This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

Designation: C981 – 20

Standard Guide for Design of Built-Up Bituminous Membrane Waterproofing Systems for Building Decks[1]

This standard is issued under the fixed designation C981; 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 describes the design of fully adhered built-up bituminous membrane waterproofing systems for plaza deck and promenade construction over occupied spaces of buildings where covered by a separate wearing course.

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

1.3 The committee with jurisdiction over this standard is not aware of any comparable standards published by other organizations.

1.4 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C33/C33M Specification for Concrete Aggregates
C578 Specification for Rigid, Cellular Polystyrene Thermal Insulation
C755 Practice for Selection of Water Vapor Retarders for Thermal Insulation
C920 Specification for Elastomeric Joint Sealants
C1193 Guide for Use of Joint Sealants
C1472 Guide for Calculating Movement and Other Effects When Establishing Sealant Joint Width
D41/D41M Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
D43/D43M Specification for Coal Tar Primer Used in Roofing, Dampproofing, and Waterproofing
D173/D173M Specification for Bitumen-Saturated Cotton Fabrics Used in Roofing and Waterproofing
D226/D226M Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
D227/D227M Specification for Coal-Tar-Saturated Organic Felt Used in Roofing and Waterproofing
D312/D312M Specification for Asphalt Used in Roofing
D449/D449M Specification for Asphalt Used in Dampproofing and Waterproofing
D450/D450M Specification for Coal-Tar Pitch Used in Roofing, Dampproofing, and Waterproofing
D1079 Terminology Relating to Roofing and Waterproofing
D1327/D1327M Specification for Bitumen-Saturated Woven Burlap Fabrics Used in Roofing and Waterproofing
D1668/D1668M Specification for Glass Fabrics (Woven and Treated) for Roofing and Waterproofing
D2178/D2178M Specification for Asphalt Glass Felt Used in Roofing and Waterproofing
D4586/D4586M Specification for Asphalt Roof Cement, Asbestos-Free
D4601/D4601M Specification for Asphalt-Coated Glass Fiber Base Sheet Used in Roofing
D4990 Specification for Coal Tar Glass Felt Used in Roofing and Waterproofing
D5295/D5295M Guide for Preparation of Concrete Surfaces for Adhered (Bonded) Membrane Waterproofing Systems
D5643/D5643M Specification for Coal Tar Roof Cement, Asbestos Free
D5898/D5898M Guide for Standard Details for Adhered Sheet Waterproofing
D5957 Guide for Flood Testing Horizontal Waterproofing Installations

[1] This guide is under the jurisdiction of ASTM Committee D08 on Roofing and Waterproofing and is the direct responsibility of Subcommittee D08.22 on Waterproofing and Dampproofing Systems.

Current edition approved May 1, 2020. Published May 2020. Originally approved in 1983. Last previous edition approved in 2013 as C981 – 05 (2013). DOI: 10.1520/C0981-20.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

Copyright © ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959. United States

D6152/D6152M Specification for SEBS-Modified Mopping Asphalt Used in Roofing
D6162/D6162M Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcements
D6163/D6163M Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Glass Fiber Reinforcements
D6164/D6164M Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Polyester Reinforcements
D6451/D6451M Guide for Application of Asphalt Based Protection Board
D6506/D6506M Specification for Asphalt Based Protection Board for Below-Grade Waterproofing
D6622/D6622M Guide for Application of Fully Adhered Hot-Applied Reinforced Waterproofing Systems
D7492/D7492M Guide for Use of Drainage System Media with Waterproofing Systems

2.2 *Other Documents:*
ACI 301 Specifications for Structural Concrete in Buildings[3]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this guide, refer to Terminology D1079.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *prefabricated drainage composite*—a preformed porous material, usually plastic, with a filter-type fabric over it.

4. Significance and Use

4.1 This guide provides information and guidelines for the selection of components and the design of a built-up bituminous membrane waterproofing system in building deck construction. Where the state of the art is such that criteria for particular conditions are not established or have numerous variables that require consideration, applicable portions of design considerations, Sections 5 – 16, serve as reference and guidance for selection by the designer of the system.

5. Comparison to Other Standards

5.1 The Committee with jurisdiction over this standard is not aware of any comparable standards published by other organizations.

5.2 For application methods, refer to Guide D6622/D6622M. For design of typical details not addressed in this guide, refer to Guide D5898/D5898M.

6. General

6.1 The design of plaza deck waterproofing cannot be satisfactorily determined without consideration of the several subsystems, their material components, and interrelationships. The proper selection from a variety of components that form a built-up bituminous membrane waterproofing system must be predicated upon specific project requirements and the interrelationship of components. The variety of the types of surfaces exposed to weather, the difference of climatic conditions to which the deck is exposed, and the interior environmental requirements of the occupied space are major determinants in the process of component selection. Essential to determination of the deck design components is information relative to temperature extremes of the inner and outer surfaces, precipitation rates, solar exposure, prevailing wind direction, the pattern and reflectivity of adjacent structures, anticipated amount and intensity of vibration resulting from function or adjacent occupancies, and design live loads both normal and emergency.

6.2 It is essential that all components and contiguous elements be compatible and coordinated to form a totally integrated waterproofing system.

6.3 The plaza deck system is normally composed of several subsystems: the structural building deck (membrane substrate), the waterproofing membrane, the drainage subsystem, the thermal insulation, protection or working slab, and the wearing course (see Fig. 1). Fig. 1 as well as details, subsystems, components, and illustrations that follow are intended to illustrate a principle but are not necessarily the only solution for a diversity of environments.

7. Substrate

7.1 The building deck or substrate referred to in this guide is reinforced cast-in-place structural concrete.

7.1.1 High early strength and lightweight insulating concretes do not provide suitable substrates. Additives made to the

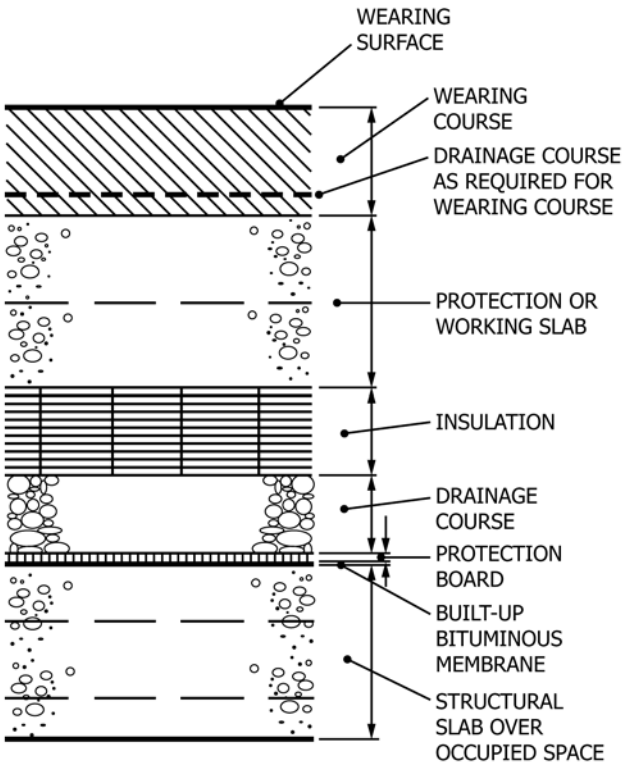

FIG. 1 Basic Components of Built-up Bituminous Membrane Waterproofing System with Separate Wearing Course (see 6.3)

[3] Available from ACI International, PO Box 9094, Farmington Hills, MI 48333–9094.

concrete mix (such as calcium chloride) to promote curing, reduce water requirements, or modify application temperature requirements should not be used unless the manufacturer of the waterproofing system specifically agrees.

7.1.2 Precast concrete slabs pose more technical problems than cast-in-place concrete, and the probability of lasting watertightness is greatly diminished and difficult to achieve because of the multitude of joints that have the capability of movement and must be treated accordingly. Moving joints are critical features of waterproofing systems and are more critical when sealed at the membrane level than at a higher level with the use of integral concrete curbs. Such curbs are impractical with precast concrete slabs and necessitate an even more impractical drain in each slab. Other disadvantages of precast concrete slabs are their inflexibility in achieving contoured slope to drains and the difficulty of coordinating the placement of such drains.

7.2 *Slope for Drainage*—Drainage at the membrane level is important. When the waterproofing membrane is placed directly on the concrete slab, a monolithic concrete substrate slope of a minimum 2 % (¼ in./ft) should be maintained. The maximum slope is related to the type of membrane used. Slope is best achieved with a monolithic pour as compared with a separate concrete fill. The fill presents the potential of additional cracks and provides a cleavage plane between the fill and structural slab. This cleavage plane complicates the detection of leakage in the event that water should penetrate the membrane at a crack in the fill and travel along the separation until reaching a crack in the structural slab.

7.3 *Strength*—The strength of concrete is a factor to be considered with respect to the built-up bituminous membrane insofar as it relates to finish, bond strength, and continuing integrity. The cast-in-place structural concrete should have a minimum density of 1762 kg/m^3 (110 lb/ft^3).

7.4 *Finish*—The structural slab should have a finish of sufficiently rough texture to provide a mechanical bond for the membrane, but not so rough to preclude achieving continuity of the membrane across the surface. As a minimum, ACI 301 floated finish is required with ACI 301 troweled finish preferred, deleting the final troweling.

7.5 *Curing*—Curing the structural slab is necessary to provide a sound concrete surface and to obtain the quality of concrete required. Curing is accomplished chemically with moisture and should not be construed as drying.

7.5.1 *Moist Curing*—Moist curing is achieved by keeping the surfaces continuously wet by covering with burlap saturated with water and kept wet by spraying or hosing. The covering materials should be placed to provide complete surface coverage with joints lapped a minimum of 75 mm (3 in.).

7.5.2 *Sheet Curing*—Sheet curing is accomplished with a sheet vapor retarder that reduces the loss of water from the concrete and moistens the surface of the concrete by condensation, thus preventing the surface from drying while curing. Laps of sheets covering the slab should be not less than 50 mm (2 in.) and should be sealed or weighted (see Practice C755).

7.5.3 *Chemical Curing*—Liquid or chemical curing compounds applied to the surface of the structural slab should not be used unless approved by the manufacturer of the built-up bituminous membrane, as the material may interfere with the bond of the membrane to the structural slab.

7.6 *Dryness*—Membrane manufacturers' requirements for substrate dryness vary from being visibly dry to having a specific maximum moisture content. Since there is a lack of unanimity in this regard, it is necessary to conform to the manufacturer's requirements for the particular membrane being applied. Adequate drying of residual moisture from slabs poured over a permanent metal deck will normally take longer than from slabs stripped of forming. Subsequent underside painting of stripped concrete slabs that might inhibit moisture vapor transmission and possibly cause loss of membrane adhesion should be avoided.

7.7 *Joints*—Joints in a structural concrete slab are herein referred to as reinforced joints, unreinforced joints, and expansion joints.

7.7.1 *Reinforced Joints*—Reinforced joints consist of hairline cracks, cold joints, construction joints, and isolation joints held together with reinforcing steel bars or wire fabric. These are considered static joints with little or no movement anticipated because the slab reinforcement is continuous across the joint.

7.7.2 *Nonreinforced Joints*—Nonreinforced joints consist of butt-type construction joints and isolation joints not held together with reinforcing steel bars or wire fabric. These joints are generally considered by the designer of the structural system as nonmoving or static joints. However, the joints should be considered as capable of having some movement, the magnitude of which is difficult to predict.

7.7.3 *Expansion and Seismic Joints*—Expansion joints, as differentiated from control joints, are designed to accommodate movement in more than one direction, are an integral part of the building structural system, and must be carried through the entire structure. Expansion joints are incorporated in the structural frame (*1*) to reduce internal stresses caused by wide temperature ranges or differential movement, or both, between structural elements as might be the case in large adjoining heated and unheated spaces; (*2*) where there are different foundation settlement conditions between adjacent elements; or (*3*) where movements between high- and low-attached structures are anticipated. Seismic joints are a special case in which the joints are generally quite large and are designed to limit damage to the structural frame during earthquakes. Expansion and seismic joints are best located at high points of contoured substrates to deflect water away from the joint. For expansion joints designed for thermal movement only, the movement is expected to be only in the horizontal plane. Seismic joints are designed to accommodate both vertical and horizontal movement.

7.8 *Flashing Substrate*—The vertical surface that the membrane waterproofing intersects must be sound, with a smooth or floated finish, dry, and free of cracks and loose materials as stated for the horizontal or deck substrate. The vertical surfaces may be of concrete, stone, or masonry, and should be reinforced against shrinkage and cracks.