

COMMITTEE ON MATERIALS AND PAVEMENTS

Meeting (Annual or Mid-Year)

Annual

Date

August 7th, 2017

Scheduled Time

1:30 – 3:30 PM

Technical Subcommittee & Name

3b – Fresh Concrete

Chair Name and (State)

Mick Syslo (NE)

Vice Chair Name and (State)

Wally Heyen (NE)

Research Liaison Name and (State)

I. Introduction and Housekeeping

II. Call to Order and Opening Remarks

A. Brief Summary of Activities

III. Roll Call of Voting Members

Present	Member Name	State	Present	Member Name	State
<input type="checkbox"/>	Syslo, Mick	Nebraska	<input type="checkbox"/>	Turgeon, Curt	Minnesota
<input type="checkbox"/>	Ingram, Steven	Alabama	<input type="checkbox"/>	Trautman, Brett Steven	Missouri
<input type="checkbox"/>	Sandoval-Gil, Jesus A	Arizona	<input type="checkbox"/>	Tedford, Darin P	Nevada
<input type="checkbox"/>	Lauzon, Robert G	Connecticut	<input type="checkbox"/>	Dusseault, Chuck R.	New Hampshire
<input type="checkbox"/>	Khan, Wasi U	District of Columbia	<input type="checkbox"/>	Streeter, Donald	New York
<input type="checkbox"/>	Armenteros, Jose L	Florida	<input type="checkbox"/>	Miller, Daniel Ian	Ohio
<input type="checkbox"/>	Wu, Peter	Georgia	<input type="checkbox"/>	Seward, Kenny R.	Oklahoma
<input type="checkbox"/>	Ikehara, Brian	Hawaii	<input type="checkbox"/>	Lane, Becca	Ontario
<input type="checkbox"/>	Santi, Mike J	Idaho	<input type="checkbox"/>	Feller, Joe J.	South Dakota
<input type="checkbox"/>	Krstulovich, James Martin	Illinois	<input type="checkbox"/>	Egan, Brian	Tennessee
<input type="checkbox"/>	Barezinsky, Richard A	Kansas	<input type="checkbox"/>	Lawrence, William J	Utah
<input type="checkbox"/>	Myers, Allen H	Kentucky	<input type="checkbox"/>	Andrus, Scott S	Utah
<input type="checkbox"/>	Stilwell, Joseph	Maine	<input type="checkbox"/>	Babish, Charles A.	Virginia
<input type="checkbox"/>	Barot, Sejal	Maryland	<input type="checkbox"/>	Williams, Kurt R	Washington
<input type="checkbox"/>	Staton, John F.	Michigan	<input type="checkbox"/>		

Quorum Rules Met?

Annual Meeting: Simple majority of voting members (☐y/ ☐n) | Mid-Year Meeting: Voting members present (☐y/ ☐n)

A. Review of Membership (*New members, exiting members, etc.*)

IV. Old Business


- A. Proposed New Provisional Standard - The Box Test in Slip Form Paving of Fresh Portland Cement Concrete – Tyler Ley
- B. Task Force Update
- C. Ballots

1. All ballots were addressed at the Mid-Year meeting.

V. New Business

A. WAQTC

- a. Editorial changes to AASHTO t 121 – Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
- b. Revision to AASHTO t 309 - Temperature of Freshly Mixed Portland Cement Concrete

8. PROCEDURE	
8.1. Place sensor of the thermometer in the freshly mixed concrete so that it has at least 75 mm (3 in.) of concrete cover in all directions around the sensor.	
8.2. Gently press the concrete in around the sensor of the thermometer at the surface of the concrete so that air cannot reach the sensor.	
8.3. Leave the sensor of the thermometer in the freshly mixed concrete for a minimum of 2 minutes or until the temperature reading stabilizes.	
8.4. Complete the temperature measurement of the freshly mixed concrete within 5 minutes of obtaining the sample.	
8.5.0. Concrete containing aggregate of a nominal maximum size greater than 75 mm (3 in.) may require up to 20 minutes for the transfer of heat from the aggregate to the mortar after batching.	
8.6.8.5. Read and record the temperature to the nearest 0.5°C (1°F).	 Desna Bergold Statement is confusing and has been interpreted in various ways. If it remains in place, further action should be clarified.

B. AASHTO m 302 - Slag Cement for Use in Concrete and Mortars

9. SAMPLING	
The following sampling and testing procedures shall be used by the purchaser to verify compliance with this specification (Note 4).	
<u>Note 4—The sampling procedure is not intended for the purpose of process control.</u>	
9.1.	
<u>9.1.</u>	Take random grab samples either from a delivery unit or at some point in the loading or unloading process so that no sample represents more than 115 Mg (125 tons) (Note 45). If samples are taken from rail cars or trucks, take at least two separate 2-kg (5-lb) portions and thoroughly mix them to obtain a test sample (Note 56). Sample by removing approximately a 300-mm (12-in.) layer of slag cement. Make a hole before obtaining a sample to avoid dust collector material that may be discharged into the delivery unit after the slag cement flow ceases. Sample at a rate of ten samples per month or one sample for each 2300 Mg (2500 tons) of shipments, whichever is more frequent.
9.2.	
Note 45	Standard statistical procedures are recommended for ensuring that samples are selected by a random procedure; see ASTM D3665. These procedures can be used to select the days within a month or within a week that samples will be taken. The delivery unit or time of day then should be chosen randomly.
Note 56	The quantity of sample specified is more than adequate for the testing required. A 2-kg (5-lb) portion should be retained in a sealed container for retesting if that is considered necessary to verify compliance.

- C. Update on the SAM (Super Air Meter) – Tyler Ley
- D. ASTM Update – Larry Sutter
- E. AASHTO re:source/CCRL/NTPEP

- F. Revisions/Work on Standards for Coming Year
- G. NCHRP Issues
- H. Proposed New Task Forces
- I. Reconfirmation Ballots
 - M 154 - Air-Entraining Admixtures for Concrete
 - R 060 - Sampling Freshly Mixed Concrete
 - T 157 - Test for Air-Entraining Admixtures for Concrete
 - T 325 - Estimating the Strength of Concrete in Transportation Construction by Maturity Tests
 - T 345 - Passing Ability of Self-Consolidating Concrete (SCC) by J-Ring

VI. Open Discussion

- A. Other

VII. Adjourn

TS Meeting Summary

Meeting Summary		
Items Approved by the TS for Ballot <i>(Include reconfirmations.)</i>		
Standard Designation	Summary of Changes Proposed	Ballot Type
		<input type="checkbox"/> TS <input type="checkbox"/> COMP <input type="checkbox"/> CONCURRENT
		<input type="checkbox"/> TS <input type="checkbox"/> COMP <input type="checkbox"/> CONCURRENT
		<input type="checkbox"/> TS <input type="checkbox"/> COMP <input type="checkbox"/> CONCURRENT
		<input type="checkbox"/> TS <input type="checkbox"/> COMP <input type="checkbox"/> CONCURRENT
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		<input type="checkbox"/> TS <input type="checkbox"/> COMP <input type="checkbox"/> CONCURRENT
New Task Forces Formed		
Task Force Name	Summary of Task	TF Member Names and (States)
Research Proposals <i>(Include number/title/states interested.)</i>		

Meeting Summary
Other Action Items

SUBCOMMITTEE ON MATERIALS

2018 Mid Year Meeting – Webinar

Tuesday, November 13th 2018

10:00 – 11:30 PM CST

TECHNICAL SECTION 3b

Fresh Concrete

I. Call to Order and Opening Remarks

- Casey updated the group on the recent change to the COMP Operations Guide. The change of note is that a TS vote (voice vote or ballot) is now only required to pass by simple majority rather than 2/3 majority.

II. Roll Call

Individual Name	Agency Name	Attendance
Syslo, Mick	Nebraska Department of Transportation	
Ingram, Steven	Alabama Department of Transportation	
Burch, Paul	Arizona Department of Transportation	X
Lauzon, Robert G	Connecticut Department of Transportation	
Khan, Wasi U	District of Columbia Department of Transportation	
DeFord, Harvey Dale	Florida Department of Transportation	X
Wu, Peter	Georgia Department of Transportation	
Ikehara, Brian	Hawaii Department of Transportation	
Santi, Mike J	Idaho Transportation Department	
Tobias, Daniel H	Illinois Department of Transportation	
Barezinsky, Richard A	Kansas Department of Transportation	x
Myers, Allen H	Kentucky Transportation Cabinet	
Barot, Sejal	Maryland Department of Transportation	
Staton, John F.	Michigan Department of Transportation	X
Turgeon, Curt	Minnesota Department of Transportation	
Trautman, Brett Steven	Missouri Department of Transportation	
Tedford, Darin P	Nevada Department of Transportation	
Boisvert, Denis M.	New Hampshire Department of Transportation	
Streeter, Donald	New York State Department of Transportation	X
Miller, Daniel Ian	Ohio Department of Transportation	X
Seward, Kenny R.	Oklahoma Department of Transportation	X
Lane, Becca	Ontario Ministry Of Transportation	
Feller, Joe J.	South Dakota Department of Transportation	
Lane, Danny L.	Tennessee Department of Transportation (Egan)	X
Andrus, Scott S	Utah Department of Transportation	X
Babish, Charles A.	Virginia Department of Transportation	
Williams, Kurt R	Washington State Department of Transportation	

Attendance list from gotowebinar is below:

Attended	Last Name	First Name	Email Address	
Yes	Barezinsky	Rick	rick.barezinsky@ks.gov	KS
Yes	Burch	Paul	pburch@azdot.gov	AZ
Yes	Wilson	Craig		AZ
Yes	DeFord	Harvey	harvey.deford@dot.state.fl.us	FL
Yes	Egan	Brian	Brian.Egan@tn.gov	TN

Yes	Glass	Wesley	wesley.glass@ky.gov	KY
Yes	Heyen	Wally	wally.heyen@nebraska.gov	NE (vc)
Yes	Lawrence	Bill	BillLawrence@utah.gov	UT
Yes	Ley	Tyler	tyler.ley@okstate.edu	
Yes	Melander	John	john.melander@slagcement.org	
Yes	Miller	Dan	daniel.miller@dot.ohio.gov	OH
Yes	Parker	Sean	Sean.P.Parker@odot.state.or.us	OR
Yes	Prowell	Jan	jprowell@astm.org	
Yes	Seward	Kenny	kseward@odot.org	OK
Yes	Staton	John	statonj@michigan.gov	MI
Yes	Streeter	Don	donald.streeter@dot.ny.gov	NY
Yes	Sutter	Larry	lsutter@mtu.edu	
Yes	Syslo	Mick	mick.syslo@nebraska.gov	NE (c)
Yes	Tedford	Darin	dtedford@dot.nv.gov	NV
Yes	Tennis	Paul	ptennis@cement.org	
Yes	Trautman	Brett	Brett.Trautman@modot.mo.gov	MO

III. Approval of Technical Section Minutes

Reviewed TS meeting minutes from the summer meeting. Motion to approve by OH and second by MO. 2018 Annual meeting minutes are approved.

IV. Old Business

A. Review of Ballots

- M 295 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete – [Moving forward](#). Discussion to address negative: Finding that negative was non-persuasive. They just wanted additional language for other items in order to continue improving the standards. The negative did not have a problem with the current language but wanted additional language. This will move forward.
 - Affirmative 35, Negative 1, No Vote 15

Mississippi Department of Transportation	MDOT does not feel that this standard adequately covers sulfate conditions. We feel that ASR may be covered adequately but that this standard should also cover sulfate conditions to some level.
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- M 302 - Standard Specification for Slag Cement for Use in Concrete and Mortars
 - Affirmative 36, Negative 0, No Vote 15
 - [Moving forward](#)
- R 39 - Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
 - Affirmative 36, Negative 0, No Vote 15
 - [Moving forward](#)

- T 121 – Standard Method of Test for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
 - Affirmative 36, Negative 0, No Vote 15
 - [Moving forward](#)
- T 152 – Standard Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method
 - Affirmative 36, Negative 0, No Vote 15
 - [Moving forward](#)

B. Results of Reconfirmed Ballots

- M 205M/M 205 - Standard Specification for Molds for Forming Concrete Test Cylinders Vertically
 - Affirmative 26, Negative 0, No Vote 1
 - [Moving forward](#)
- M 295 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
 - Affirmative 25, Negative 1, No Vote
 - [Moving forward](#)

Nebraska Department of Transportation (Mick S Syslo) (mick.syslo@nebraska.gov)	a revised version will be coming to a full concurrent ballot shortly.
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[Negative addressed: This is an administrative stop to give it time to harmonize with ASTM. This is being accepted under the full ballot. Mr. Sutter discussed further \(below\).](#)

- T 158 - Standard Method of Test for Bleeding of Concrete
 - Affirmative 26, Negative 0, No Vote 1
- T 196M/T 196 - Standard Method of Test for Air Content of Freshly Mixed Concrete by the Volumetric Method
 - Affirmative 26, Negative 0, No Vote 1
- T 197M/T 197 - Standard Method of Test for Time of Setting of Concrete Mixtures by Penetration Resistance
 - Affirmative 26, Negative 0, No Vote 1
- T 309 - Standard Method of Test for Temperature of Freshly Mixed Portland Cement Concrete
 - Affirmative 26, Negative 0, No Vote 1
- T 318 - Standard Method of Test for Water Content of Freshly Mixed Concrete Using Microwave Oven Drying
 - Affirmative 26, Negative 0, No Vote 1

[All of the above items balloted for reconfirmation passed and will move forward.](#)

C. Update of ASTM – Larry Sutter

[Invited to update the group on M 295 to harmonize with ASTM. The ASTM meeting is coming up the first week in December.](#)

- [They will remove the administrative negative on this on ASTM C 618. C 618 will be published with the change using Calcium Oxide as the ash specification.](#)
- [There's an existing ballot item adjusting the reporting requirements for water demand. There are a number of negatives that will be discussed at the meeting.](#)
- [The committee generally would like to move away from stating limits within a standard then listing exceptions to those limits. Discussed adding Class B which would be bottom ash materials. Class B would be similar to Class C. This would change the scope of the standard which may open up the standard to additional changes.](#)

[C 1697 Blended SCM specification has a good amount of discussion that needs to happen. They would like to add a second path where materials that do not meet the Standard may be blended to meet the Standards of C 618.](#)

V. New Business

A. Box Test – Tyler Ley

Box test is a lab test to help evaluate if the mixture can be correctly placed with a paver. This is a test to determine workability of concrete. Presentation attached. NY motion to move to TS ballot. DeFord from FL to move forward as a TS ballot in the next few weeks. Proposed Box Test Standard is attached.

VI. Open Discussion

A. There were no additional topics brought up for consideration

VII. Adjourn

Overview of the Box Test

Why is this test helpful?

A lab test is needed to help evaluate if a mixture can be correctly placed with a paver.

Concrete mixtures need to be workable enough to be placed by the paver but not too workable.

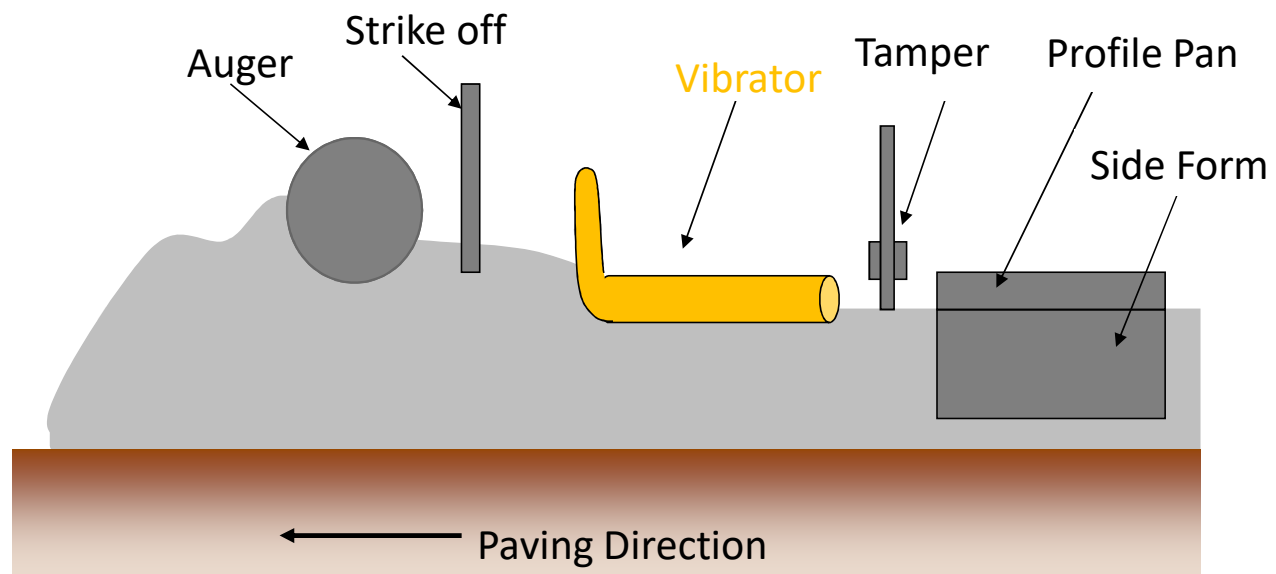
The slump can not tell us this...





Slip Formed Paver

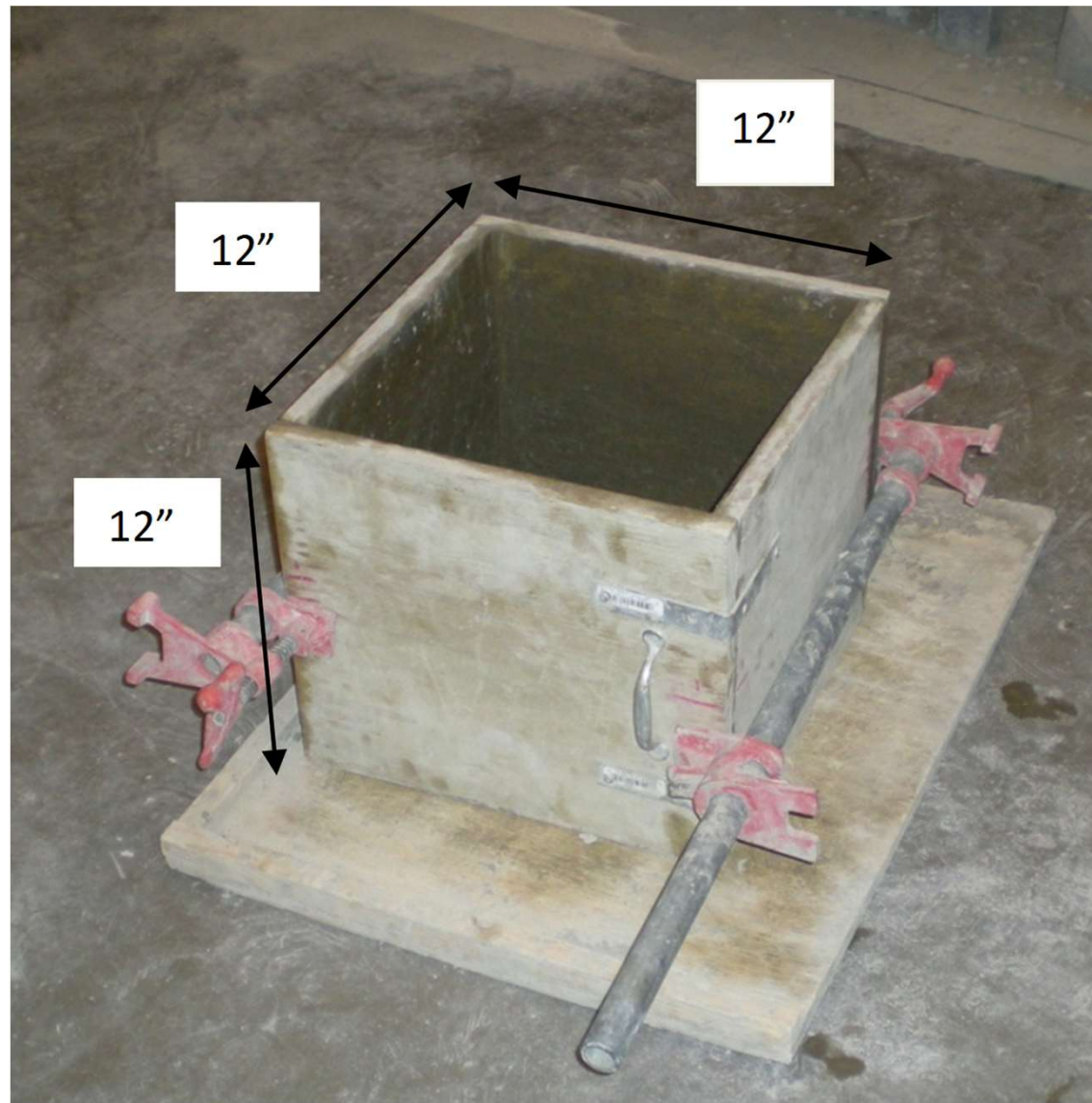
What part of a paver is the most critical for concrete consolidation?



We want a test that is simple and can examine:

- Response to vibration
- Filling ability of the grout (avoid internal voids)
- Ability of the slip formed concrete to hold a sharp edge (cohesiveness)

The slump test can not tell us this!



Box Test

Add 9.5" of unconsolidated concrete to the box

A 1" diameter stinger vibrator is inserted into the center of the box over a three count and then removed over a three count

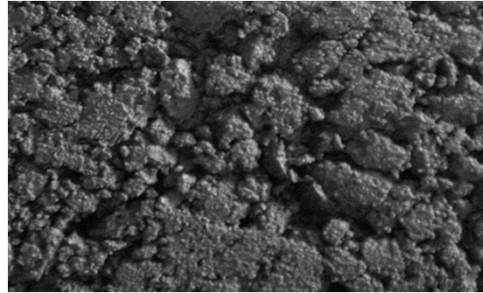
The edges of the box are then removed and inspected for honey combing or edge slumping





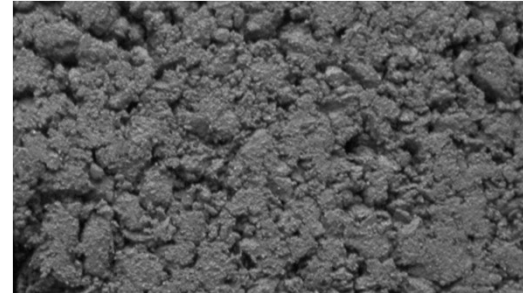


Box Test Ranking Scale



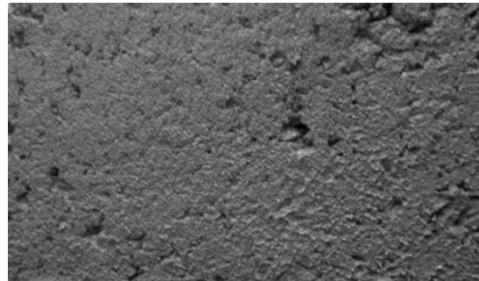
4

Over 50% overall surface voids.



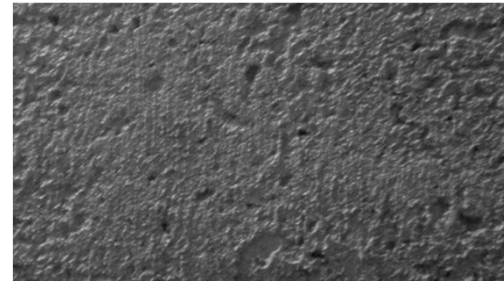
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30-50% overall surface voids.



2

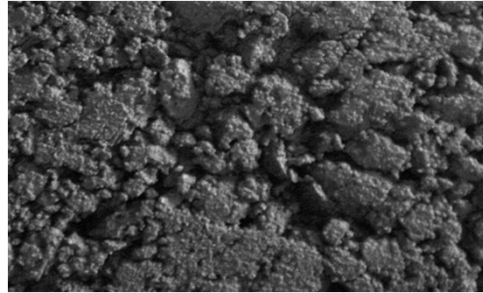
10-30% overall surface voids.



1

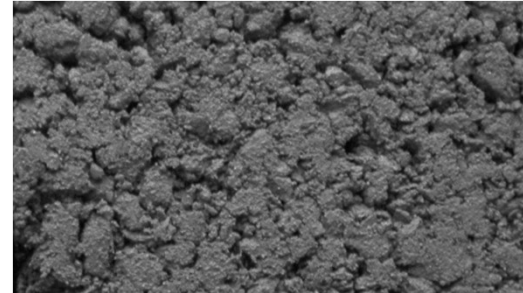
Less than 10% overall surface voids.

Box Test Ranking Scale



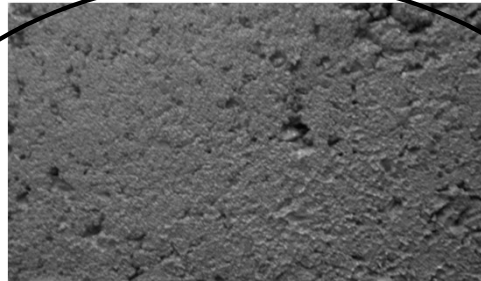
4

Over 50% overall surface voids.



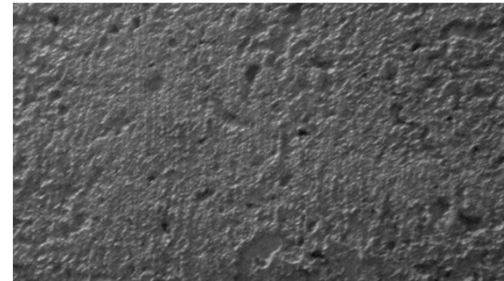
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30-50% overall surface voids.



2

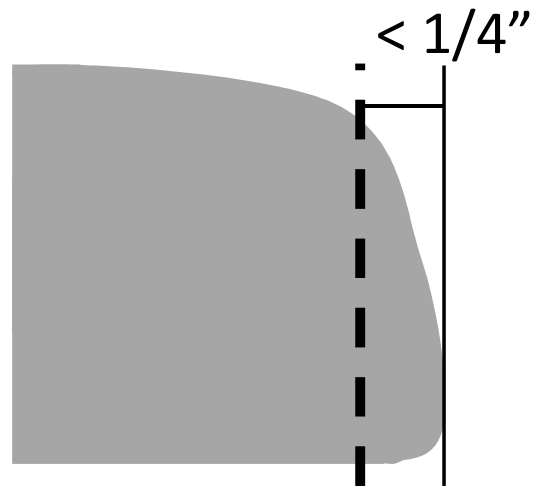
10-30% overall surface voids.



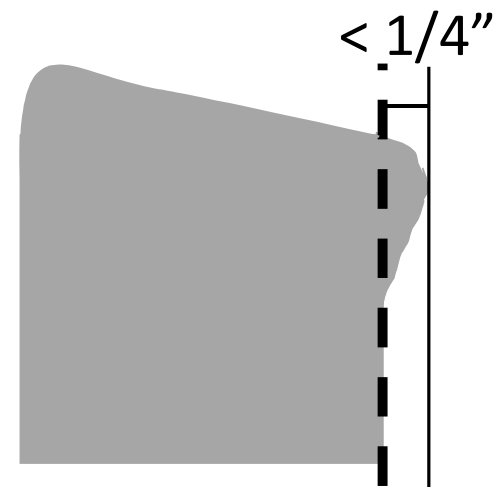
1

Less than 10% overall surface voids.

Edge Slumping



Bottom Edge Slumping



Top Edge Slumping

No Edge Slump



Edge Slump



Summary

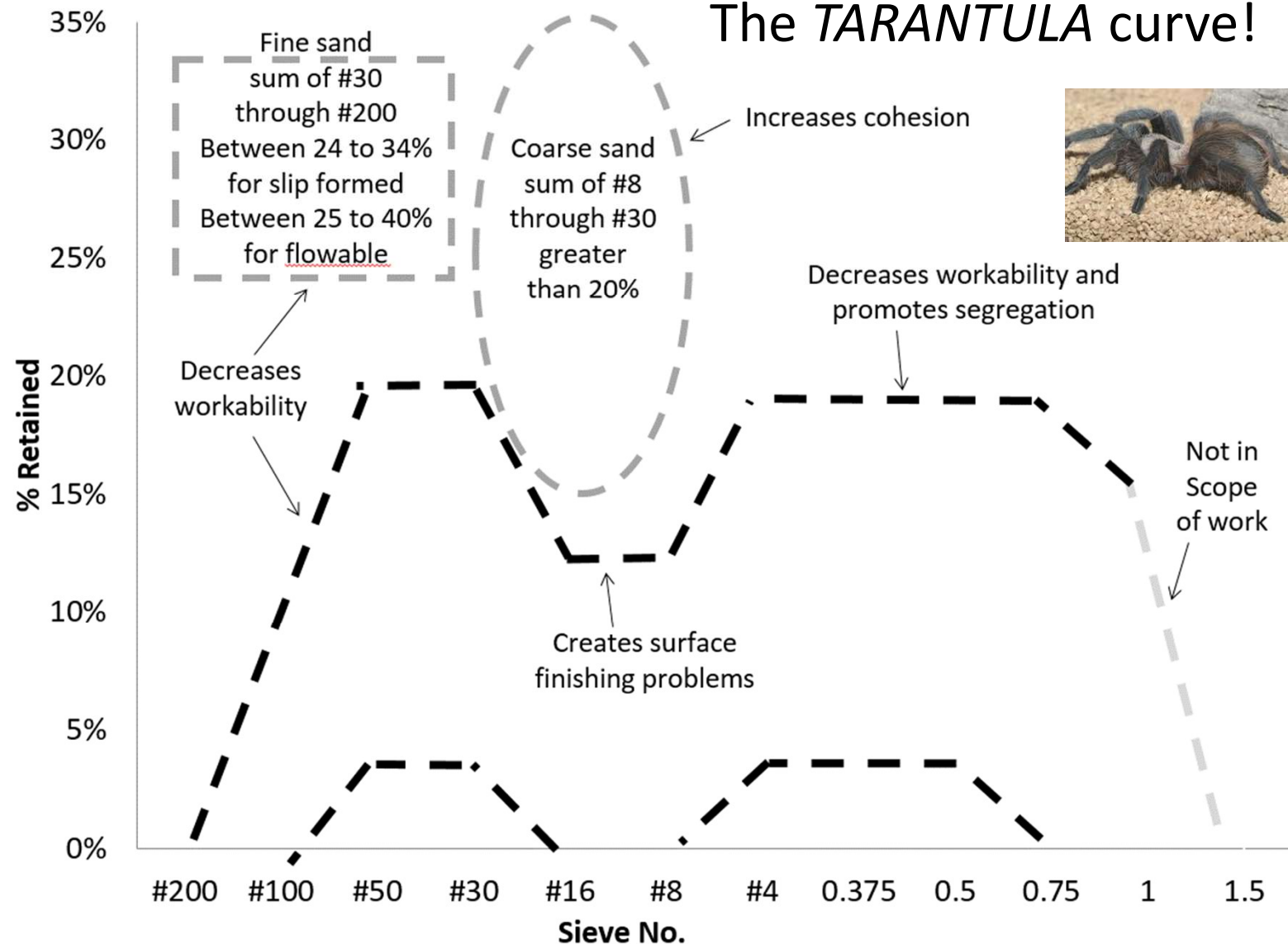
The Box Test examines the window of workability for concrete pavement mixtures

This is helpful when:

- mixtures are designed in the lab
- trial batching in the field
- troubleshooting field problems
- measuring variation in production

It is like having a miniature paver!!!

The *TARANTULA* curve!



www.youtube.com/tylerley

**Tarantula
curve
Intro**

Tyler Ley, PE, PhD



What vibrators can I use?

12,500 vpm frequency

All meet the specification:

- Wyco 992,
- Wyco Sure Speed (@12,500 vpm),
- Wacker M1500,
- Northrock Pro 1.5,
- MultiQ Cv2A

Standard Method of Test for

**The Box Test in Slip Form Paving
of Fresh Portland Cement Concrete**

AASHTO Designation: TP xxx-yy¹

Release: Group 1 (Month yyyy)



American Association of State Highway and Transportation Officials
444 North Capitol Street N.W., Suite 249
Washington, D.C. 20001

Standard Method of Test for

The Box Test in Slip Form Paving of Fresh Portland Cement Concrete

AASHTO Designation: TP xxx-yy

Release: Group 1 (Month yyyy)



1. SCOPE

- 1.1. This test method describes the workability measurement of hydraulic-cement concrete in a slip formed paving applications, both in the laboratory and in the field.
- 1.2. *Unit* – the values stated in either SI units or inch-pound units are to be regarded separately as the standard. Within the text, the inch-pound units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.
- 1.3. *The standard does not purport to address all the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.*
- 1.4. The text of this standard references notes and footnotes which provide explanatory information. These notes and footnotes shall not be considered as requirements of this standard.

2. REFERENCED DOCUMENTS

- 2.1. Cook, M., Ley, M. and Ghaeezadah, A. (2014). A workability test for slip formed concrete pavements. *Construction and Building Materials*, 68, pp.376-383.
- 2.2. Alturki, R. (2016). “Quantitative Evaluation in The Box Test and Evaluation of Field Mixtures by The Tarantula Curve,” thesis, presented to Oklahoma State University at Stillwater, OK, in partial fulfilment of the requirements for the degree of Master of Science.
- 2.3. AASHTO Standard:
 - T119, Slump of Hydraulic Cement Concrete
 - R60, Practice for Sampling Freshly Mixed Concrete
- 2.4. ASTM Standard:
 - C143, Slump of Hydraulic Cement Concrete
 - C172, Practice for Sampling Freshly Mixed Concrete

3. SUMMARY OF TEST METHOD

- 3.1. This test method composes a two part measurement to assess the dynamic behavior (ability to flow) of plastic concrete through vibration and the static behavior (ability to hold an edge) of plastic concrete mixtures through removal of forms.
- 3.2. First, a sample of unconsolidated concrete is filled into a standard box.
- 3.3. Second, a vibrator is used to consolidate the concrete using the standard procedure.
- 3.4. Third, the forms are removed and the amount of voids are determined. This parameter indicates the responsiveness of a mixture to vibration.
- 3.5. Last, a straight edge is used to measure top and bottom edge slumping. This parameter indicates the potential of a mixture to edge slump.

4. SIGNIFICANCE AND USE

- 4.1. This test method provides a simplistic and economic approach to determine the workability of slip formed paving applications. This test method measures the response of a pavement mixture to vibration and the ability of the concrete to hold an edge.
- 4.2. This test method is not considered applicable to mixtures with a slump greater than 3 in. (75 mm) as measured with T119.

5. APPARATUS

- 5.1. The Box Test apparatus is composed of a platform, Box Test Forms, form holders, a vibrator, and a straight edge as shown in Figure 1.
- 5.2. Box Test forms—for enclosing a 1 ft³ (0.028 m³) as shown in Figure 2, shall be made of a 0.5 in (12.5 mm) plywood with an inside measurement for length, width, and height of 12 in (300 mm) when connected together for a box shape with an open top and bottom. Two form clamps were installed in two of the four corners of the forms to create L-shaped forms as shown in Figure 2.
- 5.3. Form clamps— two pipe clamps with a minimum span of 14 in (460 mm) are used to hold L-shaped forms together as shown in Figure 2. These clamps must be strong enough keep the forms together throughout the testing process.
- 5.4. Platform— for performing the Box Test on it, shall be made of a 0.5 in (12.5 mm) plywood with a minimum length and width of 18 in (380 mm).

Vibrator— a portable electrical vibrator with a 1 in. square head and a vibration frequency of 12500 vibration per minute (vpm) shall be used in accordance with the procedure of this method. Varying from these vibrator criteria will most likely yield dissimilar results. **Note 1**—Some examples of electric vibrator motors meeting this include: Wyco 992, Wyco Sure Speed (@12,500 vpm), Wacker M1500, Northrock Pro 1.5, MultiQ Cv2A
- 5.5. Straight-edge— a 12 in (305 mm) metal tool commonly used in carpentry to measure the vertical alignment of the fresh concrete sample.

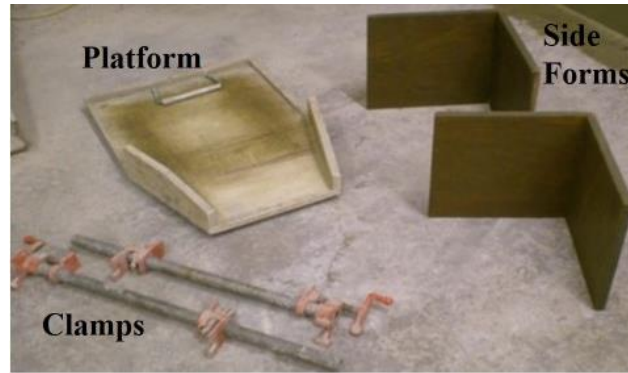


FIG. 1 Each Component of the Box Test

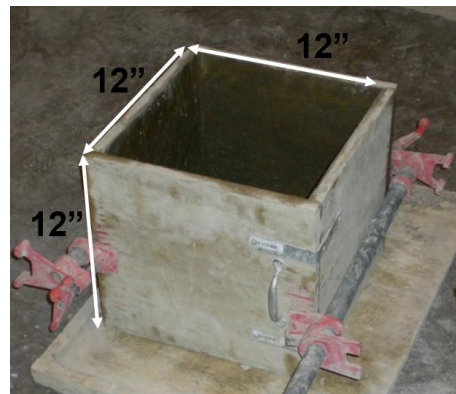


FIG. 2 The Box Test Assembled with dimensions of 12 in (305 mm).

6. SAMPLING, TEST SPECIMENS, AND TEST UNITS

- 6.1. Sample concrete in accordance with R 60.

7. PROCEDURE

- 7.1. This process can be described as four steps as shown in Figure 3
- 7.2. Dampen the forms with form oil and construct Box Test components on a flat and level surface.
- 7.3. Using a hand scoop place fresh, unconsolidated concrete in the constructed box forms to a depth of 9.5 in (241 mm).
- 7.4. Keeping the head of the vibrator perpendicular to the platform, insert the vibrator head with 12,500 vibrations per minute at the top center of the sample and vertically lower it in a continuous downward direction for three seconds to reach the bottom of the concrete sample. Attention should be taken to ensure vibrator does not touch the platform.
- 7.5. Next, move the vibrator in a vertically upward direction to the top of the concrete sample for three seconds while keeping the head of the vibrator perpendicular to the platform.

- 7.6. Loosen and detach the form clamps. Then remove the Box Test forms in an ascending vertical direction. Care must be taken to ensure the concrete will not stick to the forms.
- 7.7. Estimating voids— Rank each side of four sides based on the amount of voids as shown in Figure 4. This should be used in comparing the amount of voids on each of the four concrete faces. An average of the four sides should be calculated as described in section 8 and used as the overall ranking.
- 7.8. Edge slump— Then vertically align a straight edge onto a corner of the sample and measure the largest extruding length to the nearest 0.25" (6 mm) as shown in Figure 5. This shall be conducted for all four sides of the sample and each value shall be reported.





	
<p>Step 1</p> <p>Assemble the components. Hand scoop mixture into box until the concrete level is 9 in. (240 mm).</p>	<p>Step 2</p> <p>From the top surface of the concrete, vibrate straight downward for 3 seconds.</p>
	
<p>Step 3</p> <p>Now, vibrate straight upward for 3 seconds. Then remove vibrator.</p>	<p>Step 4</p> <p>After removing the clamps and forms, inspect the sides for surface voids and edge slumping.</p>

FIG. 3 The Box Test Steps

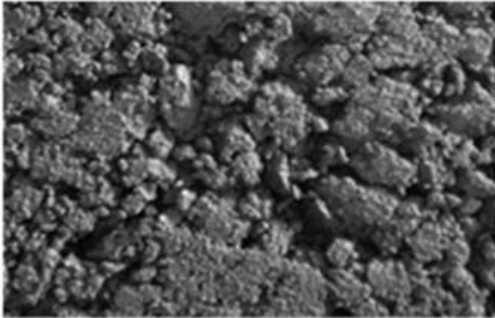
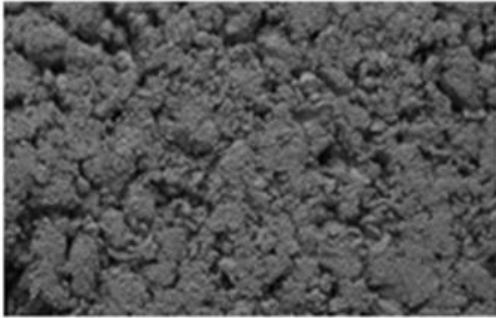
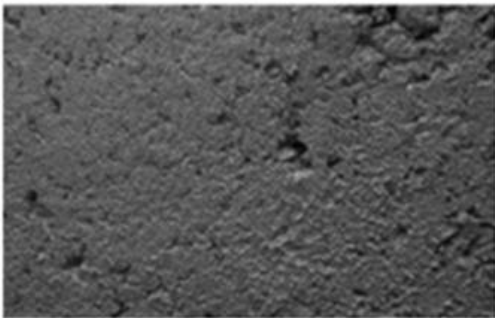
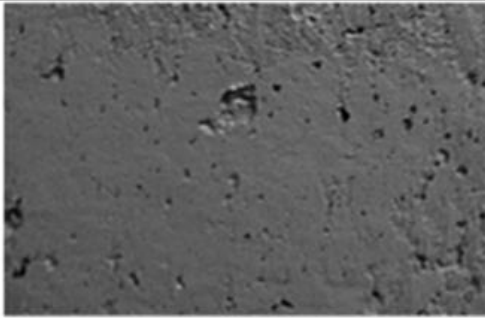
	
4	3
Over 50% overall surface voids.	30-50% overall surface voids.
	
2	1
10-30% overall surface voids.	Less than 10% overall surface voids.

FIG. 4 The Box Test Ranking Scale

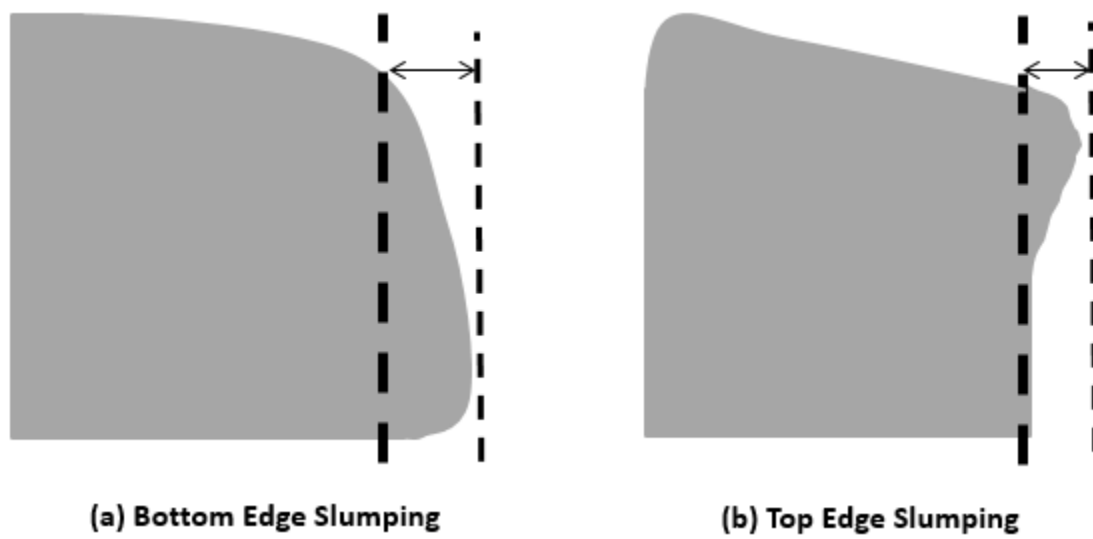


FIG. 5 Edge Slump Measurement illustrated for (a) Bottom Edge Slumping and (b) Top Edge slumping.

8. CALCULATION AND REPORT

- 8.1. Estimating voids– After ranking the each side of four sides based in Figure 4, calculate the average and standard deviation of these numbers. A ranking of two or less than 30% void count has been deemed sufficient consolidation for slip form paving applications where the specified consolidation energy is used.
- 8.2. Edge slump– After measuring all four sides with a straight edge. An edge slump of 0.25” (6 mm) or less has been deemed sufficient edge slumping to not require edge forms for slip form paving applications.

9. PRECISION AND BIAS

- 9.1. Precision – The visual rating of voids were evaluated for single and multiple operator repeatability.
- 9.2. Single-Operator Precision- Ten different mixtures were blindly replicated three times and evaluated each of the three times by a single operator. The standard deviation of the estimated void count was 1.3% and the coefficient of variation was 14.7. [2.2].
- 9.3. Multiple-Operator Precision – The different mixtures were blindly replicated three times and evaluated each of the three times by three different operators. The standard deviation of the estimated void count was 2.8% and the coefficient of variation was 21.0. [2.2].
- 9.4. The Box Test shall be conducted within 45 minutes after discharging.

10. KEYWORDS

- 10.1. Box Test; Workability test, slipform paving concrete; vibration