SUBCOMMITTEE ON MATERIALS

101st Annual Meeting – Pittsburgh, Pennsylvania
Tuesday, August 4, 2015
10:15 am – 12:00 pm CST

TECHNICAL SECTION 1b
Subsurface Investigation, Soil Instrumentation, Soil Stabilization, and Field Testing of Soils

Meeting Minutes

I. Call to Order and Opening Remarks

James welcomed everyone to the meeting at 10:20amEST. During his opening remarks the chairman reminded industry about the opportunity to become Friends of Tech Section. It was noted that we the Tech Section has excellent participation on Tech Section ballots. All were encouraged to keep up the good work. Registration on the I-pad.

II. Roll Call

Introductions were made around the room. Darin Tedford is our research liaison.

Name	Affiliation	Designation	Type	Present
Williams, III, James A.	Mississippi Department of Transportation	Chair	Voting	X
Blackburn, Lyndi D	Alabama Department of Transportation	Vice Chair	Voting	X
Johnson, Brian	AMRL	Liaison	Non-Voting	X
Lacinak, Henry	AASHTO	Liaison	Non-Voting	
Rothblatt, Evan	AASHTO	Liaison	Non-Voting	X
Knake, Maria	AMRL	Member	Non-Voting	X
Breth, Christopher	AMRL	Member	Non-Voting	
Uherek, Greg	AMRL	Member	Non-Voting	X
Lenker, Steven E.	AMRL	Member	Non-Voting	X
Davis, Kaye C	Alabama Department of Transportation	Member	Non-Voting	
Stolarski, Phil J	California Department of Transportation	Member	Voting	X
Fontaine, Leo Louis	Connecticut Department of Transportation	Member	Voting	
Aschenbrener, Tim	Federal Highway Administration	Member	Non-Voting	
Lopez, Aramis	Federal Highway Administration	Member	Non-Voting	
Rivers, Benjamin	Federal Highway Administration	Member	Voting	
Voth, Michael D	Federal Highway Administration	Member	Non-Voting	
Springer, Jack	Federal Highway Administration	Member	Non-Voting	X
Horhota, David J	Florida Department of Transportation	Member	Voting	
Hasty, Charles Allen	Georgia Department of Transportation	Member	Voting	X
Newman, Garth H	Idaho Transportation Department	Member	Voting	X
Frempong, Eric M	Maryland Department of Transportation	Member	Non-Voting	
Smith, Timothy E.	Maryland Department of Transportation	Member	Voting	
Tedford, Darin P	Nevada Department of Transportation	Member	Voting	X
Dusseault, Charles R.	New Hampshire Department of Transportation	Member	Voting	
Boisvert, Denis M.	New Hampshire Department of Transportation	Member	Voting	
Burnett, Robert A.	New York State Department of Transportation	Member	Voting	X
Seiter, Scott	Oklahoma Department of Transportation	Member	Voting	X
Franco, Colin A	Rhode Island Department of Transportation	Member	Voting	
Zwanka, Merrrill E	South Carolina Department of Transportation	Member	Voting	X
Smith, Travis Wallace	Tennessee Department of Transportation	Member	Voting	
Heinen, Caroline	Texas Department of Transportation	Member	Voting	

Babish, Charles A.	Virginia Department of Transportation	Member	Voting	X
Lane, Becca	Ontario Ministry Of Transportation	Associate Member	Voting	
Jones, Cecil L	American Concrete Institute	Friend	Non-Voting	X
Savage, David A	Construction Materials Engineering Council	Friend	Non-Voting	X
Pyle, Roger	Pine Test Equipment, LLC	Friend	Non-Voting	
Reaves, Dick	Troxler Electronic Laboratories, Inc.	Friend	Non-Voting	X

III. Approval of Technical Section Mid-Year Webinar Minutes

The Technical Section 1b Mid-Year Webinar was held on Thursday, February 26, 2015 at 2:30 PM. The Mid-Year Webinar Minutes are attached as **Appendix B**.
There was a motion to approve the minutes as written by New York (Burnett) and a second was made by Oklahoma (Seiter). Motion passed.

IV. Old Business

A. SOM Ballot Items
2014 SOM Ballot Items – Negative Votes and Comments were addressed at the Mid-Year Webinar (See Appendix A). There are no remaining items to be addressed by the TS.

B. TS ballots

- **TS Ballot TS1b-15-02 to: Discontinue M 92, Revise T 272, and Adopt a new Standard Practice.** Ballot Results are included in **Appendix B, Attachment 1 (Pages 152 – 158)**.

  Item 1 – M 92, *Wire Cloth Sieves for Testing Purposes*, is identical to ASTM E 11-09. In the interest of cleaning up the historical Category "C" standards, this ballot is to discontinue publishing M 92.

  Ballot Results: Yes – 13, No Vote – 6, Negative – 0, No Comments

  NY (Burnett) made a motion to move this ballot item to SOM ballot. A second was made by Rhode Island. Motion passed.

  Item 2 – Revise T 272, *Family of Curves – One-Point Method*, based on WAQTC recommendations.

  Ballot Results: Yes – 13, No Vote – 6, Negative – 0, 1 Comment

  Comment from NY: There are multiple inconsistencies and errors to be addressed. While deleting the information contained elsewhere, the new document becomes difficult to follow as the reader is constantly referencing other sources. Recommend that it be thoroughly edited and basic necessary information be reinserted, followed by the reference.

  Resolution of Comment: The Chairman recommends that NY provide detailed information regarding the inconsistencies and errors for review prior to the SOM Ballot. Correction of errors and clarifications deemed to be editorial in nature can be made to the standard prior to the SOM Ballot.

  The TS Ballot for T 272 passes and will be forwarded for the SOM Ballot.

  Motion to take comments from NY (Burnett) incorporate into the standard and move to full SOM ballot. – NY Second – RI Motion passed.

  Item 3 – Adopt a new Standard Practice, R-XX, *Developing a Family of Curves*. The intent is to replace the Appendix XI of T 272.

  Ballot Results: Yes – 13, No Vote – 6, Negative – 0, 1 Comment

Comment from NY: NYSDOT felt that it was unclear on just what was the correct process. Section 4.1 states "All curves must be developed from a single method." This is counter to section 5 which directs the curves to be sorted by method.

Garth Newman explained the need for development of this new standard of practice. That the family of curves s currently in the Annex and should be moved to the procedure.

Resolution of Comment: The Chairman and Garth Newman will review Section 4.1 and Section 5 to ensure clarity of the process. This will be done prior to the SOM Ballot.

The TS Ballot for adopting a new Standard Practice, R-XX passed Tech Section.

Motion: To Forward for the SOM Ballot. – NY Second – RI Motion passed.

- **TS Ballot TS1b-15-03 to: Revise T 225, *Diamond Core Drilling for Site Investigation*, to include the definition and use of Triple-Tube Core Barrels. The revisions also provide new language cautioning the use of Single-Tube Core Barrels. These Changes are proposed by Task Force 15-01.** Ballot Results are included in **Appendix B, Attachment 2 (Pages 159 – 160)**.

  Ballot Results: Yes – 14, No Vote – 5, Negative – 0, No Comments

  The revision stemmed from a reconfirmation ballot. Ben Rivers (FHWA) made this suggestion and headed the task force to incorporate these changes.

  Motion: The TS Ballot for T 225 passes and will be forwarded for the SOM Ballot. – FL. Second – VA Motion passed.

C. Task Force Reports

TASK FORCE 10-04:

Development of a new provisional standard for the In-Place Determination of Density and Water Content of Soil and Aggregate by Subsurface Electrical Method. TP 112

- Dennis Anderson, Cecil Jones, Darin Tedford (NV), Bob Burnett (NY)
  - The Chairman expressed the need for new members for this task force.
  - Dennis Anderson and Cecil Jones presented the work that has gone on this past year and the data collected. They are currently working with eight states, AK, ND, NE, VT, Virginia, NV, MD ID (get list from Cecil). Some data sets from this work were presented. A couple of states commented on this method/equipment as difficult to use of states. A couple of states had good comparisons however, one state reported poor comparisons. Nevada is continuing to do research.
  - Calibration of the gage was questioned and discussed concerning the appropriate method. Dennis discussed the optimized algorithm that has been added and is under beta testing to help with the calibration.
  - Maryland recently used the gage and reported the compaction part did very well with correlation but the moisture did not. Maryland offered to supply their data to Dennis.
  - Scott (OK) commented that the task force should continue based on the 8 states that are working with this new technology.

TASK FORCE 12-01:

Address comments on Technical Section Ballot 12-01 to revise M 147.

- Andy Babish (VA), Jamie Blanton (LA), Scott Seiter (OK), Sejal Barot (MD), and James Williams, (MS)
  - Terminology used was vague and not specific.
  - Survey was done to see how many states are using this standard. A fair amount of states are using this standard. . At this point it is believed that a minor changes are needed.
  - The task force will work on presenting revised language at a future meeting.

TASK FORCE 12-02:

Address negative votes and comments related to Technical Section Ballot 12-04 to revise T 99 and T 180.

- Garth Newman (WAQTC), Scott Seiter (OK), Jamie Blanton (LA), David Horhota (FL), James Williams (MS)
  - Changes suggested by the task force were balloted and passed, and are currently published.
  - The comment from FL is still outstanding. Florida's comment were with concerns about the mandatory requirement to have two points passed optimum this can be an issue when dealing with a granular material with a relatively flat moisture-density curve. Tim (FL) suggested that this requirement be made into a note so it would not necessarily be mandatory. Maine and OK were in agreement with the comment from FL.
  - Garth mentioned that T 99 was originally developed for a cohesive soil. The two data points are really needed past optimum to define the zero air voids curve.
  - Tim indicated that Dave Horhota (FL) would lead the effort to look at some language. The task force will schedule a conference call within the next month or so to look into this issue. (AASHTO staff volunteered offered assist in facilitating this call.)

V. New Business

A. Research Proposals **(See Appendix C, Pages 161-175)**

RPS – Research Problem Statements

- *Development of Mechanistic-Empirical Pavement Design Criteria for Pavement Rehabilitation using Full-Depth Reclamation*
  TRB committees AFD70 and AFH60
  - The chairman asked if there was interest in supporting and endorsement by the TS.
  - Members in attendance felt that this project was a little premature at this point in time. The consensus is that the topic is high reaching at this time and basic research on FDR is still needed before this research would be valuable. Nelson Gibson mentioned a current ongoing NCHRP study that is looking a material properties.
  - No motion was made to endorse this research needs statement.

- *Evaluation and Consideration of Site Variability in the Geotechnical LRFD Design*
  TRB committees AFP30, AFS30, and AFP20
  Mohammed Mulla, NCDOT
  David Horhota, FDOT
  Ching Tsai, LADOTD
  Khamis Haramy FHWA-Central Federal Land
  - Members in attendance felt that this project has value.
  - Motion: Chris (LA) recommended this topic be endorsed by the TS. Second – FL. Motion passed.

- *Development of a Permanent Deformation Test Procedure for Evaluating Rutting Potentials of Pavement Granular Base/Subbase Layers*
  TRB committee AFP70
  - Scott (OK) indicated that this proposal does have a deliverable of a test method. This idea is needed but this issue is complex.
  - This research needs statement was presented to the Tech Section last year and was not supported.
  - Motion to co-endorse with 1C: OK Second – Delaware (Sejal Barot) Motion passed.

- *Including the Effects of Shrink/Swell and Frost Heave in Mechanistic Empirical Pavement Design*
  TRB committee AFS60
  - The chair mentioned that there is a gap in the ME design in this regard.
  - Bob (NY) stated that this topic is needed and moved to endorse. 2nd – VA. Motion passed.
  - Jack mentioned that these ME topics should probably go to Joint Technical Committee for their comments.

B. AASHTO Issues
   - The Chair expressed the Technical Sections' thanks for AASHTOs and AMRLs help and work.
   - Brian Johnson reminded members to let AMRL know if there are issues you are having in your states that can be resolved by AMRL involvement / accreditation (such as adding tests to the scope of the program).

C. NCHRP Issues - None

D. Correspondence, calls, meetings/ Presentation by Industry
   i. Date for Mid-Year Web Meeting (Currently scheduled for February 3, 2016)
   ii. Presentation by Robyn Myers, Troxler Electronic Laboratories, Inc.
   Introduction of Troxler's Non-Licensed Soil Nuclear Wet Density Gauge
   - This gage uses a low activity nuclear source that is not regulated. This gage has small differences in the operation but very similar to existing gages. The moisture measurement is external. Other gages have to be more the 30 feet away. The lower source only allows 8 inch reliable depth measurement. Uses a gamma source but moisture system is different. Electromagnetic technology is used for measuring the moisture. Data was presented showing the correlation with existing 3440 model nuclear gage. US Army Core of Engineers have done a research project looking at low nuclear and non-nuclear methods. No soil modeling was necessary. Troxler has done a preliminary repeatability and reproducibility study for wet density.
   - Methodology for moisture – use the same hole
   - Available for purchase this summer. Cost approximately $15,000
   - Working with ASTM for a standard – the debate by ASTM is still ongoing about whether to make this a new standard or to incorporate into the existing standard.

E. Proposed New Standards
   None known at this time.

F. Proposed New Task Forces

G. Standards Requiring Reconfirmation
   These will go out at the same time as the SOM but will be a separate ballot.

H. SOM Ballot Items (including any ASTM changes)

VI. Open Discussion

- Jeff commented on design build projects where a large amount of data is incorporated there needs to be more specified in calibration of nuclear gages. Jeff Seiters would like to work with Pennsylvania to further explain calibration requirements in the nuclear density gauge standards.
- Jeff will send in their concerns through Darin Hazlett and will report back to the Tech Section at a future meeting.

VII. Adjourn

The Chairman adjourned the meeting at 11:47am EST.

APPENDICES

A – Meeting Attendance (Sign-in by I-Pad)

B – Approved Meeting Minutes, 2015 Mid-Year Webinar

C – Technical Section 1b, Tuesday, August 4, 2015 Meeting Summary

D – Subcommittee on Materials Ballot Items and Ballot Attachments

- **Attachment 1, Revised T 272**
- **Attachment 2, New Standard Practice, R-XX, *Developing a Family of Curves***
- **Attachment 3, Revise T 225**

APPENDIX A

AASHTO Subcommittee on Materials
101st Annual Meeting - Pittsburgh, Pennsylvania
Technical Section 1b Meeting Attendance
Tuesday, August 4, 2015
10:15 am - 12:00 pm CST

First Name	Last Name	Organization	Email	Phone
Trudy	Keefer	AASHTO	tkeefer@amrl.net	240-436-4824
Georgene	Geary	GGfGA Engineering, LLC	ggeary@ggfga.com	770-337-5817
Angela	Wong	ICF International	angela.wong@icfi.com	202-572-9450
Bill	Schiebel	CO DOT	bill.schiebel@state.co.us	303-398-6501
Jennifer	Albert	FHWA	jennifer.albert@dot.gov	717-221-3410
Steve	Lenker	Director AMRL CCRL	slenker@amrl.net	
Sejal	Barot	MD SHWA	sbarot@sha.state.md.us	443-572-5269
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John	Melander	John M Melander, Consultant	jmmelander@gmail.com	847-942-2332
Garth	Newman	WAQTC	garth.newman@itd.idaho.gov	208-334-8039
Cecil	Jones	Diversified Engineering Services Inc.	cecil.jones@nc.rr.com	919-616-5139
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Jeff	Seiders	Raba Kistner Infrastructure, Inc.	jeff.seiders@rkci.com	512-904-9177
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Nelson	Gibson	FHWA	nelson.gibson@dot.gov	202-493-3073
Merrill	Zwanka	SC DOT	zwankame@scdot.org	803-737-6682
Matthew	Bluman	AASHTO (AMRL)	mbluman@amrl.net	240-436-4849
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Deborah	Kim	AASHTO	dkim@aashto.org	202-624-5883
Robert	Burnett	NYSDOT	bob.burnett@dot.ny.gov	518-457-4711
Ron	Holsinger	Consultant	ronald20405@comcast.net	301-916-2507
Josiah	Beakley	American Concrete Pipe Association	jbeakley@concrete-pipe.org	972-894-2906
Scott	Andrus	UTDOT	scottandrus@utah.gov	801-965-4859
Mladen	Gagulic	VTAOT	mladen.gagulic@vermont.gov	802-828-6405
Andy	Mergenmeier	FHWA	andy.mergenmeier@dot.gov	410-962-7971
Scott	Seiter	OK DOT	sseiter@odot.org	405-521-2186
Steven	Ingram	AL DOT	ingrams@dot.state.al.us	334-206-2335
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James	Hammons	MS DOT	jchammons@mdot.ms.gov	601-359-9770
Darin	Tedford	NV DOT	dtedford@odot.state.nv.us	775-888-7784
Anne	Holt	Ontario Ministry of Transportation	anne.holt@ontario.ca	416-235-3724
Michael	San Angelo	State Materials Engineer	michael.sanangelo@alaska.gov	907-269-6234
David	Savage	CMEC	davesavage@cmec.org	407-628-3682
Dick	Reaves	Troxler Electronic Laboratories, Inc.	dreaves@troxlerlabs.com	919-819-4551
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Dennis	Anderson	Electrical Density Gauge	arai01@sbcglobal.net	775-741-3897
Jesus	Sandoval-Gil	AZ DOT	jsandoval-gil@azdot.gov	928-200-4260
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Ali	Regimand	President	aregimand@instrotek.com	919-875-8371
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Victor (Lee)	Gallivan	Gallivan Consulting, Inc.	lee@gallivanconsultinginc.com	
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Kevin	Kennedy	MI DOT	kennedyk@michigan.gov	517-322-6043
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Timothy	Ruelke	FL DOT	timothy.ruelke@dot.state.fl.us	352-955-6620
Casey	Soneira	AMRL	csoneira@amrl.net	240-436-4863
William	Troxler, Jr.	Troxler Electronic Laboratories, Inc.	btroxler@troxlerlabs.com	919-485-2200
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Greg	Stellmach	OR DOT	greg.f.stellmach@odot.state.or.us	503-986-3061
Michael	Sullivan	MS DOT	msullivan@mdot.ms.gov	601-359-1666
Maria	Knake	AMRL	mknake@amrl.net	240-436-4804
Chris	Abadie	LADOTD	chris.abadie@la.gov	225-248-4131
James	Williams	MS DOT	jwilliams@mdot.ms.gov	601-359-7007
Desna	Bergold	WAQTC	dbconsulting.desna@gmail.com	801-721-7146
Mark	Felag	RI DOT	mark.felag@dot.ri.gov	401-641-8279
Charles	Babish	VADOT	andy.babish@vdot.virginia.gov	804-328-3102
Hany	Fekry	DelDOT	hany.fekry@state.de.us	302-760-2551

APPENDIX B

AASHTO THE VOICE OF TRANSPORTATION
SUBCOMMITTEE ON MATERIALS

SUBCOMMITTEE ON MATERIALS

Mid-Year Web Meeting
Thursday, February 26, 2015
2:30 pm – 4:30 pm EST

TECHNICAL SECTION 1b
Subsurface Exploration, Soil Instrumentation, Soil Stabilization, and Field Testing of Soils

I. Call to Order and Opening Remarks

Chairman James Williams called the meeting to order thanking everyone for their attendance. The membership and friends were encouraged to continue the strong support of TS 1b and the SOM by participating in TS and SOM ballots as well as Task Forces. The Chairman acknowledged the hard work of the TS over the last few years in updating and creating new standards.

Reid Kaiser (NV) has taken a new job with NV and was thanked for his service to TS 1b as the Research Liaison. Darin Tedford (NV) volunteered to be the new Research Liaison for TS 1b and he was thanked for his willingness to serve in this role.

II. Roll Call Attendees Present

Williams, III, James A.	Mississippi Department of Transportation	Chair
Barnhart, Tracy	AMRL	Liaison
Johnson, Brian	AMRL	Liaison
Lacinak, Henry	AASHTO	Liaison
Knake, Maria	AMRL	Member
Soneira, Casey	AMRL	Member
Rivers, Benjamin	Federal Highway Administration	Member
Springer, Jack	Federal Highway Administration	Member
Voth, Michael D	Federal Highway Administration	Member
Horhota, David J	Florida Department of Transportation	Member
Smith, Timothy E.	Maryland Department of Transportation	Member
Tedford, Darin P	Nevada Department of Transportation	Member
Boisvert, Denis M.	New Hampshire Department of Transportation	Member
Burnett, Robert A.	New York State Department of Transportation	Member
Seiter, Scott	Oklahoma Department of Transportation	Member
Zwanka, Merrrill E	South Carolina Department of Transportation	Member
Heinen, Caroline	Texas Department of Transportation	Member
Lane, Becca	Ontario Ministry Of Transportation	Associate Member
Jones, Cecil L	American Concrete Institute	Friend
Reaves, Dick	Troxler Electronic Laboratories, Inc.	Friend
Fish, Marc	New Hampshire Department of Transportation	Visitor
Clarke, Chris	Oklahoma Department of Transportation	Visitor
Thomas, John	Oklahoma Department of Transportation	Visitor
Si, Jimmy	Texas Department of Transportation	Visitor
Sangiuliano, Tony	Ontario Ministry of Transportation	Visitor
Jowers, Robert	Tennessee Department of Transportation	Visitor
Smith, Travis	Tennessee Department of Transportation	Visitor
Hannah, Amir	TRB	Visitor
Cowsert, Jack	North Carolina Department of Transportation	Visitor

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Peoples, Chris	North Carolina Department of Transportation	Visitor
Fontaine, Leo	Connecticut Department of Transportation	Visitor
Schoup, Heather	Illinois Department of Transportation	Visitor
Fernandez, Ben	Louisiana Department of Transportation and Development	Visitor
Abadie, Chris	Louisiana Department of Transportation and Development	Visitor
Benson, Michael	Arkansas Department of Transportation	Visitor

The following changes in membership were recommended to the Chairman:

Roger Pile (Pine Instruments) is no longer with Pine and should be removed as a Friend
Reid Kaiser (NV) has been replaced by Darin Tedford (NV) as a Voting Member
Haleh Azari is no longer with AMRL
Travis Smith (TN) requested membership on the TS as a Voting Member
Leo Fontaine (CT) requested membership on the TS as a Voting Member

III. Approval of Technical Section Minutes

Minutes of the TS 1b meeting held on July 29, 2014 in Minneapolis, Minnesota were distributed prior to the Mid-Year Webinar to the TS for review. The TS unanimously approved by voice vote the minutes of this meeting. **(M/S, NY/OK)**. See Appendix A

IV. Old Business

A. SOM Ballot Items

Item Number: 5

Description: SOM ballot item to revise T 298, "High-Strain Dynamic Testing of Piles." See pages 2 and 85-99 of the minutes.

Affirmative 46 of 53
Negative 0 of 53
No Vote 7 of 53

South Dakota Department of Transportation	In paragragh 5.2.4 change piezoresitive to piezoresistive • Editorial
Idaho Transportation Department	- Item 3.2.1. The description of Hammer cushion is incorrect and should be replaced with the following: Hammer cushion: the material placed between the hammer striker plate and the drive cap or helmet to protect the hammer during driving. Add "to protect the pile during driving" at the end of the description of Pile cushion. - Item 3.2.8: Replace all the word "column" with "pile".

Resolution of Comments:

The comment from SD editorial in nature and was changed editorially by the Chairman prior to publication.

The comments from ID were taken under advisement and editorial changes made by the Chairman to provide clarity to the standard prior to publishing.

APPENDIX B

Item Number 6

Description: Concurrent ballot item to revise T 99 and T 180." See pages 3-4 and 100-132 of the minutes.

Affirmative 45 of 53

Negative 1 of 53

No Vote 7 of 53

Rhode Island Department of Transportation **Negative**	A1.1.2 states to "Obtain the sample in accordance with AASHTO T 310". Note: there is no note of sampling method in AASHTO T 310. Rhode Island has indicated they will withdraw their negative if a reference is added to specifically point to Section 9.6.
Virginia Department of Transportation	Some suggested editorial changes to make to both T99 and T180 are: Table 1 : 0.333+/- 0.0005 should be changed to 0.0333+/- 0.0005 Table 2: 0.07500+/- 0.0009 needs to be changed to 0.0750+/- 0.0009
Oregon Department of Transportation	Final version of T 180 should delete T 224 as one of the "Referenced Documents" since the information is being added to T 180 in the Annex. This looks like it was done for the version of T 99 but not for T 180.
Idaho Transportation Department	- Replace 3.1.1 with the following: A mold having volume of 0.000943 +/- 0.000014 cu.m (0.0333 +/- 0.0005 cu.ft.) with an inside diameter of 101.6 +/- 0.4 mm (4.0 +/- 0.016 in.) and a height of 116.4 +/- 0.5 mm (4.584+/- 0.018 in.) (Figure 1). Determine mold volume in accordance with section "Calibration of Measure" of T19M/T19 for Unit Mass of Aggregate. - Replace 3.1.2 with the following: A mold having volume of 0.002124+/- 0.000025 cu.m (0.075 +/- 0.0009 cu.ft.) with an inside diameter of 152.40+/- 0.7 mm (6.0 +/- 0.026 in.) and a height of 116.4 +/- 0.5 mm (4.584+/- 0.018 in.) (Figure 2). Determine mold volume in accordance with section "Calibration of Measure" of T19M/T19 for Unit Mass of Aggregate. - Add "Figure 1 - Cylindrical Mold and Base Plate (101.6 mm Mold)" below the figure in page 103 same as in T 180 on page 119.
Florida Department of Transportation	Affirmative with comment regarding the new requirement of performing an additional pill such that there is a minimum of 2 determinations over the optimum moisture. We would suggest to make this a note and not a requirement because this could increase sample size and test time driving up consultant costs for these tests. For granular soils with shallow proctor curves, we would prefer if the test method allows some judgment to use 4 points versus mandating 5 points (or more) which wouldn't add much greater precision for these types of soils while possibly resulting in increased costs.

Resolution of Negative:

RI agreed to withdraw their negative vote based on the chair agreeing that a reference in Section A1.1.2 to point directly to T 310, Section 9.6 would provide clarity to the standard. This change was made prior to publishing by the Chairman.

Resolution of Comments:

VA, ID, and IL comments related to the dimensional requirements of the molds were investigated and corrected by TF 12-02 and the Chairman. Corrections to the dimensional requirements were made by the Chairman prior to publication.

The comment by OR regarding referenced documents was changed editorially by the Chairman prior to publishing.

The comment from FL will be taken under advisement for further investigation by TF 12-02.

Item Number 7
Description: Concurrent ballot item to revise T 272, "Family of Curves "One-Point Method." See pages 3-4 and 133-141of the minutes.
Affirmative 46 of 53
Negative 0 of 53
No Vote 7 of 53

Idaho Transportation Department	- Section 3.1: Label the figure of Family of Curves as "Figure 1". - Section 6.3.1: In second sentence, change "nearest one g" to "nearest 2 g" (2g to be consistent with tolerance of 0.005 pound). Make same change in 10.3.1 - Section 15.1.4: Add "3/4 in." behind 19 mm.

The Comments from ID were taken under advisement by the Chairman. Appropriate changes were made to the standard editorially by the Chairman prior to publication.

Item Number 8
Description: Concurrent ballot item to discontinue T 224, "Correction for Coarse Particles in the Soil Compaction Test." See pages 3-4 of the minutes.
Affirmative 45 of 53
Negative 1 of 53
No Vote 7 of 53

Rhode Island Department of Transportation **Negative**	From the minutes it states, In the early 1970â€™s the replacement model was eliminated. T 224 was developed for oversized and is a mathematical calculation. The information in T 224 should be added as an appendix in T 99 and T 180. If this is discontinued, is the information added to T 99 and T 180 as stated? Rhode Island has indicated they will withdraw their negative after email discussions.

Resolution of Negative:

RI withdrew their negative vote based on changes to T 99 and T 180 passing SOM ballot.

B. TS letter ballots
Reconfirmation Ballot for the following:
- *M 092-10 Wire-Cloth Sieves for Testing Purposes*
- *M 231-95 (2010) Weighing Devices Used in the Testing of Materials*
- *T 225-06 (2010) Diamond Core Drilling for Site Investigation*
- *T 306-11 Progressing Auger Borings for Geotechnical Explorations*
- *TP 100-12 Deep Foundation Elements under BI-Directional Static Axial Compressive Load*
- *TP 104-13 Rapid Axial Compressive Load Testing of Deep Foundation Units*

Ballot closed February 13, 2015.

All reconfirmation ballots passed the TS. Based on comments related to M 92 being a Category C standard identical to the ASTM version, the TS indicated that the Chairman should ballot to discontinue M 92. The Chairman agreed to submit a TS ballot prior to the annual meeting.

Ben Rivers (FHWA) recommended changes to T 225 which resulted in the formation of TF 15-01 consisting of Ben Rivers (FHWA – Chair), David Horhota (FL), and Bob Burnett (NY). The TF will recommend changes to T 225 for future TS ballot.

AL asked on the T 306 ballot about the status of the update to the 1988 AASHTO Subsurface Investigation Manual. NCHRP 21-10 was funded to update the manual based on advances in technology and current practice. James Williams and Ben Rivers are on the panel for the project and anticipate an updated draft of the manual to be submitted to AASHTO for adoption within approximately two years.

C. Task Force Reports

TASK FORCE 10-02:

Research needed changes to update T 298.

- James Williams (MS) Lyndi Blackburn (AL), David Horhota (FL)
  Item Number 5 on SOM Ballot.

The work of TF 10-02 resulted in balloted changes to T 298. The TF was discontinued and thanks given to the TF for their work to update this standard.

TASK FORCE 10-04:

Development of a new provisional standard for the In-Place Determination of Density and Water Content of Soil and Aggregate by Subsurface Electrical Method. TP 112

- Dennis Anderson, Cecil Jones, Jim Pappas (DE), Reid Kaiser (NV), Georgene Geary (GA), Bob Burnett (NY)

TP 112-14, *Determining In-Place Density and Moisture Content of Soil and Soil-Aggregate Using Complex Impedance Methodology* was adopted by the SOM in 2014. Cecil Jones provided an update of ongoing work in various states utilizing the technology. The TF will continue as the technology advances and more data is acquired. The Chairman thanked TF 10-04 for their efforts and continued work in this area.

TASK FORCE 12-01:

Address comments on Technical Section Ballot 12-01 to revise M 147.

- Andy Babish (VA), Jamie Blanton (LA), Georgene Geary (GA), Scott Seiter (OK), and James Williams, (MS)

A survey was conducted to gauge the use of the standard. Based on the survey, there was interest in maintaining the standard. The TF was continued to look at potential updates.

TASK FORCE 12-02:

Address negative votes and comments related to Technical Section Ballot 12-04 to revise T 99 and T 180.

- Garth Newman (WAQTC), Scott Seiter (OK), Jamie Blanton (LA), David Horhota (FL), James Williams (MS)
  Item Number 6 and 8 on SOM Ballot.

Work of this TF resulted in major changes to T 99 and T 180. The Chairman asked that the TF be maintained to help modify the standards prior to publishing. The TF may be discontinued at the annual meeting.

V. New Business

A. Research Proposals

The research liaison for TS 1b is Darin Tedford (NV). The research liaison is responsible for compiling potential research needs. The TS was encouraged to contact the research liaison or the TS Chair with potential topics.

B. AMRL/CCRL Issues

None Noted

C. NCHRP Issues

Amir Hannah (TRB) updated the TS on the NCHRP process and deadlines. Amir encouraged the SOM TS to endorse potential research needs statements.

D. Correspondence, calls, meetings/ Presentation by Industry

Dick Reeves from Troxler asked to give a presentation to the TS at the annual meeting related to the newly introduced Troxler E-Gauge.

E. Proposed New Standards
None Noted

F. Proposed New Task Forces
Task Force 15-01 was organized to propose changes to T 225.

G. Standards Requiring Reconfirmation
AASHTO staff will generate a reconfirmation ballot for TS 1b standards requiring reconfirmation prior to the 2016 publication.

H. Ballot Items (including any ASTM changes)
The Chairman will generate a TS ballot to discontinue M 92 prior to the annual meeting.

VI. Open Discussion

VII. Adjourn

APPENDIX B

TS 1b Mid Year Web Meeting Summary		
Meeting Date:	2/26/2015	
Items approved by the TS for Subcommittee Ballot:		
Standard Designation	**Summary of Proposed Changes**	**Subcommittee Only or Concurrent?**
M92	Remove from publication	TS Ballot
New Task Forces Formed:		
Task Force Name	**Summary of Task**	**Names of TF Members**
15-01	Update T225 to show that the double tube core barrel is the standard, but the single tube is still used for harder rock. Also, there was a suggestion to add a description of the use of photography in this standard. See the comments on the reapprovals for more details.	Ben Rivers (FHWA) is the Chair, David Horhota (FL), Bob Burnett (NY) are also members, Ben will contact GA DOT to see if they want to participate due to their commment on photography.
Research Liaison:	Darin Tedford (NV)	
Other Action Items:		
Task Force 10-02 is disbanded.		

APPENDIX C

TS1b Meeting Summary		
Meeting Date:	August 4, 2015 10:15 AM EST	
Items approved by the TS for Subcommittee Ballot:		
Standard Designation	**Summary of Proposed Changes**	**Subcommittee Only or Concurrent?**
M 92	Discontinue publication	Subcomittee
T 272	Revise based on WAQTC recommendations	Subcommittee
R XX (New standard)	New standard entitled "Developing a Family of Curves." The intent is to replace Appendix XI of T 272.	Subcommittee
T 255	Revise to include the definition and use of Triple-Tube Core Barrels	Subcommittee
New Task Forces Formed: None.		
Research Liaison:	Darin Tedford (Nevada)	
Other Action Items:		
-Task Force 12-02 will hold a conference call to discuss how many points passed optimum are required for granular soils. AASHTO staff volunteered to help facilitate the call.		
-Motions were made by the Tech Section to endorse 3 research needs statements: Evaluation and Consideration of Site Variability in the Geotechnical LRFD Design (TRB Committees AFP30, AFS30, AFP20), Development of a Permanent Deformation Test Procedure for Evaluating Rutting Potentials of Pavement Granular Base/Subbase Layers (TRB Committee AFP70); Including the Effects of Shrink/Swell and Frost Heave in Mechanic Empirical Pavement Design (TRB Committee AFS60)		
-Jeff Seiters would like to work with Pennsylvania to further explain calibration requirements in the nuclear density gauge standards. Jeff will report back to the Tech Section at a future meeting.		

TS 1b
SOM Ballot Items

Num.	Ballot Item	SOM	Concurrent
1	M 92, *Wire Cloth Sieves for Testing Purposes*, is identical to ASTM E-11-09. In the interest of cleaning up the historical "Category C" standards, this ballot is to discontinue publishing M 92. See page 2 of the minutes.	X	
2	Revise T 272, *Family of Curves – One-Point Method*, based on WAQTC recommendations. In addition to deleting information contained in other standards, the revision removes the appendix for developing a family of moisture-density curves. The development of a family of curves is proposed as a new standard practice. See pages 2 and 17-29 of the minutes.	X	
3	Adopt a new Standard Practice, R-XX, *Developing a Family of Curves*. The intent is to replace the Appendix XI of T 272. See pages 2-3 and 30-34 of the minutes.	X	
4	Revise T 225, *Diamond Core Drilling for Site Investigation*, to include the definition and use of Triple-Tube Core Barrels. The revisions also provide new language cautioning the use of Single-Tube Core Barrels. These changes are proposed by Task Force 15-01. See pages 3 and 35-42 of the minutes.	X	

Standard Method of Test for

~~Family of Curves—~~ One-Point Method for Determining Maximum Dry Density and Optimum Moisture

AASHTO Designation: T 272-~~10~~XX

AASHTO
THE VOICE OF TRANSPORTATION

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

~~Family of Curves~~ One-Point Method for Determining Maximum Dry Density and Optimum Moisture

AASHTO Designation: T 272-~~10~~XX

AASHTO
THE VOICE OF TRANSPORTATION

1. SCOPE

1.1. ~~These~~ This method~~s~~ ~~is of tests are~~ for the rapid determination of the maximum dry density and optimum moisture content of a soil sample ~~utilizing a family of curves and~~using a one-point determination and an individual moisture/density curve or a family of curves.

~~1.2. One-point determinations are made by compacting the soil in a mold of a given size with a 2.5-kg (5.5-lb) rammer dropped from a height of 305 mm (12 in.). Four alternate procedures are provided as follows:~~

~~1.2.1. *Method A*—A 101.6-mm (4-in.) mold; soil material passing a 4.75-mm (No. 4) sieve (see Sections 5 and 6);~~

~~1.2.2. *Method B*—A 152.4-mm (6-in.) mold; soil material passing a 4.75-mm (No. 4) sieve (see Sections 7 and 8);~~

~~1.2.3. *Method C*—A 101.6-mm (4-in.) mold; soil material passing a 19.0-mm ($^3/_4$-in.) sieve (see Sections 9 and 10); or~~

~~1.2.4. *Method D*—A 152.4-mm (6-in.) mold; soil material passing a 19.0-mm ($^3/_4$-in.) sieve (see Sections 11 and 12).~~

~~1.3. The methods described herein correspond to the methods in T 99 and must be chosen accordingly; that is, when moisture-density relationships as determined by Method C of T 99 are used to form the family of curves, then Method C described in this procedure must be used for the one-point determination (Note 1).~~

~~**Note 01**—Direct reference to T 99 is made throughout these test methods, and most terminology, apparatus, and procedures are the same.~~

~~1.4. In addition, the concepts described herein are applicable to one-point determinations and moisture-density relationships as specified in T 180, with appropriate apparatus and method used as required.~~

~~1.5.~~1.2. The following applies to all specified limits in this standard: For the purposes of determining conformance with these specifications, an observed value or a calculated value shall be rounded off "to the nearest unit" in the last right-hand place of figures used in expressing the limiting value, in accordance with the rounding-off method of ASTM E 29.

~~1.6.~~1.3. The values stated in SI units are to be regarded as the standard.

2. REFERENCED DOCUMENTS

2.1. *AASHTO Standards*:

~~T 19M/T 19, Bulk Density ("Unit Weight") and Voids in Aggregate~~

T 99, Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop

T 180, Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

T 224, Correction for Coarse Particles in the Soil Compaction Test

2.2. *ASTM Standard*:

E 29, Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

3. ~~DEFINITION~~SIGNIFICANCE AND USE

3.1. The method described herein corresponds to the methods in either T 99 or T 180 and must be chosen accordingly; for example, when moisture-density relationships as determined by Method C of T 99 are used to form the family of curves, then Method C described in T 99 must be used for the one-point determination.

~~3.1.~~3.2. A family of curves is a group of typical soil moisture-density relationships determined using T 99 or T 180, which reveal certain similarities and trends characteristic of the soil type and source. Soils sampled from one source will have many different moisture-density curves, but if a group of these curves are plotted together, certain relationships usually become apparent. In general, it will be found that higher unit mass soils assume steeper slopes with maximum dry densities at lower optimum moisture contents, while the lower unit mass soils assume flatter, more gently sloped curves with higher optimum moisture contents ~~(Figure 1)~~.

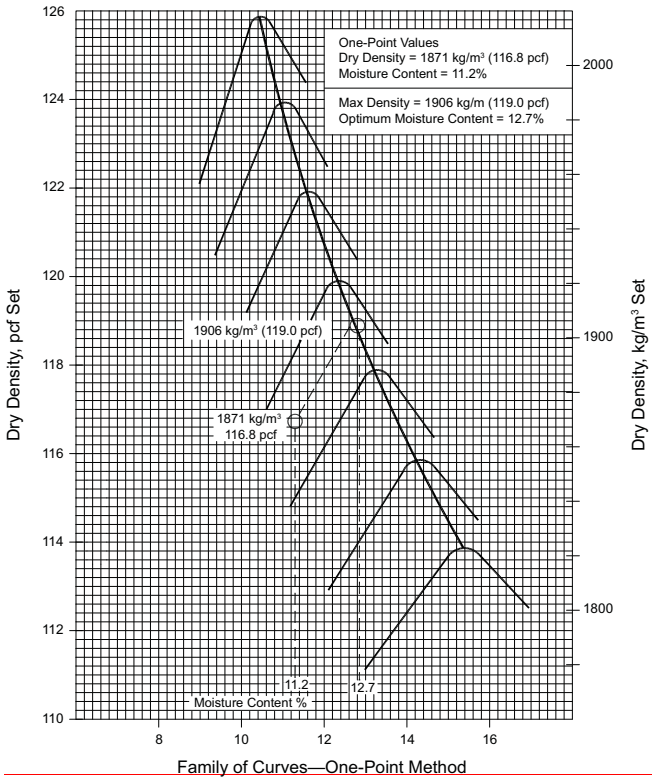

Figure 1—Example of Curves

4. METHOD SELECTION

4.1. See T 99 or T 180.

4.2. One-point determinations are made by compacting soil using T 99 or T 180 and one of the procedural methods described therein:

Method A—A 101.6-mm (4-in.) mold; soil material passing a 4.75-mm (No. 4) sieve. Sections 5 and 6.

Method B—A 152.4-mm (6-in.) mold; soil material passing a 4.75-mm (No. 4) sieve. Sections 7 and 8.

Method C—A 101.6-mm (4-in.) mold; soil material passing a 19.0-mm ($^3/_4$ in.) sieve. Sections 9 and 10.

Method D—A 152.4-mm (6-in.) mold; soil material passing a 19.0-mm ($^3/_4$ in.) sieve. Sections 11 and 12.

4.3. The method used to compact the sample shall be the same method and procedure used to develop the moisture/density curve or family of curves used for the reference curve(s).

~~4.~~5. APPARATUS

~~4.1.~~5.1. See T 99 or T 180 for the selected method.~~, Section 3.~~

~~METHOD A~~

~~5.~~6. SAMPLE

6.1. ~~See T 99, Section 4.~~Refer to T 99 or T 180.

6.1.1. Follow the initial drying step in 'Sample' section of T 99 or T 180 or;

~~5.1.~~6.1.2. Sieve sample over the appropriate sieve.

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~~6.~~7. PROCEDURE

7.1. The representative sample needs to be between 80 to 100 percent of the optimum moisture. Adjust the moisture content, if necessary. The maximum density determination will be more accurate the closer the moisture content is to the optimum moisture content.

7.2. Compact the prepared soil using the selected procedural method.

7.3. Determine the wet density of the compacted sample according to T 99 or T 180.

7.4. Determine the moisture content using one of the following methods: T 217, T 255, or T 265.

7.5. Determine the dry density using the wet density determined in Section 7.3 and moisture content determined in Section 7.4 according to the calculation Section in T 99 or T 180.

~~6.1. Thoroughly mix the selected representative sample with sufficient water to dampen approximately 4 percentage points below optimum moisture content. Greater accuracy in the determination of the maximum density will result as the moisture content used approaches optimum moisture content. Moisture content of the sample should never exceed the optimum water content.~~

~~6.2. Form a specimen by compacting the prepared soil in the 101.6-mm (4-in.) mold (with collar attached) in three approximately equal layers to give a total compacted depth of about 125 mm (5 in.). Compact each layer by 25 uniformly distributed blows from the rammer dropping free from a height of 305 mm (12 in.) above the elevation of the soil when a sleeve type rammer is used, or from 305 mm (12 in.) above the approximate elevation of compacted soil when a stationary mounted type of rammer is used. During compaction, the mold shall rest firmly on a dense, uniform, rigid, and stable foundation (Note 2).~~

~~**Note 2**—Each of the following has been found to be a satisfactory base on which to rest the mold during compaction of the soil: a block of concrete, with a mass not less than 91 kg (200 lb) supported by a relatively stable foundation; a sound concrete floor; and for field application, such surfaces as are found in concrete box culverts, bridges, and pavements.~~

~~6.2.1. Following compaction, remove the extension collar, carefully trim the compacted soil even with the top of the mold by means of the straightedge, and determine the mass of the mold and moist soil in kilograms to the nearest 5 g, or determine the mass in pounds to the nearest 0.01 pounds. For molds conforming to tolerances given in T 99 and masses recorded in kilograms, multiply the mass of the compacted specimen and the mold, minus the mass of the mold, by 1060, and record the result as the wet density, W_t, in kilograms per cubic meter, of compacted soil. For molds~~

conforming to tolerances given in T 99 and masses recorded in pounds, multiply the mass of the compacted specimen and the mold, minus the mass of the mold, by 30, and record the result as the wet density, W_t, in pounds per cubic foot, of compacted soil. For used molds out of tolerance by no more than 50 percent (T 99), use the factor for the mold as determined in accordance with T 19M/T 19.

6.3. Remove the material from the mold and slice vertically through the center. Take a representative sample of the material from one of the cut faces, determine the mass immediately, and dry in an oven at 110 ± 5°C (230 ± 9°F) for at least 12 h, or to a constant mass to determine the moisture content. The moisture sample shall have a mass not less than 100 g.

METHOD B

7. SAMPLE

7.1. Select the representative sample in accordance with Section 5, except that it shall have a mass of approximately 7 kg (16 lb).

8. PROCEDURE

8.1. Follow the same procedure as described for Method A in Section 6, except for the following: Form a specimen by compacting the prepared soil in the 152.4-mm (6-in.) mold (with collar attached) in three approximately equal layers to give a total compacted depth of about 125 mm (5-in.), each layer being compacted by 56 uniformly distributed blows from the rammer. For molds conforming to tolerances given in T 99 and masses recorded in kilograms, multiply the mass of the compacted specimen and the mold, minus the mass of the mold, by 471, and record the result as the wet density, W_t, in kilograms per cubic meter of compacted soil. For molds conforming to tolerances given in T 99 and masses recorded in pounds, multiply the mass of the compacted specimen and the mold, minus the mass of the mold, by 13.33, and record the result as the wet density, W_t, in pounds per cubic foot, of the compacted soil. For used molds out of tolerance by no more than 50 percent (T 99), use the factor for the mold as determined in accordance with T 19M/T 19.

METHOD C

9. SAMPLE

9.1. If the soil sample is damp when received from the field, dry it until it becomes friable under a trowel. Drying may be in air or by use of a drying apparatus such that the temperature does not exceed 60°C (140°F). Then thoroughly break up the aggregations in such a manner as to avoid reducing the natural size of individual particles.

9.2. Sieve an adequate quantity of the representative pulverized soil over the 19.0-mm sieve. Discard the coarse material, if any, retained on the 19.0-mm sieve (Note 3).

Note 3 — The discarded coarse material may be utilized in T 224.

9.3. Select a representative sample having a mass of approximately 5 kg (12 lb) or more of the soil prepared as described in Sections 9.1 and 9.2.

10. PROCEDURE

10.1. Thoroughly mix the selected representative sample with sufficient water to dampen it to approximately 4 percentage points below optimum moisture content. Greater accuracy in the determination of the maximum density will result as the moisture content used approaches the optimum moisture content.

10.2. Form a specimen by compacting the prepared soil in the 101.6-mm (4-in.) mold (with collar attached) in three approximately equal layers to give total compacted depth of about 125 mm (5 in.). Compact each layer by 25 uniformly distributed blows from the rammer dropping free from a height of 305 mm (12 in.) above the elevation of the soil when a sleeve-type rammer is used or from 305 mm (12 in.) above the approximate elevation of each finely compacted layer when a stationary mounted type rammer is used. During compaction, the mold shall rest firmly on a dense, uniform, rigid, and stable foundation (Note 2).

10.2.1. Following compaction, remove the extension collar and carefully trim the compacted soil even with the top of the mold by means of the straightedge. Holes developed in the surface by removal of coarse material shall be patched with smaller-size material. Determine the mass of the mold and moist soil in kilograms to the nearest 5 grams, or determine the mass in pounds to the nearest 0.01 pounds. For molds conforming to tolerances given in T 99 and masses recorded in kilograms, multiply the mass of the compacted specimen and the mold, minus the mass of the mold, by 1060, and record the result as the wet density, W_t, in kilograms per cubic meter of compacted soil. For molds conforming to tolerances given in T 99 and masses recorded in pounds, multiply the mass of the compacted specimen and the mold, minus the mass of the mold, by 30, and record the result as the wet density, W_t, in pounds per cubic foot, of compacted soil. For used molds out of tolerance by no more than 50 percent (T 99), use the factor for the mold as determined in accordance with Section 8 (Calibration of Measure) of T 19M/T 19.

10.3. Remove the material from the mold and slice vertically through the center. Take a representative sample of the material from one of the cut faces, determine the mass immediately, and dry to a constant mass using a drying apparatus described in T 99 to determine the moisture content. The moisture sample shall have a mass no less than 500 g.

METHOD D

11. SAMPLE

11.1. Select the representative sample in accordance with Section 9.3 except that it shall have a mass of approximately 11 kg (25 lb).

12. PROCEDURE

12.1. Follow the same procedure as described for Method C in Section 10, except for the following: Form a specimen by compacting the prepared soil in the 152.4-mm (6-in.) mold (with collar attached) in three approximately equal layers to give a total compacted depth of about 125 mm (5 in.), each layer being compacted by 56 uniformly distributed blows from the rammer. For molds conforming to tolerances given in T 99 and masses recorded in kilograms, multiply the mass of the compacted specimen and the mold, minus the mass of the mold, by 471, and record the result as the wet density, W_t, in kilograms per cubic meter, of compacted soil. For molds conforming to tolerances given in T 99 and masses recorded in pounds, multiply the mass of the compacted specimen and the mold, minus the mass of the mold, by 13.33, and record the result as the wet density, W_t, in pounds per cubic foot, of the compacted soil. For used molds out of

~~tolerance by no more than 50 percent (T 99), use the factor for the mold as determined in accordance with Section 8 (Calibration of Measure) of T 19M/T 19.~~

8. MAXIMUM DENSITY AND OPTIMUM MOISTURE CONTENT DETERMINATION

8.1. An individual moisture/density curve as determined by T 99 or T 180 or a family of curves as developed by R XX may be used for the reference curve(s).

8.2. *Individual moisture/density curve*:

8.2.1. Moisture content must be within in 80 to 100 percent of optimum moisture of the reference curve. Compact another specimen, using the same material, at adjusted moisture content if the one-point does not fall in the 80 to 100 percent of optimum moisture range.

8.2.2. Plot the one-point moisture content as the abscissa and the corresponding dry density (unit mass) of the soil as ordinate to define the one-point on the reference curve.

8.2.3. Use the maximum dry density and optimum moisture content defined by the curve when the one-point falls on the curve or within ±2.0 lbs/ft^3 of the curve at the one-point moisture content (Figure 1).

8.2.4. Perform a full moisture/density relationship if the one-point determination cannot meet these requirements.

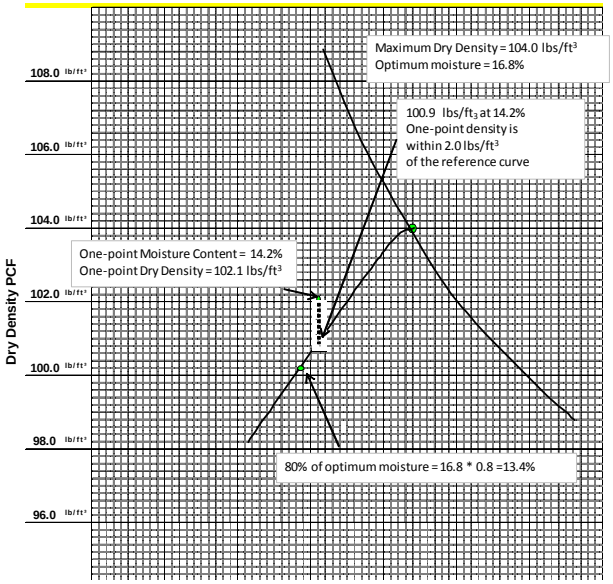

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Figure 1—Determining maximum dry density and optimum moisture content using individual moisture/density curve.

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8.3. *Family of curves:*

8.3.1. Plot the one-point moisture content as the abscissa and the corresponding dry density (unit mass) of the soil as ordinate to define the one-point on the reference family of curves.

8.3.2. If the one-point falls on one of the curves in the family of curves, use the maximum dry density and optimum moisture content defined by that curve

8.3.3. Draw a new curve through the plotted one-point parallel and in character with the nearest existing curve in the family of curves when the one-point falls within the family but not on a curve.

8.3.4. Determine the maximum dry density and optimum moisture content as defined by the new curve. The moisture content must be within in 80 to 100 percent of the determined optimum moisture content. (Figure 2)

8.3.5. Perform a full moisture/density relationship if the one-point determination does not fall within the family or cannot meet the 80 to 100 percent range.

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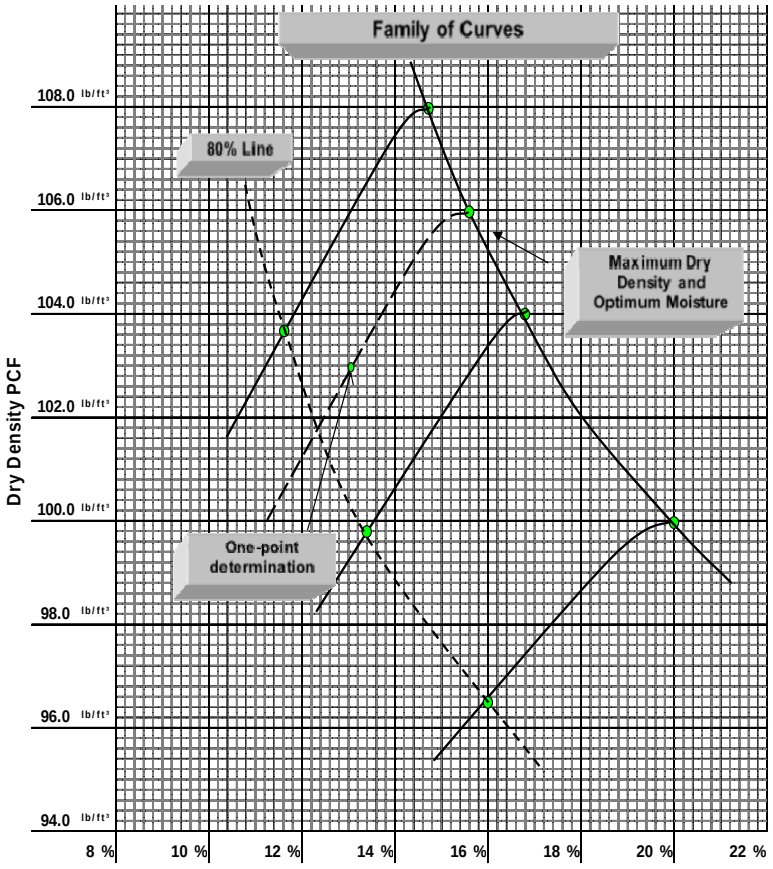

Figure 2— Determining maximum dry density and optimum moisture content using family of curves.

~~CALCULATIONS AND REPORT~~

~~13. CALCULATIONS~~

~~13.1. See T 99, Section 12.~~

~~14. MAXIMUM DENSITY AND OPTIMUM MOISTURE CONTENT DETERMINATION~~

~~14.1. The calculations in Section 13.1 shall be made to determine the moisture content and corresponding oven-dry mass (density) in kilograms per cubic meter (pounds per cubic foot) of the compacted specimen. The dry density (unit mass) of the soil shall be plotted as ordinate and the corresponding moisture content as the abscissa to define one-point within or on the family of curves (Figure 1).~~

~~14.2. If the one-point falls on one of the curves in the family of curves, the maximum dry density and optimum moisture content defined by that curve shall be used (Note 4).~~

~~14.3. If the one-point falls within the family but not on a curve, a new curve shall be drawn through the plotted one-point parallel and in character with the nearest existing curve in the family of curves. The maximum dry density and optimum moisture content as defined by the new curve shall be used (Note 4).~~

~~**Note 4**—If the one-point plotted within or on the family of curves does not fall in the 80 to 100 percent of optimum moisture range, compact another specimen, using the same material, at an adjusted moisture content that will place the one-point within this range.~~

~~14.3.1. If the family of curves is such that the profile of a new curve to be drawn through a one-point is not well defined or in any way questionable, then a full moisture-density relationship shall be made for the soil in question to correctly define the new curve and verify the applicability of the family of curves (Note 5).~~

~~**Note 5**—New curves drawn through plotted one-point determinations shall not become a permanent part of the family of curves until verified by a full moisture-density relationship.~~

~~15.~~9. REPORT

~~15.1.~~9.1. *The report shall include the following*:

~~15.1.1.~~9.1.1. The method used (Method A, B, C, or D).

~~15.1.2.~~9.1.2. The optimum moisture content as a percentage to the nearest whole number.

~~15.1.3.~~9.1.3. The maximum density to the nearest 0.5 kg/m^3 (1.0 lb/ft^3).

15.1.4. In Methods C and D, indicate if the material retained on the 19.0-mm sieve was removed or replaced.

15.1.5. Type of face if other than 50.8-mm (2-in.) circular.

Note 6—Inherent variability of soils places limitations on this method of test. The person using this test method must realize this and become thoroughly familiar with the material being tested. Knowledge of the AASHTO Soil Classification System and ability to recognize the gradation of soils are requirements for this work.

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APPENDIX
(Nonmandatory Information)

X1. DEVELOPING A MOISTURE-DENSITY FAMILY OF CURVES

X1.1. The purpose of the family of curves is to represent the average moisture-density characteristics of the material. The family must, therefore, be based on moisture-density relationships that adequately represent the entire mass range and all types of material for which the family is to be used. It may be that particular soil types have moisture-density relationships that differ considerably and cannot be represented on one general family of curves; in this case, a separate family may be developed. Also, moisture-density relationships for material of widely varying geologic origins should be carefully examined to determine if separate families are required.

X1.2. When a small number of moisture-density relationships are being used to develop a family of curves, plot the point representing the maximum density and optimum moisture content for each relationship on a single sheet of graph paper. Draw a smooth curve as close as possible to connect all the points. This line will define the maximum density and optimum moisture content of the material represented by this family of curves. At 1-kg (2-lb) increments, draw moisture-density curves with slopes similar to the slopes of the original moisture-density relationships. Slopes should gradually steepen, going from low to high maximum density material.

X1.3. When a great number of moisture-density relationships are available, the above procedure can be modified by using average values. Tabulate the maximum density, optimum moisture content, and slope for all moisture-density relationships in each 1-kg (2-lb) increment of density. Average the maximum densities and optimum moisture contents for each increment and plot these values. As before, draw a smooth curve as close as possible to connect all the points. Determine the average slope for each increment, and at each 1-kg (2-lb) increment, draw a moisture-density curve using this average slope value. A computer may be used to accomplish this work.

X1.4. The accuracy of a family of curves can be checked by comparing the maximum density and optimum moisture content from an individual moisture-density relationship with that obtained using the One-Point Method and family of curves. A point representing 80 percent of optimum moisture content is taken from the individual moisture-density relationship and used as described in the One-Point Method to determine the maximum density and optimum moisture content from the family of curves. These values are compared with the values from the individual moisture-density relationship. The difference represents the maximum variance expected when the One-Point Method and family of curves are used for material represented by that individual moisture-density relationship. This comparison should be made for all types of material over the mass range of the family. Based on these results, some adjustments may be necessary to the family, and/or it may be recognized that the family is not applicable to some types of material. Families based on relatively few moisture-density relationships will generally require the closest scrutiny, because it can be expected that a larger number of relationships will give better average conditions.

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Standard Practice for Developing a Family of Curves

AASHTO Designation: R-XX

AASHTO
THE VOICE OF TRANSPORTATION

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

Standard Practice for

Developing a Family of Curves

AASHTO Designation: R XX

1. SCOPE

1.1. This standard practice provides a process for developing a family of curves using multiple individual moisture/density relationships (curves) developed according to T 99 or T 180.

1.2. The values stated in SI units are to be regarded as the standard.

2. REFERENCED DOCUMENTS

2.1. *AASHTO Standards*:

T 99, Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop

T 180, Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

3. TERMINOLOGY

3.1. *family of curves* - a group of soil moisture-density relationships (curves) determined using T 99 or T 180 which reveal certain similarities and trends characteristic of the soil type and source.

4. SIGNIFICANCE AND USE

4.1. All curves used in a family must be developed using a single Method: A, B, C, or D of T 99 or T 180.

4.2. Curves are plotted on a graph; the family is developed by drawing a smooth line through the maximum density/optimum moisture points. At least three curves are required to form a single family.

4.3. Generally, it will be found that higher unit mass soils assume steeper slopes with maximum dry densities at lower optimum moisture contents, while the lower unit mass soils assume flatter, more gently sloped curves with higher optimum moisture contents (Figure 1).

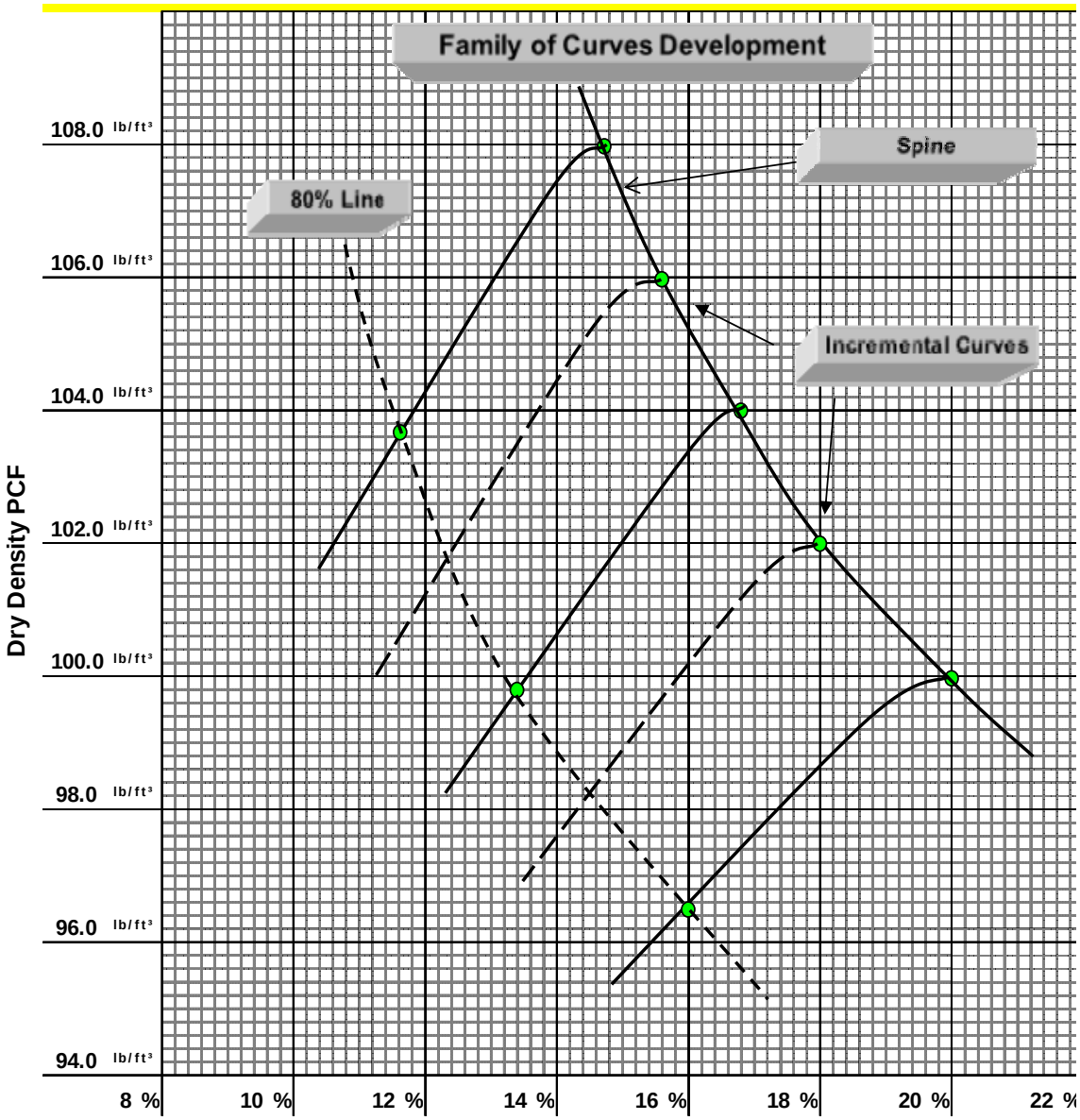

Figure 1—Example of Curves

5. DEVELOPING A MOISTURE-DENSITY FAMILY OF CURVES

5.1. Sort the curves by Method (A, B, C or D of T 99 or T 180). At least three curves are required per family.

5.2. Select the highest and lowest maximum dry densities from those selected to assist in determining the desired scale of the subsequent graph.

5.3. Plot the maximum density and optimum moisture points of the selected curves on the graph.

5.4. Draw a smooth, “best fit,” curved line through the points creating the spine of the family of curves (Figure 1).

5.5. Remove maximum density and optimum moisture points that were not used to establish the spine.

5.6. Add the moisture/density curves associated with the points that were used to establish the spine. It is not necessary to include the portion of the curves over optimum moisture.

Note 1: Intermediate template curves using slopes similar to those of the original moisture-density curves may be included when maximum density points are more than 2.0 lbs/ft^3 apart. Template curves are indicated by a dashed line.

5.7. Plot the 80 percent of optimum moisture range when desired:

5.7.1. Using the optimum moisture of an existing curve, calculate 80 percent of optimum moisture and plot this value on the curve. Repeat for each curve in the family.

5.7.2. Draw a smooth, “best fit,” curved line connecting the points plotted on the curves that parallels the spine.