LONG TERM PAVEMENT PERFORMANCE PROGRAM DIRECTIVE

For The Technical Direction Of The LTPP Program

Program Area:	Monitoring	Directive Number:	SM-11
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Subject:	Field Density Test for Use with TDR Moisture Content Determination		

The SMP study is relying on TDR probes installed at each test site to monitor subsurface moisture contents over time. Volumetric moisture contents are estimated from the TDR-derived dielectric constant, using one of several relationships currently available in the literature -- e.g., Topp's equation. Conversion from volumetric to gravimetric moisture content is based on an estimate of the material's dry density.

Estimates of dry density are obtained from test pit density measurements or laboratory tests on test pit samples taken from the top 305 mm of the subgrade surface. While this density provides a good starting point, results of a research study currently underway at the FHWA clearly show that compactive effort has a tremendous impact on the TDR-derived moisture predictions. Accordingly, effective immediately, a single field density (one-point Proctor) test will be performed at SMP sites where instrumentation has not yet been installed.

As the instrumentation borehole is excavated and soil recovered in buckets, a sample of soil will be taken and compacted in a Proctor mold, to determine the unit weight, moisture content and dry density of the material; the sample will subsequently be returned to the appropriate bucket and, in turn, back to the borehole. The specific procedure to be followed by the RCOCs is detailed in the attached document titled "Field Density (One-Point) Test for Use with TDR Moisture Content Determination".

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FIELD DENSITY (ONE-POINT PROCTOR) TEST
FOR USE WITH
TDR MOISTURE CONTENT DETERMINATION

PURPOSE

The TDR moisture probe measures the dielectric constant of a soil-moisture-air mixture by comparing the "apparent" electrical length of the probe from the TDR signal to is actual length. The volumetric moisture content is estimated from this measured dielectric constant using a relationship (regression equation) such as was developed by Topp et al. Conversion of volumetric moisture content to gravimetric (weight basis) moisture content requires use of an estimate of the dry density of the soil.

Currently this estimate utilizes density values obtained from test pit density measurements or laboratory tests on test pit samples taken from the top 305 mm (12 in) of the subgrade surface. In view of recent findings on the magnitude of changes in moisture content caused by different degrees of compaction, it is considered prudent to include an actual density determination during installation of the TDR probes at seasonal monitoring sites.

REPRESENTATIVE DRY DENSITY DETERMINATION (see AASHTO T99-86)

Equipment:

1. One 102 mm (4 in) diameter steel Proctor mold with extension collar and 2.5 kg (5.5 lb) Proctor rammer

2. One 200 mm (8 in) steel spatula and soil scoop

3. One large mixing pan or tray

4. One 250 mm (10 in) long steel straight edge

5. One balance (capacity 11.5 kg, readability 5 g)

Procedure:

1. Take approximately 3 kg (7 lb) of soil from the material that is being collected from the installation borehole at a depth of about 1.2 m (4 ft). Place it in the mixing pan. Remove any large size rocks [> 10 mm (0.5 in)], and return them to the appropriate collection container.

2. Take a moisture sample, approximately 100 g, for moisture content determination in the field.

   Notes: (1) Values measured or calculated during the moisture content determination must be recorded on lines "m" through "r" of Data Sheet SMP-I07.

(2) If so desired, moisture content determinations can be performed in the laboratory instead of the field or as a verification to the field measurements.

(3) If moisture content determination is not performed immediately after sample is taken, place sample in plastic zip bag and seal bag. If test is done in the laboratory, place plastic zip bag inside another suitable bag or container and label with section number and date.

3. Determine the weight of the 102 mm (4 in) diameter x 150 mm (4.6 in) high empty metal mold [interior volume is 943.9 cm^3 (1/30 ft^3)]. Record weight in line "a" of Data Sheet SMP-I07.

4. Assemble the mold and collar on the base plate and secure with thumb screws.

5. Place the soil material in the mold, push the spatula down through the soil several times to re-distribute the larger particles, and compact each of three layers using 25 blows of the compaction rammer to obtain a cylinder of soil about 125 mm (5 in) in height. The 50 mm (2 in) diameter face of the compaction rammer should be moved after each blow so that the 25 blows are uniformly distributed over the area of the mold. The 2.5 kg (5.5 lb) hammer has to be dropped free within the guiding sleeve -- i.e. the rammer should be held vertically, and the weight allowed to drop freely through a 305 mm (12 in) fall.

   During compaction the base plate and mold should rest on a solid foundation such as the pavement or culvert wall.

6. Remove the 50 mm (2 in) collar and trim the soil column with the steel straight edge to a flat surface even with the top of the mold.

7. Remove mold from the base plate and obtain the weight in grams to the nearest 5 g, or in pounds to the nearest 0.01 lb. Record weight in line "b" of Data Sheet SMP-I07.

8. Subtract the weight of the mold from the weight of the mold and compacted soil to get the weight of the compacted soil. Record weight in line "c" of Data Sheet SMP-I07.

9. Divide the weight of the sample by the volume of the mold -- 943.9 cm^3 (1/30 ft^3) -- to determine the unit weight of the compacted soil. Record weight in line "d" of Data Sheet SMP-I07. This value represents the wet density of the material.

10. After the moisture content of the material is determined, use this value to determine the dry density of the soil. Record dry density in line "e" of Data Sheet SMP-I07.

11. Extrude or otherwise remove the compacted soil to the appropriate collection container for return later to the borehole.

LTPP Seasonal Monitoring Program Data Sheet SMP-I07 Representative Dry Density	Agency Code [_ _] LTPP Section ID [_ _ _ _]

Depth of Representative Sample (from pavement surface): _._ _ m

Dry Density Determination:

a.	Tare Weight of Empty Mold:		_ _ _ _ g (_._ _ lb)
b.	Weight of Mold and Compacted Soil:		_ _ _ _ g (_._ _ lb)
c.	Weight of Compacted Soil (b - a):		_ _ _ _ g (_._ _ lb)
d.	Unit Weight of Compacted Soil = (c / 943.0) =		_._ _ g/cm^3
		([c / (1 / 30)] =	_ _ _._ lb/ft^3)
e.	Dry Density of Compacted Soil = [d / (1 + r/100)] =		_._ _ g/cm^3
			(_ _ _._ lb/ft^3)

Moisture Content Determination:

m.	Tare Weight of Pan:	_ _ _._ g
n.	Weight of Pan and Moisture Sample:	_ _ _._ g
o.	Weight of Pan and Dry Sample:	_ _ _._ g
p.	Weight of Moisture (n - o):	_ _ _._ g
q.	Weight of Dry Sample (o - m):	_ _ _._ g
r.	Moisture Content by Weight = [(p / q) * 100] =	_ _._ %

Comments: _____

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Prepared by: _____ Employer: _____

Date (dd/mmm/yy): _ _ / _ _ _ / _ _