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Coatings for Masonry Surfaces

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Please note

The term masonry originally meant a building component constructed by a mason from individual units of stone, brick or tile. Later, it was extended to include monolithic items, such as cast concrete which were used in place of the unit masonry. At present, masonry surfaces comprise these materials plus precast concrete, concrete block, asbestos-cement board, renderings, e.g. stucco and plaster. and plasterboard. Some of the materials are restricted to interior applications while others are generally used only on the exterior of buildings. This Digest discusses the coatings that may be applied on the various masonry surfaces in context with their uses. The word "coating" is employed deliberately instead of "finish" because the latter is also used to describe the type of surface treatment given to placed concrete before it sets, e.g., a trowelled finish.

Characteristics of Masonry Materials

Bulk as well as surface properties of masonry affect the performance of coatings. As discussed in **CBD 127**, masonry materials contain pores, i.e., voids within the material rather than holes at the surface. even highly compacted concrete must contain small air pockets or it will not be resistant to freezing. The porosity results in most cases from the water used in some stage of production so that the material can be shaped into its final form. During curing or firing. the water is removed leaving the pores. In some materials the pores may be so extremely small that only water or other small molecules can enter them. From the point of view of coatings, which contain much larger molecules, these substances are non-porous, e.g. most stones. Nevertheless material that is porous to water will, when circumstances dictate, absorb water. When porosity is involved, careful design and construction are required if entry of water with all its attendant problems for the coating and for the structure is to be avoided. The degree of porosity in some common building materials is given in **CBD 127**.

The surface property of smoothness influences the performance of masonry coatings. Since the chemical constitutions of substrate and coating differ so markedly, much of the adhesion between them is due to mechanical keying. Highly trowelled concrete, polished stone and glazed brick and tile are surfaces too smooth for good adhesion. It is, of course, a common experience that organic coatings do not adhere well to untreated glass. At the other extreme is cast concrete which has not been well compacted against the moulding forms. In this case the surface is rough and may contain large holes. It is impossible for thin organic coatings to provide a continuous film on such a substrate.

A chemical property of masonry that has a great effect on its coatability is alkalinity. Most masonry is highly alkaline and although stones or bricks are normally neutral, the mortars in which they are set are quite basic. Fresh concrete is very alkaline because of the original constituents and because of the release of calcium hydroxide (hydrated lime) during the curing process. With time this chemical reactivity may be reduced through carbonation by the carbon dioxide in air although this seldom occurs in more than a thin surface layer. Passage of moisture through the bulk concrete can thus readily bring fresh alkali to the surface. Precast concrete and concrete blocks are not so strongly basic when steam cured. In addition, blocks tend to be more porous so that carbonation can occur to a greater depth. On the other hand, blocks are laid up with mortars that are alkaline so that one condition counteracts the other. Asbestos-cement boards differ widely in alkalinity because of the two curing processes in common use. Products cured in an autoclave with addition of silica have a low alkali content; those cured at normal temperature in a moist atmosphere are more alkaline than concrete placed in situ(1). Stucco is strongly basic because of its constituents of cement and lime. Plasterboard is made from gypsum so is neutral but plaster, at least on this continent, contains lime in the white finish coat which is, therefore, alkaline.

Another chemical characteristic of masonry is the presence of soluble salts. These may result from the chemical reactions that take place during manufacture or curing. from soluble impurities in some of the ingredients, or from materials used in mortars for placing unit masonry. As the water of construction dries out it carries the soluble salts to the surface where they are left as efflorescence when the water evaporates. If in subsequent use the structure picks up water which in turn is carried to the surface, there will be further efflorescence. Monolithic concrete is not generally subject to this condition unless the design of the structure allows rain penetration or the concrete is excessively porous. Concrete blocks may effloresce because they are more porous and because they are set in mortar. As discussed in **CBD 2**, the probability of brick construction efflorescing depends upon the properties and composition of both the brick and the mortar. Production of white salts is reduced when the content of sodium and potassium salts in the mortar is low. Autoclaved cement products are relatively free from the deposit but normally cured items are not because of their high cement content. Because of its composition, stucco may also exhibit efflorescence but the appearance may not be so objectionable because the contrast in colour is not so great as with red bricks.

Problems in Coating Masonry

These problems are naturally related to the characteristics of masonry. Thus the chief difficulty has been caused by the high alkali content. This was particularly true with older types of coatings that were based on oils or oil-containing vehicles. Oils readily react with alkalies in the chemical process called saponification which, in fact, is the basic reaction in the manufacture of soap. It is not. however, a desirable process with applied paints as the dry film becomes soft and tacky and, if carried far enough, reverts to a liquid. Because of the possibility of the reaction taking place it is necessary to ensure that non-saponifiable coatings are used, at least for the prime coat, or that the substrate remains so dry that the reaction cannot proceed. With most exterior surfaces the latter is not possible. A third approach is to attempt to neutralize the alkali chemically. Although treatment of concrete with hydrochloric acid is often recommended to "neutralize" it, this is not really possible except for a thin surface layer. If sufficient acid were applied to neutralize completely all the alkali, the concrete would be destroyed. Subsequent passage of water through the material can. therefore, bring fresh alkali to the surface.

Before the advent of latex paints, plaster surfaces were frequently treated with a zinc sulfate solution. This resulted in precipitation of free lime as calcium sulfate (gypsum) thus rendering the surface neutral. No treatment is necessary with alkali-sensitive solvent-based coatings when latex primers are to be used. Where the treatment is applied, latex paints cannot be used because the zinc sulfate can cause them to coagulate.

Efflorescence causes coating failure by mechanically destroying the film, the force exerted during crystallization of the salts being strong enough to overcome the bond to the substrate or the cohesive strength of the film. Hence it is not sufficient merely to clean efflorescence off a masonry wall before painting it. After removal of the white salts. the surface should be observed for some time to see whether there will be a recurrence. Further efflorescence indicates either that too much of the original moisture is still present or that water is entering at some structural defect. In the latter case it is necessary to detect the source and, if possible, to remedy the situation. When latex paints were first introduced some of them produced efflorescence from within the paint film. This was caused by the presence of certain water-soluble surfactants but with the latex paints manufactured today it is no longer a problem.

Since water is necessary before either process of saponification or efflorescence can proceed. it might be considered as the agent that has the greatest effect on coating performance. Large quantities of water are involved in construction with many masonry materials. This must be allowed to dry out or its eventual evaporation may cause problems. If the surface is wet. solvent-based coatings cannot be applied as proper adhesion cannot develop. Moist surfaces do not harm water-based paints but an excess of water prevents proper film formation. The surface of a structure may appear to be dry while water of construction remains in the interior. Application of a coating may trap this water which. if it migrates to the coated surface. may bring alkali that will chemically destroy saponifiable paints or salts that may mechanically destroy films through efflorescence. Use of dry forms of construction eliminates these problems but careful design is required to ensure that the materials do not absorb water in service. Thus, in cold climates air leakage can transfer large quantities of water to outside walls.

Chemical surface-active treatments associated with various masonry materials can cause difficulties when coatings are to be applied. For example, form release agents used with concrete result in problems. As many of these compounds contain hydrocarbon waxes or petrolatum, water-based coatings will not wet the surface properly and the adhesion or drying time of solvent-based coatings is adversely affected. Damp-proofing admixtures in concrete or water-repellent treatments on asbestos-cement sheets and bricks can similarly prevent proper wetting of the surface by water paints. Weathering for six months to one year or removal by abrasion is usually recommended especially for repellent treatments, before attempting to paint masonry containing these agents. Form oils may also be removed by chemical cleaners.

Cleaning agents and paint removers can also cause problems with coatings applied subsequently. If the cleaner contains alkaline chemicals which are not thoroughly washed off, there will be the same reaction with saponifiable paints as was described before. Some water-soluble paint removers also contain alkali and many of the solvent-type incorporate wax to reduce solvent evaporation. If left on the surface, the wax will interfere with paint performance in the same manner as the form oils. Adequate removal of all residues of cleaners ind removers is necessary before the surface can be painted.

In common with other exterior substrates, atmospheric conditions at the time of painting can affect the performance of painted masonry. Because of their porous structures, masonry and wood materials are able to absorb water during a rainfall or when the relative humidity is high. Consequently, when the weather improves more time is required for these materials to dry out than is needed for non-porous metallic substrates. It is necessary to follow closely the manufacturer's instructions regarding application conditions if one wishes to ensure satisfactory coating life. This applies particularly to chemically-cured finishes which may not cure at all under adverse conditions

General Recommendations

Concrete, stucco and brick walls are usually coated with the same type of materials. Since their introduction, latex paints have been preferred and have made concrete and stucco probably less difficult to paint than other exterior surfaces such as metals which corrode and wood which is less stable dimensionally. Latex paints have given good results on concrete block as well as concrete and stucco. Repainting of latex paints should be carried out before the previous coat chalks excessively. As discussed in **CBD 91**, latex paints cannot penetrate chalk which must be removed by scrubbing or bound with a penetrating sealer. With regard to stucco, tests in Germany on exterior masonry renderings of high lime content showed that application of latex paint might cause freeze-thaw damage to fresh rendering if the wall permitted entry of water[2].

Cement-containing renderings did not exhibit this type of failure and since stucco is a cement plaster it can be coated with a latex paint. As mentioned earlier, design considerations apply also to other types of masonry since structural defects may lead to efflorescence which a thin coating cannot be expected to prevent.

Whether brick should be painted is a subject of disagreement. There have been obvious failures when brick was painted and several factors appear responsible: (1) older types of coatings such as oil paints did not perform well on bricks and generally peeled or flaked off after a few years; (2) some types of water-repellent treatments for brick may interfere with application of latex paints; (3) if the coating is fairly impermeable it may retain sufficient water, which has gained access to the wall, to cause spalling of the brick surface when there are repeated cycles of freezing and thawing. Latex paints usually have high water vapour permeability and thus have performed well on brick substrates that were properly prepared before painting. The surfaces should be free of dust and dirt and defective mortar joints must be repainted. Sprinkling with water will indicate whether a repellent is present. If the water collects in droplets instead of being absorbed by the brick. a test patch of latex paint should be tried before attempting to coat the whole wall. Lack of crawling of the wet paint and good adhesion of the dry film are indications that the brick may be safely painted. It should be recognized that organic coatings will in time weather away so that repainting will eventually be required.

Other coatings that have been used successfully on concrete, stucco and brick are the heavily-applied coatings of the so-called "breathing" type. These materials, which generally contain asbestos fibre and sand, are applied at a high film thickness so that minor imperfections are hidden. There are two types _ water and solvent based _ but their intended uses are practically identical. Small amounts of moisture on the surface are not detrimental to the latex type, while cool (35 to 50øF) application temperatures are less damaging to the solvent variety. Because of the low binder and very high pigment contents, the adhesion of these coatings is mostly mechanical. Care must therefore be taken to apply them properly. Some coatings in this category have a special primer to ensure adhesion. Although these highly-filled materials allow passage of water vapour, they cannot transmit large quantities of water, which enters at a construction defect. As has been said, paint is not a substitute for gutters, flashings and moisture barriers. Failure by delamination usually occurs when water that has accumulated behind the film as frost during the winter thaws in the spring. These coatings have given good long-term performance on masonry but do tend to show stains where run-off occurs. Overcoating with a clear topcoat is sometimes recommended to reduce staining but it also reduces the ability to transmit moisture which was one basis for the original selection of this kind of material.

Solvent-based coatings of normal thickness have been widely promoted by manufacturers of alkali-resistent resins. The various types of binders include vinyltoluene-acrylic, styrene-butadiene and chlorinated rubber and the coatings are often referred to as "rubber base." Although they perform as well as latex paints and are reported to be more resistant to efflorescence, the cost of the resins and solvents makes it somewhat difficult to compete economically with water-dispersed coatings.

Cement paints were widely used before the introduction of latex paints. Generally, they have been unsatisfactory on exterior masonry because the original colour is soon lost due to chalking of the film. In addition, if not applied properly, which includes adequate wetting of the substrate, scrubbing of the paint into the surface and water spraying to cure the cement, the film tends to be porous and even powdery. A chalking cement paint presents a poor surface for recoating either with itself or other finishes. If the film is firm with light to moderate chalking, a solvent-based sealer can be applied to bind the chalk before application of any of the three kinds of coatings discussed above. If chalking is severe or the film is crumbling, the only safe albeit expensive procedure is to remove the cement paint by sand blasting.

To obtain a finish equivalent to ceramic tile or glazed brick but with the low cost of concrete block construction, high-build coatings are used, especially on the interior of institutional buildings, e.g., schools. Some of these materials are based on two-component urethanes, polyesters and epoxies; others consist of an emulsion base coat with a clear acrylic glaze (actually an acrylic lacquer). Spatter and veil coats can be added to obtain varied decorative effects. Most systems include a filler coat which evens out holes and depressions in the concrete blocks. Depending upon the surface smoothness, concrete placed in situ may require application of only the base coat without the filler. If these "tile-like" coatings are factory-applied to blocks. the mortar joints in the assembled walls are, of course, visible. Field application after construction obviates this defect but necessitates trained applicators, especially with the reactive types which introduce the problems of mixing on the job, limited pot-life, delayed cure at low temperatures and, in some cases, critical application requirements. Until recently epoxies and urethanes have yellowed and chalked on exterior exposure. Gloss-retentive, non-yellowing urethanes have been introduced in the past few years but are rather expensive.

Coatings applicable to asbestos-cement surface depend upon the kind of curing of the substrate. Air-cured products require coatings with high resistance to alkali, such as latex paints or the solvent-based materials previously referred to. The alkaline content of the autoclaved type is so low that any exterior coating may be used. As it is difficult to determine in the field the type of panel that is to be painted, it is customary to restrict the selection to unsaponifiable coatings. Application of impermeable coatings to one side only of asbestos-cement panels has been reported to cause bowing and warping. This is thought to be the result of greater expansion of the uncoated side if it is subjected to wet conditions. A sealer that provides an equivalent vapour barrier is required on the side opposite the high-build coating if the defect is to be avoided. Coatings of normal thickness and with a permeability greater than one perm have not been associated with warpage. When asbestos-cement sheets are assembled in sandwich panels, both faces of the panels should be coated for increased dimensional stability of the units.

Concrete basement walls below grade can be painted with latex or cement paints providing there is no leakage. Experience at DBR has shown that it is not possible for a thin interior coating to stop water ingress. Rather, the exterior of foundations should be waterproofed; this will ensure that hydrostatic pressure will aid, not destroy, adhesion of coatings.

Coating and clear treatments for concrete floors are described in **CBD 90**. Finishes for interior plaster and plasterboard are also discussed in that Digest.

Conclusion

Masonry surfaces can be successfully painted if the correct type of coating is used for the substrate in question and if good design and construction have prevented leaks and openings in the structure. In such cases, coatings not only improve the appearance, but also give some protection by preventing rain penetration. If a wall remains dry its thermal conductivity is retained and it may not be subject to other problems associated with wetness. When design or construction practices are faulty, organic coatings cannot be expected to remedy the situation.

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