
USACE / NAVFAC / AFCEA / NASA UFGS-32 11 24 (August 2008)

Preparing Activity: NAVFAC Superseding
UFGS-32 11 24 (July 2006))

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2010

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GRADED CRUSHED AGGREGATE BASE COURSE FOR [PERVIOUS][FLEXIBLE] PAVEMENT

08/08

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SECTION 32 11 24

GRADED CRUSHED AGGREGATE BASE COURSE FOR [PERVIOUS][FLEXIBLE] PAVEMENT 08/08

NOTE: This guide specification covers the requirements for graded crushed aggregate base course with a CBR 100 for use under flexible pavements and pervious pavement systems.

Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

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

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of Technical Proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

PART 1 GENERAL

1.1 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 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.

ASTM INTERNATIONAL (ASTM)

ASTM C 117	(2004) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 131	(2006) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 29/C 29M	(2007) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM D 1556	(2007) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(2009) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³) (2700 kN-m/m ³)
ASTM D 1883	(2007e2) CBR (California Bearing Ratio) of Laboratory-Compacted Soils
ASTM D 2217	(1985; R 1998) Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants
ASTM D 4318	(2005) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 6938	(2008a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D 75/D 75M	(2009) Standard Practice for Sampling Aggregates

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED	(2002; R 2005) Leadership in Energy and
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1.2 RELATED SECTIONS

NOTE: Pervious pavement systems shall be installed in areas with gently sloping or flat ground, light traffic, limited heavy truck use, and where pavements will not receive snow and ice treatments (salt, sand, or chemical). Consult manufacturer's recommendations for cold regions, arid regions, and regions with high wind erosion. Parking lots are generally good pervious pavement applications. Installing pervious pavement systems contributes to the following LEED credit: SS6.

Pervious pavement systems shall use Section 32 11 16.16 [BASE COURSE FOR RIGID] [AND SUBBASE COURSE FOR FLEXIBLE] [SUBBASE COURSE FOR PERVIOUS] PAVING, and Section 32 13 13.06 PERVIOUS PORTLAND CEMENT CONCRETE PAVEMENT FOR ROADS AND SITE FACILITIES or Sections 32 10 00 PERVIOUS BITUMINOUS CONCRETE PAVEMENT and 32 12 10 BITUMINOUS TACK AND PRIME COATS, in addition to this section.

1.3 SUBMITTALS

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation 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 projects.

Submittal items not designated with a "G" are considered as being for information only for Army

**projects and for Contractor Quality Control approval
for Navy projects.**

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Aggregates; (LEED)

Submit documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project.

[**Local/Regional Materials; (LEED)**

Submit documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project.]

SD-06 Test Reports

Gradation

Bearing ratio

Liquid limit

Plasticity index

Percentage of wear

[**Dry weight of slag]**

Density

Gradation

Smoothness

Density

Thickness

1.4 DELIVERY AND STORAGE

Inspect materials delivered to site for damage and store as to prevent segregation and contamination.

1.5 WEATHER LIMITATIONS

Do not construct base course when atmospheric temperature is below 2 degrees C 35 degrees F or when rainfall or other weather conditions detrimentally affect the quality of the finished course.

1.6 CONSTRUCTION EQUIPMENT

Equipment shall be dependable and adequate for the purpose intended. Maintain equipment in satisfactory and safe operating condition. Subject to approval, special equipment dictated by local conditions may be used. Calibrated equipment, such as scales, batching equipment, spreaders, and similar items, shall have been recalibrated by [an approved calibration laboratory] [a State calibration laboratory] within [12] [_____] months of commencing work.

1.7 SUSTAINABLE DESIGN REQUIREMENTS

1.7.1 Local/Regional Materials

NOTE: Using local materials can help minimize transportation impacts, including fossil fuel consumption, air pollution, and labor. Using materials harvested and manufactured within a 500 mile radius from the project site contributes to the following LEED credit: MR5. Coordinate with Section 01 33 29 LEED(tm) DOCUMENTATION. Use second option if Contractor is choosing local materials in accordance with Section 01 33 29 LEED(tm) DOCUMENTATION. Use second option for USACE projects. Army projects shall include option only if pursuing this LEED credit.

[Use materials or products extracted, harvested, or recovered, as well as manufactured, within a [500][_____] mile [800][_____] kilometer radius from the project site, if available from a minimum of three sources.][See Section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total local material requirements. Aggregate materials may be locally available.]

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Aggregates

NOTE: Maximum amount of material passing 75 micrometers No. 200 sieve for 50 mm 2 inch maximum should not be more than 7 percent, for 38 mm 1 1/2 inch maximum 8 percent, and for 25 mm one inch maximum 9 percent, where frost is a factor in design.

NOTE: Delete percentage of wear and weight of slag not applicable to the project. For pavement designed for aircraft equipped with tires having

pressure of 1725 kPa 250 psi or more, the percentage of wear should not exceed 40; and for slag, the weight should be not less than 1120 kg per cubic meter 70 pounds per cubic foot; for tire pressures less than 1725 kPa 250 psi, the percentage of wear may be increased to 45; and for slag, the weights may be reduced to 29.4 kg 65 pounds. The requirements of 40 or less for wear test under high pressure tires may be increased to 45 if a satisfactory service record can be demonstrated.

NOTE: Delete the sizes which are unsuitable for the thickness of the base course layer to be constructed or are not available. The compacted thickness of any compacted base course layer should be limited to a maximum of 150 mm 6 inches and a minimum of 75 mm 3 inches. The gradations may be modified to suit local conditions; however, the composite material must meet the required California Bearing Ratio. Prior to specifying any modified gradation, tests should be performed using the material to be incorporated in the base course to determine whether the modified gradation will provide the required California Bearing Ratio.

NOTE: Use of materials with recycled content, calculated on the basis of post-industrial and post-consumer percentage content, contributes to the following LEED credit: MR4. Coordinate with Section 01 33 29 LEED(tm) DOCUMENTATION. Designer must verify that products meeting the indicated minimum recycled content are available, preferably from at least three sources, to ensure adequate competition. If not, write in suitable recycled content values that reflect availability and competition. Use second option if Contractor is choosing recycled content products in accordance with Section 01 33 29 LEED(tm) DOCUMENTATION.

Consist of durable and sound crushed concrete, crushed masonry, crushed tile, crushed gravel, crushed stone, or crushed slag, free of lumps or balls of clay or other objectionable matter. Materials shall originate primarily from on-site construction waste, then from off-site construction waste, and finally from other nearby sources as needed. [Aggregate material shall contain in total a minimum of [5][10][_____] percent post-consumer recycled content, or a minimum of [20][40][_____] percent post-industrial recycled content.][See Section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total recycled content requirements. Material may contain post-consumer or post-industrial recycled content.] Crushed stone and gravel shall be free from flat, elongated, soft, or disintegrated pieces. Crushed gravel retained on a 4.75 mm No. 4 sieve shall have at least 90 percent by weight with at least two fractured faces and 100 percent by weight with at least one fractured face. Base course materials samples shall have a bearing ratio of at least 100 as determined by

laboratory tests on a 4-day soaked specimen in accordance with [ASTM D 1883](#); compact specimen in accordance with [ASTM D 1557](#), Method D. Determine grain size in accordance with [ASTM C 136](#) and amount of material finer than [75 micrometers](#) [200 mesh](#) sieve in accordance with [ASTM C 117](#). Aggregate, other than slag, shall have a [percentage of wear](#) not exceeding [40] [45] when tested in accordance with [ASTM C 131](#), Grading A. Slag shall be an air-cooled, blast furnace product having a [dry weight](#) of not less than [1120] [1041] kilograms per cubic meters [70] [65] pounds per cubic foot when tested in accordance with [ASTM C 29/C 29M](#) and shall consist of angular fragments uniform in density and quality, reasonably free from thin, elongated pieces, dirt, or other objectionable material. Soil binder material, that portion of material passing the [425 micrometers](#) [No. 40](#) sieve, shall be of such composition that the composite material conforms to the requirements specified herein. The base course shall be of such nature that it can be compacted readily with watering and rolling to a firm, stable base and shall conform to one of the following sizes:

Percentage by Weight Passing
Square Mesh Laboratory Sieves

<u>Size Numbers</u>			
<u>Sieves</u>	<u>1</u>	<u>2</u>	<u>3</u>
50.0 mm	100	-	-
37.5 mm	70-100	100	-
25.0 mm	45-80	60-100	100
12.5 mm	30-60	30-65	40-70
4.75 mm	20-50	20-50	20-50
2.0 mm	15-40	15-40	15-40
425 micrometers	5-25	5-25	5-25
75 micrometers	0-10	0-10	0-10

Percentage by Weight Passing
Square Mesh Laboratory Sieves

<u>Size Numbers</u>			
<u>Sieves</u>	<u>1</u>	<u>2</u>	<u>3</u>
2 inch	100	-	-
1 1/2 inch	70-100	100	-
1 inch	45-80	60-100	100
1/2 inch	30-60	30-65	40-70
No. 4	20-50	20-50	20-50
No. 10	15-40	15-40	15-40
No. 40	5-25	5-25	5-25
No. 200	0-10	0-10	0-10

That portion of the material passing the [425 micrometers](#) [No. 40](#) sieve shall have a [liquid limit](#) of not more than 25 and a [plasticity index](#) of not more than 5 as determined by [ASTM D 4318](#). Prepare samples in accordance with [ASTM D 2217](#), Procedure A.

[2.1.2 Pervious Base Course

NOTE: The following paragraph applies only to
pervious pavement systems.

Base aggregate for pervious pavement systems shall consist of aggregate as specified in paragraph Aggregates except as specified below. Material passing the 75 micrometers No. 200 sieve is not permitted. Unevenly graded screenings and stone dust are not permitted.

2.1.2.1 Asphalt-Treated Permeable Base

Asphalt binder shall be steam-refined asphalt, grade [AR-8000][_____].
"Popcorn mix" aggregate shall conform to the following grading:

Percentage by Weight Passing
Square Mesh Laboratory Sieves

<u>Sieves</u>	<u>Percent Passing</u>
25.0 mm	100
19.0 mm	90-100
12.5 mm	35-65
9.0 mm	20-45
4.75 mm	0-10
2.4 mm	0-5

Percentage by Weight Passing
Square Mesh Laboratory Sieves

<u>Sieves</u>	<u>Percent Passing</u>
1 inch	100
3/4 inch	90-100
1/2 inch	35-65
3/8 inch	20-45
No. 4	0-10
No. 8	0-5

2.1.2.2 Cement-Treated Permeable Base

Portland cement binder shall be Type II Modified. Pozzolan shall not be substituted for portland cement. Aggregate shall conform to the 1 inch x No. 425 mm x 4.75 mm primary nominal coarse aggregate grading, with 52 to 85 percent by weight passing through a 3/4 inch 19 mm sieve.

]PART 3 EXECUTION

3.1 BASE COURSE

Construct the graded aggregate base course on a [prepared subgrade] [previously constructed subbase course], as indicated. Verify compacted subgrade, granular base, or stabilized soil is acceptable and ready to support paving and imposed loads. Provide line and grade stakes for control. Place grade stakes in lanes parallel to the centerline of areas to be paved and space for string lining or other control methods. The base course shall consist of aggregate processed, deposited, spread, and compacted on a prepared surface. The Contractor shall be responsible for protection of completed areas against detrimental effects. Recondition,

reshape, and recompact areas damaged by freezing, rainfall, or other weather conditions.

[3.2 OPENING AND OPERATION OF PITS

**NOTE: If suitable material is available from
stockpiles, it should be so stated and the location
of the stockpiles shown or specified.**

**NOTE: Delete this paragraph when material is
furnished by the Contractor from other than
Government owned or licensed pits.**

Perform stripping, clearing, processing, and blending in the opening of new pits and operation of existing pits as necessary to obtain acceptable material. Open pits in a manner to expose the vertical faces of the deposits for suitable working depths, following which the material shall be obtained in successive vertical cuts extending through the exposed strata. Waste strata and pockets of unsuitable materials overlaying or occurring in the deposit. Change or modify the method of operating the pits, and the processing and blending of the material when necessary to obtain material conforming to the specified requirements. Upon completion of the work, condition pits to drain readily and leave in a satisfactory condition.

]3.3 MIXING OF MATERIALS

Mix aggregates in a stationary or traveling plant. Proportion aggregates by weight or volume in such quantities that specified gradation, liquid limit, and plasticity index requirements are met after the base course has been placed and compacted. Incorporate, during the mixing operation, water in quantities sufficient to provide the necessary moisture content for the specified compaction. Mixing operations shall produce satisfactory uniform blending and the method of discharging into trucks shall not produce segregation.

3.4 PLACING

Do not dump mixed materials in piles, but place on prepared subgrade or subbase in layers of uniform thickness with a spreader. When a compacted course 150 mm 6 inches in thickness is required, place material in a single layer. When a compacted course in excess of 150 mm 6 inches is required, place material in layers of equal thickness. Do not exceed 150 mm 6 inches or have less than 75 mm 3 inches in thickness for any compacted layer. Place layers so that when compacted, they will be true to grades or levels required with the least possible surface disturbance. Where the base course is constructed in more than one layer, clean previously constructed layers of loose and foreign matter. Maintain material water content during the placing period to obtain the compaction specified. Make adjustments in placing procedures or equipment to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to insure a satisfactory base course.

3.4.1 Stationary-Plant Method

Mix aggregates, binder material and water until a uniform homogeneous

mixture is obtained. Do not dump materials in piles; place in layers of essentially uniform thickness, not to exceed 150 mm 6 inches after compaction, by an approved spreader. Tail gate spreading will be acceptable only with permission, under conditions such as where space limitations prohibit use of the spreader.

3.4.2 Windrow Traveling-Plant Method

Place aggregates and binder materials in windrows of such cross section and proportions that, when picked up, mixed, and redeposited in windrows, the finished mixture shall conform to the specified requirements. Do not exceed the rated capacity of the traveling plant with the size of the windrow of the combined materials. Add water, in quantity sufficient to provide the necessary moisture content for compacting, to the aggregates at the time of mixing. Mix materials uniformly by the traveling plant, deposit in windrows of uniform cross section, and spread in a layer of uniform thickness to the required contour and grades.

3.5 COMPACTING AND FINISHING

NOTE: Specify method of determining in-place density by nuclear procedures for projects which require large quantities of base course material and provided that the available nuclear devices can be standardized for the graded aggregate base materials.

Immediately following the placing, spread the finished mixture uniformly in a layer and bring to optimum moisture content. The loose thickness and the surface of the layer shall be such that the specified density and the required thickness shall be obtained after compaction. Compact the layer with steel-faced, vibrating or pneumatic-tired rollers, or other suitable compacting equipment or combinations thereof. Continue compacting until the layer is compacted through the full depth to a field density of at least 100 percent of the maximum density at optimum moisture content tested in accordance with ASTM D 1556 [ASTM D 6938 .] In areas not accessible to rollers or compactors, compact the mixture with mechanical hand tampers. If the mixture is excessively moistened by rain, aerate by blade graders, or other suitable equipment. Aerate until the moisture content of the material is that needed to obtain the required density. Finish the surface of the layer by a combination of rolling and blading. Final surface shall be smooth and free from waves, irregularities, and ruts or soft yielding spots.

[3.6 PROOF ROLLING

NOTE: Modify this paragraph as necessary to proof roll other areas. The areas given in this paragraph are as required by Design Manual 21.03 for Navy airfield pavements but may be modified if project requirements so dictate. For proof rolling requirements of Air Force airfield pavements, See DM 21.03 and modify this paragraph to suit.

On the center 7.50 m 25 feet of taxiways and on the center 30 m 100 feet of runways, in addition to compacting the base course to the required density,

proof roll the top surface of the completed base course by making eight coverages with a heavy rubber-tired roller having four tires with each tire loaded to 13,600 kg 30,000 pounds or more and inflated to at least 1034 kPa 150 psi. Make four coverages over other areas to be paved, excluding the runway over-runs, blast protection areas, and shoulders. A coverage is defined as one application of one tire print over each point in the surface of the designated area. When under the action of the proof rolling, the base course yields, pumps, or otherwise fails, remove, replace with suitable materials, and recompact materials in the base course or in the underlying layers indicated to be unsatisfactory. The speed of the roller shall not exceed 8 kph 5 miles per hour. Obtain approval upon completion of the proof rolling of the base course.

]3.7 FINISHING AT EDGES OF BASE COURSE

Place earth or other approved materials along the edges of the base course in such quantity that it will compact to the thickness of the course being constructed. When the course is being constructed in two or more layers, place material to the thickness of each layer. In each operation, allow at least a 300 mm one foot width of the shoulder to be rolled and compacted simultaneously with the rolling and compacting of each layer.

3.8 FIELD QUALITY CONTROL

Approve materials and material sources in advance of the use of such materials in the work. Replace base where samples are removed. [Provide duplicate samples to the Contracting Officer on an average of [_____] samples a [week] [month]. Take duplicate samples at the same time and in the same manner as the original.]

3.8.1 Sampling

3.8.1.1 Aggregates at the Source

Prior to production and delivery of aggregates, take at least one initial sample in accordance with ASTM D 75/D 75M. Collect each sample by taking three incremental samples at random from the source material to make a composite sample of not less than 23 kg 50 pounds. Repeat above sampling when source of material is changed or when unacceptable deficiencies or variations from specified grading of materials are found in testing.

3.8.1.2 During Construction

Take one random sample from each [1000] [_____] metric tons [1000] [_____] tons of completed course material, but not less than one random sample per day's run. Take samples in accordance with ASTM D 75/D 75M.

3.8.1.3 Sample Identification

Place each sample in a clean container, securely fastened to prevent loss of material. Tag each sample for identification and with the following information:

Contract No. _____
Sample No. _____ Quality _____
Date of Sample _____
Sampler _____
Source _____
Intended Use _____

For Testing_____

3.8.2 Testing

3.8.2.1 Aggregates

Test each sample of base course material without delay. Make gradation tests from each sample in accordance with ASTM C 136. Make sieve analysis on material passing the 75 micrometers No. 200 sieve in accordance with ASTM C 117.

3.8.2.2 Smoothness Tests

Test with a 3 m 10 foot straightedge, applied parallel with and at right angles to the center line of the paved area. Correct deviations in the surface in excess of [10] [13] mm [3/8] [1/2] inch by loosening, adding or removing material, reshaping, watering, and compacting. The smoothness requirements specified herein apply only to the top layer when base course is constructed in more than one layer.

3.8.2.3 Field Density Tests

NOTE: Specify method of determining in-place density by nuclear procedures for projects which require large quantities of base course material and provided that the available nuclear devices can be standardized for the graded aggregate base materials.

ASTM D 1556 or [ASTM D 6938]. Take one test for each [420] [_____] square meters [500] [_____] square yards of each layer of base course.

3.8.2.4 Laboratory Density Tests

In accordance with ASTM D 1557, Method D.

3.8.2.5 Thickness Tests

Measure thickness of base course at intervals such that there will be a depth measurement for at least each [420] [_____] square meters [500] [_____] square yards of complete base course. Make depth measurements by test holes, at least 75 mm 3 inches in diameter, through the base course. Where base course deficiency is more than 13 mm 1/2 inch, correct by scarifying, adding mixture of proper gradation, reblading, and recompact. Where the measured thickness is more than 13 mm 1/2 inch thicker than indicated, consider it as the indicated thickness plus 13 mm 1/2 inch for determining the average. The average thickness is the average of the depth measurements and shall not underrun the thickness indicated.

3.9 MAINTENANCE

After construction is completed, maintain the base course throughout, except where portion of the succeeding course is under construction thereon. Maintenance includes drainage, rolling, shaping, and watering, as necessary, to maintain the course in proper condition. Correct deficiencies in thickness, composition, construction, smoothness, and density, which develop during the maintenance, to conform to the requirements specified herein. Maintain sufficient moisture by light

sprinkling with water at the surface to prevent a dusty condition.

-- End of Section --