

DEPARTMENT OF TRANSPORTATION
ENGINEERING SERVICES
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OPERATION OF CALIFORNIA PROFILOGRAPH AND EVALUATION OF PROFILES

CAUTION: Prior to handling test materials, performing equipment setups, and/or conducting this method, testers are required to read “**SAFETY AND HEALTH**” in Part 4 of this method. It is the responsibility of the user of this method to consult and use departmental safety and health practices and determine the applicability of regulatory limitations before any testing is performed.

A. SCOPE

The operation of the California profilograph, the procedures used for determining the Profile Index from profilograms of pavements made with the profilograph, and the procedure used to locate individual high points in excess of 7.5 mm are described in Parts 1, 2, and 3, respectively, in this test method.

PART 1. USE OF THE CALIFORNIA PROFILOGRAPH

A. EQUIPMENT

The California profilograph consists of a frame 7.62 m in length supported upon wheels at either end. The profile is recorded from the vertical movement of a wheel attached to the frame at mid-point and is in reference to the mean elevation of the points of contact with the road surface established by the support wheels (see Figure 1). The profilogram is recorded on a scale of 1 mm equal to 300 mm longitudinally, and 1 mm equal to 1 mm, or full scale, vertically. Motive power may be provided manually or by the use of a propulsion unit provided it does not adversely affect the operation or function of the profilograph in any manner. The

propulsion unit shall not be used to push the profilograph from behind.

The profilograph may be either a manual or an automated model.

B. OPERATION AND CALIBRATION OF THE PROFILOGRAPH

B.1 OPERATION

The instructions for assembling the profilograph are contained in a booklet accompanying each unit.

In operation, the profilograph should be moved at a speed no greater than a walk so as to eliminate as much bounce as possible. Too high a speed will result in a profilogram with excessive spikes that may be difficult to evaluate.

B.2 CALIBRATION

The profilograph shall be calibrated both horizontally and vertically prior to use in the project, weekly during use and at such times as the Engineer determines verification is necessary. Calibrations should be performed per the manufacturer's recommendations.

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Additionally, vertical calibration is required after every profile wheel change and each re-assembly of the profilograph. The air pressure of the profile wheel shall be checked daily. A log of the tire pressure and the calibration information shall be kept with the profilograph.

The horizontal calibration standard is a straight roadway section at least 160 m (528 ft) long, measured accurately to within 0.32 m (1.05 ft), or 0.2% of the length. The roadway test section shall be measured by a measuring tape or wheel or other means acceptable to the Engineer.

Proof of calibration shall be in the form of a recording on a chart for the manual devices or a printed document for the automated devices.

Horizontal calibration shall be accepted when the following procedures have been successfully completed:

Perform horizontal calibration by pushing the profilograph over a measured test section at least 160 m (528 ft) long.

With manual devices determine the scale factor by dividing the length of this test section in meters (feet) by the length of the recording on the chart, measured to the nearest 1.27 mm (0.5 in.)

This factor must be 300.00 with a tolerance of 2.4 (0.8%).

For the automated devices the profilograph shall be rerun over the same calibrated distance to assure that the diagnostic was performed correctly. The tolerance is 1.28 m (4.20 ft)

The vertical deflection standards are flat plates of known thickness or a single device with graduated thickness. The initial plate will be used to place the profile wheel on a flat surface and establish a baseline value in which to measure subsequent elevations. The initial thickness may not exceed 25.4 mm (1.0

in.). Ensure that the initial plate is firmly seated so that it cannot flex or tilt. Subsequent measurements shall be at 25.4 mm (1 in.) and 50.8 mm (2 in.) and accurate to within 0.254 mm (0.01 in) in thickness.

Vertical calibration shall be accepted when the following procedure has been successfully completed:

Perform vertical calibration on a flat, level area using the standard plates of known thickness or a single device with graduated thickness.

Elevate the profile wheel and place the initial plate or initial step of the graduated device under the wheel to establish the baseline elevation value.

When the wheel has been lowered onto the plate mark the recorder pen elevation on the manual device or record the elevation displayed on the automated device.

Elevate the wheel again and insert another plate on top of the initial baseline plate under the wheel or slide the graduated device to the next elevation. Again mark the recorder pen elevation on the manual device or record the displayed elevation on the automated device

Elevate the wheel again and insert another plate on top of the second plate under the wheel or slide the graduated device to the next elevation. Again mark the recorder pen elevation on the manual device or record the displayed elevation on the automated device

Reverse this process, by removing the two individual plates one at a time or stepping down the graduated device and marking or recording the change in elevation after the removal of each successive plate

The calibration is considered complete, if the marking pen or recorded elevation returns to the original position, obtained from the initial plate used to establish a baseline value, +/- 0.76 mm (0.03 in.)

Adjust chart deviations in excess of 0.76 mm (0.03 in.) according to the manufacturer's recommendations.

The profilograph shall also be able to demonstrate an acceptable repeatability level, the acceptable level is defined as, "after three tests, difference in the measured PI shall not exceed a PI of 1 between any two tests, when testing pavements with a PI of up to 15.

If required by the Engineer, all model test results must correlate to those generated by the Department's profilograph to within a Profile Index (PI) of 1 for pavement surfaces up to a PI of 15.

PART 2. DETERMINATION OF THE PROFILE INDEX

A. EQUIPMENT

The Profile Index can be determined by the use of an automated or manual profilograph model. Both models will create a profile trace or profilogram. The profile trace or profilogram shall indicate the Profile Index (PI) for the required distance as well as the location of all scallops in excess of 7.5 mm.

The Profile Index is defined as "millimeters per 0.1km in excess of the 5 mm blanking band,"

A.1 AUTOMATED PROFILOGRAPH

An automated profilograph device collects data by means of a digital response resulting from the vertical movement of the profile wheel. The data collected shall be processed by a software program capable of generating a computerized profile trace or profilogram. The computer software shall be set with the following settings:

Data Filters

- Filter Type: 3rd Order Butterworth
- Filter Length: 610 mm (2.0 ft)
- Blanking Band: 5 mm
- Bump Locator: On
- Bottom Bump: Off

Alternative settings will only be allowed with the approval of the Engineer.

A.2 MANUAL PROFILOGRAPH

A manual profilograph collects data by measuring with a pen-recording device on a paper reel resulting from the vertical movement of the profile wheel.

The Profile Index from the manually generated profilograph trace can be determined by using a scanning device or by a manual count.

To determine the Profile Index manually, use a plastic scale 40 mm wide and 333.3 mm long representing a pavement length of 100 m or 0.1 km at a scale of 1:300. A plastic scale for the profilograph may be obtained by the districts from the Transportation Laboratory. Near the center of the scale is an opaque band 5 mm wide extending the entire length. On either side of this band are scribed lines 2 mm apart and parallel to the opaque band. These lines are used to measure deviations or excursions of the graph above or below the blanking band. The deviations are called "scallops".

B. METHOD OF COUNTING

Place the plastic scale over the profile in such a way as to "blank out" as much of the profile as possible. When this is done, scallops above and below the blanking band usually will be approximately balanced. See Figure 1.

The profile trace will move from a generally horizontal position when going around super elevated curves making it impossible to blank out the central portion of the trace without shifting the scale. When such conditions occur, the profile should be broken into short sections and the blanking band repositioned on each section while counting, as shown in the upper part of Figure 2.

Starting at the right end of the scale, measure and total the height of all the scallops appearing both above and below the blanking

band, measuring each scallop to the nearest 1 mm. Write this total on the profile sheet near the left end of the scale together with a small mark to align the scale when moving to the next section. Short portions of the profile line may be visible outside the blanking band, but unless they project 0.6 mm or more and extend longitudinally for 0.6 m (2 mm on the profilogram) or more, they are not included in the count. See Figure 1 for illustration of these special conditions.

When scallops occurring in the first 0.1 km are totaled, slide the scale to the left, aligning the right end of the scale with the small mark previously made, and proceed with the counting in the same manner. The last section counted may or may not be an even 0.1 km. If not, its length should be scaled and the counts proportioned to an equivalent 0.1 km section. For example, 9 counts in 0.07 km = 12.9 or 13 per 0.1 km.

C. LIMITATIONS OF COUNT IN 0.1 KM SECTIONS

When the specifications limit the amount of roughness in "any 0.1 km section", the scale is moved along the profile and counts made at various locations to find those sections if any, that do not conform to specifications. The limits are then noted on the profile and can be later located on the pavement preparatory to grinding.

D. LIMITS OF COUNTS — JOINTS

When counting profiles, a day's paving is considered to include the last portion of the previous day's work, which includes the daily joint. The last 5 to 10 m of a day's paving cannot usually be obtained until the following day. In general, the paving contractor is responsible for the smoothness of joints if he places the concrete pavement on both sides of the joint. On the other hand, the contractor is responsible only for the pavement placed by him if the work abuts a bridge or a pavement placed under another contract. Profilograph readings, when approaching such joints,

should be taken in conformance with current specifications.

PART 3. DETERMINATION OF HIGH POINTS IN EXCESS OF 7.5 MM

A. EQUIPMENT

Use a plastic template having a line 25 mm long scribed on one face with a small hole or scribed mark at either end, or a slot 7.5mm from and parallel to the scribed line. See Figure 2. (The 25 mm line corresponds to a horizontal distance of 7.5 m on the pavement.) The plastic template may be obtained from Transportation Laboratory.

B. LOCATING HIGH POINTS IN EXCESS OF 7.5 MM

At each prominent peak or high point on the profile trace, place the template so that the small holes or scribe marks at each end of the scribed line intersect the profile trace to form a chord across the base of the peak or indicated bump. The line on the template need not be horizontal. With a sharp pencil draw a line using the narrow slot in the template as a guide. Any portion of the trace extending above this line will indicate the approximate length and height of the deviation in excess of 7.5 mm.

There may be instances where the distance between easily recognizable low points is less than 25 mm. In such cases a shorter chord length shall be used in aligning the scribed line on the template tangent to the trace at the low points. It is the intent of this requirement that the baseline for measuring the height of bumps will be as near to 25 mm as possible, but in no case exceed this value. When the distance between prominent low points is greater than 25 mm make the ends of the scribed line intersect the profile trace when the template is in a nearly horizontal position. Examples of the possible positions are shown in Figure 2.

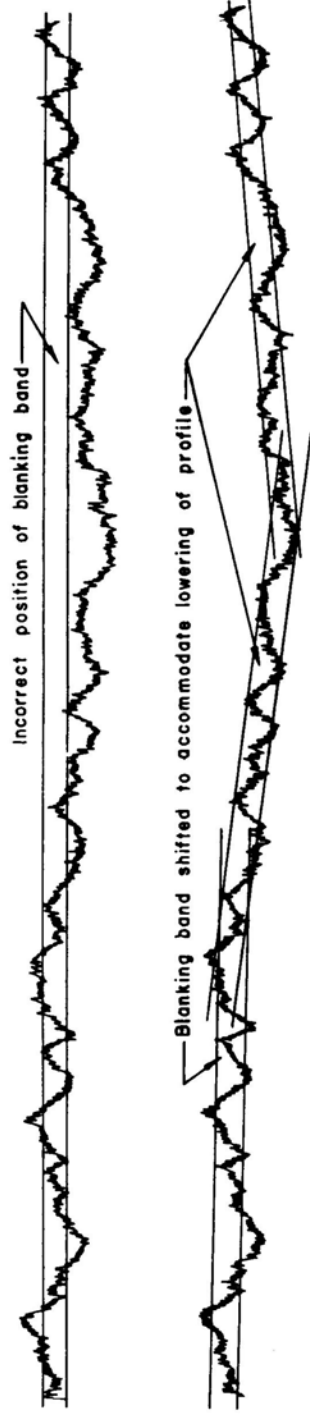
PART 4. SAFETY AND HEALTH

Use leather gloves when assembling and storing the profilograph frame. Use proper lifting methods and be aware of pinch points and sharp edges.

Prior to handling gasoline, or operating equipment, operators are required to read Caltrans Laboratory Safety Manual Part A, Section 5.0, Hazards and Employee Exposure; Part B, Section 5.0, Safe Laboratory Practices; and Part C, Section 1.0, Safe Laboratory Practices and Section 2.0, Field Operations and Testing. Users of this method do so at their own risk.

**End of Text (California Test 526 contains 8
Pages)**

**METHOD OF COUNTING WHEN POSITION OF PROFILE SHIFTS AS IT MAY
WHEN ROUNDING SHORT RADIUS CURVES WITH SUPERELEVATION**



METHOD OF PLACING TEMPLATE WHEN LOCATING BUMPS TO BE REDUCED

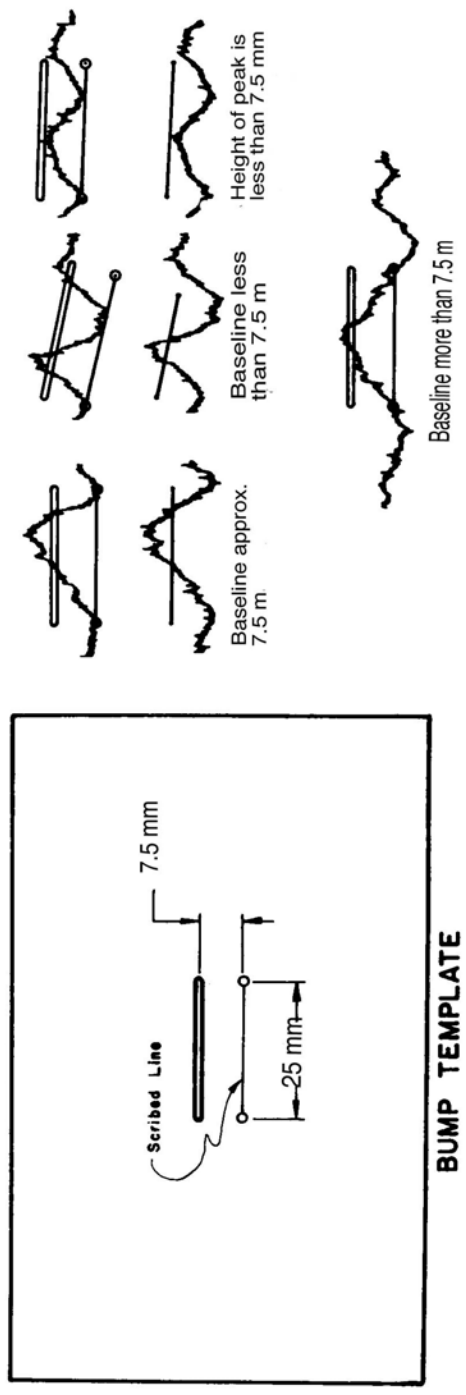


FIGURE 2

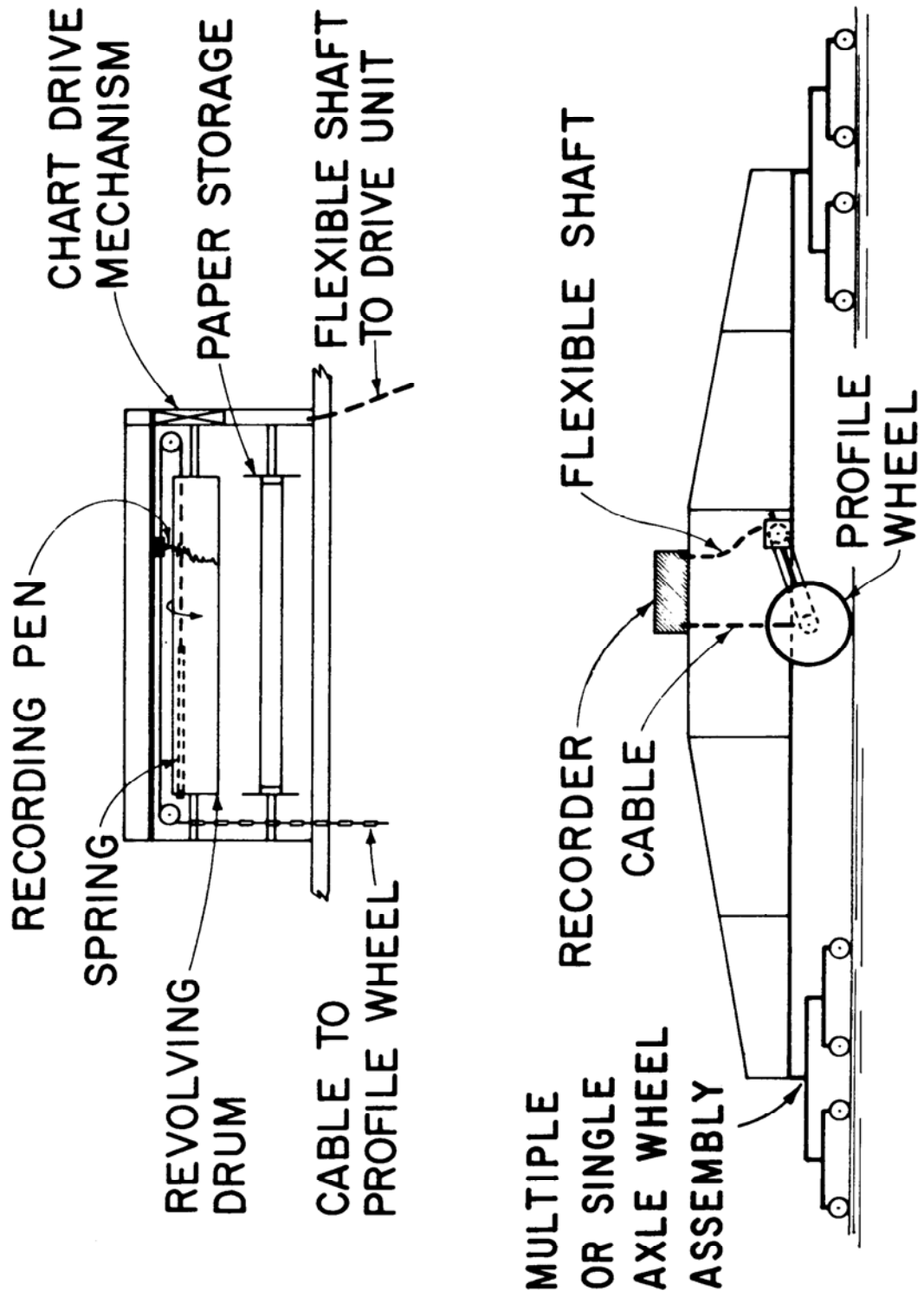


FIGURE 3