Preparing Activity: USACE Superseding without Revision
UFGS-31 60 00 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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SECTION TABLE OF CONTENTS

DIVISION 31 - EARTHWORK

SECTION 31 66 10

ROCK FOUNDATION PREPARATION

02/21

PART 1 GENERAL

1.1 UNIT PRICES
1.1.1 Preliminary Cleanup
1.1.1.1 Payment
1.1.1.2 Measurement
1.1.1.3 Unit of Measure
1.1.2 Final Cleanup
1.1.2.1 Payment
1.1.2.2 Measurement
1.1.2.3 Unit of measure
1.1.3 Foundation Preparation
1.1.3.1 Payment
1.1.3.2 Measurement
1.1.3.3 Unit of measure
1.1.4 Dental Concrete
1.1.4.1 Payment
1.1.4.2 Measurement
1.1.4.3 Unit of measure
1.1.5 Dental Mortar
1.1.5.1 Payment
1.1.5.2 Measurement
1.1.5.3 Unit of measure
1.1.6 Shotcrete
1.1.6.1 Payment
1.1.6.2 Measurement
1.1.6.3 Unit of measure
1.1.7 Protective Coating
1.1.7.1 Payment
1.1.7.2 Measurement
1.1.7.3 Unit of measure
1.2 REFERENCES
1.3 DEFINITIONS
1.3.1 Foundations

1.3.2 Rock Joints
1.4 SUBMITTALS

PART 2 PRODUCTS

2.1 MATERIALS
2.1.1 Dental Concrete
2.1.2 Dental Mortar
2.1.3 Shotcrete
2.1.4 Welded Wire Fabric
2.1.5 Filter Material

PART 3 EXECUTION

3.1 EXAMINATION
3.2 PREPARATION
3.2.1 Equipment
3.2.1.1 Tools
3.2.1.2 Air Jet
3.2.1.3 Air/Water Jet
3.2.1.4 Water Jet
3.3 PRELIMINARY CLEANUP
3.4 FINAL CLEANUP AND FOUNDATION PREPARATION
3.5 DENTAL TREATMENT
3.5.1 Dental Concrete
3.5.2 Dental Mortar
3.6 PROTECTIVE TREATMENT
3.6.1 Wetting
3.6.2 Shotcrete
3.6.3 Protective Coating
3.6.4 Protective Backfill
3.6.5 Protective Concrete
3.6.6 Temporary Earth Cover
3.7 TESTS
3.7.1 General
3.7.1.1 Equipment
3.7.1.2 Foundation Excavation
3.7.1.3 Inspection, Mapping, and Cleanup
3.7.1.4 Specialized operations
3.7.2 Reports
3.8 FOUNDATION INSPECTION AND GEOLOGIC MAPPING

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC / NASA **UFGS-31 66 10 (February 2021)**

Preparing Activity: USACE **Superseding without Revision UFGS-31 60 00 (November 2008)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023

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SECTION 31 66 10

ROCK FOUNDATION PREPARATION
02/21

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NOTE: This guide specification covers the requirements for embankments and concrete structures placed on rock foundations, including all operations on the rock surface to make that surface acceptable for the placement of embankment or concrete. This section was originally developed for USACE Civil Works projects.

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 section is not complete, but should normally be incorporated into the sections dealing with 31 00 00 EARTHWORK, and/or CONCRETE, or a separate section on FOUNDATION PREPARATION may be included in the project specifications.

****

1.1 UNIT PRICES

****

NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.
****

1.1.1 Preliminary Cleanup

1.1.1.1 Payment

Payment will be made for costs for each preliminary cleanup satisfactorily performed at the direction of the Contracting Officer. Payment will be made for each cleanup of the same area if more than one cleanup has been directed and satisfactorily performed.

1.1.1.2 Measurement

Preliminary cleanup will be measured for payment by determining the area cleaned to the nearest square meter yard.

1.1.1.3 Unit of Measure

Unit of measure: square meter yard.

1.1.2 Final Cleanup

1.1.2.1 Payment

Payment will be made for costs associated with final cleanup of the area [for each type of foundation preparation] that has been satisfactorily prepared. Where preliminary cleanup has been directed and performed and the Contractor subsequently performs final cleanup, payment will be made for preliminary cleanup. Payment will not be made for any cleanup subsequent to final cleanup.

1.1.2.2 Measurement

Final cleanup will be measured for payment by determining the area cleaned to the nearest square meter yard.

1.1.2.3 Unit of measure

Square meter yard.

1.1.3 Foundation Preparation

1.1.3.1 Payment

Payment will be made for costs associated with foundation preparation of the area [for each type of foundation preparation] that has been satisfactorily prepared. Where preliminary cleanup has been directed and performed and the Contractor subsequently performs foundation preparation, payment will be made for foundation preparation. Payment will not be made for more than one foundation preparation of the same area.

1.1.3.2 Measurement

Foundation preparation will be measured for payment by determining the area prepared to the nearest square meter yard.

1.1.3.3 Unit of measure

Square meter yard.

1.1.4 Dental Concrete

1.1.4.1 Payment

Payment will be made for costs associated with dental concrete placed.

1.1.4.2 Measurement

Dental concrete will be measured for payment by determining the volume to the nearest one-tenth cubic meter yard.

1.1.4.3 Unit of measure

Cubic meter yard.

1.1.5 Dental Mortar

1.1.5.1 Payment

Payment will be made for costs associated with dental mortar placed.

1.1.5.2 Measurement

Dental mortar will be measured for payment by determining the volume to the nearest one-tenth cubic meter yard.

1.1.5.3 Unit of measure

Cubic meter yard.

[1.1.6 Shotcrete

1.1.6.1 Payment

Payment will be made for costs associated with shotcrete satisfactorily placed.

1.1.6.2 Measurement

Shotcrete will be measured for payment by determining the area satisfactorily covered to the nearest square meter yard.

1.1.6.3 Unit of measure

Square meter yard.

][1.1.7 Protective Coating

1.1.7.1 Payment

Payment will be made for costs associated with protective coating satisfactorily applied. Separate payment will not be made for reapplication necessary due to damage by construction activities, fault or negligence of the Contractor, or failure of the Contractor to prosecute the work in a timely manner. Otherwise, make separate payment for each reapplication directed and satisfactorily performed.

1.1.7.2 Measurement

Protective coating will be measured for payment by determining the area satisfactorily covered to the nearest square meter yard.

1.1.7.3 Unit of measure

Square meter yard.

]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 CONCRETE INSTITUTE (ACI)

ACI 506.2	(2013; R 2018) Specification for Materials, Proportioning, and Application of Shotcrete

ASTM INTERNATIONAL (ASTM)

ASTM A1064/A1064M	(2022) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

ASTM C270	(2019a; E 2019) Standard Specification for Mortar for Unit Masonry
ASTM C387/C387M	(2017) Standard Specification for Packaged, Dry, Combined Materials for Concrete and High Strength Mortar

1.3 DEFINITIONS

1.3.1 Foundations

The rock foundation is comprised of the rock surfaces upon which [embankment] [and] [concrete] structures are placed. Vertical surfaces, where permitted or required by these specifications, are included.

1.3.2 Rock Joints

Rock joints are all planar and/or curvilinear fractures, including cracks, crevices, and seams which separate a rock mass into individual rock blocks of various sizes. They may be open or closed and may be filled with material other than rock material.

1.4 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, Air Force, and NASA 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, Air Force and NASA 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 Contractor Quality Control approval.][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

Tools; G[, [_____]]

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Dental Concrete

Provide dental concrete conforming to the requirements of ASTM C387/C387M, normal weight and strength.

2.1.2 Dental Mortar

Provide dental mortar conforming with ASTM C270 or ASTM C387/C387M, Type N.

2.1.3 Shotcrete

****
NOTE: Select appropriate alternative.
****

Furnish shotcrete conforming to the requirements of [Section 03 37 13 SHOTCRETE] [ACI 506.2. The compressive strength of the concrete must be 27.6 MPa 4000 psi].

2.1.4 Welded Wire Fabric

Use welded wire fabric 150 by 150 mm 6 by 6 inches - W3 x W3, conforming to ASTM A1064/A1064M.

2.1.5 Filter Material

****
NOTES: Information on the design of filter materials can be found in the Engineering Manual (ER) 1110-2-1901, "Seepage Analysis and Control for Dam," ER 1110-2-2300, "Earth and Rock Fill Dams General Design and Construction Considerations.

The Specifier should use the first paragraph if there is a concrete section, an embankment for earth dams, or a stone protection section in the specifications and if the gradation therein is satisfactory for filter materials. If there is no concrete section, or if the gradation therein is unsatisfactory for filter materials, the Specifier should use the second paragraph.

****

[Provide filter material consisting of [sand and gravel] [and crushed stone]. Provide [sand and gravel] [and crushed stone] for filter materials meeting the applicable requirements of [Section 03 70 00 MASS CONCRETE, paragraph MATERIALS] [Section 35 31 19 STONE, CHANNEL, SHORELINE/COASTAL PROTECTION FOR STRUCTURES, paragraph MATERIALS,] [Section 35 73 13 EMBANKMENT FOR EARTH DAMS, paragraph MATERIALS.]] [Provide filter material consisting of [sand,] [gravel,] [crushed stone]. Provide [filter material] composed of tough, durable particles, reasonably free from thin, flat and elongated pieces, and containing no organic matter nor soft, friable particles in quantities considered objectionable by the Contracting Officer. Furnish grading conforming to the following requirements:

U.S. STANDARD SIEVE	PERMISSIBLE LIMITS PERCENT BY WEIGHT, PASSING
SAND	
[_____]	[_____]
[_____]	[_____]
[_____]	[_____]
GRAVEL "D"	
[_____]	[_____]
[_____]	[_____]
[_____]	[_____]
CRUSHED STONE	
[_____]	[_____]
[_____]	[_____]
[_____]	[_____]

Well-grade the [filter materials] between the limits shown. [Do not use crushed stone for gravel.] Perform at least one test on each 1000 tons (metric) 2,000,000 lb to be delivered to the project site for each gradation band. Obtain points on individual grading curves from representative samples of [filter material] that lie between the boundary limits as defined by smooth curves drawn through the tabulated grading limits plotted on a mechanical analysis diagram. Do not exhibit abrupt changes in slope denoting either skip grading or scalping of certain sizes or other irregularities which would be detrimental to the proper functioning of the filter.]

PART 3 EXECUTION

3.1 EXAMINATION

The limits of the proposed foundations for the various parts of the work are approximately as indicated. The Contracting Officer reserves the right to change the depth to, or the width of, the foundations if, conditions exposed in the foundation excavations, or as determined by exploratory drilling, warrant such modifications.

3.2 PREPARATION

3.2.1 Equipment

3.2.1.1 Tools

Submit for approval tabular list of light power tools, to be used in lieu of hand tools, prior to their use on the job site. Hand tools, where required or permitted by these specifications include, but are not limited to [shovels,] [bars,] [picks,] [wedges,] [and] [brooms]. Light power tools may be used in lieu of hand tools only when such use is approved.

3.2.1.2 Air Jet

Furnish an air jet consisting of a [40] [_____] mm [1-1/2] [_____] inch nozzle with a supply hose connected to a suitable source of compressed air. Provide compressed air with a pressure between [620] [_____] and [760] [_____] kPa [90][_____] and [110] [_____] psi. Control compressed air at the nozzle.

3.2.1.3 Air/Water Jet

Furnish an air/water jet consisting of a [40] [_____] mm [1-1/2][_____] inch nozzle with associated controls and supply hoses connected to suitable sources of compressed air and water. Provide compressed air with a pressure between [620] [_____] and [760] [_____] kPa [90] [_____] and [110] [_____] psi. Introduce water into the airstream at the nozzle when needed, at a rate of up to [2] [_____] L/s [30] [_____] gpm. Control air and water separately at the nozzle.

3.2.1.4 Water Jet

Furnish a water jet consisting of a [25] [_____] mm [1] [_____] inch nozzle with a supply hose connected to a suitable source of water. Provide system capable of delivering up to [13] [_____] L/s [200] [_____] gpm. Control the flow rate at the nozzle.

3.3 PRELIMINARY CLEANUP

When the excavation has reached the approximate limits shown or when the Contracting Officer determines that a satisfactory foundation may have been reached, the Contracting Officer may direct that a preliminary cleanup be performed on all or any part of the rock foundation surface. Remove all debris, loose rock, sand, silt, and other objectionable material by hand tools followed by [air] [water] [air/water] jets or any combination of additional methods approved or directed. The Contracting Officer may require that the excavation be continued and the preliminary cleanup procedure repeated until a satisfactory foundation surface is reached.

3.4 FINAL CLEANUP AND FOUNDATION PREPARATION

****

NOTE: Insert a description of the areas to receive (this type) foundation preparation.

Where more than one type of final cleanup and foundation preparation is needed, this paragraph may be repeated with appropriate variations. See EM 1110-2-2300 for guidance on where foundation preparation should be required under embankment dams. Compacted filter material should be used under overhangs only when granular fill is being placed against the foundation.

****

Unless otherwise directed, perform final cleanup and foundation preparation [, structural] [, embankment] [, type [_____]] [_____]. This work consists of removing loose and/or weather rock and pockets of fines, sand, rock rubble or gravel and other objectionable material from the in place rock surface including areas of depression, large crevices, and open rock joints. [The loose material need not be removed where the width of the opening is less than [_____] mm inches.] [Mechanical equipment may be used but such equipment will be rubber tired only.] Picking, barring, and hand excavation may be necessary to obtain a foundation surface free from loose, drummy, or shattered materials. [Trim irregularitites in the rock surfaces to form a reasonable uniform slope on the abutments.] [Slopes steeper than [_____] vertical on [_____] horizontal are not permitted.] [Overhangs are not be permitted at any location.] [Excavate and backfill overhangs with compacted [filter] [granular] materials. Place filter materials in accordance with the provisions contained in Section [35 73 13 EMBANKMENT FOR EARTH DAMS] [_____].] [Vertical surfaces are not be [permitted.] [higher than [_____] m feet] and benches between vertical surfaces must be of such width so as to provide a stepped slope comparable to the adjacent uniform slope.] Thoroughly clean the final rock surface using [air jets] [water jets] [air/water jets] or other approved method and maintain in a clean condition until the placement of [embankment] [or] [concrete] thereon.

3.5 DENTAL TREATMENT

****

NOTE: If a schedule is not provided, a description of the areas to receive dental treatment, and the minimum width joint to be treated should be included. For embankment dams, the minimum width joint to be treated depends on the gradation of the embankment material that will be placed against the joint (see EM 1110-2-2300).

****

Provide dental treatment consisting of excavation, if necessary, of the material in joints, cavities, depressions, and overhangs and the placement of [concrete] [or] [mortar] such that the final surface is satisfactory for the subsequent placement of [embankment] [or] [concrete]. [Unless otherwise directed, perform dental treatment in accordance with the following schedule:

Foundation Area	Minimum Width Joint to be Treated
[_____]	[_____]
[_____]	[_____]

]

Excavate joints and cavities to a depth [3] [_____] times the width (measured at the base of the excavation) of the joint or cavity.

3.5.1 Dental Concrete

****

NOTE: Normally the concrete specification will be included in Division 03, Concrete. When Division 03 would not otherwise be included, and only small quantities will be needed, the ASTM alternate may be used. The maximum aggregate size in dental concrete should not be more than one third the minimum widths of joints in which it is to be used.

****

Use concrete to fill joints, cavities, depressions, and overhangs except where the use of mortar is required or permitted. Prior to placement, the surfaces of the joint, cavity, depression, or overhang will be thoroughly cleaned using [air] [or] [air/water] [or] [water] jets. Provide maximum aggregate size of [[_____] mm inch] [as directed]. Furnish concrete conforming with paragraph MATERIALS.

3.5.2 Dental Mortar

Use mortar to fill joints, cavities, depressions, and overhangs when the width of the opening is less than [_____] mm inches and at other areas as directed or approved. Placement of the sand-cement mortar will be accomplished by [troweling] [brooming] the mortar [with stiff bristled brooms] into the cleaned joints, cracks, and crevices so as to provide a thorough seal. Minimize the absorption of water from the mortar mix in the surface moisture of the rock. However, no standing water will be allowed. Remove all mortar which cannot be worked into the joints from the rock surface. [Moist cure the mortar for a period of at least [_____].] Provide mortar conforming with paragraph MATERIALS.

3.6 PROTECTIVE TREATMENT

****

NOTE: Insert here a description of the areas to be protected, and the type(s) of protection to be used. If more than one type of protection is specified, it should be clear which method(s) is (are) required for each area. If the choice of methods is optional with the Contractor that should be stated. Care should be used when selecting protective measures. Not all methods are suitable in all situations or with all types of rock. Of the following paragraphs, only those methods specified should be included.

****

Provide [_____] protective treatment.

3.6.1 Wetting

Keep the area wet by [continuous spraying] [flooding] or by other approved method. [Provide positive measures to control the runoff.]

3.6.2 Shotcrete

****
NOTE: See ACI 506.2 for additional options that may be specified and for guidance on their use. The first alternate should be used if shotcrete is being used for other purposes on the job, or if a different shotcrete specification is appropriate.
****

Alternate 1: [Furnish shotcrete conforming to the requirements of paragraph MATERIALS.]

Alternate 2: [Cover the area to be protected by welded wire fabric in accordance with paragraph MATERIALS.] Anchor the fabric securely in place as shown on the contract drawings. Furnish shotcrete conforming to paragraph MATERIALS. The Contractor is responsible for construction and preconstruction testing. [Gradation [_____] will be used.] [Gradations [_____] or [_____] will be used.] Provide minimum cover [over reinforcement,] of [_____] mm inches.

3.6.3 Protective Coating

****
NOTE: Celtite 42-51 HI-SEAL, (42-52C (Clear)), and (45-51W (White)) epoxy resin and emulsion, manufactured by Celtite, Inc., telephone 1-800-626-2948 and Aero-Spray, manufactured by American Cyanamid/CYTEC, telephone 1-800-835-9844, (Mining Products Division) have been successfully used and were available at time of publication. However, the availability of these and similar products should be investigated before their use is specified. Asphaltic emulsions have been used, with limited success, in some applications.
****

Apply an approved protective coating within [_____] hours of exposure of the rock surface in accordance with the manufacturer's recommendations or as otherwise approved. Reapply the coating as necessary to repair damage caused by construction activities or when needed to provide adequate protection. [Provide [_____] protective coating, or equal.]

3.6.4 Protective Backfill

Accomplish the final [600] [_____] mm [2] [_____] feet of excavation, final cleanup and foundation preparation, inspection, [dental treatment,] and placement of the first [300] [_____] mm [12] [_____] inches of backfill within a period of [16] [_____] hours. Within [48] [_____] hours after the start of the final excavation, provide backfill with a minimum thickness of [1000] [_____] mm [3] [_____] feet. Place thebackfill in accordance with the requirements of Section [31 00 00 EARTHWORK] [_____].

3.6.5 Protective Concrete

Accomplish the final [600] [_____] mm [2] [_____] feet of excavation, [cleanup,] inspection, preparation, [dental treatment,] and placement of at least [_____] mm inches of protective concrete within a period of [_____] hours. Provide concrete conforming to the requirements of Section [03 30 00 CAST-IN-PLACE CONCRETE] [03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE] [_____].

3.6.6 Temporary Earth Cover

****
NOTE: Insert the requirements of the material to be used.
****

[Within [_____] hours of excavation,] [Before freezing weather is expected,] [Before other construction activities are permitted,] the area will be protected by a temporary earth cover [_____] mm feet thick. The material must [_____]. Remove the material and [clean,] [inspect,] [and prepare] the area prior to placement of [embankment] [or] [concrete] thereon.

3.7 TESTS

3.7.1 General

Establish and maintain quality control for foundation preparation operations to assure compliance with contract specifications and maintain records of the quality control for all operations including but not limited to the following:

3.7.1.1 Equipment

Quantity and type.

3.7.1.2 Foundation Excavation

Strict adherence to foundation excavation limits and depths.

3.7.1.3 Inspection, Mapping, and Cleanup

Orderly prosecution of inspections, mapping, and cleanup of foundation excavation areas.

3.7.1.4 Specialized operations

Protective treatment [and Dental treatment].

3.7.2 Reports

Submit three copies of these records of inspection as well as corrective action taken daily.

3.8 FOUNDATION INSPECTION AND GEOLOGIC MAPPING

Inspections to determine adequacy of the foundations will be performed by the Contracting Officer in all foundation areas between completion of excavation and placement of [embankment,] [or] [concrete,] [or protective

treatment]. The Contractor will cooperate to the extent necessary to assist in inspection and mapping activities which may require additional survey control points and access. Coordinate the schedule for foundation excavation and preliminary cleanup with the Contracting Officer to ensure that the cleanup, inspection, and mapping proceed in an orderly manner.

-- End of Section --