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Standard Guide for Preparation of Concrete Surfaces for Adhered (Bonded) Membrane Waterproofing Systems[1]

This standard is issued under the fixed designation D 5295; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide provides recommendations for the preparation of concrete surfaces prior to the application of adhered (bonded) waterproofing.

1.2 This guide is directed primarily toward installations of new concrete, but is also applicable for existing concrete installations. (See also ACI 116 and ACI 546.)

1.3 This guide does not apply to loose laid systems, bentonite systems, lead, or the like.

1.4 This guide does not apply to applications involving insulating concrete.

1.5 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 1079 Terminology Relating to Roofing, Waterproofing, and Bituminous Materials[2]

D 4262 Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces[3]

D 4263 Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method[3]

2.2 *ACI Standards:*

ACI 116 Cement and Concrete Terminology[4]

ACI 301 Specifications for Structural Concrete for Buildings[4]

ACI 311 Guide to Inspection of Concrete[4]

ACI 515 A Guide to the Use of Waterproofing, Dampproofing, Protective and Decorative Barrier Systems for Concrete[4]

ACI 546 Repair of Concrete[4]

3. Significance and Use

3.1 The success of a waterproofing application depends on, among other things, the type, smoothness, and cleanliness of the concrete surface being coated. This guide describes conditioning or repairing of the concrete surface by the removal or other constructive modification of those surface defects that can affect the performance of the waterproofing system. It also covers surface preparation by chemical and blast cleaning methods in order to provide good adhesion between the waterproofing system and the concrete as well as the effect and control of various surface contaminants. (See also ACI 515.)

3.2 This guide is not intended to offer guidelines for the selection of a suitable waterproofing system; the use of specific application techniques; or the design and installation of flashing, terminations, expansion joint details, etc. (For definitions of terms, see Terminology D 1079.)

3.3 The recommended procedures described herein are minimums; the waterproofing materials manufacturer may require more strict or specific procedures for the preparation of concrete surfaces for the application of the manufacturer's specific system.

4. Adhesion Inhibitors

4.1 *General*—Among the items that inhibit the adhesion of membrane waterproofing systems are form release agents, concrete curing compounds, admixtures, laitance, moisture, and grease or oils.

4.2 Form release agents, such as oil, grease, wax, and silicones, will transfer to the surface of the concrete during casting. These will cause poor adhesion of waterproofing systems. Since these are almost invisible, it is difficult to detect their presence. Any procedure for the removal of such materials will be specific to that material. Proprietary form coating materials should be accepted prior to use and after evaluation by the specifier to determine that they are appropriate for use with the proposed waterproofing materials and systems. Proprietary paint systems applied to the forms that are nontransferable and formulated to prevent contamination of the concrete surface should be used.

4.3 Concrete curing compounds may contain waxes, resins, chlorinated rubber, or film formers of various types. If such materials must be used, the specifier should be certain that the

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[2] *Annual Book of ASTM Standards*, Vol 04.04.

[3] *Annual Book of ASTM Standards*, Vol 06.01.

[4] Available from American Concrete Institute, P.O. Box 19150, Redford Station, Detroit, MI 48219.

materials can be completely removed or that the waterproofing system manufacturer has evaluated them for use with the manufacturer's system to determine that they are acceptable for such use. These materials should be accepted prior to use and after evaluation by the specifier to determine that they are appropriate for use with the proposed waterproofing materials and system.

4.4 Admixtures such as water-immiscible chemical curing agents are sometimes used in concrete. These should be avoided unless the specifier has determined that they are acceptable for use with the intended waterproofing materials. These materials should be accepted prior to use and after evaluation by the specifier to determine that they are appropriate for use with the proposed waterproofing materials and system.

4.5 Laitance, dust and dirt, moisture, and grease and oil can inhibit or impair adhesion of the waterproofing system. These must be removed; controlled in a manner acceptable to the waterproofing materials manufacturer; or found by the manufacturer to be non-detrimental to the adhesion and performance of the waterproofing system to be employed.

5. Repair of Surface Defects

5.1 *General*—Surface defects that may impair adhesion include honeycomb, fins, tie holes, "bug holes," sharp offsets from displaced forms, rutted cracks, ragged corners, deviations in the surface plane, and other similar concrete defects, along with spalling and delaminations of the concrete surface. (See also, Concrete Manual.[5])

5.2 Fins, protrusions, or similar irregularities should be cut back to the surface by chipping, bushhammering, needlegunning, or wirebrushing. Avoid polishing of the concrete surface by these techniques.

5.3 Sharp offsets in the surface, such as those caused by formwork misalignment, should be cut back to an even surface by chipping, bushhammering, needlegunning, wirebrushing, or transitioning with grout. This could also be performed in accordance with the applicable provisions of ACI 301 and 311. Avoid polishing the concrete surface by any of these techniques.

5.4 Sharp offsets between precast sections should be corrected as indicated in 5.5.

5.5 Defective concrete areas should be removed down to sound concrete, preferably by chipping; if grinding is necessary, care must be taken to avoid "polishing" the surfaces. If sizable areas or amounts of unsound concrete are found, a structural engineer shall specify appropriate corrective action. Cracks exceeding 2 mm (1⁄16 in.) should be investigated to determine whether they are still active. Such cracks should be chipped out before being patched, and edges should be undercut slightly, in accordance with the suggestions and recommendations of applicable portions of ACI 301 and 311, or as recommended by the manufacturer of the patching material. No feathered edges shall be permitted. Tie holes and "bug holes" larger than 16 mm (5⁄8 in.) in diameter or deeper than 3 mm (1⁄8 in.), or both, should be prepared similarly for patching.

5.5.1 The areas to be patched, along with a band at least 150 mm (6 in.) wide surrounding it, should be dampened before the patching application to prevent rapid absorption of water from the bonding grout and the patching mortar, or this can be performed in accordance with the applicable provisions of ACI 301 and 311.

5.5.2 Immediately after the surface water has evaporated from the dampening step, a bonding grout or bond coat, consisting of approximately one part of cement to one part of fine sand passing No. 30 mesh sieve with an amount of water sufficient to obtain a consistency of thick cream, should be brushed thoroughly into the surface, or this can be performed in accordance with the applicable provisions of ACI 301 and 311.

5.5.3 The patching mortar should be made from the same materials and in the same proportions as the concrete, with the exception of coarse aggregate. (In any case, use no more than one part cement to 2.5 parts sand.) Mix the patching mortar thoroughly with an amount of water sufficient only to obtain the stiffest consistency that will permit placement. Apply the mortar as soon as the bonding coat begins to loose the water sheen. Mortar should be worked thoroughly into place and struck off slightly higher than the surrounding area to allow for some initial shrinkage. Such patches should set for at least 1 hour before surface finishing and then be damp-cured for seven days. Any tie holes or "bug holes" should be filled completely with mortar. This can also be performed in accordance with the applicable provisions of ACI 301 and 311.

5.5.4 Proprietary materials may be used either in lieu of or in addition to the patching materials described in 5.5.3. Such compounds must be used in accordance with the manufacturer's instructions. These proprietary materials must be compatible with, and not interfere with, adhesion of the waterproofing system to be employed. Proprietary patching materials should be accepted prior to use and after evaluation by the specifier to determine that they are appropriate for use with the proposed waterproofing materials and system.

6. Surface Preparation

6.1 *General*—Most waterproofing systems depend on good adhesion to the concrete. This, in turn, depends on proper surface preparation. The concrete surfaces must be free of loose, weak, and unsound materials (including laitance), as well as any chemical contamination that may adversely affect the bond. Some tests for the adequacy of the surface preparation are reviewed (see also 7.5). The preparation and testing of the concrete surfaces could also be performed in accordance with the applicable provisions of ACI 301 and 311. When there is doubt concerning selection of a cleaning method, a small trial installation using one or more cleaning methods followed by a patch test should be performed.

6.2 Scraping is a technique used frequently to remove a thin, top layer of unsound concrete, for example, using a straight, flat edge blade to remove laitance. It does not gouge the surface but still returns to a sound substrate. It is used instead of sanding because sanding tends to drive the dust from the surface into the pores, thereby providing an interfacing or

[5] Available from U.S. Bureau of Reclamation, Denver, CO, *Concrete Manual*, 8th Edition, 1975, pp. 393–429.

parting film. Cleaning the surface after scraping is usually performed by air blast using oil-free compressed air. If materials do not adhere to such surfaces, a primer will frequently be required.

6.3 Chemical cleaning may be necessary prior to blast cleaning or acid etching, in order to remove surface contaminants such as oil, grease, and dirt. Solutions of 10 % caustic soda or of trisodium phosphate may be used as well as proprietary detergents specially formulated for use on concrete. They should be applied with vigorous scrubbing, followed by flushing with water to remove all traces of both the detergent and the contaminant, until the surface is neutral or only slightly alkaline, as indicated by litmus or pH paper. Solvents must be avoided because they dissolve the oil, grease, etc. and spread the contamination over a larger area.

6.4 Mechanical cleaning procedures are normally considered to be scarification and blast cleaning.

6.4.1 Scarification by a mechanical impacting device is used on concrete surfaces to remove thick overlays of dirt or weak surface material. After scarification, water or sand-blasting is required to remove aggregates weakened by mechanical impacting. If the scarification process produces a surface too coarse or too uneven for proper adhesion, it should be made smooth with patching mortar.

6.4.2 Blast cleaning is an effective method for the removal of laitance, dirt, efflorescence, and weak surface material. There are three types of blast cleaning methods: dry sandblasting, wet sandblasting, and high-pressure water jetting. Dry and wet sandblasting are usually the most effective. Abrasive cleaning techniques can also be used, provided the abrasive used does not contaminate the surface being prepared. Oils or greases should be removed prior to blast cleaning. If compressed air is used, it must be clean and free of water or oil. Care must be exercised to ensure that clean water is used for wet-blast cleaning. The concrete surface should be abraded in the blasting step to the extent that small aggregate particles are exposed. The amount removed should be sufficient to provide a strong, sound substrate suitable for the application of waterproofing.

6.5 *Acid Etching*:

6.5.1 *General*—Acid etching procedures may be used in lieu of mechanical cleaning procedures; however, mechanical abrading methods are preferred to acid etching because of possible chloride ion contamination (and resultant deterioration) of the concrete unless extreme care is taken and because acid etching is not as dependable as mechanical abrasion. Because of these factors and the potential hazards involved with the use of acid, as well as cleanup and environmental considerations, such cleaning should be used only where no alternative means of cleaning are possible and should be performed only by those experienced in its use.

6.5.2 A 10/90 to 20/80 dilution of commercial grade hydrochloric acid in water is typically prepared and applied to the concrete at a rate of 1.0 L/m^2(1 qt/yd^2). The surface to be etched is normally predampened to obtain a more uniform acid etch. The acid solution is scrubbed into the surface. Foaming will subside in 3 to 5 min, after which the surface should be flushed thoroughly with fresh water while scrubbing with stiff bristle brushes, in order to remove the salts formed by the acid reaction and to dislodge loose particles. A second treatment may be necessary to obtain a reasonably clean surface. When the presence of chlorides is inadvisable (due to effects on concrete or reinforcing steel), a 15 % phosphoric acid solution should be used. The application and washing techniques are the same. The efficacy of the flushing operation should be verified at a number of points within the area treated by placing litmus or pH paper on the wet surface to determine that the surface is reasonably free of acid and chloride residues.

7. Surface Evaluation

7.1 *General*—Concrete surfaces should be tested to verify they are suitable for waterproofing application. The number of tests to be made, the specific areas to be tested, and the tests to be used are to be mutually agreed upon by the manufacturer of the waterproofing materials, the applicator, and the representative(s) of the owner. This information should be specified in the contract documents. While various test procedures are described in this section, additional testing and test procedures may be required by the waterproofing materials manufacturer.

7.2 *Temperature Conditions*—It is important that extremes in ambient temperature conditions always be avoided during surface evaluation test applications as well as during application of the waterproofing system itself. This might be achieved by postponing the application to a better time or by providing special protection for the area being waterproofed, etc. The recommendations of the waterproofing materials manufacturer should be followed. If the concrete is exposed to the sun and air for a period of time (about 6 hours), it is more likely to have a lower surface moisture content.

7.3 *Moisture in Concrete and Effect on Adhesion*—Concrete surfaces generally should be surface dry (that is, free from moisture due to rain, snow, or other precipitation) unless specifically otherwise allowed by the manufacturer of the waterproofing materials. Both surface moisture and the moisture remaining in the concrete may affect the ability to develop a good bond to the surface. In some cases, the waterproofing material can displace or be unaffected by the amount of moisture remaining in the concrete; other materials are quite sensitive. The manufacturer of the waterproofing materials should specify the requirements and testing procedure for dryness for his particular system.

7.4 *Encapsulation of Concrete*—Encapsulation of a concrete element such as a wall, slab, etc., that is, the waterproofing of both faces, can lead to blistering or loss of adhesion of the waterproofing film, or both, as well as deterioration of the concrete. Such problems can be prevented by proper design. The designer should avoid this condition or provide for vapor pressure relief by such venting devices as “pipe stem weeps.” A “breathable” or vapor-permeable system, such as a cementitious topcoat, may reduce the vapor pressure problem.

7.5 *Field Testing*:

7.5.1 *Dust*—An experienced evaluator should check for dusty conditions by wiping the dry surface with a dark cloth. If a layer of whitish powder is found on the cloth, the surface is too dusty. An alternate verification can be made using a variably aggressive material, such as mystic tape. If in doubt, brush or air hose the surface with oil-free compressed air. Refer

to 7.5.5 for a specific test for laitance.

7.5.2 *Oily Condition*— Test for the presence of oil or grease by sprinkling water on the dried concrete surface. If the water beads on the surface and does not spread out immediately, the surface is probably contaminated by oils or dust.

7.5.3 *Acid Condition*— Wet the surface at the area to be tested with clean potable water of neutral pH. After several minutes, use pH paper to determine the acidity or alkalinity at the surface of the concrete. A pH below 4 (acid) is often considered unacceptable. A pH above 11 (alkaline) should be considered suspect. The actual permissible pH range should be established by the waterproofing materials manufacturer. Additional details of this testing may be found in Test Method D 4262.

7.5.4 *Surface Dryness*— If the surface of the concrete appears dry enough to coat, the surface dryness of concrete can be evaluated qualitatively by taping an 0.46 by 0.46 m (18 by 18 in.) clear 4-mil polyethylene sheet to the concrete surface and observing the moisture that may collect on the underside of the polyethylene sheet. Additional details of this type may be found in Test Method D 4263. The ambient conditions (sunlight, temperature, and humidity) during the test should simulate, insofar as practical, the conditions that will exist during application of the waterproofing system. Alternately, the waterproofing materials manufacturer should provide a testing procedure that the manufacturer considers satisfactory. In any case, the waterproofing materials manufacturer should provide descriptions of those application conditions and plastic film test results that will allow satisfactory application of the manufacturer's materials to be made.

7.5.5 *Laitance*—Laitance will inhibit proper adhesion of the waterproofing system. Laitance is a layer of weak and nondurable material containing cement and fines from aggregates, brought by bleeding water to the top of overwet concrete. It is generally produced by the overworking or overmanipulating of concrete at the surface through the use of improper finishing techniques. Laitance may be detected by scraping the surface with a putty knife; if a quantity of loose powdery material is observed or easily removed, excessive laitance is considered to be present. Refer to 6.2 for removal. The manufacturer of the waterproofing membrane should determine the suitability of such a surface for use.

7.5.6 *Patch Test*—The patch test consists of applying the waterproofing system to a small, typical area of clean, dry concrete. After curing of the waterproofing system has taken place, the adhesion of the test patch is evaluated. No established test procedure exists for this evaluation. The manufacturer of the waterproofing system should therefore recommend procedures for conducting and evaluating this test and approve or disapprove the application if the results are questionable.

8. Keywords

8.1 concrete; evaluation; repair; surface preparation; waterproofing