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Colorless Coatings for Brick Masonry

Abstract: This *Technical Note* discusses common reasons for applying colorless coatings to above-grade brick masonry and the appropriateness of such actions. The types of products often used and the advantages and disadvantages of each are presented. Issues to consider prior to application of a clear coating to brick masonry are provided.

Key Words: clear, colorless coatings, film former, graffiti-resistant, penetrant, silane, siloxane, water penetration, water repellent.

SUMMARY OF RECOMMENDATIONS:

General

- Application of a water repellent coating is not necessary to achieve water resistance in brickwork subjected to normal exposures where proper material selection, detailing, construction and maintenance have been executed
- Application is not recommended on newly constructed brick veneer or cavity walls or on new or existing pavements using clay pavers
- Correct conditions contributing to water penetration before applying a coating to brickwork
- Consider providing vents at top of drainage spaces when a water repellent coating is applied

General Selection Criteria

- Consult the brick manufacturer prior to the selection of a coating
- Select only coatings intended for use on clay brickwork
- Consider the effects of all coating properties on brickwork, not just the desired property
- Select coatings that have demonstrated consistent performance on similar installations, materials and exposures for a minimum period of five years
- Except for anti-graffiti applications, use only breathable coatings with a water vapor permeability of 0.98 or greater as measured by ASTM E96
- Consider the use of a siloxane or siloxane/silane pre-blended coating
- Use comparative testing of treated and untreated walls using ASTM E514 or ASTM C1601 to determine coating effectiveness
- Do not apply film-forming coatings to brickwork located in freeze-thaw environments

Specific Selection Criteria

- For exterior brickwork, consider a condensation analysis to determine whether coating affects the dew point location within the wall
- For paving, consider the effects of coating on pavement slip resistance and the abrasion resistance of the coating

Application

- Use a contractor with a minimum of five years experience installing selected coating on similar installations
- Apply the coating according to the coating manufacturer directions

INTRODUCTION

Colorless coatings are available in many types and are designed for a variety of uses. When needed, colorless coatings for brick masonry should be selected based on their intended use, documented performance and chemical and physical properties [Refs. 4, 6, 10, 13]. Clear coatings formulated for use on other masonry materials may not be appropriate for brick masonry and may in fact be detrimental to brick. Clay brick masonry has physical and chemical properties that are different from stone, concrete or concrete masonry. Brick masonry has a different pore structure and is generally less absorptive, less permeable and less alkaline than concrete masonry. The recommendations included herein are applicable only to clay brick masonry.

The type of exposure the brickwork is subject to also plays an important role in coating selection. Coatings suitable for interior brick masonry may not be suitable for exterior exposures. Similarly, coatings applied to floors or pavements are subject to conditions different from those in brick walls.

Specific recommendations regarding the reasons for, selection of and use of colorless coatings are found throughout this *Technical Note*. Opaque coatings, such as damp-proofing or waterproofing coatings, are not addressed. For further information about opaque coatings, refer to *Technical Note* 6, which covers painting of brick masonry.

REASONS FOR USE

Clear coatings may be applied to brick masonry in an effort to facilitate cleaning, to resist graffiti, to provide gloss or to reduce water absorption or penetration. Often, a single product is used to achieve several of these objectives. Selection of a coating should be based on the desired appearance, resistance to water penetration, application of brickwork, material substrate, economics, life span or other criteria set by the designer or user. The disadvantages of using colorless coatings should also be considered during selection.

Water Penetration Resistance

It is desirable to minimize the penetration and absorption of water in brickwork to avoid problems encountered in walls. Problems caused by excessive water penetration include freezing and thawing deterioration; corrosion of metal ties, metal studs and other items; rotting of wood members; mold growth; and damage to interior finishes.

The most effective means of minimizing water penetration include exercising care during material selection, designing and detailing brick masonry properly, constructing high-quality brickwork, and performing proper maintenance. Detailed discussions of these issues are provided in the *Technical Note* 7 Series. Drainage-type walls, such as brick veneer and cavity walls, are designed to accommodate water penetration of the exterior brickwork without damage to the interior components of the wall system through its drainage system.

Nonetheless, water-repellent coatings are sometimes suggested to reduce the amount of water that penetrates brickwork. Research indicates varied effectiveness of clear water repellents in reducing water leakage through a brick masonry wythe. [Refs. 3, 7, 11] Water-repellent coatings are most effective at reducing the amount of water absorbed by brick masonry. But water usually penetrates brick masonry at separations and cracks between brick and mortar or at junctures with other materials. Thus, a change in the absorption properties of brick masonry provided by a water-repellent coating may not significantly reduce water penetration through brickwork. Water-repellent coatings cannot stop water penetration caused by design or construction deficiencies such as ineffective sills, caps or copings, or incompletely filled mortar joints. Penetrating water-repellent coatings seldom stop water penetration through cracks more than 0.02 in. (0.5 mm) wide, and their effectiveness under conditions of wind-driven rain is limited. As a result, the use of water-repellent coatings to eliminate water penetration in a wall with existing defects can be futile.

Water repellents can be useful for barrier walls, chimneys, parapets and other brickwork that is particularly vulnerable to water absorption and penetration, especially in climates that receive large amounts of rain. When a water-repellent coating is considered for use on these elements, the benefits must be weighed against the possible disadvantages. Past successful performance of the proposed coating, for a number of years in the same exposure conditions and on the same type of brick and mortar, should be required. In climates that experience freezing and thawing cycles, the effect of a coating on the durability of the brickwork is of particular concern.

The age of construction and limitations of different types of water repellents are described in the sections that follow. Methods for evaluating the effectiveness of water repellents are discussed under Performance Criteria.

New Construction Use. Water repellents sometimes are specified for newly constructed brick masonry to protect against water penetration due to imperfections in construction. As discussed previously, water repellents have limited effectiveness and cannot compensate for poor construction or design. Furthermore, most brick masonry wall systems do not require a water repellent to effectively manage water and prevent water intrusion into the interior of a building. For these reasons, the use of water repellents on newly constructed drainage walls is not recommended.

Remedial Use. Water-repellent coatings most often are applied in an attempt to reduce or eliminate water penetration in existing brickwork experiencing water penetration problems. As noted previously, water repellents cannot prevent water from penetrating cracks wider than 0.02 in. (0.5 mm). Therefore, the source of water penetration should be determined and necessary repairs completed prior to the application of a water-repellent coating. Exterior walls should be inspected to determine the condition of caps and copings, flashing, weeps, sealant joints, mortar joints, brick units and general execution of details. *Technical Note* 46 provides an inspection checklist for areas of concern. Repair and replacement of missing, broken, failed or disintegrating items identified during the inspection and essential to the water resistance of the brickwork should be completed prior to

application of a water repellent. The application of a water repellent is rarely effective and is not recommended in lieu of the following common repairs:

1. Removal of failed sealant, and cleaning, priming and replacement with an appropriate grade of elastomeric sealant at all windows, copings, sills, expansion joints and between brick masonry and other materials.
2. Repointing of incompletely filled, cracked or disintegrated mortar joints.
3. Removal and replacement of brick with spalled faces or cracks extending through the face shell.
4. Surface grouting of separations between the brick units and the mortar.

These remedial measures are described in *Technical Note* 46.

Other repairs, which are generally more difficult and costly to complete, include the following:

1. Clearing of mortar blockage from weeps and the air space or cavity.
2. Removal and replacement of damaged, omitted or improperly installed flashing.

The latter repairs are considered by some to be unnecessary or uneconomical if a water repellent is applied. However, these repair techniques provide long-term solutions to water penetration problems. Not completing them may allow water within a wall to become trapped, resulting in failure of the coating or deterioration of brickwork.

After remedial repairs have been completed and inspected, it is advisable to wait a period of several months to determine whether a water repellent is necessary. Moisture penetration problems often will be corrected by these initial repairs, and further consideration of coatings can be dismissed.

If water penetration remains a problem, or long-term solutions are judged to be too costly despite their benefits, the application of a water repellent can be considered. If water absorption appears to be the problem, a water repellent can be particularly effective. However, water repellents are not a permanent solution and will require reapplication. See the discussion under Durability of Coating for further information on the life span of coatings.

Stain Resistance and Efflorescence Prevention

By reducing the amount of water absorbed by brickwork, colorless coatings may help reduce staining and efflorescence. As a result, colorless coatings are sometimes used on brickwork that is subject to severe exposures or on units that have a relatively high absorption. Brick manufacturers sometimes apply colorless coatings to units during manufacture to reduce staining or initial rate of absorption. ASTM standards for face brick require that the brick manufacturer report the presence of such coatings. Selection of a coating for any of these uses should be based on demonstrated successful performance on similar brick with comparable exposures. Staining and efflorescence may not be completely eliminated by application of a coating. If staining or efflorescence occur on masonry treated with a colorless coating, the stains and salts may be difficult or impossible to remove. Further, for film-forming coatings and water repellents with a vapor permeability less than 0.98, efflorescing salts may become trapped under the coating, causing damage to the brick.

Appearance Change

Another common reason for using a colorless coating is to achieve a darker, wet or glossy appearance. In some cases, a colorless coating may result in an undesired sheen or gloss. Such gloss may be an indication of an improperly applied coating or of poor coating selection (see Photo 1). Satisfactory appearance of a treated surface is best judged by examining a sample panel or test area of masonry before and after treatment.

Photo 1
Undesired Gloss Due to a Colorless Coating

Graffiti Resistance

Resistance to graffiti and ease of cleaning can be important attributes for public structures such as schools, government buildings, libraries and noise barrier walls, where brick masonry is chosen for its

appearance and low maintenance. Colorless coatings are sometimes applied to brick masonry to keep graffiti or dirt on the surface of the brickwork for easier removal. Glazed brick often are used in similar installations to provide the same benefits. Note that some coatings used for graffiti resistance are sacrificial, meaning that the coating itself is removed when the graffiti is removed.

TYPES OF COLORLESS COATINGS

Colorless coatings for brick masonry can be classified into two general categories: film formers and penetrants. The two types have significantly different physical properties and performance. As the name implies, film formers produce a continuous film on the surface of the masonry. Penetrants enter up to ⅜ in. (10 mm) into the brick masonry and do not form a surface film.

Colorless coatings may be either waterborne or solvent-borne. Carrier type influences permissible application conditions. Originally, better penetration and performance were attained using solvent-borne solutions. However, manufacturers are increasingly producing waterborne solutions that have lower volatile organic compound (VOC) content. Coatings with higher solids content also may have lower VOC content. VOC content is regulated by the Environmental Protection Agency nationwide because of its connection with poor air quality. In addition, many green building guidelines have limits on VOC content in coatings. Product data and test results should be examined carefully to compare performance. Temperature range, substrate moisture content, environmental regulations and effects on adjacent materials and vegetation must be considered.

Colorless coatings are discussed in the following sections according to generic chemical type. Most colorless coating manufacturers will provide information on the generic chemical composition of their products. In addition, handbooks are available that classify many proprietary coatings according to their generic chemical composition.

Film Formers

Typically, film-forming products adhere to the brick masonry and form a film on the surface. Surface preparation can be important in achieving satisfactory adhesion of a film-forming coating. Film-forming products should be applied only to dry surfaces. Film materials, continuity and product concentration determine the performance characteristics.

Film-forming products are effective at preventing water from penetrating into brick masonry. Film formers can bridge the small, hairline cracks that are commonly the source of water penetration. If the crack is active, such as one created by wind load or thermal fluctuations, a film-forming product may also crack. This obviously reduces its effectiveness. However, a film-forming product's ability to exclude water from the exterior also inhibits evaporation of water within the masonry through the exterior face and can result in clouding (see Photo 2) and spalling (see Photo 3) if the source of moisture is not addressed. The reduced water vapor transmission rate, or lack of "breathability," is of special concern in exterior brick masonry subject to freezing and thawing cycles. Thus, film-forming products are not recommended for brick masonry in such environments.

Photo 2
Clouding of Brick Masonry Wall with a Film-Forming Coating

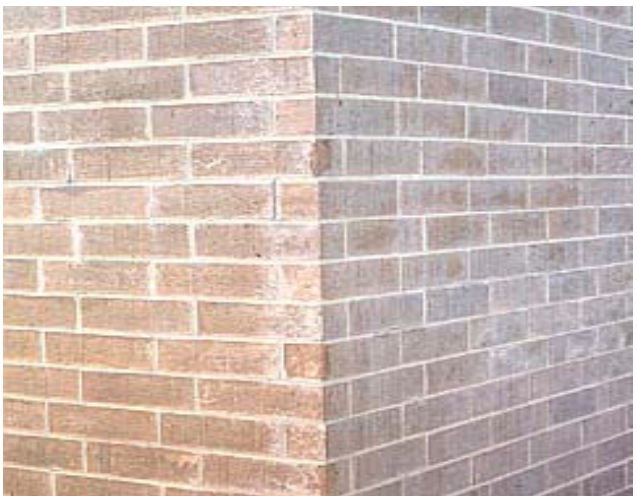

Photo 3
Spalling of Brick Masonry Wall with a Film-Forming Coating

A film on a masonry wall may facilitate cleaning by keeping surface contaminants from penetrating into the masonry. This characteristic leads to such products' use as graffiti-resistant coatings. When an appearance change is desired, film formers typically are used. Film-forming products, by their nature, tend to produce a sheen or gloss when applied. When used in high concentrations, they may darken the appearance of a wall (the “wet look”).

Acrylics, stearates, mineral gum waxes and urethanes are among the products that form a film when applied to brick masonry. The large molecular size of these products prevents them from penetrating into the masonry.

Acrylics. Acrylics can be effective as water repellents. They often are used when a high gloss is desired. Acrylics are available in two forms, waterborne and solvent-borne. Acrylic emulsions are waterborne. Acrylic solutions are solvent-borne. Because of increasing regulation of solvent-borne products, acrylic emulsions are more widely used. Coating manufacturers typically recommend that acrylics be applied to substrates that are thoroughly dry. If applied to a damp substrate, the acrylic film can separate from the masonry, giving it a cloudy, or whitened, appearance. Some acrylics can create a slippery surface, which is a concern in pavements. However, some acrylics increase slip resistance. When stabilized against degradation in ultraviolet (UV) light, acrylics can last approximately five to seven years.

Stearates. Stearates promoted for use on masonry are generally aluminum or calcium stearates. They are sometimes known as metallic soaps. Stearates form a water-repellent surface by reacting with free salts in mineral building materials and plugging the pores. Some formulations are used as integral water repellents in concrete masonry and mortar. Their effectiveness as applied water repellents varies, and typically film-forming stearates must be reapplied every year. Stearates also have the potential to turn cloudy if moisture gets behind the coating.

Mineral Gum Waxes. Paraffin wax and polyethylene wax are commonly referred to as mineral gum waxes. These products are typically solvent-borne and can be good water repellents, able to bridge hairline cracks. As with other coating types, mineral gum waxes can be used to protect units from staining. However, they have been known to darken the substrate and, in cases where moisture gets behind the coating, turn the surface a milky white. If the sources of moisture are not addressed, clouding and eventual spalling of the masonry may occur.

Urethanes. Urethanes, chemically referred to as polyurethanes, are isocyanate resins. They are classified as either aromatic or aliphatic, depending on the resulting chemical. They are considered one-part urethanes if cured by moisture in the substrate or air and two-part if they require a chemical catalyst to cure. While urethanes can be excellent water repellents and provide good gloss, they can break down under UV light and have very low vapor permeability. Chemical additives often are used in urethanes to prevent UV degradation and yellowing and to improve gloss retention. Urethanes with such additives usually last from one to three years.

Penetrants

Penetrating type coatings are characterized by their penetration into the substrate, typically to depths up to ⅜ in. (10 mm). They repel water by changing the capillary force, or contact angle with water, of the pores in the face of the masonry from positive (suction) to negative (repellency). Penetrating coatings are typically more resistant to UV degradation because of their chemical composition and because they penetrate below the masonry surface. Because they coat the pores rather than bridge them, penetrants tend to have better water vapor transmission characteristics. The solids content of these materials commonly ranges from 5 to 40 percent by weight. Higher solid content typically indicates better water penetration resistance. Penetrants can be categorized into six groups — siloxanes, silanes, silicates, methyl siliconates silicone resins and RTV silicone rubber — and blends of these.

Siloxanes. Siloxanes have a larger molecular structure than silanes and provide good penetration and water repellency. Siloxanes bond chemically with silica- or alumina-containing materials, such as brick and mortar, to make the material water-repellent. This results in a long life, up to 10 years or more, and makes the coating more difficult to remove. Some siloxanes can also be applied to slightly damp surfaces. Siloxanes are less volatile than silanes and react with chemically neutral substrates without a chemical catalyst. Siloxanes are typically used in solutions having 5 to 12 percent solids by weight. Siloxanes have been known to work well on certain brick

masonry installations. However, siloxanes are highly reactive with silica and will bond with glass that is not properly protected.

Silanes. Silanes used as clear water repellents have a smaller molecular structure than siloxanes, which allows good penetration on dense substrates. They are used in relatively high concentrations (typically 20 percent or greater solids content). Like siloxanes, silanes bond chemically with silica- or alumina-containing materials and can bond with unprotected glass. Silanes can be applied to slightly damp substrates. An alkaline substrate, such as concrete or concrete masonry, acts as a catalyst to speed the reaction to form a water-repellent surface. Chemical catalysts also are used with silanes to improve the chemical reaction on less alkaline substrates such as brick.

Silicates. Ethyl silicates are commonly used in restoration of deteriorated masonry as consolidants for natural stone and occasionally brick masonry. Consolidants are designed to react with and stabilize the substrate to which they are applied. Their use on brick is uncommon. None are effective water repellents, and they are not recommended for this use on brick masonry.

Methyl Siliconates. Methyl siliconates are alkaline solutions that react with silica-containing materials in the presence of carbon dioxide to form a water-repellent surface. Siliconates are sometimes injected into brick masonry to form a horizontal barrier to rising damp.

Silicone Resins. Silicone resins come in many weights and forms. The 5 percent silicone resin is the most common penetrating formula. Silicones do not chemically bond with the substrate and as a result have a short life. Many silicones require reapplication on a yearly basis, although some last longer.

RTV Silicone Rubber. Room temperature vulcanizing (RTV) silicone rubber is a penetrating water repellent that contains petroleum distillates. It does not require the presence of alkali to react with the substrate. Once cured, RTV silicone rubber retains its elasticity, helping it to bridge hairline cracks. Asphalt, plastic rubber and glass surfaces must be protected from contact with it. RTV silicone rubber is commonly used in anti-graffiti coatings.

Blends. Colorless coatings also are made from blends of the materials listed above. Blends are created to produce products with the benefits of the constituent materials. As such, they reflect the properties of the constituent materials, but the properties will be modified somewhat. Thus, it is important to review product data and test results for products, especially blended ones. For quality assurance that a blend is formulated in the correct proportions, select a product that is pre-blended by the manufacturer.

PERFORMANCE CRITERIA

Any coating applied to brick masonry will change the physical properties of the masonry. The most critical properties of colorless coatings to be evaluated are water vapor transmission, water penetration and repellency, durability, compatibility with the substrate, gloss, slip resistance, graffiti resistance, VOC content and environmental considerations. A variety of industry standard tests for evaluating these properties exist; however, it can be difficult to compare products because the reported performance characteristics of each product may be based on a different set of tests.

Another difficulty exists in correlating test results with in-service performance of coatings applied to brickwork. For example, one method of evaluating water repellency of a coating is by comparing the cold water absorption of an untreated brick to that of a treated brick, using the method described in ASTM C67, *Test Methods of Sampling and Testing Brick and Structural Clay Tile*. Although such a test may indicate the ability of a coating to reduce the amount of water absorbed through the faces of individual brick, it neglects the effect of mortar joints on the water penetration resistance of brickwork. The presence of partially filled mortar joints, hairline cracks and minute separations that occur in brickwork will often reduce, and sometimes completely negate, the “tested” effectiveness of a coating.

Until standard tests better correlate with performance of brickwork in service, good judgment and experience are necessary in establishing performance criteria. The properties discussed in the following sections can be useful in comparing colorless coating alternatives. Table 1 presents a relative comparison of several colorless coating properties.

TABLE 1
Typical Properties of Colorless Coatings for Brick Masonry[1]

	Water Vapor Transmission	Water Repellency	Life Span, Years	Available with Glossy Finish	Graffiti Resistance
Film Formers					
Acrylics	Poor	Very good	5 to 7	Yes	Yes
Stearates	Poor	Varies	1	No	No
Mineral gum waxes	Poor	Good	Varies	No	No
Urethanes	Poor	Very good	1 to 3	Yes	Yes
Penetrants					
Siloxanes	Very good	Very good	10+	No	No
Silanes	Very good	Very good	10+	No	No
Silicates	Poor	Poor	Varies	No	No
Methyl siliconates	Good	Fair	Varies	No	No
Silicone resins	Fair	Varies	1	Yes	No
RTV silicone rubber	Good	Good	5 to 10	No	Yes
Blends	Varies	Varies	Varies	No	No

1. Refs. 6, 14

Water Vapor Transmission Rate and Permeability

The most important property to consider when selecting a coating for application on exterior brick masonry is the water vapor transmission rate. The water vapor transmission, or breathability, determines the rate and amount of water that can evaporate through the face of the brickwork. Coatings that have low water vapor transmission rates inhibit evaporation and can trap water within the brickwork, leading to clouding of the coating, as shown in Photo 2 and Photo 4.

Low water vapor transmission may also result in the premature deterioration of brickwork. Water that is unable to pass through a coating increases risks of masonry deterioration due to freeze-thaw cycles and deposition of water-soluble salts behind the coating. As these salts crystallize, they grow significantly in size and can create enough expansive pressure to cause spalling of brick.

Mike Dickey, Frieze & Associates

Photo 4
Clouding of a Colorless Coating on a Brick Pavement

For these reasons, the effect of a coating on the water vapor transmission rate of brickwork should be carefully considered, particularly for walls exposed to freezing and when moisture problems such as rising damp and condensation are known to exist. Coatings with a water vapor permeability of 0.98 or higher allow natural evaporation to occur, thus reducing the potential for problems. However, even a highly breathable coating may lower the vapor transmission of a wall by preventing moisture migration to the exterior surface where evaporation occurs. A condensation analysis, as described in *Technical Note* 47, should be performed before applying a coating to determine the effect of the coating on the location of condensation within the wall system.

At present, there is no definitive test establishing the effect of colorless coatings on the water vapor transmission rate and durability of brick masonry. However, the water vapor transmission rate of a coating can be measured using ASTM E96, *Test Methods for Water Vapor Transmission of Materials*. To accurately replicate field conditions (air rather than water on one side of the brick), the desiccant method is preferred. Using this test, the effect of a coating can be evaluated through a comparative measurement between an untreated and a treated brick. For comparative testing, a maximum 10 percent reduction in the rate of vapor transmission is the recommended limit.

Another method to evaluate the potential of a colorless coating to entrap damaging salts and cause spalling is proposed by Binda [Ref. 2]. Individual brick are treated with the colorless coating on their exposed faces. The sides of the units are sealed with rubber to prevent evaporation except through the treated face. The units are subjected to cycles of immersion in a salt solution for four hours and air drying for 44 hours. The cross-sectional size is measured after each cycle. Deterioration is typically by delaminations of the treated brick face, hence a reduction in brick cross section. A correlation of the number of cycles to deterioration in this test to the durability of a masonry assemblage has not yet been established. However, this method is one means of assessing salt crystallization damage potential when evaluating colorless coatings.

Water Repellency

Water repellency is an important criterion when a coating is intended to reduce water penetration resistance. However, water repellency of most coatings is based on reducing the amount of water absorbed by a substrate. Water repellency is often evaluated by comparing the absorptions of treated and untreated brick using the ASTM C67 test for cold water absorption. As discussed previously, this approach has significant limitations. Because most water penetrates brickwork through voids or cracks in mortar joints and minute separations between brick and mortar, tests of water repellents on individual brick cannot accurately indicate the performance of a water repellent on brickwork. The effectiveness of water-repellent coatings in reducing water penetration through brickwork is more accurately evaluated by using representative brickwork panels.

ASTM E514, *Test Method for Water Penetration and Leakage Through Masonry*, is the preferred laboratory test for evaluating the ability of a coating to reduce the water penetration of brickwork. The test can be used to compare the water penetration resistance of brickwork treated with water-repellent coatings to untreated brickwork. Testing should be performed on a minimum of three identical wall specimens of the intended materials and construction. The amount of water penetration should be measured on each specimen in accordance with ASTM E514 before and after coating with the clear water repellent. The percentage reduction in water penetration is a measure of the water repellent effectiveness. A 90 percent reduction in maximum leakage rate; and a 75 percent reduction in percent area of dampness on the back face of the wall and total water collected after 24 hours of testing [Ref. 3] as compared to the untreated wall panel is recommended. ASTM E514 has its limitations. Performance of coatings in laboratory tests may differ from results on actual brickwork due to the variables inherent in construction. Thus, a tested percent reduction rate for a laboratory test does not automatically translate into the same percent reduction in water leakage through the exterior brickwork of a constructed building.

ASTM C1602, *Test Method for Field Determination of Water Penetration of Masonry Wall Surfaces*, provides a means to evaluate the effectiveness of a coating in the field. The test can be used on existing masonry walls or field mock-ups. A sheet of water is to be developed and maintained on the wall surface during testing. If the sheet of water does not consistently form, the results of this test may be inaccurate. After a preconditioning period, a specified water flow rate and air pressure are maintained. The amount of water applied to the face of the wall during the test is measured and the water loss calculated. Again, a coating should provide at least a 75 percent reduction in loss of water.

Durability of Coating

The durability of a coating is an important selection criterion. Greater depth of penetration or film thickness and greater resistance to degradation in UV light and harmful environments imply longer life for coatings applied to exterior brickwork. Durability of coatings applied to brick pavements may also depend on resistance to abrasion. A coating's durability also determines how often it must be reapplied, which may have permeability and ongoing maintenance implications.

Most coatings must be reapplied every five to 15 years, and some last considerably shorter periods of time. Many coatings are warranted by the manufacturer to last 10 years or more. It is common for film-forming products to require reapplication more often than penetrants, particularly if they are applied to brick floors subject to significant

amounts of traffic. Evaluation of a coating's resistance to abrasion is difficult, because there are no direct test methods for measurement on brick. Reapplication of a coating (especially if carried out prematurely) may decrease the vapor permeability of the brickwork. This may be a concern for exterior brick masonry walls, particularly in climates subject to freezing and thawing.

One way to evaluate the durability of a coating is with laboratory tests that simulate outdoor exposure. ASTM G154, *Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials*, is one often specified. The difficulty with using laboratory tests to measure the life span of a coating is trying to correlate laboratory test results to field performance. Coating characteristics, such as gloss or water repellency, can be measured before and after exposure and the results compared, but such tests have not been correlated to the actual life expectancy of the coating.

Periodic evaluations of field performance can also be used to determine whether a coating continues to be effective. Results of field tests conducted on a specified area of a newly treated wall can be compared to tests performed in the same location after some period of service. Such evaluation will indicate if the coating has met its warranted life and help to determine when reapplication may be necessary.

Compatibility. Compatibility of a coating with the brickwork and its existing surface treatments should be determined prior to application. Only coatings specifically formulated for use on brickwork should be selected. Incompatibility of a coating with the brickwork or an existing coating may adversely affect durability, appearance or otherwise prevent the coating from performing as intended. Penetrating coatings are typically incompatible with existing film-forming coatings. In some cases, reapplication of a coating may cause clouding and may be difficult or impossible to remove.

It may be necessary to remove any existing coating, following the coating manufacturer's recommendations before reapplication or application of a different coating. This procedure may involve hazardous chemicals often regulated or restricted from use by local, state or federal environmental regulations. Thus, an existing coating may have to remain in place until it wears off, even if deterioration of the masonry calls for its removal.

Environmental Considerations

Possible environmental hazards are also of concern when considering a colorless coating. Often the chemicals used in colorless coatings are highly reactive and can etch glass, damage paint, kill vegetation and emit harmful vapors. This requires attention to worker safety and proper protection of adjacent surfaces.

Appearance

Some coatings, particularly film-formers, may impart a gloss, sheen or darkening to brickwork. Acceptable appearance is a subjective matter and should be determined by the designer or owner prior to application. Gloss is best evaluated by treating half of a test area representing the entire range of brick colors and textures and comparing the treated half to the untreated half. An accepted test area should be retained as a means of judging acceptability of other treated areas. When necessary, a number of ASTM test methods can be used to evaluate differences and to establish tolerances [Ref. 1, Volume 6.01].

Slip Resistance

A coating can adversely affect the slip resistance of a brick floor or pavement. The slip resistance of coated floors or pavements should be evaluated for safety reasons, especially in public access areas and in areas where water may contact the floor or pavement. The slip resistance of coatings often is measured in the laboratory using ASTM D2047, *Test Method for Static Coefficient of Friction of Polish-Coated Floor Surfaces as Measured by the James Machine* [Ref. 1]. A value of 0.5, measured by the James machine, is the recognized minimum value for slip-resistant walking surfaces in courts of law in the United States. Slip resistance can be measured in the field using portable devices such as the NBS-Brungraber machine (also known as the Mark I Slip Tester). The United States Access Board recommends coefficient of friction values of 0.6 for a level surface and 0.8 for ramps, as measured using the NBS-Brungraber machine [Ref. 14].

Graffiti Resistance

Effective graffiti resistance depends on the ability of a coating to prevent penetration of unwanted markings into brickwork and facilitate their removal. Often, water repellency, appearance, durability and other properties are also

important selection criteria for anti-graffiti coatings. A method for determining the effectiveness of an anti-graffiti coating is described in ASTM D7089, *Practice for Determination of the Effectiveness of Anti-Graffiti Coating for Use on Concrete, Masonry and Natural Stone Surfaces by Pressure Washing* [Ref. 1]. Satisfactory performance is indicated by successful removal of intentionally applied graffiti. Always consult the coating manufacturer prior to testing, as reactions between the cleaner and the coating may be hazardous.

Anti-graffiti coatings generally employ either a "barrier" or "sacrificial" strategy to resist graffiti. Barrier or permanent coatings must be resistant to cleaning chemicals so that they remain on the surface of brickwork after graffiti is removed. Conversely, sacrificial coatings should be easy to remove. Removal of graffiti should always follow coating manufacturers' recommendations, because many anti-graffiti coatings are intended to be used with a particular removal method or cleaning product.

As anti-graffiti coatings provide a barrier to paint and other staining, they also provide a barrier to water evaporation through the outer face of the brick, similar to that of glazed brick. Therefore, most of the drying of the brickwork occurs by evaporation through the back face of the brick, into the air space. It is important that when an anti-graffiti coating is used, the cavity behind the brick be vented at top and bottom to help remove the excess moisture in the air space created by this evaporation.

CONSIDERATIONS PRIOR TO COATING

Selection of a colorless coating for use on brick masonry should be based on the desired performance, the information discussed in this *Technical Note* and literature from the coating manufacturer. Additional items to be considered prior to application of a colorless coating follow. Whenever possible, consult with the brick manufacturer for specific recommendations regarding coating of a particular brick. Properties of each brick are unique and can affect coating performance.

1. It is suggested that the designer or user require test reports for relevant performance criteria and a written warranty from the coating manufacturer for the performance of the coating over a designated period of time.
2. The coating should be that of a well-known manufacturer who has been in business for at least five years. It is suggested that a brand name be used that has a good track record over a period of at least five years. References of projects with similar installations, materials and exposure should be investigated.
3. The coating should be applied at the application rate and under the climatic conditions recommended for clay brick masonry substrates by the coating manufacturer. Typically, temperatures above 40 °F (4 °C) and below 100 °F (38 °C) are required. Application on windy days should be avoided when possible.
4. Repair and replacement of brick and mortar joints and other necessary repairs should be completed prior to applying a colorless coating.
5. A minimum of one month should pass after close-in of the building before a water repellent is applied to newly constructed brickwork. This period allows the evaporation of moisture from the building materials to occur naturally, unimpeded by a coating on the brickwork, and permits the walls to cure sufficiently. In fact, many colorless coating manufacturers recommend application only to a relatively dry substrate. A delay of one year is preferred so that efflorescence due to water absorbed during construction, often known as "new building bloom," is not entrapped by the coating. For a more complete discussion of efflorescence, refer to the *Technical Note* 23 Series.
6. There should have been no efflorescence or, at the maximum only a minor occurrence of efflorescence, on the brick masonry to be treated. Walls with a history of efflorescence should be coated only after the source of moisture has been addressed.
7. The wall must be clean at the time of application [Ref. 9]. Heavy accumulations of dirt will interfere with proper penetration or adhesion of the coating and result in poor performance and shorter life. See ASTM D5703, *Practice for Preparatory Surface Cleaning for Clay Brick Masonry* [Ref. 1], for a discussion of cleaning techniques that may be required. In addition, freshly repointed mortar and repaired sealant joints should cure for a minimum of 72 hours before a coating is applied [Ref. 11].
8. The brickwork should have a moisture content consistent with that recommended by the coating manufacturer. Moisture content of the brick masonry should be checked at several locations by the method recommended by the coating manufacturer.
9. Apply samples of the selected coating to test areas of at least 10 ft² (1 m²) on the building at a location representative of the area to be treated or on a sample panel. Allow these test areas to cure as recommended by the coating manufacturer. Inspect and test them to determine satisfactory performance with respect to the performance criteria established.

10. The application contractor should know the work to be performed and should protect adjacent and surrounding surfaces from over-spray as necessary. Qualifications of the contractor should be verified.

These steps must be taken in conjunction with the recommendations contained within the applicable sections of this *Technical Note*. They cannot guarantee successful performance but will greatly increase the likelihood that the colorless coating will perform as intended. The coating manufacturer often will have additional recommendations regarding coating selection, substrate preparation, curing, application methods and coverage rates. The coverage rate is especially critical, because over-application of the coating can reduce its breathability. Failure to consider these items can result in poor performance of the coating and can cause severe harm to the masonry or surrounding elements.

RECOMMENDATIONS FOR USE

Selection of a specific product should be based on recommended performance criteria described herein and any other criteria set by the designer to address the particular conditions involved. In addition, the brick manufacturer should be consulted for recommendations on the use of colorless coatings prior to coating selection.

There are a variety of reasons that colorless coatings may be considered for application to brickwork. However, it is important to recognize that coatings change the physical properties of the brickwork to which they are applied. Therefore, the potential advantages of colorless coatings should be carefully weighed against their disadvantages.

Exterior Walls

Penetrating coatings are preferred for exterior brick masonry walls because they permit water vapor transmission. Only coatings with a water vapor permeability of 0.98 or greater as measured by ASTM E96 should be used. If a water repellent is to be used, siloxanes are recommended. Siloxanes provide the advantage of good water repellency and long-term performance and have been shown to be effective on many brick masonry walls. Silanes containing chemical catalysts also have been used successfully.

Because of the effect of a film on the breathability of masonry, use of film-forming coatings is discouraged, particularly in freezing climates. Some film-forming coatings have been known to perform successfully; however, there can be significant risks. If use of a film-forming coating, such as an anti-graffiti coating, is necessary, select only products known to successfully perform in a similar climate, wall type and exposure on brick masonry with similar physical properties.

When a drainage wall is treated with a colorless coating, the use of vents at the top and bottom of wall cavities can promote evaporation of moisture from the brickwork.

Chimneys and Parapets. These elements can be subject to premature deterioration because of severe exposure. They are often exposed to wind-driven rain and water rundown on the exterior walls from the crown or coping. Because of the large amount of moisture that can contact the surface of a chimney or parapet wall, a clear water-repellent coating can sometimes be effective in reducing water-related problems. Conditions in which a clear water repellent may be recommended on chimneys and parapet walls include climates with a driving rain index above 3 (see Figure 1) and on sloped or horizontal projections of such elements where water and snow can accumulate.

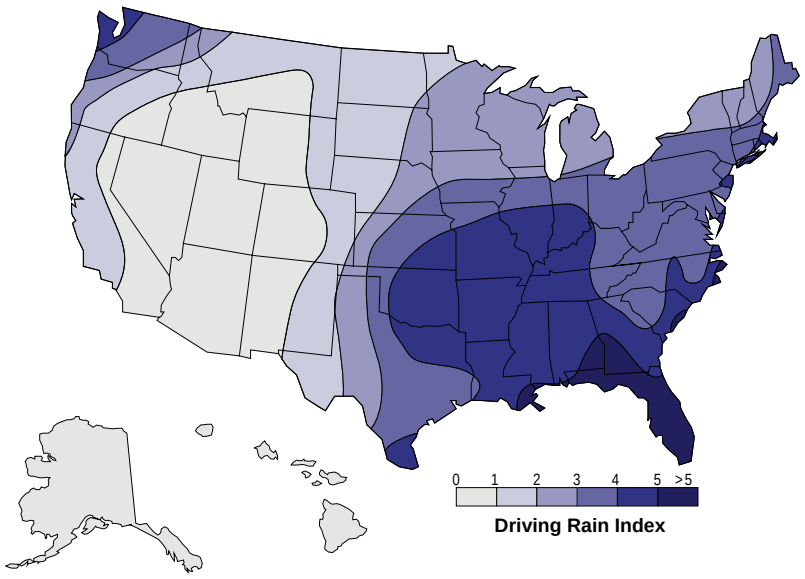

Figure 1
Driving Rain Index Map [Ref. 9]

Interior Walls

Colorless coatings are generally applied to interior walls to facilitate cleaning or to provide a gloss. Water repellency and breathability of interior walls is generally not a concern. Film-forming products, specifically water-borne acrylics (acrylic emulsions) and urethanes, typically will give the best results when gloss and ease of cleaning are desired. However, some penetrating coatings may also provide this effect. Acrylics in particular are known to provide a high gloss. Both acrylics and urethanes are durable in installations with no UV exposure.

In the case of exterior brick masonry walls that have their interior faces exposed, water vapor transmission may be a concern. Film-forming products should be used cautiously, only after the effect of the film on the water vapor transmission of the wall system has been evaluated.

Pavements and Floors

Coatings may be desired on brick pavements to resist staining or to decrease moss and mildew growth. The exposure and construction of brick pavements are significantly different from those of vertical brickwork. Lack of a drainage cavity or air space to aid in drying increases the severity of exposure. There are several disadvantages associated with the use of a colorless coating on pavement surfaces. Colorless coatings can decrease the slip resistance of the pavement or floor, especially when wet. Also, pavements and interior floors are subject to abrasion due to foot traffic, which shortens the life expectancy of most coatings compared to vertical installations. Exterior brick pavements are subjected to more severe weathering exposures than exterior vertical walls. Pavements often have prolonged contact with moisture due to their horizontal orientation and are seldom protected by overhangs.

Any joint sand stabilizers needed to protect sand in joints from erosion are typically applied before coatings. For more information about these products, refer to *Technical Note* 14A.

Exterior Pavements. By the nature of their construction, pavements allow evaporation of moisture from the masonry through only one face, the wearing surface. As a result, the potential for problems associated with reduced water vapor transmission are significant. These disadvantages usually outweigh any potential benefit. For this reason, colorless coatings are not recommended for use on exterior brick pavements subject to freezing and thawing. In exterior environments not subject to freezing, the water vapor transmission rate of the coating must be high. Clouding of the coating is a particularly common problem (see Photo 4).

Interior Floors. Colorless coatings are often applied to interior brick floors to provide a glossy finish and to facilitate cleaning. Mortarless brick pavements also can be coated to help retain the jointing sand in the joints. Urethanes, acrylics, waxes and some penetrating coatings that meet the performance criteria discussed herein, and those set by the designer, can be used on interior brick masonry floors not subject to freezing. The primary disadvantage of most colorless coatings used on floors is their tendency to reduce the skid resistance of the floor. New epoxy-based coatings show promise in this area. Film-forming coatings may separate from the brick paving and turn cloudy if moisture from the brickwork or supporting members migrates through the brick floor. Consequently, film-forming coatings should be applied only when the brick floor and supporting members are dry. Past successful performance is the best measure of a satisfactory coating.

SUMMARY

This *Technical Note* has discussed both the reasons for and the suitability of colorless coatings for brick masonry. For most exterior brick masonry, use of colorless coatings is discouraged. Furthermore, clear water repellents are not necessary on properly designed and constructed brick masonry. However, under certain conditions, clear water repellents and other colorless coatings may be beneficial.

> *The information and suggestions contained in this* Technical Note *are based on the available data and the experience of the engineering staff and members of the Brick Industry Association. The information contained herein must be used in conjunction with good technical judgment and a basic understanding of the properties of brick masonry. Final decisions on the use of the information contained in this* Technical Note *are not within the purview of the Brick Industry Association and must rest with the project architect, engineer and owner.*

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