Innovative Concepts for Concrete Pavements

Concrete Pavement Tour/Meeting

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AASHTO PP-84-17

Standard Practice for Developing Performance Engineered Concrete Pavement Mixtures

AASHTO Designation: PP 84-17₁
Tech Section: 3c, Hardened Concrete
Release: Group 1 (April 2017)

INTRODUCTION

Specifications for concrete pavement mixtures have traditionally been prescriptive, with State Highway Agencies (SHA) specifying means and methods for both constituent materials and specific requirements for proportioning. This places the majority of the performance risk on the SHA and limits innovation. Recent trends of blending cementitious materials, reducing paste content, using modern additives and admixtures, and other innovations in the industry open the opportunity to move towards specifying the performance characteristics of concrete mixtures and allowing industry to design mixtures that address specific performance requirements. New methods to evaluate concrete performance have been developed, and others are being formulated, that can result in improved performance and economics. Shifting the responsibility for performance to the contractor provides an opportunity for innovation.

SCOPE

1.1. **This specification covers the tests methods and values for a concrete pavement mixture that considers, and includes, alternative performance characteristics for acceptance.**

1.2. In Section 6 of this specification, SHA traditions of using prescriptive methods are respected while also **offering the option to use performance measures instead.**

1.3. **This specification is intended to provide SHAs flexibility in their approach to the use of performance characteristics** and includes a range of choices that can be selected to best fit the needs of the agency.

1.4. **Performance values included are for an average concrete pavement life in the range of 30 years.**

1.5. The values stated in SI units are to be regarded as the standard. The values given in parentheses are provided for information only.

1.6. **The inclusion of performance measures increases the importance of Quality Control (QC), as the acceptance criteria are predicated on a well-designed and executed QC program that includes process, production, and construction control.**

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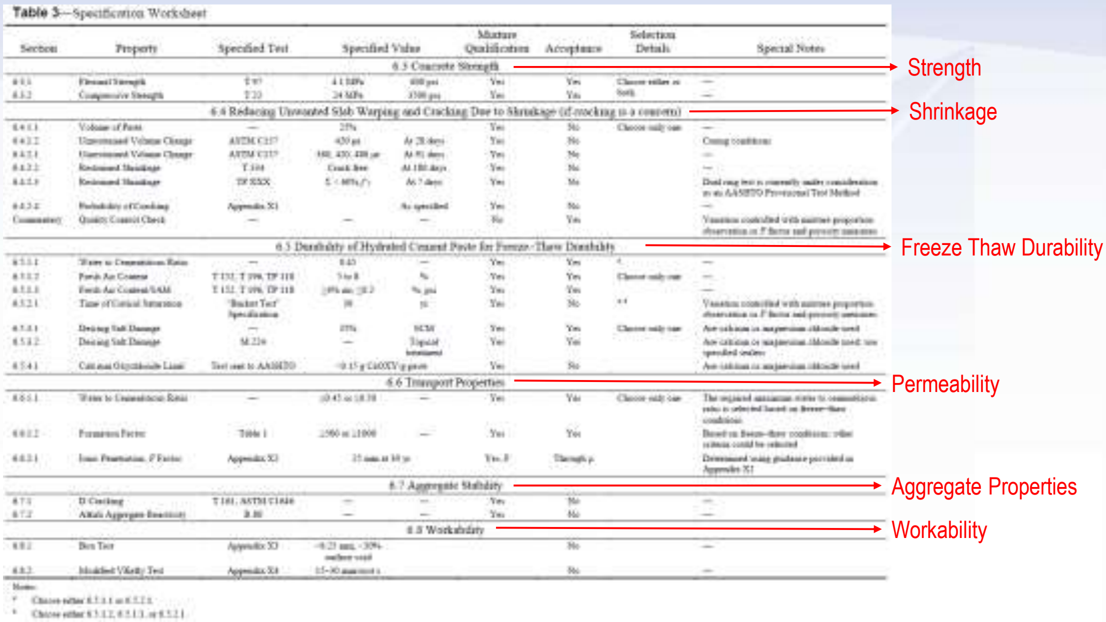

Long Life Concrete Pavement (LLCP)

LLCP Specification: Pub. 408, Section 530 approved by FHWA January 7, 2016.

PTM 529 Optimized Aggregate: Established December 2015.

Components of LLCP

- Aggregate Absorption 3% for Gravel, 2% all other (3.5 for Type A, 3.5 Type B)
- Cement factor 517 to 611 lbs./CY
- W/CM = 0.37 to 0.42
- Mix Design to meet Maximum Permeability (2000 Coulombs 56 days) & Shrinkage (500 macrostrains 28 days)
- Air content of 7%, ±1.5% in plastic state.
- Dowel Bars: Stainless Steel, bars, sleeves, filled, pipes capped. Zinc alloy sleeves.Glass Fiber Reinforced Polymer coated steel bars.
- Use of PAMS curing (Poly-Alpha Methyl-styrene)
- Incentives for: w/c Ratio.
- Use Guidelines to be developed in conjunction with spec.
  - Interstates
  - Interstate Look-a-likes
  - Projects over certain ADT
  - Projects greater than 20,000 SY.

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Super Air Meter (SAM)

The Super Air Meter (SAM) is a testing device that measures both the air void size and air volume of plastic (fresh) concrete in about 10 minutes.

The device can make almost real-time measurements of the size of the air bubbles as the concrete is being produced so that real-time changes can be made to control the size of the air bubbles.

Controlling the size of air bubbles is useful to ensure that concrete that is freeze thaw durable is being produced.

The device can also provide critical insights into how different additives or construction processes impact the size of the bubbles in the concrete mixture.

This can help reduce rejected concrete and ensure that freeze thaw durable concrete is being used.

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Permeability (Transport Properties)

Current – AASHTO T 277

Evaluating – AASHTO T 358 Surface Resistivity

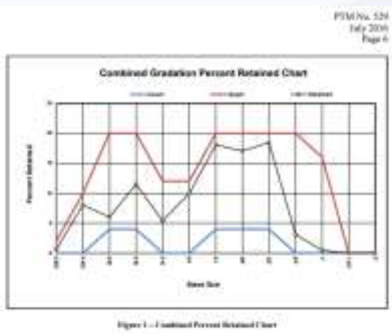
W / C Ratio below 0.45 for areas with deicer application

Future – Saturated Formation Factor.

Table 1—Saturated *F* Factor, RCPT and Resistivity

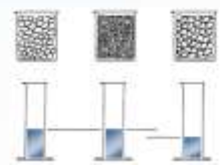
Chloride Ion Penetrability	Greatest Saturated Formation Factor[a]	Lowest Saturated Formation Factor[a]	Minimum Charge Passed @ 6 hours[b]	Maximum Charge Passed @ 6 hours[b]	Greatest Resistivity[c]	Lowest Resistivity[c]
	–	–	Coulombs	Coulombs	KΩ·cm	KΩ·cm
High	500	–	4000	–	5	–
Moderate	1000	500	2000	4000	10	5
Low	2000	1000	1000	2000	20	10
Very Low	20000	2000	100	1000	200	20
Negligible	–	20000	0	100	–	200

Optimized Aggregate Concrete Mixtures



- Reduced water demand
- Reduction of cementitious materials, if allowed
- Reduces paste content thus reduced shrinkage potential
- Strength Increase
- Longer service life

Combined grading is used to obtain the greatest aggregate density with the materials at hand



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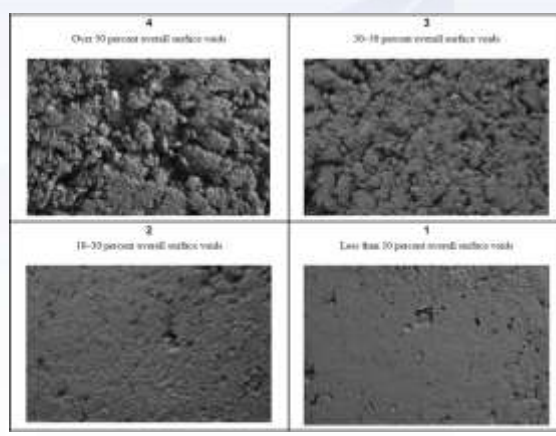
Workability (Box Test)

Not an acceptance test (Producer discretion)



Pictures courtesy of the Oklahoma Transportation Center

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Maturity Meter

Maturity Meter (ASTM C1074)

Widely used to monitor strength gain in concrete structures (buildings, bridges), paving applications include early opening to traffic, timing of joint sawing.

Publication 408 Sections that reference PTM 640 (maturity) for measuring strength to open a pavement for traffic are listed below.

These are all new/recently revised specifications.

- 501 (reinforced/plain concrete pavement)
- 530 (long-life concrete pavement)
- 540 (bonded concrete over asphalt)
- 548 (unbonded concrete over concrete)

Sections that do not reference PTM 640

- 516 (full-depth patching)
- 523 (ultra-thin concrete overlay)
- 525 (partial-depth repair)
- 545 (bonded concrete over concrete)

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Non-destructive Testing (NDT) for Concrete Thickness – PTM 605

Magnetic Imaging Tomography (MIT)


Commonwealth of Pennsylvania
Department of Transportation

MATERIALS AND TESTING DIVISION

Method of Test for

EVALUATING PORTLAND CEMENT CONCRETE PAVEMENT THICKNESS

1. SCOPE

2. EQUIPMENT

3. VERIFICATION OF EQUIPMENT

PTM 605 (Effective January 2016)

- An electromagnetic pulse induction device that creates a variant magnetic field
- Steel targets 11.8 inches in diameter (24 gauge) are nailed to the base
- Three readings at each target

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Tied Corner Repairs

Full-depth corner repairs.
(Bottom Half Repairs)

District 11
SR 51 & West Liberty Ave.
South entrance
Liberty Tunnels,
Pittsburgh, PA.

Type 3: Bottom-Half Repairs

Figure 5.5. Candidate distresses for bottom-half repairs (Frentress and Harrington 2012)

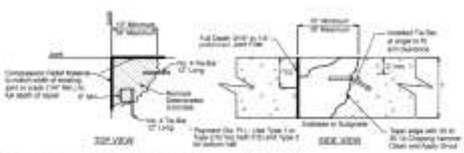
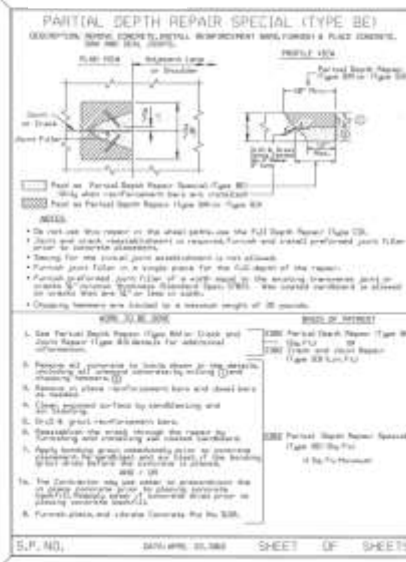


Figure 5.6. Typical details for Type 3 bottom-half repair (Frentress and Harrington 2012)

Minnesota DOT



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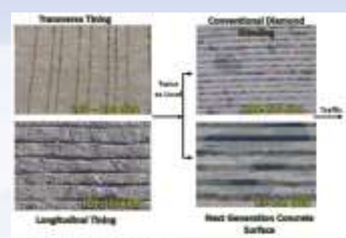
Next Generation Concrete Surface

(Grinding & Grooving)

NGCS is the quietest texture developed for non-porous concrete pavements.

Conventional diamond grinding equipment and blades are used but in a different configuration.

Predominantly a negative texture absent of upward positive elements.



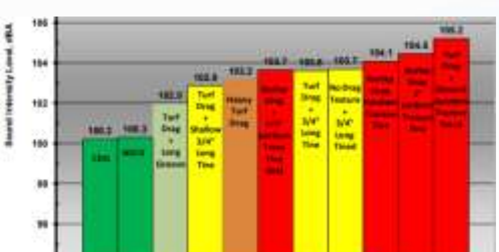


Figure 18 NCHRP 10-67 Textures Compared to NGCS Texture in 2010

Real-Time Smoothness

▪ Paver/Sensor Vibrations / Displacements

▪ GSI Machine

- ✓ Two commercially accepted manufacturers (2016):
  - Ames Real-Time Profiler (Laser),
  - Gomaco Smoothness Indicator (Ultrasonic sensors).
- ✓ Both systems use height, slope and distance data continuously fed to software during concrete placement.
- ✓ Having real-time information allows contractor to:
  - Immediately make process adjustments,
  - Make corrections during finishing.

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Thank You

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