An ***IPRF*** Research Report

Innovative Pavement Research Foundation

Airport Concrete Pavement Technology Program

MASSACHUSETTS

Highway Materials—Concrete Airfield Pavement

IPRF Project 01-G-002-05-3

REVIEW OF STATE HIGHWAY MATERIALS FOR CONCRETE AIRFIELD PAVEMENT CONSTRUCTION

Programs Management Office
5420 Old Orchard Road
Skokie, IL 60077

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REVIEW OF STATE HIGHWAY MATERIALS FOR CONCRETE AIRFIELD PAVEMENT CONSTRUCTION

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This state portfolio has been prepared by the research team under IPRF project 01-G-002-05-3. The purpose of this document is to provide engineers with a "tool" for initial determination of the suitability of state specified materials for concrete pavement airport construction funded under the Airport Improvement Program (AIP) or Passenger Facility Charge (PFC) Program. It is emphasized that this document only considers the materials aspects of the specifications, and that the means and methods as specified under FAA AC 150/5370-10C must be followed. Additionally, the engineer must independently confirm the suitability of the state-specified material, and verify that neither the state nor the FAA specification has been subsequently modified since the time of this review.

The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented within. The contents do not necessarily reflect the official views and policies of the Federal Aviation Administration. This report does not constitute a standard, specification, or regulation.

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1. INTRODUCTION

In several of its advisory circulars (AC), the Federal Aviation Administration (FAA) cites the allowable use of state highway agency (SHA) materials for certain airfield pavements subjected to specific traffic types. Maximizing the use of acceptable SHA materials on FAA projects can result in significant cost savings. This review of the Massachusetts DOT materials specifications, conducted under IPRF Project 01-G-002-05-3, *Highway Materials – Concrete Airfield Pavements*, has been completed to provide guidance to engineers and contractors on what materials might be acceptable for the construction of concrete airfield pavements, and where they can be applied. It is noted that not all SHA-specified materials correspond to the FAA items under consideration. Specific FAA items considered in this review include:

- Item P-154 – Subbase Course
- Item P-155 – Lime-Treated Subgrade
- Item P-157 – Cement Kiln Dust (CKD) Treated Subgrade
- Item P-158 – Fly Ash Treated Subgrade
- Item P-208 – Aggregate Subbase
- Item P-209 – Crushed Aggregate Subbase
- Item P-211 – Lime Rock Base Course
- Item P-213 – Sand-Clay Base Course
- Item P-219 – Recycled Concrete Aggregate Base Course
- Item P-301 – Soil-Cement Base Course
- Item P-304 – Cement-Treated Base Course
- Item P-306 – Econocrete Base Course (Lean Mix Concrete Base Course)
- Item P-401/403 – Plant Mix Bituminous Pavements
- Item P-501 – Portland Cement Concrete Pavement

This document provides engineers with a "tool" for initial determination of the suitability of state specified materials for airport construction funded under the Airport Improvement Program (AIP) or Passenger Facility Charge (PFC) Program. It is emphasized that this document only considers the materials aspects of the specifications, and that the means and methods as specified under FAA AC 150/5370-10C must be followed. Additionally, the engineer using this document must independently confirm the suitability of the SHA-specified material, and verify that neither the state nor the FAA specification has been subsequently modified since the time of this review.

Classification Groups

In this document, the material standards and special provisions for each SHA were classified into four categories based on how well they met the prevailing FAA item. The four categories are:

- Group 1 – The material meets or exceeds the requirement of the respective FAA standard and differs only by the common designation and should be acceptable for use.
- Group 2 – The material does not meet the FAA standard, but should be acceptable for use on airfields supporting aircraft less than 60,000 lbs maximum takeoff weight.
- Group 3 – The material does not meet the FAA standard, but might be used subject to specific considerations (improvement to controlling material characteristic).
- Group 4 – The material does not meet the FAA standard.

The following describes the process by which each SHA material standard and special provision was categorized into the four groups.

Group 1

As described above, Group 1 includes SHA material standards and special provisions that meet or exceed the test methods and material requirements of the equivalent FAA item and thus may be considered for use on FAA projects with no modifications or revisions. For example, a comparison of California DOT Section 24, *Lime Stabilization* with FAA Item P-155, *Lime-Treated Subgrade* is shown in table 1. In this comparison, the FAA Item P-155 requires that the lime be in accordance with ASTM C977, *Standard Specification for Lime for Soil Stabilization*. This is the same requirement as specified for the California lime stabilized material. All other FAA requirements are also met in the California DOT specification, therefore, these two specifications are considered equivalent and the California specified material was assigned a Group 1 categorization and may be considered as equivalent to FAA Item P-155.

Table 1. Example of SHA material standard meeting Group 1.

<table>
<tr><th rowspan="2">Item</th><th colspan="2">LIME-TREATED SUBGRADE</th></tr>
<tr><th>California DOT</th><th>FAA</th></tr>
<tr><td>Agency Specification</td><td>Section 24, Lime Stabilization</td><td>Item P-155, Lime-Treated Subgrade</td></tr>
<tr><td>Description</td><td>This work shall consist of mixing lime and water with soil and compacting the mixture.</td><td>One or more courses of a mixture of soil, lime, and water.</td></tr>
<tr><td>Test Methods Referenced</td><td>• ASTM C977</td><td>• ASTM C977</td></tr>
<tr><td>Materials</td><td>• Soil
• Lime
• Water</td><td>• Lime
• Water</td></tr>
<tr><td>Relevant Material Requirement(s)</td><td>Lime:
Lime shall conform to the requirements in ASTM C977, except that when a 250-gram test sample of quicklime is dry sieved in a mechanical sieve shaker for 10 minutes ±30 seconds, it shall conform to the following grading requirements:
<table><tr><th>Sieve</th><th>% Passing</th></tr><tr><td>3/8 in.</td><td>98 – 100</td></tr><tr><td>#100</td><td>0 – 25</td></tr><tr><td>#200</td><td>0 – 14</td></tr></table></td><td>Lime:
• Hydrated lime meeting ASTM C977
• Commercial lime slurry consisting of hydrated lime meeting the following:
– Grade 1 “dry solids content” ≥ 31%
– Grade 2 “dry solids content” ≥ 35%
– Chemical composition, ≥ 70% CaO and MgO
<table><tr><th>Sieve</th><th>Residue, % Retained</th></tr><tr><td>#6</td><td>0.0</td></tr><tr><td>#10</td><td>≤ 1.0</td></tr><tr><td>#30</td><td>≤ 2□5</td></tr></table></td></tr>
</table>

Group 2

SHA material standards and special provisions categorized as Group 2 include materials that do not meet the FAA standard but could be used on concrete airfield pavements supporting aircraft less than 60,000 lbs maximum takeoff weight. An example of a SHA material meeting a Group 2 classification is shown in table 2. In this table, the Alabama DOT Section 301, *Soil, Soil Aggregate, and Aggregate, Base and Subbases* is compared to FAA Item P-154, *Subbase Course*. FAA Item P-154 requires that the subbase material meet ASTM D4318, *Standard Method of Test for Determining the Liquid Limit, Plastic Limit, and Plasticity Index of Soils*, while the Alabama specification requires the material to meet AASHTO T 89 and T 90, *Standard*

Method of Test for Determining the Liquid Limit of Soils and *Standard Method of Test for Determining the Plastic Limit and Plasticity Index of Soils*, respectively. The two specifications differ in aggregate gradation requirements; however, this difference was not deemed to be significant regarding performance for pavements carrying aircraft weighing 60,000 lbs or less since the SHA-specified material is used for pavements constructed to withstand 80,000-lb truck loads. Therefore in this case, the Alabama DOT Section 301, *Soil, Soil Aggregate, and Aggregate, Base and Subbases* might be considered as a suitable replacement for FAA Item P-154, *Subbase Course* for pavements serving aircraft weighing less than 60,000 lbs.

Table 2. Example of SHA material standard meeting Group 2.

Item	SUBBASE COURSE	
	Alabama DOT	**FAA**
Agency Specification	Section 301, Soil, Soil Aggregate, and Aggregate, Base and Subbases	Item P-154, Subbase Course
Description	Base and subbase materials consist of natural soil, natural soil and natural aggregate combinations, manufactured aggregates, or any combination of these with or without a stabilizing agent.	Subbase course composed of granular materials constructed on prepared subgrade or underlying course.
Test Methods Referenced	• AASHTO T 89 • AASHTO T 90	• ASTM D4318
Materials	• Soil • Soil aggregate • Aggregate	• Aggregate
Relevant Material Requirement(s)	**Granular soil material:** • Granular soil material shall be of the kind and general character of sand-clay, topsoil, sand, soft sand rock, and so on, or a combination of these. • Quality requirements: – Clay content, range o Type A, 2 – 18% o Type B, 1 – 18% o Type C, 1 – 16% – Liquid Limit ≤ 25 – Plasticity Index ≤ 6	**Subbase material:** • Subbase material shall consist of hard durable particles or fragments of granular aggregates blended with fine sand, clay, stone dust, or other similar binding or filler materials. • Quality requirements: – Free from vegetable matter, lumps or excessive amounts of clay, and other objectionable or foreign substances. • Material passing the #40: – Liquid Limit ≤ 25 – Plasticity Index ≤ 6 • Material finer than 0.02 mm shall be < 3%.
Relevant Material Requirement(s)	**Soil aggregate material:** • Soil aggregate material shall be of various types, such as clay gravel, clay gravel-sand, float gravel, soft sand rock, and so on. • Quality requirements: – Clay content, range o Type A, 2 – 15% o Type B, 1 – 14% o Type C, 1 – 12% – Liquid Limit ≤ 26 – Plasticity Index ≤ 6	• Gradation Requirements: **Sieve** / **% Passing** **3-in.** 100 **#10** 20 – 100 **#40** 5 – 60 **#200** 0 – 8

Group 3

Group 3 materials include SHA-specified materials that, with some modification, would meet the salient material specifications as identified in the relevant FAA items. SHA material specifications that were identified as meeting Group 3 included all of the salient material characteristics of the analogous FAA item, but differed slightly in material specifications (i.e., aggregate gradation, liquid limit, or plasticity index), or excluded several of the material characteristics that conceivably could be added to the SHA material specification to meet the FAA item requirements. The distinguishing feature of a Group 3 classification is that the SHA-specified material could meet the FAA item requirements with relatively little effort.

An example of a SHA material meeting a Group 3 classification is shown in table 3. In this table, FAA Item P-501, *Portland Cement Concrete Pavement* is compared to Idaho DOT Section 409, *Portland Cement Concrete Pavement*. As can be seen, the two specifications closely align, with the FAA Item P-501 requiring that the aggregate meet ASTM C131 (LA Wear), that the cement shall meet ASTM C150, C595, or C1157, and that the pozzolan material shall meet ASTM C618. In comparison, the Idaho specification requires that the aggregate shall meet AASHTO T 96 (*Standard Method of Testing for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine*), AASHTO M 85 (*Standard Specification for Portland Cement*) or M 240 (*Standard Specification for Blended Hydraulic Cement*), which are equivalent to ASTM C150 (*Standard Specification for Portland Cement*) and C595 (*Standard Specification for Blended Hydraulic Cement*), respectively. The Idaho specification does not specify a requirement for pozzolanic materials. But as can be seen in tables 4 and 5, the gradations between the two specifications differ slightly, but not so much so that there is a range of gradations that would meet both specifications.

Table 3. Example of SHA material standard meeting Group 3.

Item	PORTLAND CEMENT CONCRETE PAVEMENT	
	Idaho DOT	**FAA**
Agency Specification	Section 409, Portland Cement Concrete Pavement	Item P-501, Portland Cement Concrete Pavement
Description	This work shall consist of constructing a pavement composed of portland cement concrete.	Pavement course composed of portland cement concrete, with or without reinforcement.
Test Methods Referenced	• AASHTO M 6 • AASHTO M 80 • AASHTO M 85 or AASHTO M 240 • AASHTO T 96 • AASHTO T 176 • AASHTO T 303 • Idaho T-15	• ASTM C33 • ASTM C131 • ASTM C150, ASTM C595, or ASTM C1157 • ASTM C618
Materials	• Portland cement • Water • Aggregate • Concrete admixtures • Fly ash • Concrete curing materials	• Fine and coarse aggregate • Cement, fly ash, natural pozzolan, or ground blast furnace slag • Water • Cover material for curing • Admixtures

Table 3. Example of SHA material standard meeting Group 3 (continued).

Item	PORTLAND CEMENT CONCRETE PAVEMENT	
	Idaho DOT	**FAA**
Relevant Material Requirement(s)	**Coarse aggregate:** • Aggregates shall be reasonably free from wood, roots, bark, soft or disintegrated pieces, or other detrimental matter. • Blend sand may be used to correct deficiencies in gradation. • Quality requirements: – Wear, max loss: 35% – Degradation (Idaho T-15): o Percent passing the #200: • Original: 5 – 8; Final ≤ Original + 5 • Original: 9; Final ≤ 14 • Original: 10; Final ≤ 15 o Sand equivalent: • Original: ≥ 36; Final ≥ 30 • Original: 30 – 35; Final ≥ 25 • Deleterious content requirements, max content: – Clay lumps, 0.5% – Clay lumps/friable particles, 2.0% – Coal/lignite, 1.0% – Minus #200 material, 1.0% – Flat, elongated particles (5:1), 15% – Other, 5.0% **Fine aggregate:** • Aggregates shall be reasonably free from wood, roots, bark, soft or disintegrated pieces, or other detrimental matter. • Quality requirements: – Soundness meeting AASHTO M 6 – Sand equivalent ≥ 70 • Deleterious content requirements, max content: – Clay lumps, 1.0% – Coal/lignite, 1.0% – Other, 5.0% • Degradation (Idaho T-15): – Percent passing the #200: o Original: 5 – 8; Final ≤ Original + 5 o Original: 9; Final ≤ 14 o Original: 10; Final ≤ 15 – Sand equivalent: o Original: ≥ 36; Final ≥ 30 o Original: 30 – 35; Final ≥ 25 **Portland cement:** • Type I, II, III portland cement meeting AASHTO M 85. • Type IP, P, I(PM) blended cement meeting AASHTO M 240.	**Coarse aggregate:** • Crushed or uncrushed gravel, crushed stone, air-cooled blast furnace slag, or crushed recycled PCC. • Coarse aggregate shall meet ASTM C33. • Quality requirements: – Wear (C131), max loss o Used as surface course, 40% o Used as base course, 50% **Fine aggregate:** • Fine aggregate shall meet ASTM C33. **Portland cement:** • Type I, II, III, or V meeting ASTM C150 • Type IS or IP meeting ASTM C595 • Type GU, HE, HS, MH, or LH meeting ASTM C1157

Table 4. FAA and Idaho DOT coarse aggregate gradation requirements.

Sieve	% Passing									
	FAA					ITD				
	2" max[1]	1" max	1-1/2" max[1]	3/4" max	1" max	2a	2b	3	4[2]	5[2]
2-1/2"	100	--	--	--	--	--	--	--	--	100
2"	90–100	--	100	--	--	--	--	--	100	95–100
1-1/2"	35–70	100	90–100	--	100	--	--	100	95–100	--
1"	0–15	95–100	20–55	100	95–100	100	100	95–100	--	35–70
3/4"	--	--	0–15	90–100	--	95–100	80–100	--	35–70	--
1/2"	0–5	25–60	--	--	25–60	--	--	25–60	--	10–30
3/8"	--	--	0–5	20–55	--	20–55	10–40	--	10–30	--
#4	--	0–10	--	0–10	0–10	0–10	0–4	0–10	0–5	0–5
#8	--	0–5	--	0–5	0–5	0–5	--	0–5	--	--

[1] Aggregate shall be furnished in two size groups when the nominal max size is greater than 1 in.
[2] Sizes 4 and 5 shall be a combination of two or more coarse aggregate sizes.

Table 5. FAA and Idaho DOT aggregate gradation requirements.

FINE AGGREGATE		
Sieve	% Passing	
	FAA	ITD
3/8 in	100	100
#4	95–100	95–100
#8	80–100	--
#16	50–85	45–80
#30	25–60	--
#50	10–30	10–30
#100	2–10	2–10
#200	--	0–2[3]

[3] The percent passing may be ≤ 3 if the sand equivalent is ≥ 80.

Thus, for this comparison the Idaho DOT Section 409 specification meets the FAA Item 501 specifications in all critical requirements except for aggregate gradation. Although the Idaho DOT aggregate specification is slightly different from the FAA Item P-501 gradation, the differences are such that the Idaho DOT gradation could meet the FAA Item P-501 gradation and thus modification is an option. A contractor may choose to modify the Idaho DOT-specified aggregate gradation to meet the FAA P-501 specification; therefore, the Idaho DOT specified material is characterized as a Group 3.

Alternatively, it is stated under FAA Item P-501:

> *The Engineer shall specify the aggregate to be furnished from the table shown in this note. The appropriate gradation shall be inserted into Table 2. Insert points are denoted by asterisks. Where locally available aggregates cannot be economically blended to meet the grading requirements, the gradations may be modified by the Engineer to fit the characteristics of such locally available aggregates.*

This indicates the engineer can choose to accept the local gradation, in this case changing the category from a Group 3 to a Group 1. It is noted that he/she would still need to file a "modification to standard" request to the FAA to obtain material approval.

Similarly, the FAA Item P-501 also makes allowance for regional differences in aggregate percent wear requirements, as stated:

> *The Engineer shall specify the percentage of wear. It should not exceed 40 percent. In certain cases where aggregate of this quality cannot be obtained economically, aggregate with a higher percentage of wear may be used if a satisfactory service record of at least 5 years' duration under similar conditions of service and exposure has been demonstrated.*

Again, this provides a mechanism for the engineer to accept aggregate with a higher percentage of wear, but with the stipulation that a "modification to standard" request would need to be filed with the FAA to obtain material approval.

Group 4

SHA material standards and special provisions that have been categorized as Group 4 have little to no semblance to the relevant FAA item or require significant modification that would more than likely render these materials as not cost effective. An example of a SHA material receiving a Group 4 classification is shown in table 6. This table compares FAA Item P-209, *Crushed Aggregate Base Course* to Arizona DOT Section 303, *Aggregate Subbases and Aggregate Bases*. In this case, the gradations for the FAA Item P-209 and Arizona DOT Aggregate Base, Class 1 differ in a non-reconcilable way as shown clearly in figure 1. Whereas other properties of the specification could be modified, it is impossible to modify the Arizona DOT Aggregate Base, Class 1 gradation to meet the FAA Item P-209 specification. Since the material specifications are irreconcilably different, the Arizona DOT material cannot meet the FAA requirements and therefore is characterized as Group 4. Note that the Arizona DOT Aggregate Base, Class 2 base was assigned to Group 2 and Group 3.

ASTM Versus AASHTO Standards

Table 7 shows the ASTM and comparable AASHTO test methods used in the evaluation of FAA items and SHA material specifications, respectively. It is noted that these "equivalent" specifications do not always match one another exactly. For example, a slight differences in gradation is observed for fine aggregate in ASTM C33 (0 to 10 percent passing the No. 100 sieve) versus AASHTO M 6 (2 to 10 percent passing the No. 100 sieve). In addition, there is often a lag time behind a change in one (e.g. ASTM) and when it is accepted, if ever, by the other (e.g. AASHTO). A recent example of this is the allowance for 5 percent interground limestone in portland cement. ASTM C150 adopted this in 2004 and yet it wasn't until 2007 that limestone additions were allowed in AASHTO M 85. And although many states defer to AASHTO standards, most use some variation of the material specifications and test methods to create their own unique practice. And, in some cases, no equivalent AASHTO standard exists for an existing ASTM standard (e.g., no AASHTO equivalent exists for ASTM C1157, *Performance Specified Hydraulic Cement*).

Table 6. Example of SHA material standard meeting Group 4.

Item	CRUSHED AGGREGATE BASE COURSE	
	Arizona DOT	**FAA**
Agency Specification	Section 303, Aggregate Subbases and Aggregate Bases	Item P-209, Crushed Aggregate Base Course
Description	This work shall consist of furnishing, placing, and compacting aggregate subbases and aggregate bases.	Base course composed of crushed aggregate.
Test Methods Referenced	• AASHTO T 90 • AASHTO T 96	• ASTM C29 • ASTM C88 • ASTM C131 • ASTM D2419 • ASTM D4318
Materials	• Aggregate Base Classes 1 and 2	• Crushed coarse aggregate • Fine aggregate
Relevant Material Requirement(s)	**Aggregate:** • Aggregate shall consist of stone or gravel free of vegetable matter and other deleterious substances. • Quality requirements: – Wear (AASHTO T 96), max loss: 40% – Plasticity Index (AASHTO T 90): o Classes 1 and 2 ≤ 3 • For Class 1 through Class 3 aggregate, the amount of fractured coarse aggregate particles shall be at least 30 percent, when tested in accordance with the requirements of Arizona Test Method 212.	**Coarse aggregate:** • Crushed coarse aggregate shall be crushed stone, crushed air-cooled blast furnace slag, or crushed gravel. • Crushed slag unit weight: ≥ 70 lb/ft^3 • Crushed coarse aggregate shall have ≥ 90% of the material having ≥ 2 fractured faces and 100% having ≥ 1. • In frost areas, material finer than 0.02 mm shall be < 3%. • Quality requirements: – Wear (ASTM C131), max loss: 45% – Soundness (ASTM C88), max loss: 12% – Material passing the #40: o Liquid Limit ≤ 25 o Plasticity Index ≤ 4 **Fine aggregate requirements:** • Fine aggregate shall be fines produced from the crushing operation. • Sand equivalent value ≥ 35 (ASTM D2419)
Important Deviations		
Level of Acceptability for Use	• Group 2 – Except for liquid limit, ASTM C88, percent fractured faces, and aggregate gradation, the state-specified Class 2 material meets all FAA material requirements. The state-specified material may be used on airfields supporting aircraft with less than 60,000 lbs maximum takeoff weight. • Group 3 – The state-specified Class 2 material may be used on FAA facilities if the requirements for aggregate gradation, liquid limit, ASTM C88, and percent fractured faces are met. • Group 4 – The state-specified Class 1 material is unable to meet FAA aggregate gradation requirements and therefore is not acceptable for use on FAA facilities.	

In preparing this document of state practice, the research team considered these factors when comparing the SHA materials to relevant FAA items and assigning Groups. The engineer should use this document only as a tool for initial determination of material suitability and is still responsible for ensuring that the FAA standards are met.

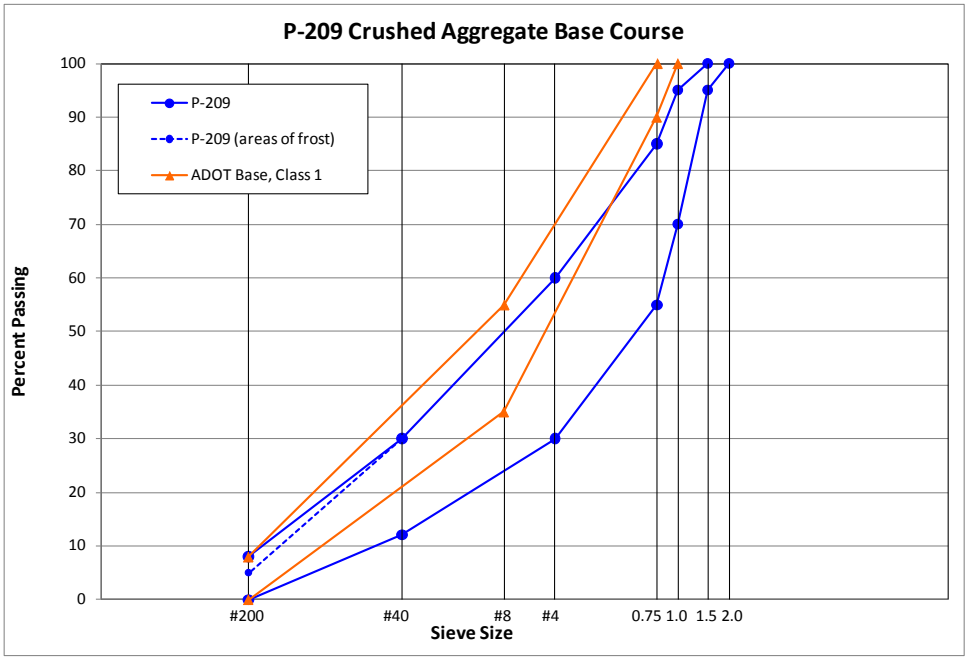


Figure 1. Gradation plot comparing FAA Item P-209 to ADOT Base, Class 1.

Table 7. "Equivalent" ASTM and AASHTO designations for test procedures or methods.

Test Procedure or Method	**ASTM Test Method**	**AASHTO Test Method**
Standard Test Method for Bulk Density (Unit Weight) and Voids in Aggregate	C29	T 19
Standard Specification for Concrete Aggregates	C33	M 6
Standard Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate	C88	T 104
Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine	C131	T 96
Standard Specification for Portland Cement	C150	M 85
Standard Specification for Blended Hydraulic Cement	C595	M 240
Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete	C618	M 295
Standard Specification for Lime for Soil Stabilization	C977	M 216
Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete	C989	M 302
Standard Performance Specification for Hydraulic Cement	C1157	N/A
Standard Specification for Cutback Asphalt	D2028	M 81
Specification for Cationic Emulsified Asphalt	D2397	M 208
Test Method for Sand Equivalent Values of Soils and Fine Aggregate	D2419	T 176
Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils	D4318	T 89/T 90

2. SUMMARY AND COMPARISON OF SHA MATERIALS

The following summarizes and compares the Massachusetts Department of Transportation (DOT) materials specifications and special provisions against the applicable FAA Items. Each of the state materials specifications have been categorized into at least one of the four previously defined acceptance groups (see table 8). Detailed tabular comparisons are presented in the remainder of this portfolio by FAA item; for each item, these tables provide the following information:

- Specification Designation and Title
- Description
- Test Methods Referenced
- Materials
- Relevant Material Requirements
- Important Deviations
- Level of Acceptability for Use
- Additional Specifications

Massachusetts DOT 1988 Standard Specifications for Highways and Bridges were used in this comparison and can be accessed at:
http://www.mhd.state.ma.us/default.asp?pgid=content/publications_const&sid=about
and the 2010 Supplemental Specifications which can be accessed at:
http://www.mhd.state.ma.us/downloads/manuals/SSP022510MetEng.pdf .

Table 8. Summary of applicable Massachusetts state specifications to FAA items.

Specification	FAA ITEM Level of Acceptability for Use[4-7]					
	P-154	P-208	P-209	P-219	P-403[8]	P-501
Section 401 – Gravel Subbase	2, 3					
Section 402 – Dense Graded Crushed Stone for Subbase	2, 3	2, 3	2, 3			
Section 404 – Reclaimed Pavement Borrow Material for Base Course				3		
Section 460 – Class I Bituminous Concrete Pavement, Type 1[8]					1	
Section 476 – Cement Concrete Pavement						
3/4 in						2, 3
3/8 and 1-1/2 in						4

Notes:

[4] Group 1 – The material meets or exceeds the requirement of the respective FAA standard and differs only by the common designation.
[5] Group 2 – The material does not meet the FAA standard, but can be used on airfields supporting aircraft with less than 60,000 lbs maximum takeoff weight.
[6] Group 3 – The material does not meet the FAA standard, but might be used subject to specific considerations (improvement to or modification of a controlling material characteristic).
[7] Group 4 – The material does not meet the FAA standard.
[8] According to AC 150/5379-10, SHA specifications for bituminous pavements may be used for P-403 as stabilized base under Item P-501, as well as for pavements not subjected to aircraft loading, such as access and perimeter roads, and for pavements designed for aircraft weights of 12,500 lbs or less.

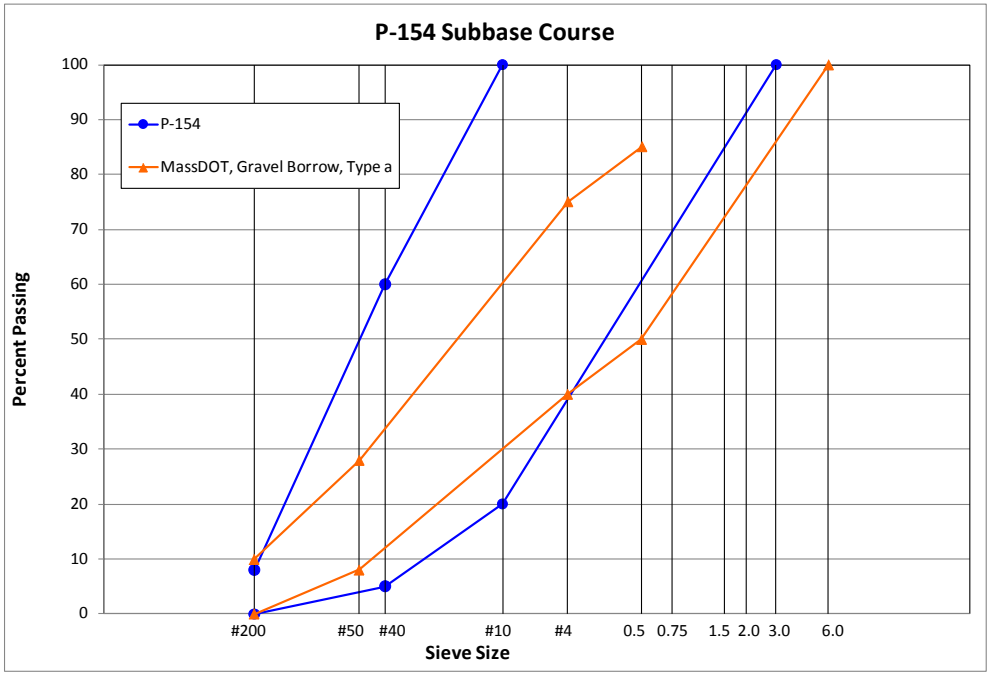
Item	SUBBASE COURSE	
	Massachusetts DOT	**FAA**
Agency Specification	Section 401, Gravel Subbase Section 402, Dense Graded Crushed Stone for Subbase	Item P-154, Subbase Course
Description	Section 401—This work shall consist of approved gravel placed on the subgrade. Section 402—This work shall consist of crusher-run coarse aggregates of crushed stone or gravel and fine aggregates of natural sand or stone screenings uniformly pre-mixed and placed on the subgrade or subbase.	Subbase course composed of granular materials constructed on prepared subgrade or underlying course.
Test Methods Referenced	• AASHTO T 96	• ASTM D4318
Materials	Section 401 • Gravel borrow (Type a or b) • Processed gravel Section 402 Dense graded crushed stone	• Aggregate
Relevant Material Requirement(s)	**Gravel borrow:** • Gravel borrow shall consist of hard, durable stone and coarse sand, free from loam and clay, surface coatings, and deleterious materials. • Processed glass aggregate (≤ 10%) may be blended with the processed gravel. **Processed gravel:** • Crusher run gravel shall consist of hard, durable stone and coarse sand, free from loam and clay, surface coatings, and deleterious materials. • Processed glass aggregate (≤ 10%) may be blended with the processed gravel. • Quality requirements: – Wear, max loss: 50% **Dense graded crushed stone:** • Crusher run coarse aggregates of crushed stone (trap only) and fine aggregates of natural sand or stone screenings. • Processed glass aggregate (≤ 10%) may be blended with the processed gravel. • Quality requirements: – Wear, max loss: 45% • Deleterious content max content: Flat, elongated particles (4:1), 15% – Flat, elongated particles (4:1), 15%	**Subbase material:** • Subbase material shall consist of hard durable particles or fragments of granular aggregates blended with fine sand, clay, stone dust, or other similar binding or filler materials. • Quality requirements: – Free from vegetable matter, lumps or excessive amounts of clay, and other objectionable or foreign substances. • Material passing the #40: – Liquid Limit ≤ 25 – Plasticity Index ≤ 6 • Material finer than 0.02 mm shall be < 3%.
Important Deviations		
Level of Acceptability for Use	• Group 2 – Except for aggregate gradation and ASTM D4318, the state-specified material meets all FAA material requirements. The state-specified material may be used on airfields supporting aircraft with less than 60,000 lbs maximum takeoff weight. • Group 3 – The state-specified material may be used on FAA facilities if the aggregate gradation and ASTM D4318 requirements are met.	

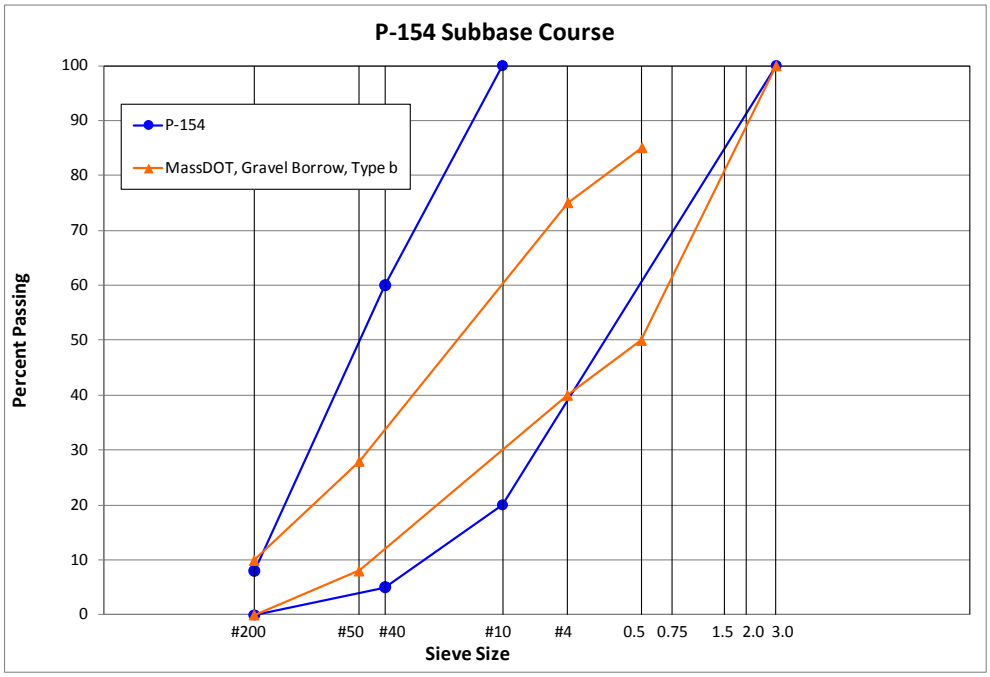
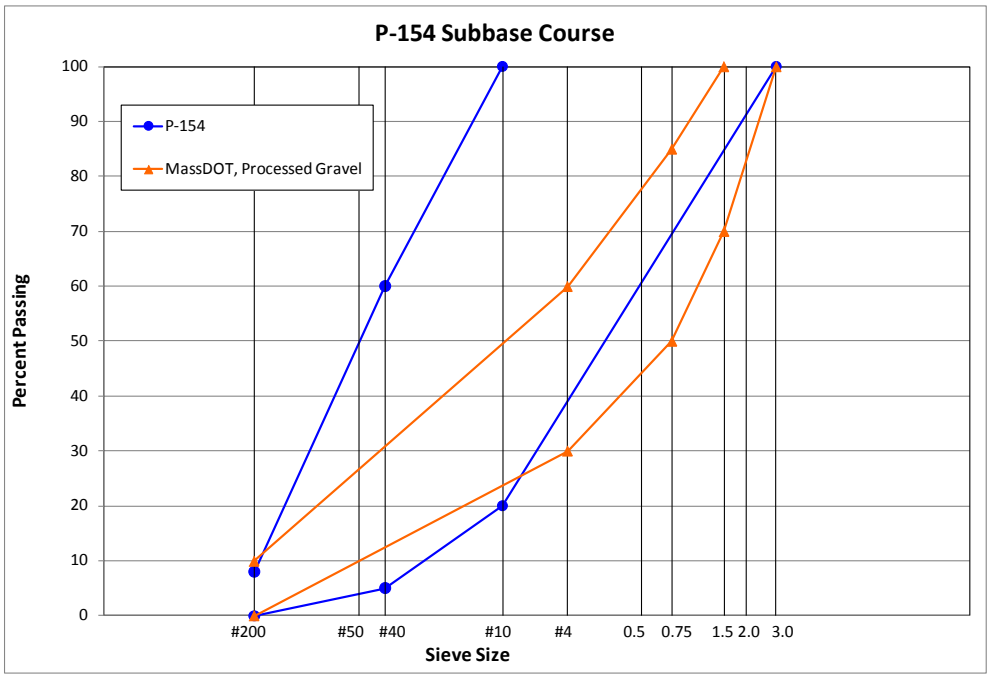
Item	SUBBASE COURSE	
	Massachusetts DOT	FAA
	Note – The FAA Item P-154 does not specify the use of processed glass aggregate in subbase courses.	

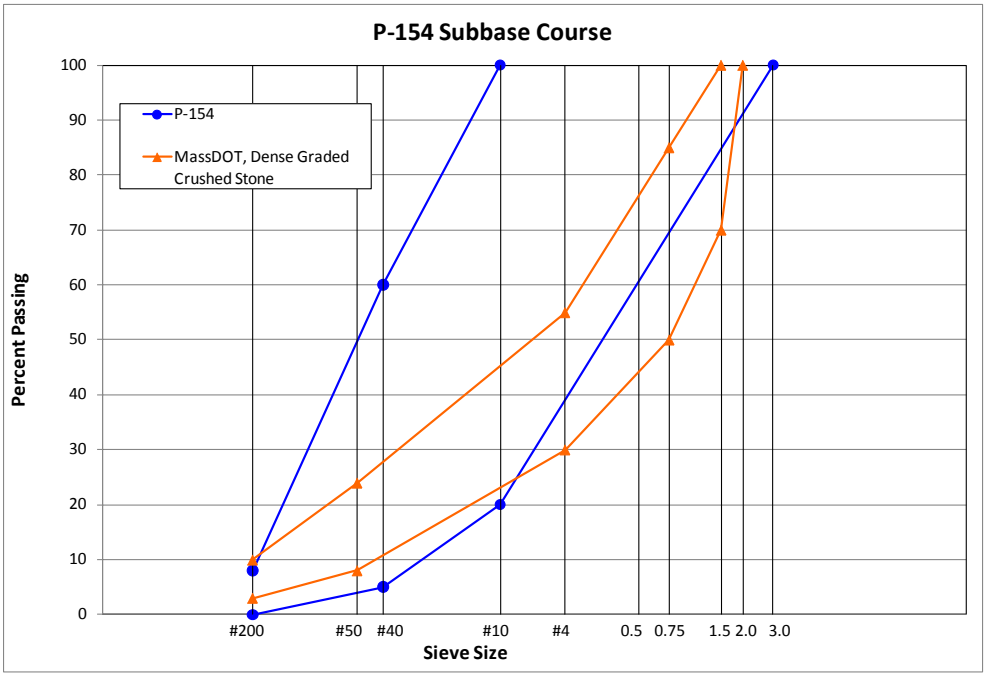
Item	SUBBASE COURSE
	Massachusetts DOT Aggregate Gradation Requirements
Additional Specifications	**Gradation requirements:**

Sieve	% Passing				
	FAA	Massachusetts DOT			
		Gravel Borrow		Processed Gravel	Dense Graded Crushed Stone
		Type a	Type b		
6 in.	--	100	--	--	--
3 in.	100	--	100	100	--
2 in.	--	--	--	--	100
1-1/2 in.	--	--	--	70 – 100	70 – 100
3/4 in.	--	--	--	50 – 85	50 – 85
1/2 in.	--	50 – 85	50 – 85	--	--
#4	--	40 – 75	40 – 75	30 – 60	30 – 55
#10	20 – 100	--	--	--	--
#40	5 – 60	--	--	--	--
#50	--	8 – 28	8 – 28	--	8 – 24
#200	0 – 8	0 – 10	0 – 10	0 – 10	3 – 10

Gradation plots comparing FAA to state agency gradation requirements:



Item	SUBBASE COURSE
	Massachusetts DOT Aggregate Gradation Requirements
Additional Specifications (Continued)	 

Item	SUBBASE COURSE
	Massachusetts DOT Aggregate Gradation Requirements
Additional Specifications (Continued)	

Item	AGGREGATE BASE COURSE	
	Massachusetts DOT	**FAA**
Agency Specification	Section 402, Dense Graded Crushed Stone for Subbase	Item P-208, Aggregate Base Course
Description	Dense graded crushed stone.	Base course composed of crushed or uncrushed aggregate bonded with either soil or fine aggregate or both.
Test Methods Referenced	• AASHTO T 96	• ASTM C29 • ASTM C88 • ASTM C131 • ASTM D4318
Materials	• Dense graded crushed stone	• Coarse aggregate • Filler material
Relevant Material Requirement(s)	**Processed gravel:** • Crusher run gravel shall consist of hard, durable stone and coarse sand, free from loam and clay, surface coatings, and deleterious materials. • Processed glass aggregate (≤ 10%) may be blended with the processed gravel. • Quality requirements: – Wear, max loss: 50% **Crushed stone:** • Crusher run coarse aggregates of crushed stone (trap only) and fine aggregates of natural sand or stone screenings. • Processed glass aggregate (≤ 10%) may be blended with the processed stone. • Quality requirements: – Wear, max loss: 45% • Deleterious content requirements, max content: – Flat, elongated particles (4:1), 15%	**Coarse aggregate:** • Crushed coarse aggregate shall be crushed stone, crushed air-cooled blast furnace slag, or crushed gravel. • Crushed slag unit weight: ≥ 70 lb/ft^3 • Crushed gravel shall have ≥ 60% of the material retained on the #4 having ≥ 2 fractured faces and 75% having ≥ 1. • Material finer than 0.02 mm shall be < 3%, unless all materials are crushed stone. In frost areas, material finer than 0.02 mm shall be < 3% for all materials, including crushed stone. • Quality requirements: – Wear (ASTM C131), max loss: o Uncrushed aggregate, 45% o Crushed aggregate, 50% **Filler material:** • Filler shall be sand passing the #4 and ≤ 5% passing the #200. • Material passing the #40: – Liquid Limit ≤ 25 – Plasticity Index ≤ 6
Important Deviations		
Level of Acceptability for Use	• Group 2 – Except for aggregate gradation and ASTM C131, the state-specified material meets FAA material requirements. The state-specified material may be used on airfields supporting aircraft with less than 60,000 lbs maximum takeoff weight. • Group 3 – The state-specified material may be used on FAA facilities if the aggregate gradation and ASTM C131 requirements are met. Note – FAA Item P-208 does not specify the use of processed glass aggregate in aggregate base course.	

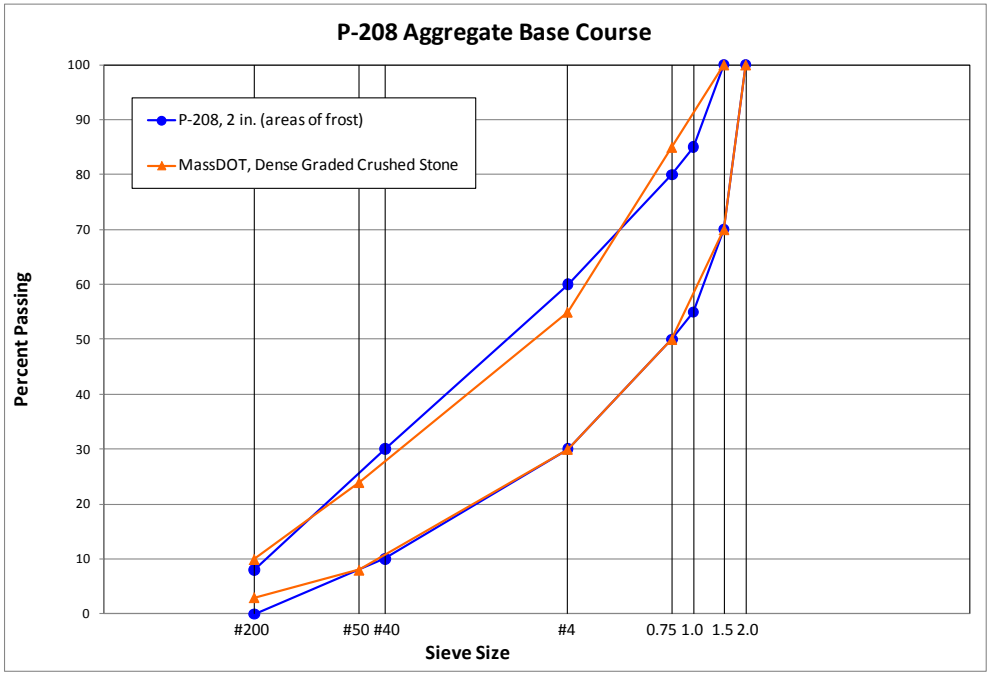
Item	AGGREGATE BASE COURSE Massachusetts DOT Aggregate Gradation Requirements

Additional Specifications

Gradation requirements:

Sieve	% Passing			
	FAA Item P-208			Massachusetts DOT Dense Graded
	2-in. max	1 1/2-in. max	1-in. max	
2 in.	100	--	--	100
1-1/2 in.	70 – 100	100	--	70 – 100
1 in.	55 – 85	70 – 100	100	--
3/4 in.	50 – 80	55 – 85	70 – 100	50 – 85
#4	30 – 60	30 – 60	35 – 65	30 – 55
#40	10 – 30	10 – 30	10 – 25	--
#50	--	--	--	8 – 24
#200	5 – 15	5 – 15	5 – 15	3 – 10
#200 (frost areas)	0 – 8	0 – 8	0 – 8	

Gradation plots comparing FAA to state agency gradation requirements:



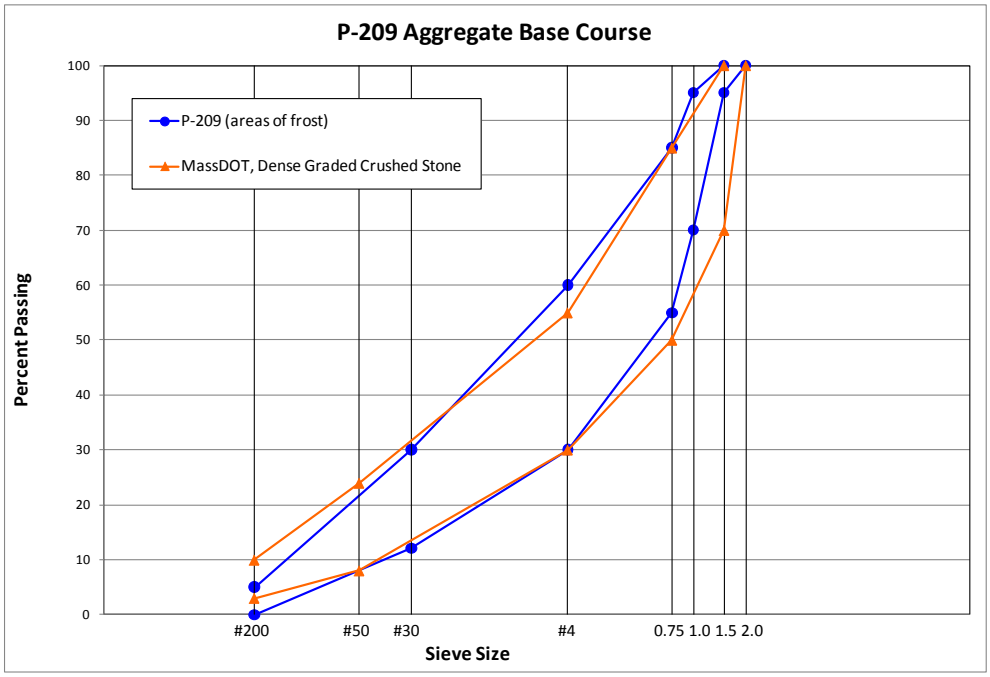
Item	CRUSHED AGGREGATE BASE COURSE	
	Massachusetts DOT	**FAA**
Agency Specification	Section 402, Dense Graded Crushed Stone for Subbase	Item P-209, Crushed Aggregate Base Course
Description	• Dense graded crushed stone	Base course composed of crushed aggregate.
Test Methods Referenced	• AASHTO T 96	• ASTM C29 • ASTM C88 • ASTM C131 • ASTM D2419 • ASTM D4318
Materials	• Dense graded crushed stone	• Crushed Aggregate
Relevant Material Requirement(s)	**Processed gravel:** • Crusher run gravel shall consist of hard, durable stone and coarse sand, free from loam and clay, surface coatings, and deleterious materials. • Processed glass aggregate (≤ 10%) may be blended with the processed gravel. • Quality requirements: – Wear, max loss: 50% **Crushed stone:** • Crusher run coarse aggregates of crushed stone (trap only) and fine aggregates of natural sand or stone screenings. • Processed glass aggregate (≤ 10%) may be blended with the processed stone. • Quality requirements: – Wear, max loss: 45% • Deleterious content requirements, max content: – Flat, elongated particles (4:1), 15%	**Coarse aggregate:** • Crushed coarse aggregate shall be crushed stone, crushed air-cooled blast furnace slag, or crushed gravel. • Crushed slag unit weight: ≥ 70 lb/ft^3 • Crushed coarse aggregate shall have ≥ 90% of the material having ≥ 2 fractured faces and 100% having ≥ 1. • In frost areas, material finer than 0.02 mm shall be < 3%. • Quality requirements: – Wear (ASTM C131), max loss: 45% – Soundness (ASTM C88), max loss: 12% – Material passing the #40: o Liquid Limit ≤ 25 o Plasticity Index ≤ 4 **Fine aggregate:** • Fine aggregate shall be fines produced from the crushing operation. • Sand equivalent value ≥ 35 (ASTM D2419)
Important Deviations		
Level of Acceptability for Use	• Group 2 – Except for aggregate gradation, percent fractured faces, ASTM C131, ASTM C88, ASTM D2419, and ASTM D4318, the state-specified material meets all FAA material requirements. The state-specified material may be used on airfields supporting aircraft with less than 60,000 lbs maximum takeoff weight. • Group 3 – The state-specified material may be used on FAA facilities if the requirements for aggregate gradation, percent fractured faces, ASTM C131, ASTM C88, ASTM D2419, and ASTM D4318 are met. Note – FAA Item P-209 does not specify the use of processed glass aggregate in aggregate base course.	

Item	CRUSHED AGGREGATE BASE COURSE Massachusetts DOT Aggregate Gradation Requirements
Additional Specifications	**Gradation requirements:**

Sieve	Percent Passing	
	FAA Item P-209	Massachusetts DOT Dense Graded
2 in.	100	100
1-1/2 in.	95 – 100	70 – 100
1 in.	70 – 95	--
3/4 in.	55 – 85	50 – 85
#4	30 – 60	30 – 55
#30	12 – 30	--
#50	--	8 – 24
#200	0 – 8[9]	3 – 10
#200 (frost areas)	0 – 5[9]	

[9] The fraction passing the #200 shall be ≤ 60% of that passing the #30.

Gradation plots comparing FAA to state agency gradation requirements:



<table>
<tr><th rowspan="2">Item</th><th colspan="2">RECYCLED CONCRETE AGGREGATE BASE COURSE</th></tr>
<tr><th>Massachusetts DOT</th><th>FAA</th></tr>
<tr><td>Agency Specification</td><td>Section 404, Reclaimed Pavement Borrow Material for Base</td><td>Item P-219, Recycled Concrete Aggregate Base Course</td></tr>
<tr><td>Description</td><td>This work shall consist of crushed asphalt pavement, crushed cement concrete, and gravel borrow pre-mixed and placed on subgrade or base.</td><td>Base course composed of recycled concrete aggregate, crushed to meet a particular gradation.</td></tr>
<tr><td>Test Methods Referenced</td><td>• AASHTO T 96</td><td>• ASTM C131
• ASTM D2419
• ASTM D4318</td></tr>
<tr><td>Materials</td><td>• Crushed asphalt pavement
• Crushed cement concrete
• Gravel borrow</td><td>• Recycled concrete aggregate
• Fine aggregate</td></tr>
<tr><td>Relevant Material Requirement(s)</td><td>Reclaimed pavement borrow material
• Reclaimed pavement borrow material shall consist of crushed asphalt pavement, crushed cement concrete, and gravel borrow, free from loam, clay, and deleterious materials such as brick, reinforcing steel, glass, wood, paper, plaster, lathing, building rubble, and so on.
• Quality requirements:
– Wear, max loss: 50%</td><td>Recycled concrete aggregate:
• Recycled concrete aggregate shall consist of ≥ 90% PCC (with virgin aggregate added if necessary), with the following making up the remaining:
<table><tr><th>Material</th><th>Max Content</th></tr><tr><td>Wood</td><td>0.1%</td></tr><tr><td>Brick, mica, schist, or other friable material</td><td>4%</td></tr><tr><td>Asphalt Concrete</td><td>10%</td></tr></table>• Quality requirements:
– Wear (ASTM C131), max loss: 45%
– Material passing the #40:
▪ Liquid Limit ≤ 25
▪ Plasticity Index ≤ 4

Fine aggregate:
• Fine aggregate shall be fines produced from the crushing operation.
• Sand equivalent value ≥ 35 (ASTM D2419)</td></tr>
<tr><td>Important Deviations</td><td colspan="2"></td></tr>
<tr><td>Level of Acceptability for Use</td><td colspan="2">• Group 3 – Except for material type, aggregate gradation and ASTM C131, the state-specified material meets FAA material requirements. The state-specified material may be used on FAA facilities if the ASTM aggregate gradation and ASTM C131 requirements are met.

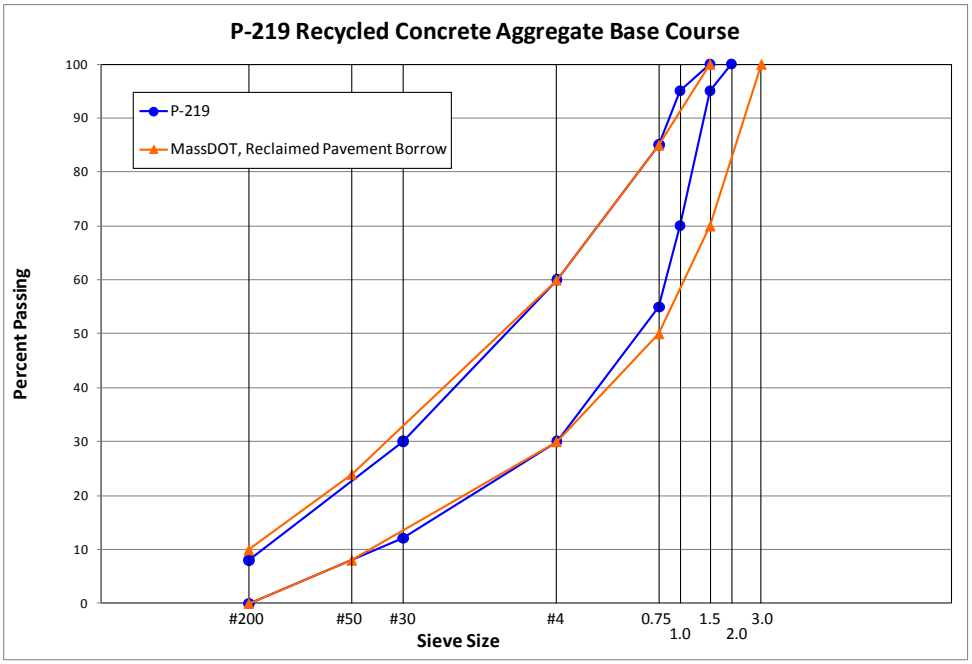
Note – FAA requires that ≥ 90% of aggregate shall consist of recycled PCC.</td></tr>
</table>

Item	RECYCLED CONCRETE AGGREGATE BASE COURSE FAA and Massachusetts Aggregate Gradation Requirements

Additional Specifications

Sieve	% Passing	
	FAA	Massachusetts DOT
3 in.	--	100
2 in.	100	--
1-1/2 in.	95 – 100	70 – 100
1 in.	70 – 95	--
3/4 in.	55 – 85	50 – 85
#4	30 – 60	30 – 60
#30	12 – 30	--
#50	--	8 – 24
#200	0 – 8	0 – 10

Gradation plots comparing FAA to state agency gradation requirements:



Item	PORTLAND CEMENT CONCRETE PAVEMENT	
	Massachusetts DOT	**FAA**
Agency Specification	Section 476, Cement Concrete Pavement	Item P-501, Portland Cement Concrete Pavement
Description	Section 476—This work shall consist of pavement composed of air-entrained portland cement concrete, plain or reinforced, constructed on an approved foundation.	Pavement course composed of portland cement concrete, with or without reinforcement.
Test Methods Referenced	• AASHTO M 85 or AASHTO M 240 • AASHTO T21 • AASHTO T71 • AASHTO T 96 • AASHTO T 104	• ASTM C33 • ASTM C131 • ASTM C150 or ASTM C595 or ASTM C1157 • ASTM C618
Materials	• Cement • Water • Fine aggregate • Coarse aggregate • Concrete admixtures • Fly ash • Concrete curing materials	• Fine and coarse aggregate • Cement, fly ash, natural pozzolan, or ground blast furnace slag • Water • Cover material for curing • Admixtures
Relevant Material Requirement(s)	**Coarse aggregate:** • Coarse aggregate for cement concrete shall be crushed rock or screened gravel. • Quality requirements: – Soundness (AASHTO T 104), max loss: 10% – Wear (AASHTO T 96), max loss: o Cement concrete base, 45% o Cement concrete pavement, 35% – Minus #200 material, max content: 1.0% • Deleterious content requirements, max content: – Clay lumps/friable particles, 2.0% – Chert[10], 3.0% – Total clay lumps/friable particles and chert, 3.0% – Coal/lignite, 0.5% – Flat, elongated particles (4:1), 15% [10] Chert having specific gravity (SSD) < 2.40. **Fine aggregate:** • Fine aggregate for cement concrete shall be washed natural sand. • Quality requirements: – Soundness (AASHTO T 104), max loss: 10% – Minus #200 material, max content: 3.0% – Fineness modules: 2.5 – 3.0 • Fine aggregate shall be free from organic impurities such that it does not produce a color darker than the standard (AASHTO T 21). – Fine aggregate failing this requirement may be approved provided the relative 28-day strength (AASHTO T 71) is ≥	**Coarse aggregate:** • Crushed or uncrushed gravel, crushed stone, air-cooled blast furnace slag, or crushed recycled PCC. • Coarse aggregate shall meet ASTM C33. • Quality requirements: – Wear (ASTM C131), max loss o Used as surface course, 40% o Used as base course, 50% **Fine aggregate:** • Fine aggregate shall meet ASTM C33. **Portland cement:** • Type I, II, III, or V meeting ASTM C150 • Type IS or IP meeting ASTM C595 • Type GU, HE, HS, MH, or LH meeting ASTM C1157

Item	PORTLAND CEMENT CONCRETE PAVEMENT	
	Massachusetts DOT	**FAA**
	95%. **Portland cement:** • Type I, IA, II, IA, III portland cement meeting AASHTO M 85. • Type IP, IP-A blended hydraulic cement meeting AASHTO M 240	
Important Deviations		
Contractor Notes		The contractor may choose to purchase individual aggregates based upon ASTM C33 or SHA gradations. However, it is advisable to specify the standard size or name, gradation, and sieve tolerances. Use of ASTM C33 or SHA materials does not negate meeting the aggregate quality requirements.
Level of Acceptability for Use	• Group 2 – Except for aggregate gradation, the state-specified 3/4 in. material meets all FAA material requirements. The state-specified material may be used on airfields supporting aircraft with less than 60,000 lbs maximum takeoff weight. • Group 3 – The state-specified 3/4 in. material may be used on FAA facilities if the requirements for aggregate gradation[11] are met. • Group 4 – The state-specified 1-1/2 in. and 3/8 in. materials are unable to meet FAA gradation requirements and therefore is not acceptable for use on FAA facilities. Note – All state materials must comply with FAA Engineering Brief 70 when pavement deicing chemicals are used.	

[11] It is stated under FAA Item P-501:

The Engineer shall specify the aggregate to be furnished from the table shown in this note. The appropriate gradation shall be inserted into Table 2. Insert points are denoted by asterisks. Where locally available aggregates cannot be economically blended to meet the grading requirements, the gradations may be modified by the Engineer to fit the characteristics of such locally available aggregates.

The engineer can choose to accept the local gradation, changing the category from a Group 3 to a Group 1. He/she would need to file a "modification to standard" request to the FAA to obtain material approval.

Item	PORTLAND CEMENT CONCRETE PAVEMENT FAA and Massachusetts Aggregate Gradation Requirements

Additional Specifications

Gradation requirements: Modified gradations fitting characteristics of local aggregates or producing concrete mixes with well-graded or optimized aggregate combinations may be permitted with FAA approval.

COARSE AGGREGATE

Sieve	% Passing						
	FAA				Massachusetts DOT		
	2 in. max[12]	1-1/2 in. max[12]	1 in. max	3/4 in. max	40 mm[13] (1-1/2 in.)	20 mm (3/4 in.)	10 mm (3/8 in.)
2-1/2 in.	100	--	--	--	--	--	--
2 in.	90 – 100	100	--	--	--	--	--
1-1/2 in.	35 – 70	90 – 100	100	--	90 – 100	--	--
1 in.	0 – 15	20 – 55	95 – 100	100	--	--	--
3/4 in.	--	0 – 15	--	90 – 100	35 – 60	90 – 100	--
1/2 in.	0 – 5	--	25 – 60	--	--	--	100
3/8 in.	--	0 – 5	--	20 – 55	10 – 25	20 – 50	85 - 100
#4	--	--	0 – 10	0 – 10	0 – 5	0 – 10	10 – 30
#8	--	--	0 – 5	0 – 5	--	0 – 5	0 – 10
#16	--	--	--	--	--	--	0 – 5

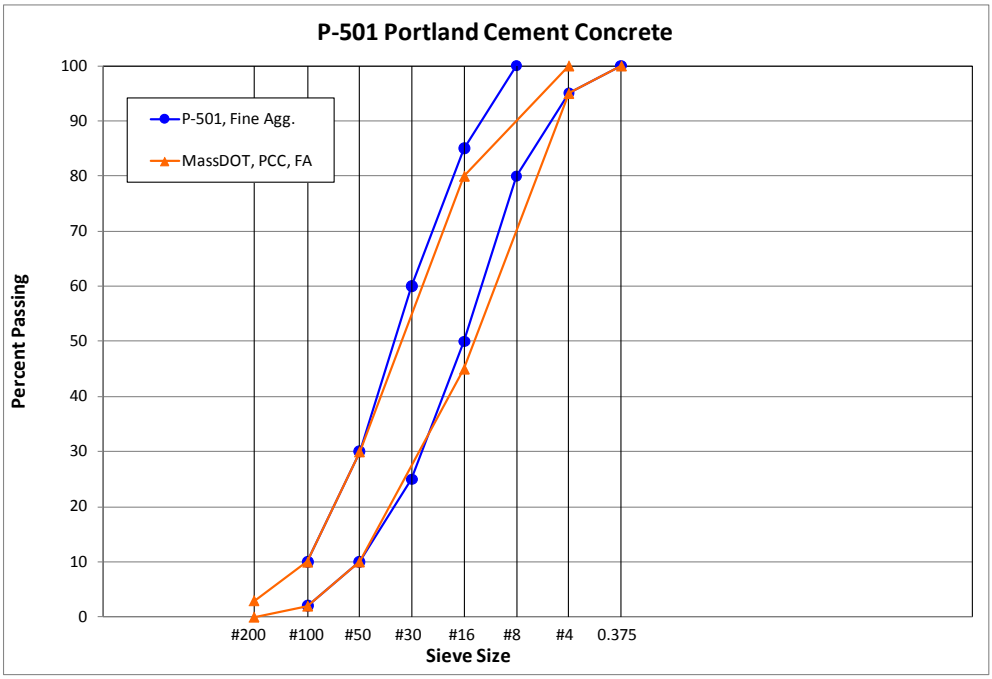
[12] Aggregate shall be furnished in two size groups when the nominal max size is greater than 1 in.

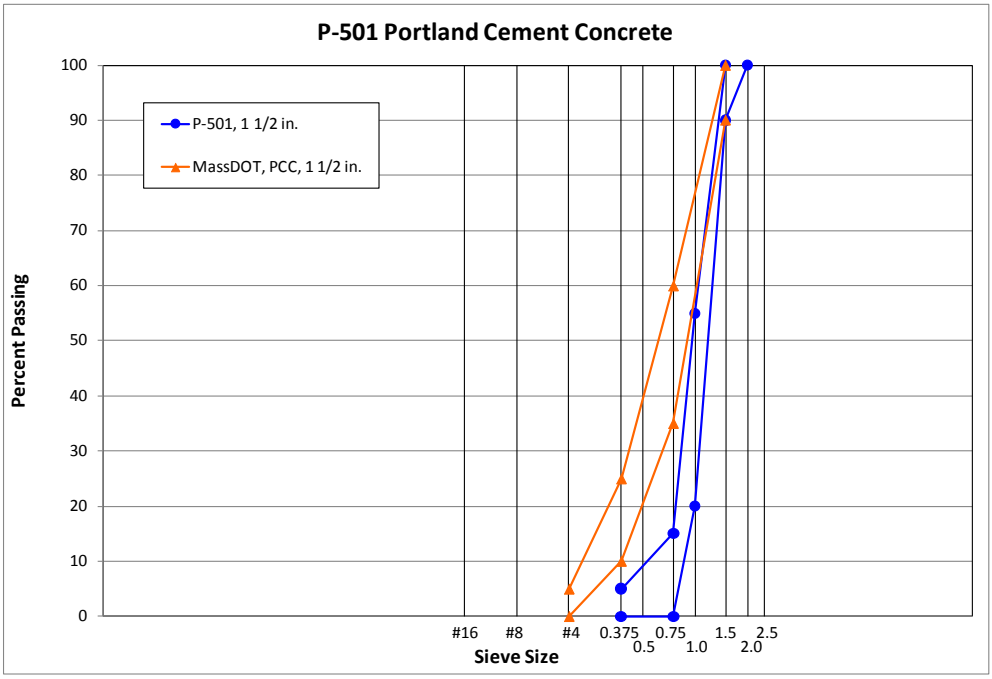
[13] Aggregate shall be proportioned in two or more sizes, separately weighed in the mix. The combined grading as proportioned in the mix shall meet the grading requirements for 40 mm coarse aggregate, as determined by actual test.

FINE AGGREGATE

Sieve	% Passing	
	FAA	Massachusetts DOT
3/8 in.	100	100
#4	95 – 100	95 – 100
#8	80 – 100	--
#16	50 – 85	45 – 80
#30	25 – 60	--
#50	10 – 30	10 – 30
#100	2 – 10	2 – 10
#200	--	0 – 3

Item	PORTLAND CEMENT CONCRETE PAVEMENT FAA and Massachusetts DOT Aggregate Gradation Requirements
Additional Specifications (Continued)	**Gradation plots comparing FAA to state agency gradation requirements:**





Item	PORTLAND CEMENT CONCRETE PAVEMENT FAA and Massachusetts DOT Aggregate Gradation Requirements
Additional Specifications (Continued)