## Item TNP-209 State Material Specification for Crushed Aggregate Base Course

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Item TNP-209, Crushed Aggregate Base Course, can be used as a base course under flexible or rigid pavements. See AC 150/5320-6 for additional guidance.

This specification differs from the FAA P-209 by allowing the Tennessee DOT standard mineral aggregate base materials to be used. The gradation and quality requirements are similar, and are suited for typical Tennessee applications.

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DESCRIPTION

**TNP-209-1.1** This item consists of a base course composed of crushed aggregate base constructed on a prepared course in accordance with these specifications and in conformity to the dimensions and typical cross-sections shown on the plans.

MATERIALS

**TNP-209-2.1 Crushed aggregate base.** Crushed aggregate shall consist of clean, sound, durable particles of crushed stone, crushed gravel, **[**or crushed slag**]** and shall be free from coatings of clay, silt, organic material, clay lumps or balls or other deleterious materials or coatings. The method used to produce the crushed gravel shall result in the fractured particles in the finished product as consistent and uniform as practicable. Fine aggregate portion, defined as the portion passing the No. 4 (4.75 mm) sieve shall consist of fines from the coarse aggregate crushing operation. The fine aggregate shall be produced by crushing stone, gravel, **[**or slag**]** that meet the coarse aggregate requirements for wear and soundness. Aggregate base material requirements are listed in the following table.

Crushed Aggregate Base Material Requirements

| Material Test | Requirement | Standard |
| --- | --- | --- |
| Coarse Aggregate | | |
| Resistance to Degradation | Loss: 50% maximum | ASTM C131 |
| Soundness of Aggregates  by Use of Sodium Sulfate **or** Magnesium Sulfate | Loss after 5 cycles: 15% maximum using Sodium sulfate | ASTM C88 |
| Percentage of Fractured Particles | Minimum 90% by weight of particles with at least two fractured faces and 98% with at least one fractured face1 | ASTM D5821 |
| Flat Particles, Elongated Particles, or Flat and Elongated Particles | 10% maximum, by weight, of flat, elongated, or flat and elongated particles 2 | ASTM D4791 |
| **[**Bulk density of slag | Weigh not less than 70 pounds per cubic foot (1.12 Mg/cubic meter) | ASTM C29**]** |
| **[**   Clay lumps and friable particles | Less than or equal to 3 percent | ASTM C142   **]** |
| Fine Aggregate | | |
| Liquid limit | Less than or equal to 30 | ASTM D4318 |
| Plasticity Index | Not more than eight (8) | ASTM D4318 |

1 The area of each face shall be equal to at least 75% of the smallest mid-sectional area of the piece. When two fractured faces are contiguous, the angle between the planes of fractures shall be at least 30 degrees to count as two fractured faces.

2 A flat particle is one having a ratio of width to thickness greater than five (5); an elongated particle is one having a ratio of length to width greater than five (5).

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Delete bracketed reference to crushed slag in above paragraph and table if slag will not be used in the project.

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TDOT Type A Grading D base material may be supplied.

**TNP-209-2.2 Gradation requirements.** The gradation of the aggregate base material shall meet the requirements of the gradation given in the following table when tested per ASTM C117 and ASTM C136. The gradation shall be well graded from coarse to fine and shall not vary from the lower limit on one sieve to the high limit on an adjacent sieve or vice versa. If TDOT Type A Grading D is used, it shall meet the gradation requirements in Table 903.05-2: Grading Table for Type A and Type B Aggregate for Mineral Aggregate Base and Surface Courses (TDOT 2021).

Gradation of Aggregate Base

| Sieve Size | FAA P-209 Design Range  Percentage by Weight passing | TDOT Type A Grading D | Contractor’s Final Gradation | Job Control Grading Band Tolerances1 (Percent) |
| --- | --- | --- | --- | --- |
| 2 inch (50 mm) | 100 | 100 |  | 0 |
| 1-1/2 inch  (37.5 mm) | 95-100 | 100 |  | ±5 |
| 1 inch  (25.0 mm) | 70-95 | 85-100 |  | ±8 |
| 3/4 inch  (19.0 mm) | 55-85 | 60-95 |  | ±8 |
| No. 4  (4.75 mm) | 30-60 | 40-65 |  | ±8 |
| No. 16 (1.16 mm) |  | 20-40 |  |  |
| No. 402  (425 µm) | 10-30 |  |  | ±5 |
| No. 100  (150 µm) |  | 9-18 |  |  |
| No. 2002  (75 µm) | **[**0-10**]** |  |  | ±3 |

1 The “Job Control Grading Band Tolerances for Contractor’s Final Gradation” in the table shall be applied to “Contractor’s Final Gradation” to establish a job control grading band. The full tolerance still applies if application of the tolerances results in a job control grading band outside the design range.

2 The fraction of material passing the No 200 (75 µm) sieve shall not exceed two-thirds the fraction passing the No 40 (425 µm) sieve.

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When non frost susceptible material is required, the maximum material passing the No. 200 (75 µm) sieve shall be reduced to 0-5%. For areas subject to substantial frost penetration into base and subgrade layers, a separation filter layer or geosynthetic separation layer is recommended.

Leave the column titled “Contractor’s Final Gradation” blank in the above table. The Contractor’s Final Gradation approved by the Engineer/RPR will be used to populate this column and the “Job Control Grading Band Tolerances for Contractor’s Final Gradation” will apply to this column for the project duration, and these limits establish quality control action limits for the Contractor.

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**TNP-209-2.3 Sampling and Testing.**

**a. Aggregate base materials.** The Contractor shall take samples of the aggregate base in accordance with ASTM D75 to verify initial aggregate base requirements and gradation. Material shall meet the requirements in paragraph TNP-209-2.1. This sampling and testing will be the basis for approval of the aggregate base quality requirements. **[**      **]**

**b. Gradation requirements.** The Contractor shall take at least **[**two**]** aggregate base samples per day in the presence of the Resident Project Representative (RPR) to check the final gradation. Sampling shall be per ASTM D75. Material shall meet the requirements in paragraph TNP-209-2.2. The samples shall be taken from the in-place, un-compacted material at sampling points and intervals designated by the RPR.

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The Engineer may require additional sampling points for quality requirements. The Engineer shall define when additional sampling points are needed in the above paragraph.

On large projects and/or projects that span multiple construction seasons, additional aggregate tests may be necessary to validate consistency of aggregate produced and delivered for the project.

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**TNP-209-2.4 Separation Geotextile**. **[**Not used.**]** **[**Separation geotextile shall be **[**   Class 2   **]**, **[**   0.02 sec-1   **]**permittivity per ASTM D4491, Apparent opening size per ASTM D4751 with **[**   0.60 mm   **]** maximum average roll value.   **]**

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The use of a geotextile to prevent mixing of a subgrade soil and an aggregate subbase/base is appropriate for pavement structures constructed over soils with a California Bearing Ratio greater than 3.

Generally, on airport projects, a Class 2 geotextile with a permittivity of 0.02 and AOS of 0.6 mm will be sufficient.

See AASHTO M288 for additional notes regarding separation geotextiles.

TDOT Geotextile (Type I) and Geotextile (Type IV) likely meet the requirements for Separation Geotextile. See Qualified Products List 36 <https://www.tn.gov/tdot/materials-and-tests/research---product-evaluation-and-qualified-products-list.html>.

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CONSTRUCTION METHODS

**TNP-209-3.1 Control strip.** The first half-day of construction shall be considered the control strip. The Contractor shall demonstrate, in the presence of the RPR, that the materials, equipment, and construction processes meet the requirements of the specification. The sequence and manner of rolling necessary to obtain specified density requirements shall be determined. The maximum compacted thickness may be increased to a maximum of 12 inches (300 mm) upon the Contractor’s demonstration that approved equipment and operations will uniformly compact the lift to the specified density. The RPR must witness this demonstration and approve the lift thickness prior to full production. If TDOT Type A Grading D is used, the maximum compacted lift thickness shall be 6 inches.

Control strips that do not meet specification requirements shall be reworked, re-compacted or removed and replaced at the Contractor’s expense. Full operations shall not continue until the control strip has been accepted by the RPR. The Contractor shall use the same equipment, materials, and construction methods for the remainder of construction, unless adjustments made by the Contractor are approved by the RPR.

**TNP-209-3.2 Preparing underlying subgrade and/or subbase**. The underlying subgrade and/or subbase shall be checked and accepted by the RPR before base course placing and spreading operations begin. Re-proof rolling of the subgrade or proof rolling of the subbase in accordance with Item P-152, at the Contractor’s expense, may be required by the RPR if the Contractor fails to ensure proper drainage or protect the subgrade and/or subbase. Any ruts or soft, yielding areas due to improper drainage conditions, hauling, or any other cause, shall be corrected before the base course is placed. To ensure proper drainage, the spreading of the base shall begin along the centerline of the pavement on a crowned section or on the high side of the pavement with a one-way slope.

**TNP-209-3.3 Production**. The aggregate shall be uniformly blended and, when at a satisfactory moisture content per paragraph TNP-209-3.5, the approved material may be transported directly to the placement.

**TNP-209-3.4 Placement**. The aggregate shall be placed and spread on the prepared underlying layer by spreader boxes or other devices as approved by the RPR, to a uniform thickness and width. The equipment shall have positive thickness controls to minimize the need for additional manipulation of the material. Dumping from vehicles that require re-handling shall not be permitted. Hauling over the uncompacted base course shall not be permitted.

The aggregate shall meet gradation and moisture requirements prior to compaction. The base course shall be constructed in lifts as established in the control strip, but not less than 4 inches (100 mm) nor more than 12 inches (300 mm) of compacted thickness. If TDOT Type A Grading D is used, the maximum compacted lift thickness shall be 6 inches.

When more than one lift is required to establish the layer thickness shown on the plans, the construction procedure described here shall apply to each lift. No lift shall be covered by subsequent lifts until tests verify that compaction requirements have been met. The Contractor shall rework, re-compact and retest any material placed which does not meet the specifications at the Contractor’s expense.

**TNP-209-3.5 Compaction**. Immediately after completion of the spreading operations, compact each layer of the base course, as specified, with approved compaction equipment. The number, type, and weight of rollers shall be sufficient to compact the material to the required density within the same day that the aggregate is placed on the subgrade.

The field density of each compacted lift of material shall be at least **[**   100%   **]** of the maximum density of laboratory specimens prepared from samples of the base material delivered to the jobsite. The laboratory specimens shall be compacted and tested in accordance with **[**   ASTM D1557   **]**. The moisture content of the material during placing operations shall be within ±2 percentage points of the optimum moisture content as determined by ASTM **[**      **]**. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

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The Engineer may specify ASTM D698 or ASTM D1557 based on the structural needs of the pavement. TDOT standard specifications section 303 requires 100 percent of ASTM D 698 for Type A Grading D.

If the material has greater than 30% retained on the 3/4-inch (19.0 mm) sieve, ASTM D1557 or D698 has suggested procedures for dealing with oversize material.

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TNP-209-3.6 Weather limitations. Material shall not be placed unless the ambient air temperature is at least 40°F (4°C) and rising. Work on base course shall not be conducted when the subgrade or subbase is wet or frozen or the base material contains frozen material.

**TNP-209-3.7 Maintenance.** The base course shall be maintained in a condition that will meet all specification requirements. When material has been exposed to excessive rain, snow, or freeze-thaw conditions, prior to placement of additional material, the Contractor shall verify that materials still meet all specification requirements. Equipment may be routed over completed sections of base course, provided that no damage results and the equipment is routed over the full width of the completed base course. Any damage resulting to the base course from routing equipment over the base course shall be repaired by the Contractor at the Contractor’s expense.

**TNP-209-3.8 Surface tolerances.** After the course has been compacted, the surface shall be tested for smoothness and accuracy of grade and crown. Any portion lacking the required smoothness or failing in accuracy of grade or crown shall be scarified to a depth of at least 3 inches (75 mm), reshaped and recompacted to grade until the required smoothness and accuracy are obtained and approved by the RPR. Any deviation in surface tolerances shall be corrected by the Contractor at the Contractor’s expense. The smoothness and accuracy requirements specified here apply only to the top layer when base course is constructed in more than one layer.

**a. Smoothness.** The finished surface shall not vary more than 3/8-inch (9 mm) when tested with a 12-foot (3.7-m) straightedge applied parallel with and at right angles to the centerline. The straightedge shall be moved continuously forward at half the length of the 12-foot (3.7-m) straightedge for the full length of each line on a 50-foot (15-m) grid.

**b. Grade.** The grade and crown shall be measured on a 50-foot (15-m) grid and shall be within +0 and ‑1/2 inch (12 mm) of the specified grade.

**TNP-209-3.9 Acceptance sampling and testing.** Crushed aggregate base course shall be accepted for density and thickness on an area basis. Two tests shall be made for density and thickness for each **[**1200 square yds (1000 m2)**]**. Sampling locations will be determined on a random basis per ASTM D3665

**a. Density.** The **[**RPR shall perform all density tests**]** **[**Contractor’s laboratory shall perform all density tests in the RPR’s presence and provide the test results upon completion to the RPR for acceptance**]**.

Each area shall be accepted for density when the field density is at least **[**   100%   **]** of the maximum density of laboratory specimens compacted and tested per ASTM **[**   1557   **] [**   D698   **]**. The in-place field density shall be determined per **[**ASTM D1556.    **] [**   or   **] [**ASTM D6938 using Procedure A, the direct transmission method, and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938.**]**. If the specified density is not attained, the area represented by the failed test must be reworked and/or recompacted and two additional random tests made. This procedure shall be followed until the specified density is reached. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

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The Engineer may specify ASTM D698 or ASTM D1557 for areas designated for aircraft with gross weights of less than 60,000 pounds (27200 kg). The Engineer shall specify ASTM D1557 for areas designated for aircraft with gross weights of 60,000 pounds (27200 kg) or greater.

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**b. Thickness.** Depth tests shall be made by test holes at least 3 inches (75 mm) in diameter that extend through the base. The thickness of the base course shall be within +0 and -1/2 inch (12 mm) of the specified thickness as determined by depth tests taken by the Contractor in the presence of the RPR for each area. Where the thickness is deficient by more than 1/2-inch (12 mm), the Contractor shall correct such areas at no additional cost by scarifying to a depth of at least 3 inches (75 mm), adding new material of proper gradation, and the material shall be blended and recompacted to grade. The Contractor shall replace, at his expense, base material where depth tests have been taken.

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The Engineer may modify the above thickness control paragraph to permit the thickness determination by survey. Survey shall be required before and after placement of the base. The survey interval should be specified based on the size of the project.

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METHOD OF MEASUREMENT

**TNP-209-4.1** The quantity of crushed aggregate base course will be determined by measurement of the number of **tons** of material actually constructed and accepted by the RPR as complying with the plans and specifications. Base materials shall not be included in any other excavation quantities.

**[**   **TNP-209-4.2** Separation geotextile shall be measured by the number of **[**   square yards   **]** **[**   square meters   **]** of materials placed and accepted by the RPR as complying with the plans and specifications excluding seam overlaps and edge anchoring.   **]**

BASIS OF PAYMENT

**TNP-209-5.1** Payment shall be made at the contract unit price per ton for crushed aggregate base course. This price shall be full compensation for furnishing all materials, for preparing and placing these materials, and for all labor, equipment tools, and incidentals necessary to complete the item.

**[**   TNP-209-5.2 Payment shall be made at the contract unit price per **[**square yard   **]** **[**   square meter**]** for separation geotextile. The price shall be full compensation for furnishing all labor, equipment, material, anchors, and incidentals necessary.    **]**

Payment will be made under:

Item TNP-209-5.1-a Crushed Aggregate Base Course Type A Grading D per ton

Item TNP-209-5.1-b Crushed Aggregate Base Course FAA P-209 Grading per ton

**[**   Item P-TNP-209-5.2 Separation geotextile per **[**square yard   **] [**   square meter   **]**    **]**

References

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 C29 Standard Test Method for Bulk Density (“Unit Weight”) and Voids in Aggregate

ASTM C88 Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

ASTM C117 Standard Test Method for Materials Finer than 75-μm (No. 200) Sieve in Mineral Aggregates by Washing

ASTM C131 Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

ASTM C136 Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates

ASTM C142 Standard Test Method for Clay Lumps and Friable Particles in Aggregates

ASTM D75 Standard Practice for Sampling Aggregates

ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

ASTM D1556 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method

ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2700 kN-m/m3))

ASTM D2167 Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method

ASTM D2419 Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate

ASTM D3665 Standard Practice for Random Sampling of Construction Materials

ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

ASTM D4491 Standard Test Methods for Water Permeability of Geotextiles by Permittivity

ASTM D4643 Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating

ASTM D4751 Standard Test Methods for Determining Apparent Opening Size of a Geotextile

ASTM D4791 Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

ASTM D5821 Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate

ASTM D6938 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

ASTM D7928 Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis

American Association of State Highway and Transportation Officials (AASHTO)

M288 Standard Specification for Geosynthetic Specification for Highway Applications

Tennessee Department of Transportation (TDOT)

Tennessee Department of Transportation. *Standard Specifications for Road and Bridge Construction*. Nashville, Tennessee. January 1, 2021.

Section 303 MINERAL AGGREGATE BASE

Section 903 AGGREGATES

TDOT Qualified Products List

List 36 Geotextiles and Geosynthetics <https://www.tn.gov/content/dam/tn/tdot/hq-materials-tests/qpl/QPL_36.pdf>

END OF ITEM TNP-209