
USACE / NAVFAC / AFCEC UFGS-32 16 19 (May 2018)

Preparing Activity: USACE

Superseding
UFGS-32 16 13 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2024

SECTION TABLE OF CONTENTS

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 16 19

CONCRETE CURBS, GUTTERS, SIDEWALKS, SWALES AND DITCHES

05/18

PART 1 GENERAL

- 1.1 UNIT PRICES
 - 1.1.1 Measurement
 - 1.1.1.1 Sidewalks
 - 1.1.1.2 Curbs, Gutters, Swales and Ditches
 - 1.1.2 Payment
 - 1.1.2.1 Sidewalks
 - 1.1.2.2 Curbs, Gutters, Swales and Ditches
- 1.2 REFERENCES
- 1.3 SUBMITTALS
- 1.4 EQUIPMENT, TOOLS, AND MACHINES
 - 1.4.1 General Requirements
 - 1.4.2 Slip Form Equipment
- 1.5 ENVIRONMENTAL REQUIREMENTS
 - 1.5.1 Placing During Cold Weather
 - 1.5.2 Placing During Warm Weather

PART 2 PRODUCTS

- 2.1 CONCRETE
 - 2.1.1 Air Content
 - 2.1.2 Slump
 - 2.1.3 Reinforcement Steel
- 2.2 CONCRETE CURING MATERIALS
 - 2.2.1 Impervious Sheet Materials
 - 2.2.2 Burlap
 - 2.2.3 White Pigmented Membrane-Forming Curing Compound
- 2.3 CONCRETE PROTECTION MATERIALS
- 2.4 JOINT FILLER STRIPS
 - 2.4.1 Contraction Joint Filler for Curb, Gutter, Swale and Ditch
 - 2.4.2 Expansion Joint Filler, Premolded
- 2.5 JOINT SEALANTS
- 2.6 FORM WORK

- 2.6.1 Wood Forms
- 2.6.2 Steel Forms
- 2.6.3 Sidewalk Forms
- 2.6.4 Curb, Gutter, Swale and Ditch Forms
- 2.7 Detectable Warning System
- 2.8 FRAME, COVER, OR GRATINGS

PART 3 EXECUTION

- 3.1 SUBGRADE PREPARATION
 - 3.1.1 Sidewalk Subgrade
 - 3.1.2 Curb, Gutter, Swale and Ditch Subgrade
 - 3.1.3 Maintenance of Subgrade
- 3.2 FORM SETTING
 - 3.2.1 Sidewalks
 - 3.2.2 Curbs, Gutters, Swales and Ditches
- 3.3 SIDEWALK CONCRETE PLACEMENT AND FINISHING
 - 3.3.1 Formed Sidewalks
 - 3.3.2 Concrete Finishing
 - 3.3.3 Edge and Joint Finishing
 - 3.3.4 Surface and Thickness Tolerances
- 3.4 CURB, GUTTER, SWALE AND DITCH CONCRETE PLACEMENT AND FINISHING
 - 3.4.1 Formed Curb, Gutter, Swale and Ditch
 - 3.4.2 Curb, Gutter, Swale and Ditch Finishing
 - 3.4.3 Concrete Finishing
 - 3.4.4 Joint Finishing
 - 3.4.5 Surface and Thickness Tolerances
- 3.5 SIDEWALK JOINTS
 - 3.5.1 Sidewalk Contraction Joints
 - 3.5.2 Sidewalk Expansion Joints
 - 3.5.3 Reinforcement Steel Placement
- 3.6 CURB, GUTTER, SWALE AND DITCH JOINTS
 - 3.6.1 Contraction Joints
 - 3.6.2 Expansion Joints
- 3.7 CURING AND PROTECTION
 - 3.7.1 General Requirements
 - 3.7.1.1 Mat Method
 - 3.7.1.2 Impervious Sheeting Method
 - 3.7.1.3 Membrane Curing Method
 - 3.7.2 Backfilling
 - 3.7.3 Protection
 - 3.7.4 Protective Coating
 - 3.7.4.1 Application
 - 3.7.4.2 Precautions
- 3.8 FIELD QUALITY CONTROL
 - 3.8.1 General Requirements
 - 3.8.2 Concrete Testing
 - 3.8.2.1 Strength Testing
 - 3.8.2.2 Air Content
 - 3.8.2.3 Slump Test
 - 3.8.3 Thickness Evaluation
 - 3.8.4 Surface Evaluation
- 3.9 SURFACE DEFICIENCIES AND CORRECTIONS
 - 3.9.1 Thickness Deficiency
 - 3.9.2 High Areas
 - 3.9.3 Appearance
- 3.10 DETECTABLE WARNING SYSTEM

-- End of Section Table of Contents --

USACE / NAVFAC / AFCEC UFGS-32 16 19 (May 2018)

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Superseding
UFGS-32 16 13 (April 2008)

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SECTION 32 16 19

CONCRETE CURBS, GUTTERS, SIDEWALKS, SWALES AND DITCHES
05/18

NOTE: This guide specification covers the requirements for concrete sidewalks and curbs and gutters.

Adhere to [UFC 1-300-02](#) Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a [Criteria Change Request \(CCR\)](#).

PART 1 GENERAL

NOTE: This specification may be adjusted to cover separate curbs and gutters or combination curbs and gutters. This guide specification will not be used for integral or monolithic curbs of concrete pavement or for curbs and gutters for bridges.

1.1 UNIT PRICES

NOTE: Delete unit price paragraphs when the work is covered by a lump-sum contract price.

1.1.1.1 Measurement

1.1.1.1.1 Sidewalks

The quantities of sidewalks to be paid for will be the number of square meters of each depth of sidewalk constructed as indicated.

1.1.1.1.2 Curbs, Gutters, Swales and Ditches

The quantities of curbs and gutters to be paid for will be the number of linear meters of each cross section constructed as indicated, measured along the face of the curb at the gutter line.

1.1.2 Payment

1.1.2.1 Sidewalks

Payment of the quantities of sidewalks measured as specified will be at the Contract unit price per square meter of the thickness specified.

1.1.2.2 Curbs, Gutters, Swales and Ditches

Payment of the quantities of curbs and gutters measured as specified will be at the Contract unit price per linear meter of each cross section.

1.2 REFERENCES

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

AASHTO M 182

(2005; R 2021) Standard Specification for
Burlap Cloth Made from Jute or Kenaf and
Cotton Mats

ASTM INTERNATIONAL (ASTM)

ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A123/A123M	(2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A536	(2024) Standard Specification for Ductile Iron Castings
ASTM A615/A615M	(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A1064/A1064M	(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM B26/B26M	(2018; E 2018) Standard Specification for Aluminum-Alloy Sand Castings
ASTM C31/C31M	(2025a) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C94/C94M	(2025) Standard Specification for Ready-Mixed Concrete
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C171	(2020) Standard Specification for Sheet Materials for Curing Concrete
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173/C173M	(2024a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C231/C231M	(2024) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM D1751	(2018) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

ASTM D1752 (2018) Standard Specification for
Preformed Sponge Rubber, Cork and Recycled
PVC Expansion Joint Fillers for Concrete
Paving and Structural Construction

ASTM D5893/D5893M (2016) Standard Specification for Cold
Applied, Single Component, Chemically
Curing Silicone Joint Sealant for Portland
Cement Concrete Pavements

KOREA FOUNDRY COOPERATIVE ASSOCIATION (KFCA)

SPS-KFCA-D4301-5015 (2014; R 2024) Grey Iron Castings

KOREAN INDUSTRIAL STANDARDS (KS)

KS D 3503 (2018; R 2023) Rolled Steels for General
Structure

KS D 3504 (2025) Steel Bars for Concrete
Reinforcement

KS D 3505 (2019; R 2024) Steel bars for prestressed
concrete

KS D 7017 (2023) Welded Wire Mash and Bar Fabrics

KS D 8308 (2016; R 2021) Zinc Hot Dip Galvanizings

KS F 2401 (2017; R 2022) Standard Test Method for
Sampling of Fresh Concrete

KS F 2402 (2022) Test Method for Concrete Slump

KS F 2403 (2019; R 2024) Standard Test Method for
Making Concrete Specimens

KS F 2421 (2016; R 2021) Method of Test for Air
Content of Fresh Concrete by Pressure
Method

KS F 2449 (2022) Test Method for Air Content of
Fresh Concrete by the Volumetric Method

KS F 2538 (2021) Standard Specifications for
Preformed Expansion Joint Fillers for
Concrete Paving and Structural Construction

KS F 2540 (2020) Standard Specifications for Liquid
Membrane-Forming Compounds for Curing
Concrete

KS F 4007 (2002; R 2022) Sheet Materials for Curing
Concrete

KS F 4009 (2024) Ready-Mixed Concrete

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM MBG 531 (2017) Metal Bar Grating Manual

NAAMM MBG 532 (2019) Heavy Duty Metal Bar Grating Manual

INTERNATIONAL CODE COUNCIL (ICC)

ICC A117.1 (2017) Standard And Commentary Accessible
and Usable Buildings and Facilities

1.3 SUBMITTALS

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy and Air Force projects, or choose the second bracketed item for Army projects.

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Concrete

SD-06 Test Reports

Field Quality Control

SD-07 Certificates

Frame, Cover, or Gratings

Certification on the ability of frame, cover, or gratings to carry the imposed live load.

1.4 EQUIPMENT, TOOLS, AND MACHINES

1.4.1 General Requirements

Plant, equipment, machines, and tools used in the work will be subject to approval and must be maintained in a satisfactory working condition at all times. Use equipment capable of producing the required product, meeting grade controls, thickness control and smoothness requirements as specified. Discontinue using equipment that produces unsatisfactory results. Allow the Contracting Officer access at all times to the plant and equipment to ensure proper operation and compliance with specifications.

1.4.2 Slip Form Equipment

Slip form paver or curb forming machines, will be approved based on trial use on the job and must be self-propelled, automatically controlled, crawler mounted, and capable of spreading, consolidating, and shaping the plastic concrete to the desired cross section in one pass.

1.5 ENVIRONMENTAL REQUIREMENTS

1.5.1 Placing During Cold Weather

Do not place concrete when the air temperature reaches 5 degrees C and is falling, or is already below that point. Placement may begin when the air temperature reaches 2 degrees C and is rising, or is already above 5 degrees C. Make provisions to protect the concrete from freezing during the specified curing period. If necessary to place concrete when the temperature of the air, aggregates, or water is below 2 degrees C, placement and protection must be approved in writing. Approval will be contingent upon full conformance with the following provisions. Prepare and protect the underlying material so that it is entirely free of frost when the concrete is deposited. Heat mixing water or aggregates as necessary to result in the temperature of the in-place concrete being between 10 and 30 degrees C. Methods and equipment for heating must be approved. Use only aggregates that are free of ice, snow, and frozen lumps before entering the mixer. Provide covering or other means as needed to maintain the concrete at a temperature of at least 10 degrees C for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period.

1.5.2 Placing During Warm Weather

The temperature of the concrete as placed must not exceed 30 degrees C except where an approved retarder is used. Cool the mixing water and

aggregates as necessary to maintain a satisfactory placing temperature.
The placing temperature must not exceed 35 degrees C at any time.

PART 2 PRODUCTS

2.1 CONCRETE

Provide concrete conforming to the applicable requirements of ASTM C94/C94M or KS F 4009 except as otherwise specified. Concrete must have a minimum compressive strength of 24 MPa at 28 days. Size of aggregate must not exceed 37.5 mm. Submit copies of certified delivery tickets for all concrete used in the construction.

2.1.1 Air Content

NOTE: The air content specified is for concrete that will be subjected to freezing weather and the possible action of deicing chemicals. In climates where freezing is not a factor but where air entrainment is used in local commercial practice to improve the workability and placeability of concrete, concrete having air content percent of 4.5 plus or minus 1.5 percent may be specified as Contractor's option to non air-entrained concrete.

Use concrete mixtures that have an air content by volume of concrete of 5 to 7 percent, based on measurements made immediately after discharge from the mixer.

2.1.2 Slump

Use concrete with a slump of 75 mm plus or minus 25 mm for hand placed concrete or 25 mm plus or minus 10 mm for slipformed concrete as determined in accordance with ASTM C143/C143M or KS F 2402.

2.1.3 Reinforcement Steel

NOTE: Reinforcement steel normally will not be required for curb and gutter construction. Where conditions exist that make it advantageous to use reinforcement steel, include the reinforcing steel details in the drawings, and include the following paragraphs in the Contract specification.

Use reinforcement bars conforming to ASTM A615/A615M or KS D 3504. Use wire mesh reinforcement conforming to ASTM A1064/A1064M or KS D 7017.

2.2 CONCRETE CURING MATERIALS

2.2.1 Impervious Sheet Materials

Use impervious sheet materials conforming to ASTM C171 or KS F 4007, type optional, except that polyethylene film, if used, must be white opaque.

2.2.2 Burlap

Use burlap conforming to **AASHTO M 182**.

2.2.3 White Pigmented Membrane-Forming Curing Compound

Use white pigmented membrane-forming curing compound conforming to **ASTM C309**, Type 2 or **KS F 2540**.

2.3 CONCRETE PROTECTION MATERIALS

Use concrete protection materials consisting of a linseed oil mixture of equal parts, by volume, of linseed oil and either mineral spirits, naphtha, or turpentine. At the option of the Contractor, commercially prepared linseed oil mixtures, formulated specifically for application to concrete to provide protection against the action of deicing chemicals may be used, except that emulsified mixtures are not acceptable.

2.4 JOINT FILLER STRIPS

2.4.1 Contraction Joint Filler for Curb, Gutter, Swale and Ditch

Use hard-pressed fiberboard contraction joint filler for curb, gutter, swale and ditch.

2.4.2 Expansion Joint Filler, Premolded

NOTE: Either type of joint sealer may be specified if determined necessary by the Contracting Officer and the inapplicable publication removed. Joint sealing material may be omitted where sealing of expansion joints is not deemed essential or advisable.

Unless otherwise indicated, use **13 mm** thick premolded expansion joint filler conforming to **ASTM D1751** or **KS F 2538**; or **ASTM D1752**.

2.5 JOINT SEALANTS

Use cold-applied joint sealant conforming to **ASTM C920** or **ASTM D5893/D5893M**.

2.6 FORM WORK

Design and construct form work to ensure that the finished concrete will conform accurately to the indicated dimensions, lines, and elevations, and within the tolerances specified. Use wood or steel forms that are straight and of sufficient strength to resist springing during depositing and consolidating concrete.

2.6.1 Wood Forms

Use forms that are surfaced plank, **50 mm** nominal thickness, straight and free from warp, twist, loose knots, splits or other defects. Use forms with a nominal length of **3 m**. Radius bends may be formed with **19 mm** boards, laminated to the required thickness.

2.6.2 Steel Forms

Use channel-formed sections with a flat top surface and welded braces at each end and at not less than two intermediate points. Use forms with interlocking and self-aligning ends. Provide flexible forms for radius forming, corner forms, form spreaders, and fillers as needed. Use forms with a nominal length of 3 m and that have a minimum of 3 welded stake pockets per form. Use stake pins consisting of solid steel rods with chamfered heads and pointed tips designed for use with steel forms.

2.6.3 Sidewalk Forms

Use sidewalk forms that are of a height equal to the full depth of the finished sidewalk.

2.6.4 Curb, Gutter, Swale and Ditch Forms

Use curb, gutter, swale and ditch outside forms that have a height equal to the full depth of the curb or gutter. Use rigid forms for curb returns, except that benders or thin plank forms may be used for curb or curb returns with a radius of 3 m or more, where grade changes occur in the return, or where the central angle is such that a rigid form with a central angle of 90 degrees cannot be used. Back forms for curb returns may be made of 38 mm benders, for the full height of the curb, cleated together. In lieu of inside forms for curbs, a curb "mule" may be used for forming and finishing this surface, provided the results are approved.

2.7 Detectable Warning System

Detectable Warning Systems shown on the Contract plans are to meet requirements of ICC A117.1 - Section 705.

2.8 FRAME, COVER, OR GRATINGS

NOTE: The likelihood of bicycle traffic should be considered in the selection of the type of inlet cover configuration.

Frame, Cover, or gratings must be cast gray iron ASTM A48/A48M Class 225B or SPS-KFCA-D4301-5015 Type GC 250; cast ductile iron ASTM A536 Grade 65-45-12; cast aluminum ASTM B26/B26M Alloy 356.OT6; or galvanized steel grating conforming to KS D 3503, KS D 3505, and ASTM A123/A123M or KS D 8308. Weight, shape, size, and waterway openings for grates and curb inlets must be as indicated on the drawings. Steel gratings must be designed in accordance with the drawings, or NAAMM MBG 531 and NAAMM MBG 532 to meet the indicated load requirements. Edges must be banded with bars 6 mm less in height than bearing bars for grating sizes above 19 mm. Bending bars must be flush with the top of bearing bars. Frames must be of welded steel construction finished to match the grating. Steel frames and gratings must be galvanized after fabrication.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

NOTE: On most projects, major grading operations

involving excavation and construction of embankments will be performed and paid for under other sections of the specifications and, therefore, are not included in this guide specification. Where such work, including the construction of any required subbase, must be done under this section, paragraphs FORM SETTING, SIDEWALK CONCRETE PLACEMENT AND FINISHING, and CURB, GUTTER, SWALE AND DITCH CONCRETE PLACEMENT AND FINISHING will be revised to cover necessary additional requirements. The subgrade will be indicated as extending at least 600 mm in width back of curb, gutter, entrance, and combination curb and gutters.

Construct subgrade to the specified grade and cross section prior to concrete placement.

3.1.1 Sidewalk Subgrade

Place and compact the subgrade in accordance with Section 31 00 00 EARTHWORK [Section [____]]. Test the subgrade for grade and cross section with a template extending the full width of the sidewalk and supported between side forms.

3.1.2 Curb, Gutter, Swale and Ditch Subgrade

Place and compact the subgrade in accordance with Section 31 00 00 EARTHWORK [Section 32 11 23 [AGGREGATE BASE COURSE] [AND/OR][GRADED CRUSHED AGGREGATE BASE COURSE] FOR FLEXIBLE PAVING] [Section [____]]. Test the subgrade for grade and cross section by means of a template extending the full width of the curb and gutter. Use subgrade materials equal in bearing quality to the subgrade under the adjacent pavement.

3.1.3 Maintenance of Subgrade

Maintain subgrade in a smooth, compacted condition in conformity with the required section and established grade until the concrete is placed. The subgrade must be in a moist condition when concrete is placed. Prepare and protect subgrade so that it is free from frost when the concrete is deposited.

3.2 FORM SETTING

Set forms to the indicated alignment, grade and dimensions. Hold forms rigidly in place by a minimum of 3 stakes per form placed at intervals not to exceed 1.2 m. Use additional stakes and braces at corners, deep sections, and radius bends, as required. Use clamps, spreaders, and braces where required to ensure rigidity in the forms. Remove forms in a manner that will not injure the concrete. Do not use bars or heavy tools against the concrete when removing the forms. Promptly and satisfactorily repair concrete found to be defective after form removal. Clean forms and coat with form oil each time before concrete is placed. Wood forms may, instead, be thoroughly wetted with water before concrete is placed, except that with probable freezing temperatures, oiling is mandatory.

3.2.1 Sidewalks

Set forms for sidewalks with the upper edge true to line and grade with an

allowable tolerance of 3 mm in any 3 m long section. After forms are set, grade and alignment must be checked with a 3 m straightedge. Sidewalks must have a transverse slope Unless otherwise indicated, construct sidewalks that are located adjacent to curbs with the low side adjacent to the curb. Do not remove side forms less than 12 hours after finishing has been completed.

3.2.2 Curbs, Gutters, Swales and Ditches

Remove forms used along the front of the curb not less than 2 hours nor more than 6 hours after the concrete has been placed. Do not remove forms used along the back of curb until the face and top of the curb have been finished, as specified for concrete finishing. Do not remove gutter, swale and ditch forms while the concrete is sufficiently plastic to slump in any direction.

3.3 SIDEWALK CONCRETE PLACEMENT AND FINISHING

3.3.1 Formed Sidewalks

Place concrete in the forms in one layer. When consolidated and finished, the sidewalks must be of the thickness indicated. Use a strike-off guided by side forms after concrete has been placed in the forms to bring the surface to proper section to be compacted. Consolidate concrete by tamping and spading or with an approved vibrator. Finish the surface to grade with a strike off.

3.3.2 Concrete Finishing

After straightedging, when most of the water sheen has disappeared, and just before the concrete hardens, finish the surface with a wood or magnesium float or darby to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. Produce a scored surface by brooming with a fiber-bristle brush in a direction transverse to that of the traffic, followed by edging.

3.3.3 Edge and Joint Finishing

Finish all slab edges, including those at formed joints, with an edger having a radius of 3 mm. Edge transverse joints before brooming. Eliminate the flat surface left by the surface face of the edger with brooming. Clean and solidly fill corners and edges which have crumbled and areas which lack sufficient mortar for proper finishing with a properly proportioned mortar mixture and then finish.

3.3.4 Surface and Thickness Tolerances

Finished surfaces must not vary more than 8 mm from the testing edge of a 3 m straightedge. Permissible deficiency in section thickness will be up to 6 mm.

3.4 CURB, GUTTER, SWALE AND DITCH CONCRETE PLACEMENT AND FINISHING

3.4.1 Formed Curb, Gutter, Swale and Ditch

Place concrete to the required section in a single lift. Consolidate concrete using approved mechanical vibrators. Curve shaped gutters must be finished with a standard curb "mule".

3.4.2 Curb, Gutter, Swale and Ditch Finishing

Approved slipformed curb and gutter machines may be used in lieu of hand placement.

3.4.3 Concrete Finishing

Float and finish exposed surfaces with a smooth wood float until true to grade and section and uniform in texture. Brush floated surfaces with a fine-hair brush using longitudinal strokes. Round the edges of the gutter and top of the curb with an edging tool to a radius of 13 mm. Immediately after removing the front curb form, rub the face of the curb with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. Brush the front curb surface, while still wet, in the same manner as the gutter and curb top. Finish the top surface of gutter and entrance to grade with a wood float.

3.4.4 Joint Finishing

Finish curb edges at formed joints as indicated.

3.4.5 Surface and Thickness Tolerances

Finished surfaces must not vary more than 6 mm from the testing edge of a 3 m straightedge. Permissible deficiency in section thickness will be up to 6 mm.

3.5 SIDEWALK JOINTS

Construct sidewalk joints to divide the surface into rectangular areas. Space transverse contraction joints at a distance equal to the sidewalk width or 1.5 m on centers, whichever is less, and continuous across the slab. Construct longitudinal contraction joints along the centerline of all sidewalks 3 m or more in width. Construct transverse expansion joints at sidewalk returns and opposite expansion joints in adjoining curbs. Where the sidewalk is not in contact with the curb, install transverse expansion joints as indicated. Form expansion joints around structures and features which project through or into the sidewalk pavement, using joint filler of the type, thickness, and width indicated. Expansion joints are not required between sidewalks and curb that abut the sidewalk longitudinally.

3.5.1 Sidewalk Contraction Joints

Form contraction joints in the fresh concrete by cutting a groove in the top portion of the slab to a depth of at least one-fourth of the sidewalk slab thickness. Unless otherwise approved or indicated, either use a jointer to cut the groove or saw a groove in the hardened concrete with a power-driven saw. Construct sawed joints by sawing a groove in the concrete with a 3 mm blade. Provide an ample supply of saw blades on the jobsite before concrete placement is started. Provide at least one standby sawing unit in good working order at the jobsite at all times during the sawing operations.

3.5.2 Sidewalk Expansion Joints

Form expansion joints using 13 mm joint filler strips. Joint filler in expansion joints surrounding structures and features within the sidewalk may consist of preformed filler material conforming to ASTM D1752 or

building paper. Hold joint filler in place with steel pins or other devices to prevent warping of the filler during floating and finishing. Immediately after finishing operations are completed, round joint edges using an edging tool having a radius of 3 mm. Remove any concrete over the joint filler. At the end of the curing period, clean the top of expansion joints and fill with cold-applied joint sealant. Use joint sealant that is gray or stone in color. Thoroughly clean the joint opening before the sealing material is placed. Do not spill sealing material on exposed surfaces of the concrete. Apply joint sealing material only when the concrete at the joint is surface dry and atmospheric and concrete temperatures are above 10 degrees C. Immediately remove any excess material on exposed surfaces of the concrete and clean the concrete surfaces.

3.5.3 Reinforcement Steel Placement

NOTE: Reinforcement steel normally will not be required for curb and gutter construction. Where conditions exist that make it advantageous to use reinforcement steel, the reinforcing steel details will be indicated, and the following paragraphs will be included in the Contract specification.

Accurately and securely fasten reinforcement steel in place with suitable supports and ties before the concrete is placed.

3.6 CURB, GUTTER, SWALE AND DITCH JOINTS

Construct curb and gutter joints at right angles to the line of curb and gutter.

3.6.1 Contraction Joints

Construct contraction joints directly opposite contraction joints in abutting portland cement concrete pavements and spaced so that monolithic sections between curb returns will not be less than 1.5 m nor greater than 4.5 m in length.

- a. Construct contraction joints (except for slip forming) by means of 3 mm thick separators and of a section conforming to the cross section of the curb, gutter, swale and ditch. Remove separators as soon as practicable after concrete has set sufficiently to preserve the width and shape of the joint and prior to finishing.
- b. When slip forming is used, cut the contraction joints in the top portion of the gutter/curb hardened concrete in a continuous cut across the curb, gutter and ditch, using a power-driven saw. Cut the contraction joint to a depth of at least one-fourth of the gutter/curb depth using a 3 mm saw blade.

3.6.2 Expansion Joints

Form expansion joints by means of preformed expansion joint filler material cut and shaped to the cross section of curb, gutter, swale and ditch. Construct expansion joints in curb, gutter, swale and ditch directly opposite expansion joints of abutting portland cement concrete pavement using the same type and thickness of joints as joints in the

pavement. Where curb, gutter, swale and ditch do not abut portland cement concrete pavement, provide expansion joints at least 13 mm in width at intervals not less than 10 meters nor greater than 36 meters. Seal expansion joints immediately following curing of the concrete or as soon thereafter as weather conditions permit. Seal expansion joints and the top 25 mm depth of curb and gutter contraction-joints with joint sealant. Thoroughly clean the joint opening before the sealing material is placed. Do not spill sealing material on exposed surfaces of the concrete. Concrete at the joint must be surface dry and atmospheric and concrete temperatures must be above 10 degrees C at the time of application of joint sealing material. Immediately remove excess material on exposed surfaces of the concrete and clean concrete surfaces.

3.7 CURING AND PROTECTION

NOTE: Only the methods of curing appropriate to local weather conditions and construction practices will be retained, but Contractor's option of at least two curing methods will be retained to promote competition in bidding.

3.7.1 General Requirements

Protect concrete against loss of moisture and rapid temperature changes for at least 7 days from the beginning of the curing operation. Protect unhardened concrete from rain and flowing water. All equipment needed for adequate curing and protection of the concrete must be on hand and ready for use before actual concrete placement begins. Protect concrete as necessary to prevent cracking of the pavement due to temperature changes during the curing period.

3.7.1.1 Mat Method

Cover the entire exposed surface with two or more layers of burlap. Overlap mats at least 150 mm. Thoroughly wet the mat with water prior to placing on concrete surface and keep the mat continuously in a saturated condition and in intimate contact with concrete for not less than 7 days.

3.7.1.2 Impervious Sheeting Method

Wet the entire exposed surface with a fine spray of water and then cover with impervious sheeting material. Lay sheets directly on the concrete surface with the light-colored side up and overlapped 300 mm when a continuous sheet is not used. Use sheeting that is not less than 450 mm wider than the concrete surface to be cured. Secure sheeting using heavy wood planks or a bank of moist earth placed along edges and laps in the sheets. Satisfactorily repair or replace sheets that are torn or otherwise damaged during curing. Sheeting must remain on the concrete surface to be cured for not less than 7 days.

3.7.1.3 Membrane Curing Method

Apply a uniform coating of white-pigmented membrane-curing compound to the entire exposed surface of the concrete as soon after finishing as the free water has disappeared from the finished surface. Coat formed surfaces immediately after the forms are removed and in no case longer than 1 hour after the removal of forms. Do not allow concrete surface to dry before

application of the membrane. If drying has occurred, moisten the surface of the concrete with a fine spray of water and apply the curing compound as soon as the free water disappears. Apply curing compound in two coats by hand-operated pressure sprayers at a coverage of approximately 5 square meters/L for the total of both coats. Apply the second coat in a direction approximately at right angles to the direction of application of the first coat. The compound must form a uniform, continuous, coherent film that will not check, crack, or peel and must be free from pinholes or other imperfections. If pinholes, abrasion, or other discontinuities exist, apply an additional coat to the affected areas within 30 minutes. Respray concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied by the method and at the coverage specified above. Respray areas where the curing compound is damaged by subsequent construction operations within the curing period. Take precautions necessary to ensure that the concrete is properly cured at sawed joints, and that no curing compound enters the joints. Tightly seal the top of the joint opening and the joint groove at exposed edges before the concrete in the region of the joint is resprayed with curing compound. Use a method used for sealing the joint groove that prevents loss of moisture from the joint during the entire specified curing period. Provide approved standby facilities for curing concrete pavement at a location accessible to the jobsite for use in the event of mechanical failure of the spraying equipment or other conditions that might prevent correct application of the membrane-curing compound at the proper time. Adequately protect concrete surfaces to which membrane-curing compounds have been applied during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from other possible damage to the continuity of the membrane.

3.7.2 Backfilling

After curing, remove debris and backfill, grade, and compact the area adjoining the concrete to conform to the surrounding area in accordance with lines and grades indicated.

3.7.3 Protection

Protect completed concrete from damage until accepted. Repair damaged concrete and clean concrete discolored during construction. Remove and reconstruct concrete that is damaged for the entire length between regularly scheduled joints. Refinishing the damaged portion will not be acceptable. Dispose of removed material as directed.

3.7.4 Protective Coating

NOTE: Concrete may require protection against the action of urea, sodium chloride, and calcium chloride used for de-icing purposes. Protection against these chemicals is not required for concrete of the specified air content that will be in place for a cumulative time of 6 weeks at a continuous minimum temperature of 5 degrees C, excluding the curing time. Concrete which is to receive protective coating should be moist cured to eliminate the need for removing a curing membrane prior to application of the protective coating. ACI Committee Report 515 provides a detailed discussion

of protective coating for concrete. The following paragraphs will be inserted if protective coating is required.

Apply a protective coating of linseed oil mixture to the exposed-to-view concrete surface after the curing period, if concrete will be exposed to de-icing chemicals within 6 weeks after placement. Moist cure concrete to receive a protective coating.

3.7.4.1 Application

Complete curing and backfilling operation prior to applying two coats of protective coating. Concrete must be surface dry and clean before each application. Spray apply at a rate of not more than 11 square meters/L for first application and not more than 15.5 square meters/L for second application, except that the number of applications and coverage for each application for commercially prepared mixture must be in accordance with the manufacturer's instructions. Protect coated surfaces from vehicular and pedestrian traffic until dry.

3.7.4.2 Precautions

Do not heat protective coating by direct application of flame or electrical heaters and protect the coating from exposure to open flame, sparks, and fire adjacent to open containers or applicators. Do not apply material at ambient or material temperatures lower than 10 degrees C.

3.8 FIELD QUALITY CONTROL

Submit copies of all test reports within 24 hours of completion of the test.

3.8.1 General Requirements

Perform the inspection and tests described and meet the specified requirements for inspection details and frequency of testing. Based upon the results of these inspections and tests, take the action and submit reports as required below, and additional tests to ensure that the requirements of these specifications are met.

3.8.2 Concrete Testing

3.8.2.1 Strength Testing

Take concrete samples in accordance with ASTM C172/C172M or KS F 2401 not less than once a day nor less than once for every 190 cubic meters of concrete placed. Mold cylinders in accordance with ASTM C31/C31M or KS F 2403 for strength testing by an approved laboratory. Each strength test result must be the average of 2 test cylinders from the same concrete sample tested at 28 days, unless otherwise specified or approved. Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength, and no individual strength test result falls below the specified strength by more than 4 MPa.

3.8.2.2 Air Content

Determine air content in accordance with ASTM C173/C173M or KS F 2449; or

ASTM C231/C231M. Use **ASTM C231/C231M** or **KS F 2421** with concretes and mortars made with relatively dense natural aggregates. Make two tests for air content on randomly selected batches of each class of concrete placed during each shift. Make additional tests when excessive variation in concrete workability is reported by the placing foreman or the Government inspector. Notify the placing foreman if results are out of tolerance. The placing foreman must take appropriate action to have the air content corrected at the plant. Additional tests for air content will be performed on each truckload of material until such time as the air content is within the tolerance specified.

3.8.2.3 Slump Test

Perform two slump tests on randomly selected batches of each class of concrete for every **190 cubic meters**, or fraction thereof, of concrete placed during each shift. Perform additional tests when excessive variation in the workability of the concrete is noted or when excessive crumbling or slumping is noted along the edges of slip-formed concrete.

3.8.3 Thickness Evaluation

Determine the anticipated thickness of the concrete prior to placement by passing a template through the formed section or by measuring the depth of opening of the extrusion template of the curb forming machine. If a slip form paver is used for sidewalk placement, construct the subgrade true to grade prior to concrete placement. The thickness will be determined by measuring each edge of the completed slab.

3.8.4 Surface Evaluation

Provide finished surfaces for each category of the completed work that are uniform in color and free of blemishes and form or tool marks.

3.9 SURFACE DEFICIENCIES AND CORRECTIONS

3.9.1 Thickness Deficiency

When measurements indicate that the completed concrete section is deficient in thickness by more than **6 mm** the deficient section will be removed, between regularly scheduled joints, and replaced.

3.9.2 High Areas

In areas not meeting surface smoothness and plan grade requirements, reduce high areas either by rubbing the freshly finished concrete with carborundum brick and water when the concrete is less than 36 hours old or by grinding the hardened concrete with an approved surface grinding machine after the concrete is 36 hours old or more. The area corrected by grinding the surface of the hardened concrete must not exceed 5 percent of the area of any integral slab, and the depth of grinding must not exceed **6 mm**. Remove and replace pavement areas requiring grade or surface smoothness corrections in excess of the limits specified.

3.9.3 Appearance

Exposed surfaces of the finished work will be inspected by the Contracting Officer and deficiencies in appearance will be identified. Remove and replace areas which exhibit excessive cracking, discoloration, form marks, or tool marks or which are otherwise inconsistent with the overall

appearances of the work.

3.10 DETECTABLE WARNING SYSTEM

Install Detectable Warning Systems required by Contract plans in accordance with ICC A117.1, Section 705, and by manufacturers' installation instructions.

-- End of Section --