frame are described in TEK 3-6A, Concrete Masonry Veneers (ref. 3).

CONTROL JOINT CONSTRUCTION

Structural masonry walls require that control joints permit free longitudinal movement while resisting lateral or out-of-plane shear loads. Because veneers are nonstructural, veneer control joints need only permit unrestricted longitudinal movement. This can be accomplished by raking out the mortar joint and installing a backer rod and appropriate sealant, as shown in Figure 4. The backer rod and sealant allows in-plane movement while keeping the joint weathertight.

Several strategies are used to make control joints less noticeable. Perhaps the simplest approach is to locate the vertical control joint behind a downspout. If the architectural style allows it, a recess can be built into the veneer to create a vertical shadow line and provide an inconspicuous control joint location, or the control jopint can be aligned with another architectural feature. When quoins are used, the control joint can be placed adjacent to the edge of the quoin to make it less noticeable.

References

1. Control Joints for Concrete Masonry Walls—Empirical Method, TEK 10-2B. National Concrete Masonry Association, 2001.

2. Water Repellents for Concrete Masonry Walls, TEK 19-1. National Concrete Masonry Association, 1995.

3. Concrete Masonry Veneers, TEK 3-6A. National Concrete Masonry Association, 1995.

4. Concrete Brick Structural Design Considerations, TEK 16-2A. National Concrete Masonry Association, 1998.

5. Structural Backup Systems for Masonry Veneer, TEK 16-3A. National Concrete Masonry Association, 1995.

6. Standard Specification for Mortar for Unit Masonry, ASTM C 270-00. American Society for Testing and Materials, 2000.

7. ASTM Specifications for Concrete Masonry Units, TEK 1-1C. National Concrete Masonry Association, 2000.

8. Anchors and Ties for Masonry, TEK 12-1A. National Concrete Masonry Association, 2001.

9. Specification for Masonry Structures, ACI 530.1-99/ASCE 6-99/TMS 602-99. Reported by the Masonry Standards Joint Committee, 1999.

10. Crack Control in Concrete Masonry Walls, TEK 10-1A. National Concrete Masonry Association, 2001.

Cleaning Instructions for Masonry

Description:

Vanatrol is a masonry cleaning material designed for the removal of excess mortar, job dirt and normal stains while preventing the appearance of vanadium (green) stains in white and other light coloured masonry materials. Vanatrol also substantially reduces manganese and iron stains in brown, black and grey coloured brick. A special wetting system actually softens excess mortar and creates a “clinging” action that holds the cleaner on the surface of the masonry work. Other exclusive ingredients slow the drying time and allow for thorough rinsing, thus preventing the cleaner from drying into the wall and creating streaks.

Recommended Cleaning Procedures:

Test recommended strengths on a small area of the building, using polyethylene or rubber buckets only. Allow test areas to thoroughly dry before determining results.

a) Thoroughly saturate a large portion of the masonry surface to be cleaned. The purpose of saturation is to keep the cleaning solution to the surface and prevent the wall from drying out before the final rinsing process, thereby preventing streaks. When working from staging, keep all lower areas “surface wet” to prevent runoff streaks.

b) The prepared cleaning solution may be applied with a low pressure sprayer (under 60 p.s.i.). A densely packed, soft fibered masonry washing brush is preferable, although on rough textured brick and block, a stiff fibered brush may be of assistance.

c) Allow the cleaning solution to remain on the wall for approximately 5 minutes. Waiting period will vary with absorption rate of the masonry surface and drying conditions. Scrape off excess mortar deposits and re-apply cleaning solution. If scrapers are required, it is recommended that small pieces of brick or wood be used.

d) Rinse thoroughly with fresh water, removing all cleaning compound and impurities.

Note: Avoid repeated re-application of the cleaning solution over the same area. Continued applications will cause too much solution to penetrate the wall and may result in a white detergent film. If mortar deposits are not softened after initial application, merely allow the solution to remain on the wall for a longer period of time.

CAUTION:

This product is extremely corrosive and vapours may be harmful. Avoid contact with eyes, skin and clothing. Do not breathe fumes. If splashed in eyes or on skin, flush thoroughly with water. If swallowed, give 3 or 4 glasses of milk or water. Do not induce vomiting. Call physician immediately.

Refer to NCMA Tek 8-2A Removal of Stains from Concrete and Masonry or contact the Shouldice Head Office for more information.

Removing Stains from Masonry

There are many common substances which can cause unattractive stains on masonry walls.

Ink stains, coffee stains and paint stains are only some common substances which can cause unattractive discolourations on masonry walls. The question is, how to get rid of them?

The following article offers helpful hints on how to identify and remove stains which can occur on masonry.

The information contained in this article has been supplied by Lafarge Canada Inc.

Coffee Stains

Coffee stains can be removed by applying a cloth saturated in glycerine diluted with four times its volume of water. Javelle water or the solution used on fire stains is also effective.

Copper, Bronze & Aluminum Stains

Copper and Bronze stains are nearly always green, but in some cases they may be brown. Aluminum stains appear as a white deposit.

For copper and bronze stains, mix together in dry form, one part ammonium chloride (sal ammoniac) and four parts powdered talc. Add ammonia water and stir until a thick paste is obtained.

"For ordinary blue writing inks make a solution of sodium perborate in hot water." Place this over the stain and leave until dry.

When working on glazed tile, use a wooden paddle to scrape off the paste. An old stain of this kind may require several applications. Aluminum chloride may be used in the above procedure instead of the sal ammoniac.

For aluminum stains, scrub with a 10 per cent solution of muriatic acid.

Ink Stains

Different inks require different treatments. For ordinary blue writing inks, make a solution of sodium perborate in hot water. Mix with whiting (which may be obtained at any paint store) to a thick paste, apply in a 5 mm layer, and leave until dry. If some of the blue colour is visible after this poultice is removed, treat it by the method for iron stains. Sodium perborate can be obtained from any druggist. Many red, green, violet, and other bright-coloured inks are water solutions of synthetic dyes. Stains made by this type of ink can usually be removed by the sodium perborate poultice described above.

Often the stain can be removed by applying ammonia water on cotton batting. Javelle water is also effective, used the same as ammonia water, or mixed to a paste with whiting and applied as a poultice.

A mixture of equal parts of chlorinated lime and whiting reduced to a paste with water may also be used as a poulticing material.

Some blue inks contain Prussian blue, a ferrocyanide of iron. These stains cannot be removed by the perborate poultice, Javelle water, or chlorinated lime poultice. Such stains yield to treatment of ammonia water applied on a layer of cotton batting. A strong soap solution applied the same way may also be effective.

Indelible ink often consists entirely of synthetic dyes. Stains may be treated as outlined above for that type. However, some indelible inks contain silver salts which cause a black stain. This may be removed with ammonia water. Usually, several applications are necessary.

Iodine Stains

An iodine stain will gradually disappear of its own accord. It may be removed quickly by applying alcohol and covering with whiting or talcum powder. If on a vertical wall, mix talcum to a paste with alcohol, apply some alcohol to the stain, then cover with the paste.

Iron Stains

Mix seven parts lime-free glyercine with a solution of one part sodium citrate in six parts luke-warm water, mix with whiting or kieselguhr to make a thick paste. Apply paste to stain with trowel, and scrape off when dried out. Repeat until stain has disappeared and wash thoroughly with clear water. (Ammonium citrate may produce quicker results than sodium citrate).

Oil Stains

Make a paste of a solution of 0.5 kilograms of trisodium phosphate to 5 litres of water and whiting. Spread this paste in a layer about 15 mm thick over the surface to be cleaned and leave it until it dries (approximately 24 hours). Remove the paste and wash surface with clear water.

An alternative treatment consists of the application of a poultice made by adding powdered talc or whiting to a five per cent solution of caustic soda.

Paint Stains
For fresh paint, apply a commercial paint remover or a solution of trisodium phosphate in water – 1 kilogram of trisodium phosphate to 5 litres of water. Allow to stand and remove paint with a scraper and wire brush. Wash with clear water.

Perspiration Stains
Secretions from the hands or oil from the hair may produce stains on concrete. The best treatment is that recommended for fire stains (see below). Bad stains may require several treatments.

Plant Growth
Occasionally an exterior masonry surface that is not exposed to sunlight and remains in a constantly damp condition will exhibit signs of a plant growth such as moss. "An iodine stain will gradually disappear but may be quickly removed by applying alcohol and covering with whiting."

Application of ammonium sulfamate (marketed under the manufacturer's brand name and available in gardening supply stores) according to directions furnished with the compound has been used successfully in the removal of such growths.

Although it is not believed that an unsightly residue will be left on the face of the wall, any powdery deposit can be removed by washing with water.

Smoke and Fire Stains
Make a smooth, stiff paste of trichlorethylene and powdered talc. Apply with a trowel, cover to prevent rapid evaporation and scrape off when dried.

Precaution should be taken to ventilate a closed space in which trichlorethylene is used, as the fumes are harmful. Soap and water applied with a stiff-bristle brush are frequently effective in removing soot and coat-smoke stains. A small amount of powdered pumice added to the soap solution may increase its effectiveness.

Tobacco Stains
Dissolve 1 kilogram of trisodium phosphate in 6 litres of water. In a separate container, make a smooth, stiff paste of 350 grams of chloride of lime with water. Pour the former into the paste and stir thoroughly.

Make a stiff paste of this with powdered talc and apply and remove in the same way as described above for iron stains.

To apply with a brush, add about 10 milliliters of sugar to each kilogram of powdered talc. This mixture is a strong bleaching agent and is corrosive to metals.

Vanadium or Molybdenum
Occasionally a green stain will appear on buff or gray clay facing brick or tile. This may be a form of efflorescence resulting from vanadium or molybdenum compounds in the clay unit.

"Hydrochloric acid shouldn't be used in removing efflorescence from vanadium or molybdenum compounds."

Hydrochloric acid should not be used in attempting to remove efflorescence resulting from such compounds. The acid may react with the vanadium or molybdenum compounds, converting them to an insoluble brown stain that is practically impossible to remove except with abrasives.

A cleaning method that has been used successfully in many such cases is to wash the wall with a solution of caustic soda, such as one part sodium hydroxide crystals (lye) to 10 parts water.

The wall should be washed with clear water, both before and after the application of the caustic soda solution, and precautions taken to protect the clothing and skin of the person using the solution.

Vanadium salts will green when precipitated from an acid medium and white when precipitated from a basic medium. Acid conditions on the face of the brick should be avoided. Carbonic acid in rain water is sufficient to cause vanadium salts to turn green.

Wood Stains
Under damp conditions, wood will rot and cause chocolate coloured stains that are readily distinguished from most other stains by its dark colour.

The best treatment is that recommended for fire stains. Action may be accelerated by first scrubbing the surface thoroughly with glycerine diluted with four times its volume of water.