DEPARTMENT OF TRANSPORTATION
DIVISION OF ENGINEERING SERVICES
Transportation Laboratory
5900 Folsom Blvd.
Sacramento, California 95819-4612

METHOD OF TEST FOR SURFACE SKID RESISTANCE WITH THE CALIFORNIA PORTABLE SKID TESTER OR CONTINUOUS FRICTION MEASURING EQUIPMENT

A. SCOPE

This test method describes the procedures for mixture design and testing for full-depth recycling of asphalt pavements using foamed asphalt as recycling agent and additives (FDR-FA).

The values stated in either International System of Units (SI units) or inch-pound units are to be regarded separately as standard. The values stated in each The apparatus and procedure for obtaining friction values of asphalt and Portland cement concrete pavements and bridge decks using a portable skid tester or Continuous Friction Measuring Equipment (CFME) are described in this test method. This test method is divided into the following parts:

1. California Portable Skid Tester Procedure
2. CFME Test Procedure

B. REFERENCES

California Test 114	Calibration of the California Portable Skid Tester
ASTM E3304	Standard Test Method for Measuring the Skid Resistance of Pavements and Other Trafficked Surfaces Using a Walking Speed Continuous Friction-Measuring Equipment (CFME) Fixed-Slip Technique
ASTM E2340	Standard Test Method for Measuring the Skid Resistance of Pavements and Other Trafficked Surfaces Using a Continuous Reading, Fixed-Slip Technique
ASTM E1551	Standard Specification for a Size 4.00-8 Smooth Tread Friction Test Tire

C. SIGNIFICANCE AND USE

California Test 342 provides a standardized method for evaluating surface skid resistance on asphalt and Portland cement concrete pavements and bridge decks using the California Portable Skid Tester. This test is critical for assessing pavement safety and ensuring consistent friction measurements across various surface types. This standard also outlines the use of walking speed Continuous Friction Measurement Equipment (CFME) for assessing surface friction on various trafficked surfaces, ASTM E3304/ASTM E2340. Walking speed CFMEs are designed for low-speed friction surveys and offers several operational advantages including: conducting surveys from a standing or rolling start, and suitability for urban and confined environments.

D. APPARATUS

1. California Portable Skid Tester

An ASTM Test Tire E1551 with 25 (±. 2) psi air pressure. The tire is brought to the required test speed by a motor. A carriage moves on two parallel guides. Friction is reduced to a low uniform value with three roller bearings fitted at 120˚ points to bear against the guide rod at each corner of the carriage. Two guide rods are rigidly connected to the end frame bars.

The front end of the guide bar frame assembly is firmly fastened to a bumper hitch to restrain forward movement. The bumper hitch provides for swinging the skid tester to the right or left after positioning the vehicle. The rear end of the frame assembly is raised by an adjustable knob to hold the tire ¼ in. above the surface to be tested. This device is constructed so that the tire may be dropped instantaneously to the test surface by tripping the release arm. A tachometer indicates the speed of the tire in miles per hour (mph). The springs are calibrated by procedures outlined in California Test 114. See Figures 1, 2 and 3.

A trailer hitch is used to fasten the skid testing unit to the test vehicle.

A 28 in. long metal carpenter's level, fitted at one end with a movable gage rod, is required. This device is calibrated to determine surface grades, in percent.

2. Continuous Friction Measurement Equipment (CFME)

An ASTM E3304 compliant Continuous Friction Measurement Equipment (CFME) configured with either two inline wheels or three wheels, one of which is designated as the measuring tire. The CFME shall be designed to measure friction by the braked wheel using the fixed slip principle with a

slip ratio around 17%. The measuring tire is mounted to a friction-measuring assembly capable of applying and recording a consistent vertical load. The friction-measuring cell is designed to detect and record a minimum horizontal force of 10 kg. The measuring tire is maintained in continuous contact with the test surface during operation, and the vertical load is applied through a calibrated spring or hydraulic mechanism. The measuring system is capable of operating at walking speed.

The CFME is equipped with a friction-measuring system integrated with a computer system for real-time data acquisition, recording, and presentation. The computer system may be built into the CFME housing or externally connected via cable or wireless interface. The CFME shall measure the friction property of the pavement surface in terms of a "friction value," which is generated from the CFME after a completed test. The "friction value" shall have a value within the range of 0.30 – 1.20.

E. MATERIALS AND EQUIPMENT

1. Glycerin
2. Water
3. Paint brush (approximately 2 in. wide)
4. Wooden spacer (1/4 in. thick, 2 ft. long and 1 in. wide)
5. A stiff fiber broom
6. Air pressure gauge
7. Infrared thermometer
8. Tread depth gauge

PART 1. CALIFORNIA PORTABLE SKID TESTER

1A. PROCEDURE

1. Clean loose material from the test surface using the stiff fiber broom.
2. Determine the grade of the test surface.
    a. Place the metal level on the test surface parallel to direction of traffic with the adjustable end down grade.

b. Adjust the level until the bubble is centered.

c. The grade is read directly on the calibrated sliding bar. See Figure 4. Record this slope to nearest 0.5 %.

3. Remove the skid testing unit from the vehicle, attach it to the bumper hitch, and connect the power cables as shown in Figure 5.

4. Position the skid tester with the test tire over the pavement surface to be tested. The test tire should be parallel to the direction of traffic.

5. Place the wooden spacer under the test tire and turn the adjustment knob to obtain a distance of¼ in. from the test surface to the bottom of the test tire. Remove the wooden spacer.

6. Wet the full circumference of the test tire and the test surface (from the initial tire contact point to approximately one foot ahead of the contact point) with glycerin, using the paint brush.

7. Release the rebound shock absorber. This device is located in front of the switch, and below the motor.

8. Set the sliding gage indicator against the carriage end.

9. Depress the starting switch and bring the test tire speed to approximately 55 mph.

10. Release starting switch.

11. Drop the test tire to the pavement surface the instant the tachometer shows 50 mph. This is performed by engaging the lever arm.

12. Read the gage at the rear edge of the indicator and record the test measurement. Obtain a coefficient of friction value for the smoothest appearing surface or surfaces on the project. For a pavement surface, obtain five test measurements and report the average as the coefficient of friction. Make the tests in a longitudinal direction at 25 ft intervals, unless any test measurement is less than the specified minimum. If less than the specified minimum, make five test measurements at 2 ft intervals within or including the smoothest appearing area. For a bridge deck, obtain the coefficient of friction value by averaging three test measurements. Space each test location for this average no nearer than 2 ft nor farther than 4 ft, from any other test location. The spacing may be lateral or longitudinal, but perform the test measurement in a longitudinal direction. For

coefficient of friction values less than the specified minimum, use a combination of visual observations and individual test measurements to define the area of noncompliance.

1B. CALCULATIONS

1. Make pavement corrections due to slope changes using Figures 6 and 7.

2. Average the corrected readings for each test location.

   Example: The following readings were taken at 25 ft intervals in a test location

Test Location	Test Measurement	% Grade	Corrected Test Measurement*
1+00	0.37	+2	0.39
1+25	0.38	+1	0.39
1+50	0.40	+1	0.41
1+75	0.39	+1	0.40
2+00	0.41	+1	0.42
Average Coefficient of Friction =			0.40

   *Corrected values for upgrade measurements were taken from chart in Figure 6.

   Examples of coefficient of friction values for different pavement textures are presented in the Appendix

1C. PRECAUTIONS

1. The rear support rod must be cleaned by washing frequently with water and a detergent to prevent sticking. A coating of light oil should be applied.

2. Sliding gage indicator must be kept clean so that it will slide very freely and adjusted so that it will not shift upon carriage recoil impact.

3. Glycerin remaining on the surface after the test should be flushed off with water.

4. A minimum of seven days should lapse after PCC placement before testing.

5. A minimum of one day should lapse after HMA placement before testing.

6. Temperatures less than 40°F will cause glycerin to become viscous and yield lower values. For full accuracy, coefficient of friction values must be obtained at temperatures greater than 40°F.

7. At the conclusion of a testing period, thoroughly wash the entire tester with water and carefully dry all parts with a cloth to minimize the corrosive properties of glycerin.

8. Use care when removing and reinserting the test apparatus in the transport vehicle. See Figures 8 and 9.

1D. REPORTING OF RESULTS

1. The report shall include the following data:

2. The name of the tester and the date when test measurements were recorded

3. The contract number

4. The year when the pavement surface was placed

5. The location of the test measurements

6. The surface grade for each test site

7. The initial and corrected test measurements and the average coefficient of friction value for each test location

8. Average air temperature during testing

9. Report California Portable Friction Tester value to the nearest hundredth of a decimal point.

PART 2. CONTINUOUS FRICTION MEASURMENT EQUIPMENT

2A. PROCEDURE

1. Ensure that all tires rotate freely on the CFME.

2. Check the condition and tire pressure for all tires on the CFME.

   a. Three-wheel CFME Measuring tire: 5 psi & 1mm tread depth, and no more than two years old from the manufacturer date.

   b. Three-wheel CFME Drive Tires: 10 psi & 1.6 mm tread depth.

3. Perform a self-test of the sensors on the CFME to verify calibration, per manufacturer specifications.

4. Ensure all user settings, e.g., water level, number of measurements per foot, are correct before making friction measurements.

2B. FIELD CALIBRATION/VALIDATION

1. Perform a calibration check according to the manufacturer's specifications before the first surface friction test at a new location, or as required by project specifications.

2. Use an infrared thermometer and pressure meter for pavement temperature and tire pressure, respectively

   a. Prior to initiating any CFME testing, verify that surface temperature conditions fall within the acceptable range of 41°F to 98°F (5°C to + 37 °C).

   b. Inspect the CFME to ensure it is operational and capable of performing measurements reliably under current weather conditions, including rain, snow, or extreme heat.

   c. Note the environmental conditions at the time of testing, including temperature, precipitation, and surface status (e.g., dry, wet, icy).

   d. If environmental conditions fall outside the specified range or present hazards that may compromise data integrity, suspend testing until conditions improve or corrective measures are implemented.

3. Ensure all sensors, electronics, and mechanical components of the CFME are functioning properly and are not adversely affected by the current weather or temperature.

4. Maintain a log of any environmental anomalies encountered during testing and note any adjustments made to the procedure or equipment setup.

2C. CFME TWO-WHEEL PROCEDURE

1. Friction data must be collected continuously along the longitudinal direction of traffic flow.

2. Data must be captured at a minimum resolution sufficient to produce a friction value, i.e., 1 data point per two feet.

3. Place the CFME battery switch to On. The display will show (Measure) START. If not, press the HOME button to go to (Measure) START.

4. Start the Tablet PC, then select the program icon (teacup icon).

5. Verify the Bluetooth connection is OK in the side panel. The word ONLINE will appear on a green background.

6. Press the Operator Control Panel OK button to start a survey.

7. The friction test may be started from a static position or at walking speed.

8. Water Option: turn On the switch of the Water Tank, before to start the survey.

9. Walk to the desired stopping point at a normal slow walking speed, minimum 0.9 m.p.h. (1.3 feet per second), maximum 2.5 mph. (3.5 feet per second), when making a survey. Ensure the handlebar is free and not causing an error in friction Mu value. At the stopping point, press the OK button to stop the survey and to transfer the data to the Tablet PC, a siren sound is heard from the Tablet PC to indicate the data transfer is completed.

10. During testing, the CFME device shall display the friction value, speed, and distance.

11. If a water system is used, ensure the water flow is present.

12. Make three friction tests along the longitudinal direction of traffic flow.

13. The allowable deviation limits are specified by the CFME manufacturer.

14. Water: turn off the switch of the Water Tank to stop the water flow.

15. Drive back to the starting point with the tires on the wet surface. Keep tires wet and cool. Repeat test.

2D. CFME THREE-WHEEL PROCEDURE

1. Friction data must be collected continuously along the longitudinal direction of traffic flow.

2. Data must be captured at a minimum resolution sufficient to produce a friction value, i.e., 1 data point per two feet.

3. Record the survey surface angle

4. Press Quick Run test option button.

5. Water: turn On the switch of the Water Tank, before to start the survey.

6. Once ready, start to walk to speed and press the Start/Stop button when passing the mark to begin the test.

7. When the survey starts an audible tone can be heard:

    a. Continuous Tone: Too Fast

    b. Intermittent Tone: Too Slow

    c. No tone: Acceptable Speed, in direct relation to the speedometer and the settings.

8. When the end mark of the test is reached, press the Start/Stop button.

9. Make three friction tests over the same friction measurement area. The allowable deviation limits are specified by the CFME manufacturer.

10. When the Quick Run is completed, name the survey and save it, otherwise save it (a consecutive number is assigned automatically).

11. Press to start Another Run, or if it is the last run has been completed, press End Survey and turn it off by pressing the green button until the unit turns off.

2E. TEST SECTION REQUIREMENTS

1. A minimum of three (3) test sections shall be designated for evaluation. Each test section consists of three (3) CFME measurements.

2. Each test section must provide 12 feet of continuous, uninterrupted surface suitable for friction measurement.

    a. A lead-in and lead-out distance of 3 feet is included to allow for stabilization of CFME measurement systems.

3. The surface of each test section shall be cleared of loose material and foreign objects prior to testing.

4. Each test section shall be clearly marked to indicate the start and end points.

2F. REPORTING OF RESULTS

1. Each CFME test report shall include, at a minimum:
    a. Name of CFME operator and test technician
    b. Date and time of test
    c. Equipment ID identification (make, model, serial number, software version, and calibration date)
2. Project location (route, direction, postmile limits)
3. Surface type
4. Environmental conditions (air and pavement temperature, weather)
5. Test section layout with start and end stationing
6. Summary table of averaged friction values for each test section
7. Data trimming percentage
8. CFME Data file in approved digital format (CSV or equivalent)

2G. RESULTS

1. Friction data shall be recorded for each individual pass.
2. Friction values shall be computed for each pass.
3. For each test section, the average friction value shall be calculated from the three overlapping passes.
4. Ensure that test results are greater than 0.30 and less than 1.20 for valid test results.
5. Data shall be visualized and analyzed using manufacturer-approved CFME software.
6. Report CFME friction value to the nearest hundredth of a decimal point.

2H. DATA TRIMMING AND VALIDITY

1. In walking-speed CFME operations, variations may occur at the beginning and end of each pass due to acceleration and

deceleration.

2. During data extraction, trimming of the lead in and lead out portions is permitted but the total trimmed data length must equal or exceed a total of six feet of testing length.

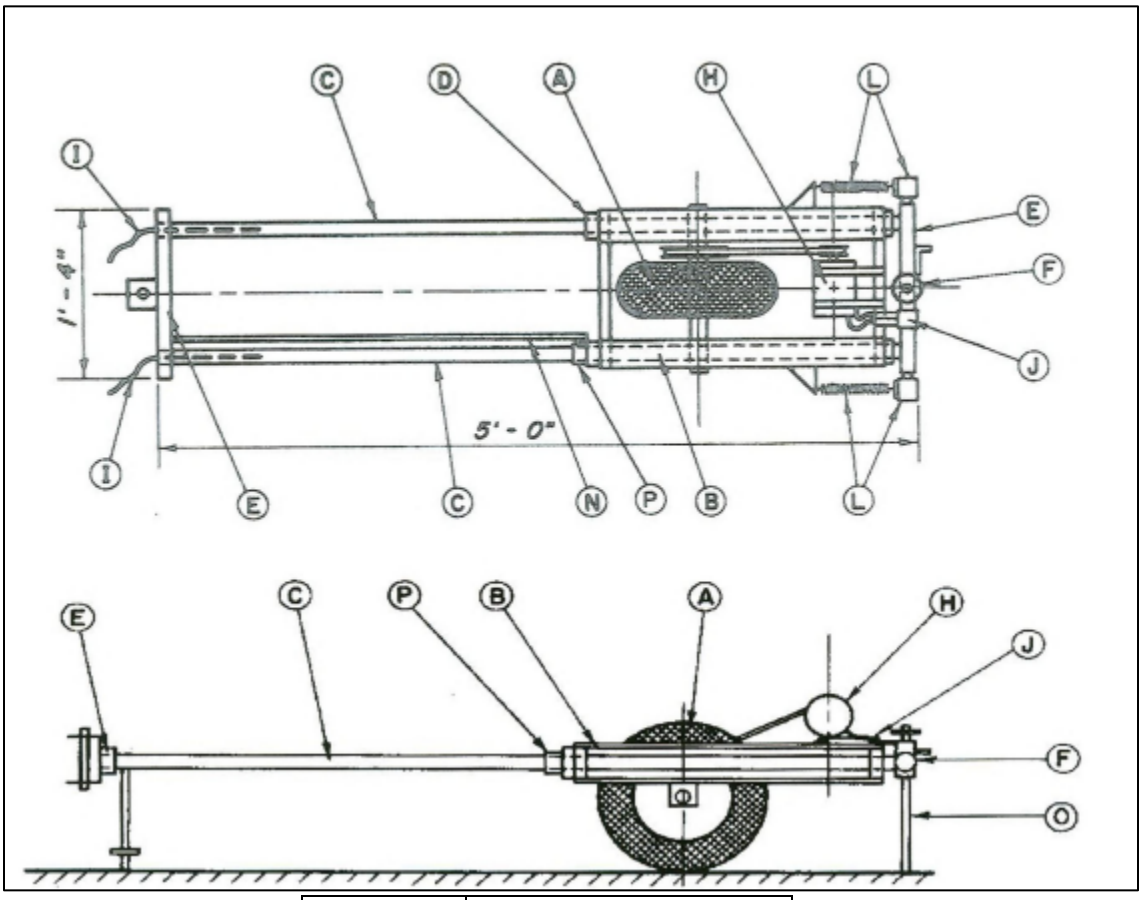
3. Retained data must constitute at least six feet of the original dataset to be considered valid. The objective of data extraction is to minimize the CV while preserving a reasonable data length as presented in Figure 10.

F. HEALTH AND SAFETY

It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Prior to handling, testing, or disposing of any materials, testers must be knowledgeable about safe laboratory practices, hazards and exposure, chemical procurement and storage, and personal protective apparel and equipment.

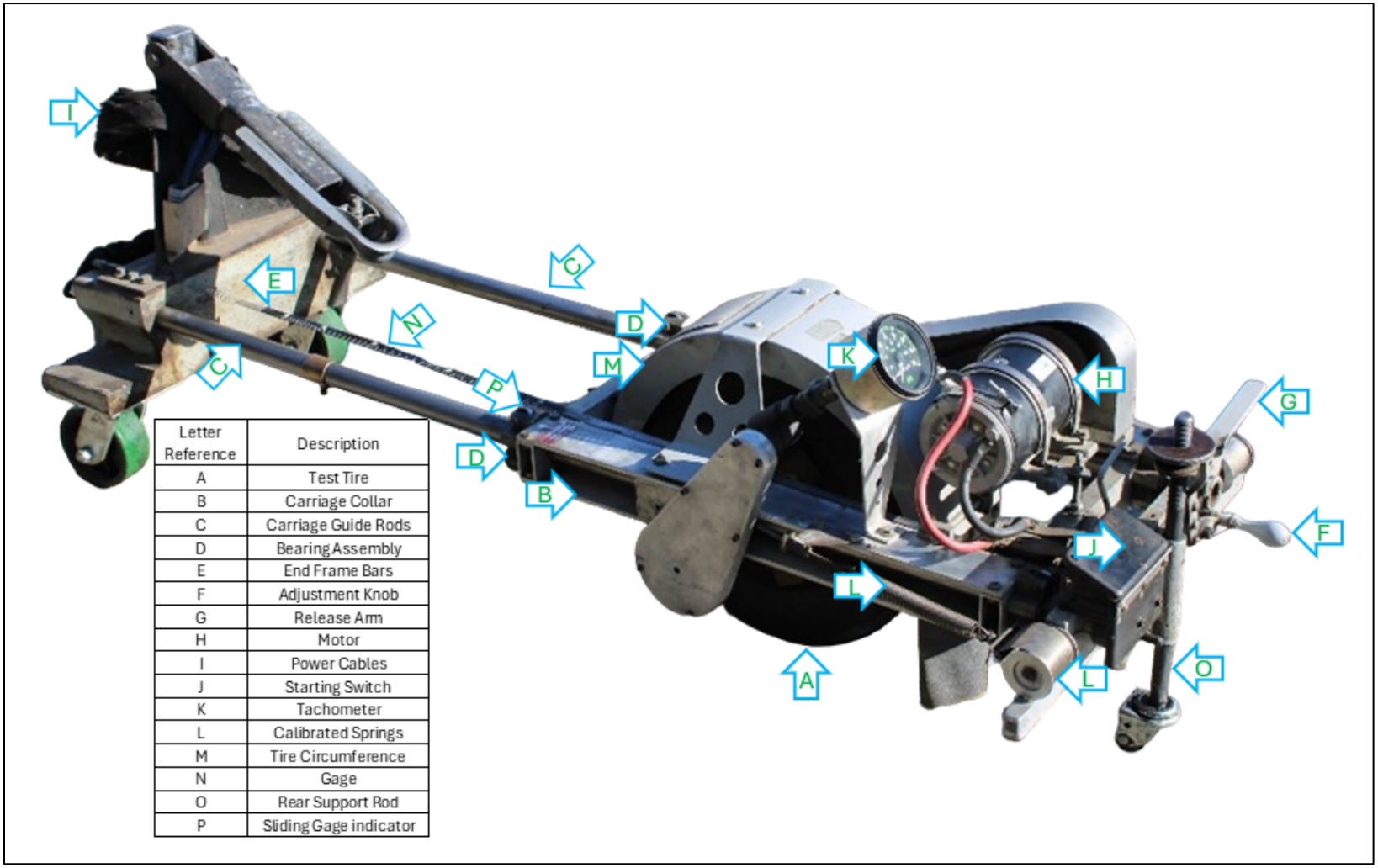
Refer to the Safety Manual for your Laboratory.

End of Text
(California Test 342 contains 23 pages)



Letter Reference	Description
A	Test Tire
B	Carriage Collar
C	Carriage Guide Rods
D	Bearing Assembly
E	End Frame Bars
F	Adjustment Knob
G	Release Arm
H	Motor
I	Power Cables
J	Starting Switch
K	Tachometer
L	Calibrated Springs
M	Tire Circumference
N	Gage
O	Rear Support Rod
P	Sliding Gage Indicator

Figure1. Diagram of PST



Letter Reference	Description
A	Test Tire
B	Carriage Collar
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H	Motor
I	Power Cables
J	Starting Switch
K	Tachometer
L	Calibrated Springs
M	Tire Circumference
N	Gage
O	Rear Support Rod
P	Sliding Gage indicator

Figure 2. Side view of the PST



Figure 3. Close-up view of the PST



Figure 4. Level for measuring pavement slope



Figure 5. Equipment in test position

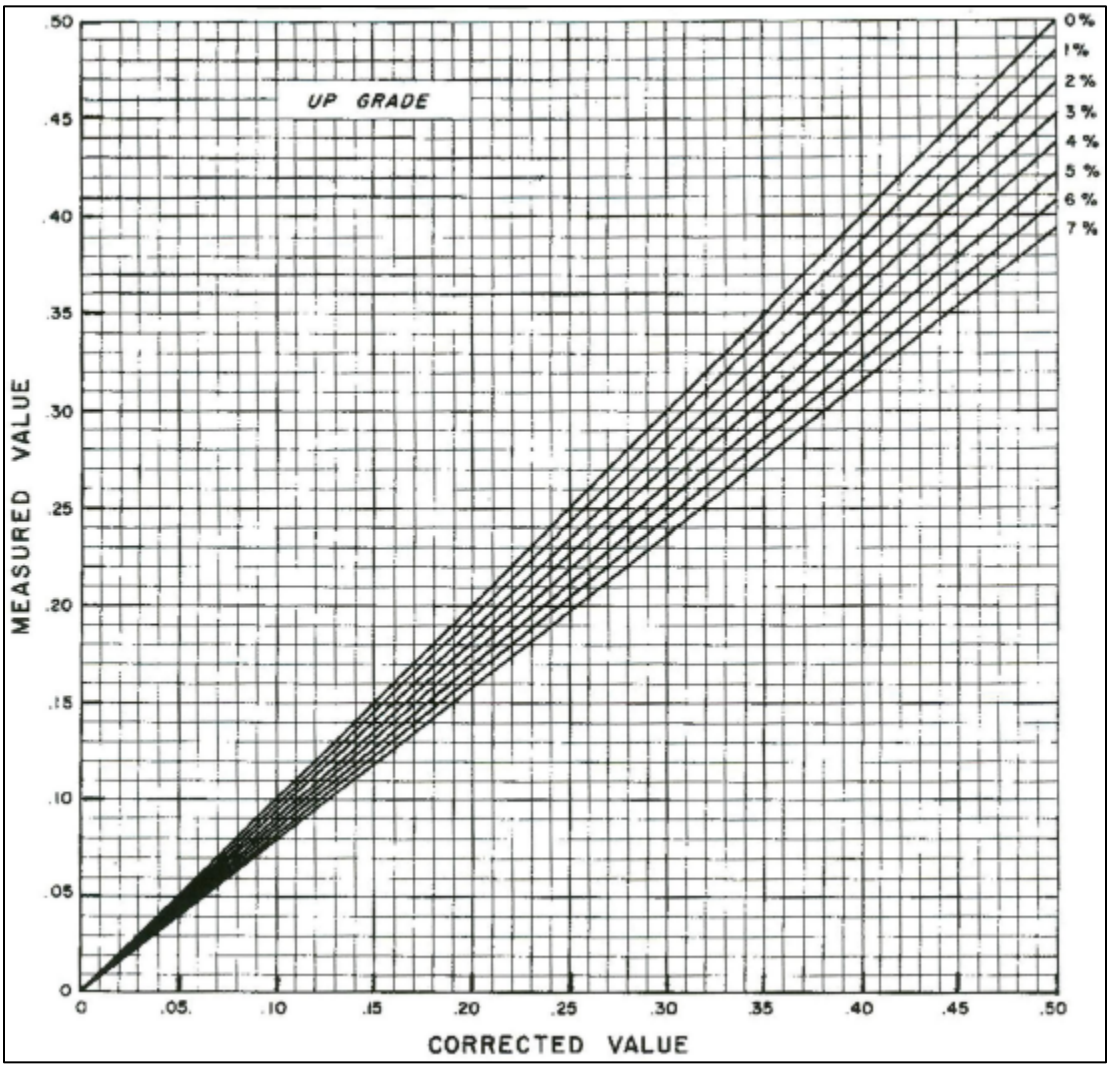


Figure 6. Coefficient of friction correction chart for measurements made on grades (Up Grade)

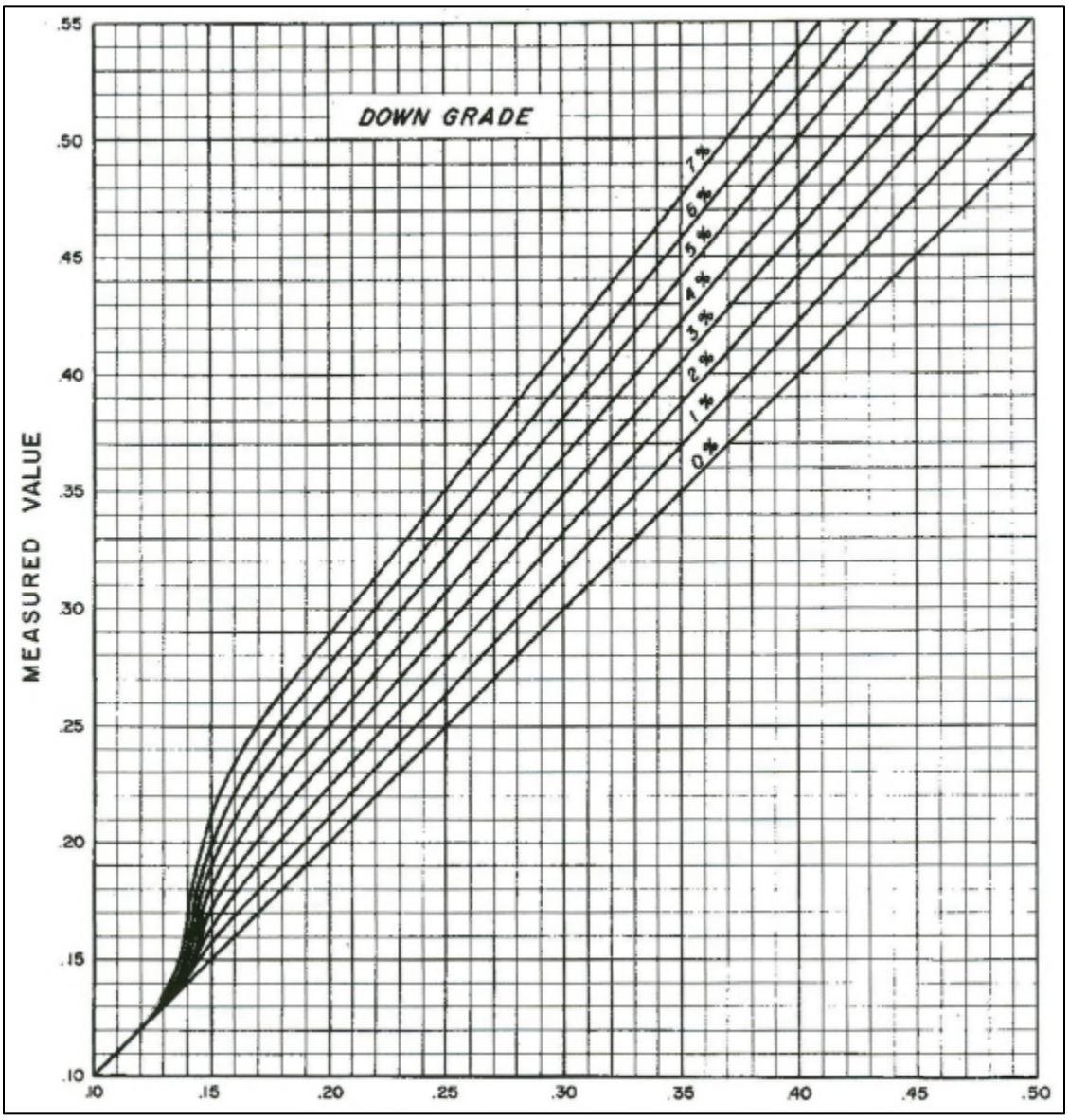


Figure 7. Coefficient of friction correction chart for measurements made on grades (Down Grade)



Figure 8. PST being placed in the vehicle by a cable with a winch.



Figure 9. PST in position for transportation.

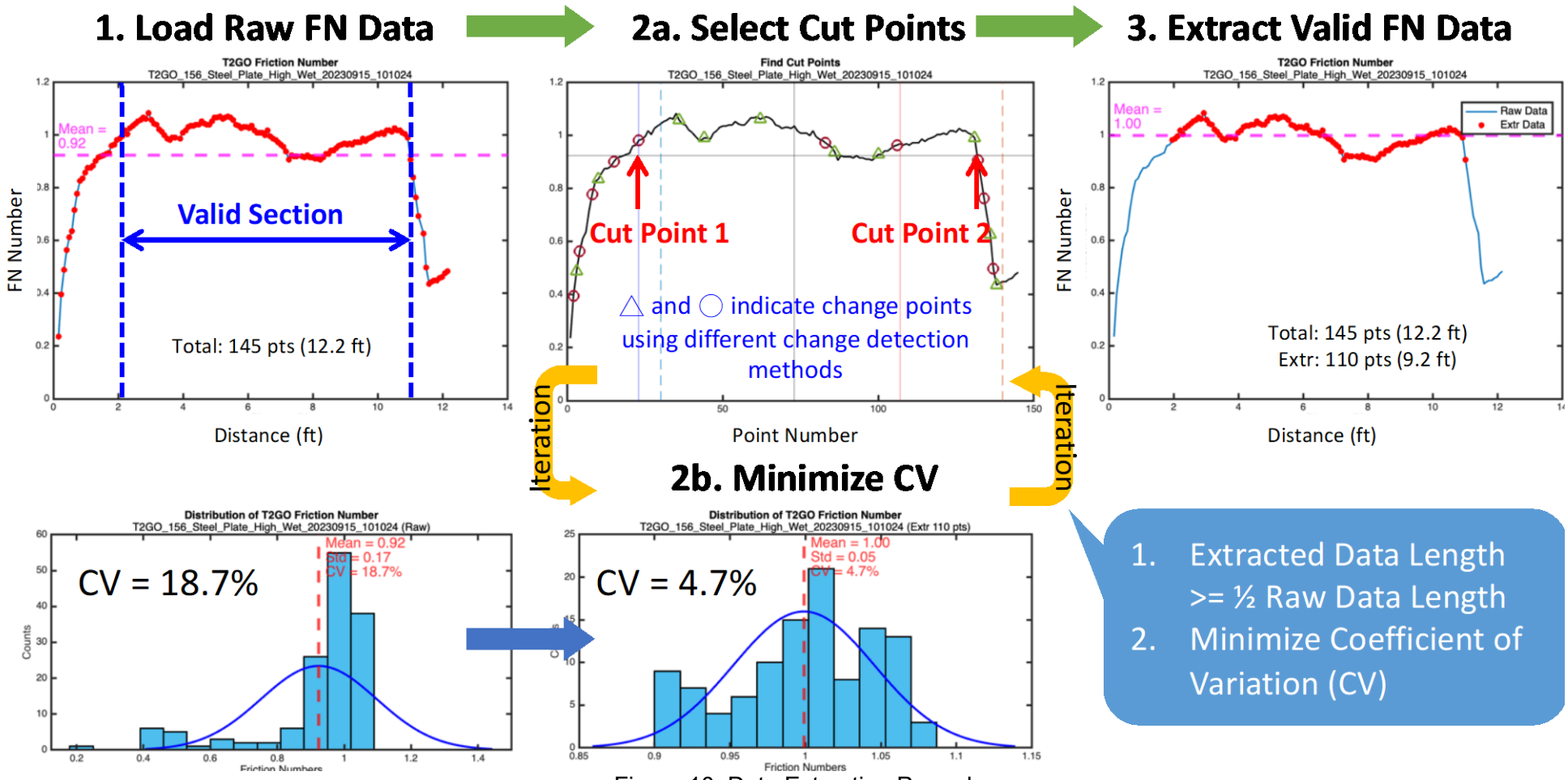


Figure 10. Data Extraction Procedure

REPORT OF PAVEMENT SKID TESTS

California Department of Transportation
Division of Engineering Services
Materials Engineering and Testing Services
Office of Roadway Materials Testing
5900 Folsom Boulevard, Sacramento, California 95819

Work Requested By: Requester
Requestor's Telephone Number: Ph #
Dist.-Co.-Rte.-PM/PM : 03-Yol-505-PM 23.5/26.5
Project No.: Project #/Phase (EFIS)
Direction & No. of Lanes: Dir (EB,WB,NB,SB) - # of lanes
Type of Surface(s): (PCC, Polyester Concrete, etc.)

Weather: condition
Test Method: CT 342
Request No.: PD06_03#02
Tested By: tester/tester
Date(s) of Test(s): 03/06/09 - 03/07/09
Date(s) Surface(s) Placed: 02/02/09 - 02/05/09

Air Temperature: Deg°F
Fed Aided?: Yes / No
Equipment: PST # 1/2

Position: In the direction of travel, measurements are taken perpendicularly from the left/right edge of the pavement.
Project Stationing: The project stationing is used as the location reference.

RWT=Right Wheel Track
LWT=Left Wheel Track
NB=Northbound Direction of Travel
SB=Southbound Direction of Travel
EB=Eastbound Direction of Travel
WB=Westbound Direction of Travel

Test No.	Location			Percent Grade	Test Measurement			Remarks and Date Surfacing Placed
	Project Stationing (Feet)	Direction & Lane #	Position (Feet)		Measured	Corrected	Average *	
1	125+00	NB LN 1 LWT	5.0	0	0.37	0.37		
	125+25	NB LN 1 LWT	5.0	0	0.35	0.35		
	125+50	NB LN 1 LWT	5.0	0	0.36	0.36		
	125+75	NB LN 1 LWT	5.0	0	0.38	0.38		
	126+00	NB LN 1 LWT	5.0	0	0.37	0.37	0.37	Placed 02/02/09
2								
3								
4								
							Average:	0.37

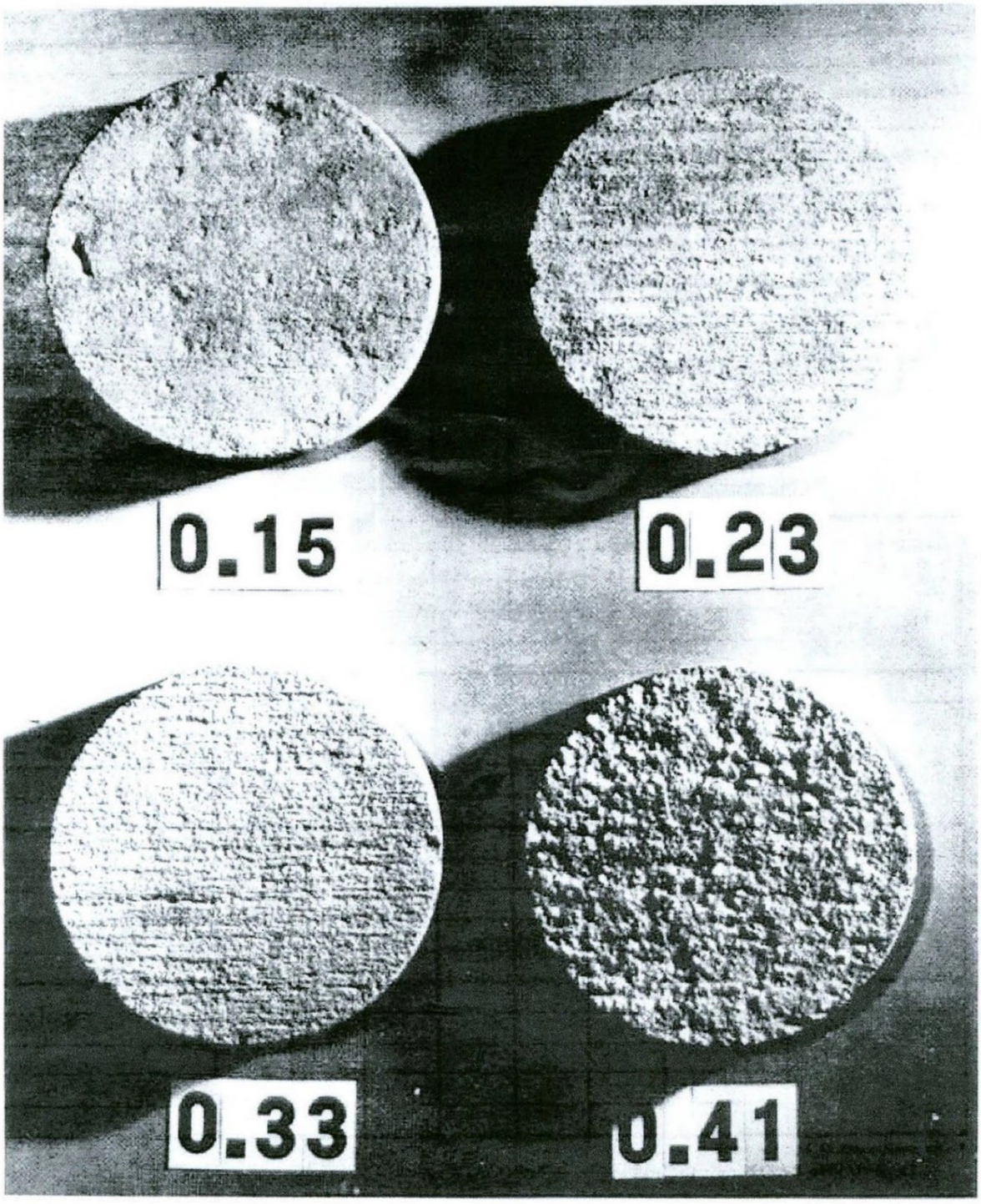
Tire Pressure: Pressure psi
Tire Pressure Specs: 25 psi +/- 2 psi
Calibration: Calibration Plate #
Calib. Plate #2 Specs: 0.42/0.30 +/- 0.02

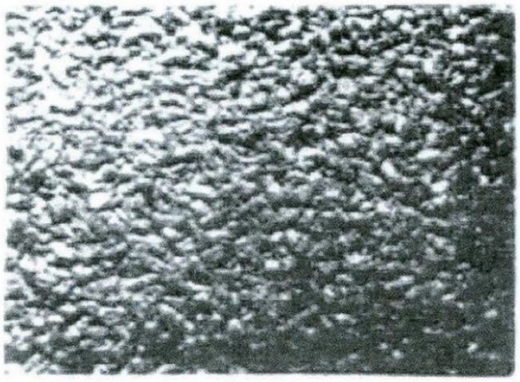
* The coefficient of friction value as measured by California Test 342

Reported By: reporter
Checked By: checker
Pavement Testing Branch
(916) 227-5847

Figure 11. Report Form

APPENDIX
COEFFICIENT OF FRICTION VALUES FOR TYPICAL PORTLAND CEMENT CONCRETE SURFACES ILLUSTRATING A RANGE OF TEXTURES

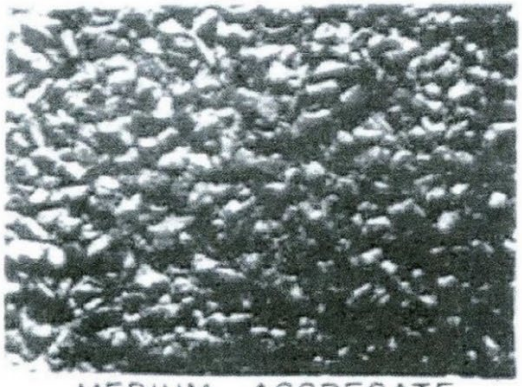




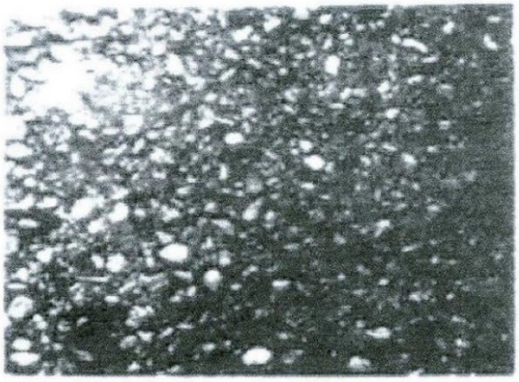
TYPICAL OPEN GRADED
0.39



TYPICAL DENSE GRADED
0.37



MEDIUM AGGREGATE
CHIP SEAL
0.43



CHIP SEAL WITH SOME
CHIPS IMBEDDED OR MISSING
0.37



EXCESSIVE FOG SEAL
OVER DGAC
0.15



BLEEDING OR FLUSHING
DGAC
0.13

COEFFICIENT OF FRICTION VALUES FOR
VARIOUS ASPHALT CONCRETE SURFACES