Stabilized Base R&D

Presented to: REDAC Subcommittee for Airports

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Background

- **Stabilized base and subbase layers have been included in FAA Advisory Circulars since at least 1956.**
- **Currently required for pavements serving aircraft with gross weights exceeding 100,000 lbs.**
- **Performance benefits:**
  - Protection from water-related damage
  - Resistance to asphalt fatigue failure
  - Extend rigid pavement structural life
  - Greater overload tolerance
- **Research request August 2018 to update AC requirements.**

Research Objectives

- **Determine when a stabilized base should be required or recommended;**
- **Determine the minimum requirements for a material to be considered a stabilized base meeting the intention of the requirement;**
- **Quantify the specific performance benefits from stabilized base courses, and determine what other base materials can provide equivalent performance.**
- **Determine appropriate stabilized base thickness requirements for flexible and rigid pavements.**

Scope

Covers four general categories of materials:

1. Standard FAA stabilized base materials (P-403 HMA Base, P-304 CTB, P-306 Lean Concrete Base).
2. Aggregate bases meeting minimum strength or other FAA requirements (e.g. P-211 Lime Rock Base).
    1. Current AC allows substituting crushed aggregate **CBR 100** or greater.
    2. Establish minimum criterion based on modulus of elasticity.
3. Stabilized (bound) materials other than standard stabilized base courses (e.g., P-307 Cement-treated Permeable Base).
4. Recycled or variable materials that may be substituted for stabilized base with FAA approval (e.g., P-219 Recycled Concrete Aggregate Base Course).

Research Tasks

Milestone	Fiscal Year				
	2019	2020	2021	2022	2023
Literature Review	x				
Desktop Study		x	x		
Laboratory Study		x	x		
Full-Scale Test		x	x	x	
Final Technical Report				x	x

- **Literature Review – Completed December 2018**
- **Estimated Project Completion 2023**

Literature Review (Dec. 2019)

Contents:

- **History of FAA Stabilized Base and Subbase Requirements**
  - Evolution of Stabilized Bases and Subbases in FAA Criteria
  - Development of Layer Equivalency Factors
  - Mechanistic-Empirical Design
- **Stabilized Materials Eligible for FAA Grants**
  - AIP Award Criteria History
  - Specific Materials Eligible for Funding
- **Research on Stabilized Bases and Subbases for Airfields**
  - USACE, NAPTF, Other

John L Rice (former manager of FAA Airport Engineering Division):

"As near as I can recall, the requirement for stabilized bases came shortly after the Boeing 727 entered service. It was tearing the living bejeebers out of pavements and FAA tried to mitigate the damage by requiring stabilized bases. The FAA made a sort of left handed approach in requiring stabilized bases without specifically calling out the 727. The 727 was murder on pavements as it was heavy and had a dual wheel landing gear."

Stabilized Materials Eligible for AIP Funding

By Year and Advisory Circular

Item	Defined In	AC 150/5320-8 1964	AC 150/5320-6 1966	AC 150/5320-6A 1971	AC 150/5320-6B 1974	AC 150/5320-6C 1978	AC 150/5320-6D 1995	AC 150/5320-6E 2009	AC 150/5320-6F 2016
P-201, Bituminous Base Course	5370-1 to -10	Yes	Yes	Yes	Yes	Yes	ND	ND	ND
P-204, Mixed In-Place Base Course	5370-1 to -1A	Yes	Yes	No	No	ND	ND	ND	NE
P-208, Aggregate Base Course	5370-10 to -10H	ND	ND	ND	No	No	No	Subbase Only	Subbase Only
P-209, Crushed Aggregate Base Course	5370-1 to -10H	No	No	No	No	Subbase Only	Subbase Only	Subbase Only	Subbase Only
P-210, Caliche Base Course	5730-10 to -10H	ND	ND	ND	No	No	No	No	No
P-211, Lime Rock Base Course	5730-10 to -10H	ND	ND	ND	Yes*	Yes*	Yes*	Yes*	Subbase Only
P-212, Shell Base Course	5730-10 to -10H	ND	ND	ND	No	No	No	No	No
P-213, Sand-Clay Base Course	5730-10 to -10H	ND	ND	ND	No	No	No	No	No
P-214, Penetration Macadam Base Course	5370-1A to -10	ND	ND	Yes	Yes	No	No	No	No

*Exception for lime rock in State of Florida

Stabilized Materials Eligible for AIP Funding
By Year and Advisory Circular (continued)

Item	Defined In	AC 150/5320-8 1964	AC 150/5320-6 1966	AC 150/5320-6A 1971	AC 150/5320-6B 1974	AC 150/5320-6C 1978	AC 150/5320-6D 1995	AC 150/5320-6E 2009	AC 150/5320-6F 2016
P-215, Cold Laid Bit. Base Course	5370-1A to -10	ND	ND	Yes	Yes	Yes	No	No	No
P-216, Mixed In-Place Base Course	5370-1 to -10	No	No	No	No	Yes	No	No	No
P-219, Recycled Conc. Agg. Base Course	5370-10H	ND	ND	ND	ND	ND	ND	No	No
P-301, Soil Cement Base Course	5730-1 to -10F	Yes[1]	Yes[1]	Yes[1]	Yes[1]	Yes	Subbase Only	Subbase Only	Subbase Only
P-304, Cement Stab. Base Course	5370-1 to -10H	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
P-305, Agg-Lime-Fly Ash Base/SB Course	5370-10 Ch. 16	ND	ND	ND	Yes	No	ND	ND	ND
P-306, Econocrete Subbase Course	5370-10A to -10H	ND	ND	ND	ND	ND	Yes	Yes	Yes
P-307, Cement Treated Perm. Base	5370-10H	ND	ND	ND	ND	ND	ND	ND	ND
P-401, Bituminous Surface Course	5370-1 to -10H	No	No	No	No	Yes	Yes	Yes	Yes

R&D Plan

- **Desktop study.**
  - Goal is to propose suitable new (non-CBR) criteria for materials to be considered the performance equivalent of stabilized base (CBR 100).
  - Nonlinear phase – uses PANDA-AP analysis tool.
- **Laboratory study.**
  - Characterize various materials for the desktop analysis above.
  - Assess the value of particular tests for base performance prediction, and potential use as screening tests.

Proposed Full-Scale Test - NAPTF

- **Designed to give updated technical criteria for a material to be considered equivalent to stabilized base in standard FAA flexible pavement designs.**
- **NAPTF test items will have a subbase failure criterion, based on limiting cumulative permanent deformation (as predicted by the PANDA-AP model).**
- **Four test items with identical structure, except for the base material:**
  - **Control section** designed to meet AC 150/5320-6 requirements for heavy aircraft traffic, consisting of 4-in. P-401 asphalt surface, 5-in. P-403 HMA stabilized base, P-209 subgrade (thickness TBD).
  - **Alternate 1**, with P-403 base replaced by additional thickness of standard P-209.
  - **Alternate 2**, with P-403 base replaced by equal thickness of improved P-209 exceeding the current 100 CBR requirement.
  - **Alternate 3**, with P-403 base replaced by equal thickness of standard P-211 lime rock base.

Questions?

P-401/P-403 HMA Surface	T=4.0 inches	E=200000 psi
P-401/P-403 HMA Stabilized	T=5.0 inches	E=400000 psi
P-209 Crushed Aggregate	T=10.0 inches	E=75000 psi
Subgrade	CBR=10.0	E=15000 psi