DEPARTMENT OF TRANSPORTATION
DIVISION OF ENGINEERING SERVICES
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METHOD OF TEST FOR SURFACE SMOOTHNESS USING THE BRIDGE PROFILOGRAPH

A. SCOPE

This test method describes the procedures for determining the "counts per 100 ft" from profilograms, and locating individual high points in excess of a specified limit.

B. REFERENCES

None.

C. EQUIPMENT

1. Bridge Profilograph - The Bridge Profilograph must be one of the following:

    a. 12 ft long rigid beam frame supported on one wheel at each end with an outrigger wheel for balancing support (see Figure 1a). Motive power for the beam frame profilograph is supplied manually from the push handle in the rear. Steering is accomplished by rotating the handle grip to move the front wheel.

    b. 12 ft long rigid truss frame supported on wheel assemblies (see Figure 1b). Motive power for the truss frame profilograph is supplied manually from the steering wheel located midpoint of the frame.

2. Two 1 in. blocks. You may use a multi-step block with at least a 1 in. and 2 in. step.

3. Data Recorder – The data recorder must be one of the following:

    a. For the rigid beam frame profilograph the mechanical recorder collects data and bumps resulting from the vertical movement of the profile wheel with a pen-recording device on a paper reel and produces a profilogram on a scale of 1 in. = 15 ft longitudinally and 1 in. = 1 in. vertically.

    b. For the rigid truss frame profilograph, the electronic recorder collects digital data from the vertical movement of the profile wheel and must be able to produce a hard copy profilogram on a scale of 1 in. = 15 ft longitudinally and 1 in. = 1 in. vertically.

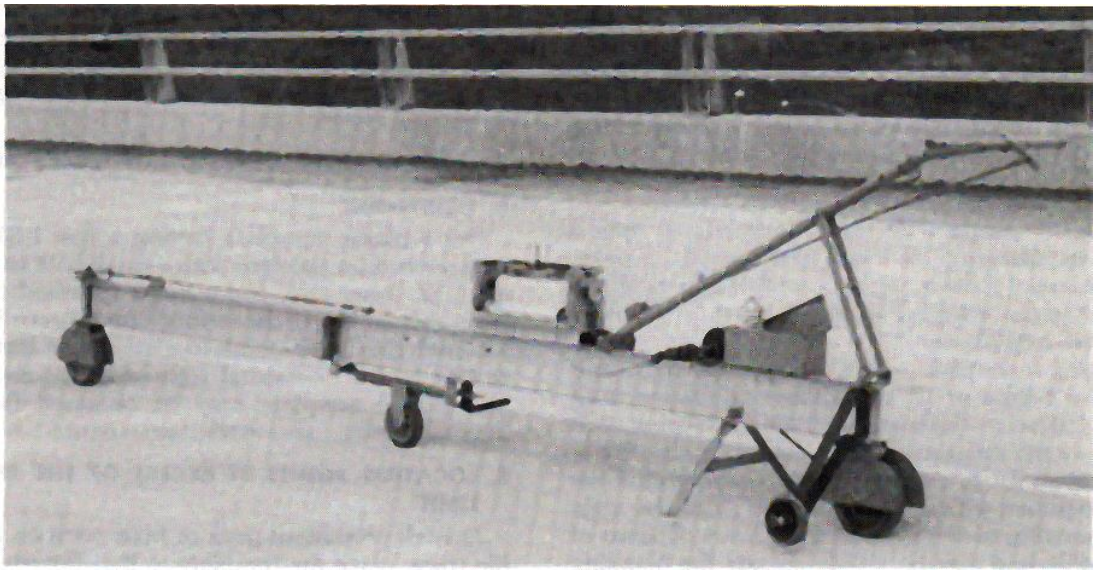

FIGURE 1a. Rigid Beam Frame Bridge Profilograph

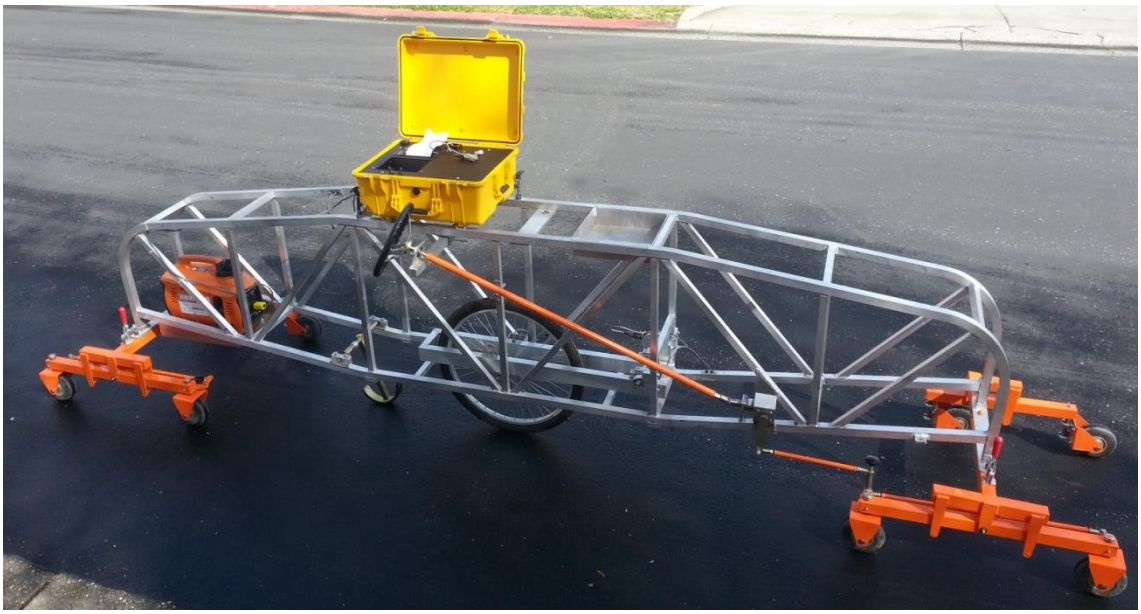

FIGURE 1b. Rigid Truss Frame Bridge Profilograph

D. PROCEDURE

PART 1. TRANSPORTATION AND ASSEMBLING

1A. The beam frame profilograph is transported and assembled in two pieces that readily bolt together. Mount the recorder using two spring clips on each end. Connect the cable from the profile wheel to the recorder for the vertical scale movement. Connect the odometer cable hookup to the recorder for the horizontal scale movement.

1B. The truss frame profilograph is transported and assembled in accordance with manufacturer's instructions supplied for each unit.

PART 2. OPERATION AND CALIBRATION OF THE PROFILOGRAPH

2A. OPERATION

Obtain profiles in accordance with the specifications for the project.

1. The bridge profile is recorded from the vertical movement of a wheel attached at the midpoint of the frame. This wheel is linked to a pen-recording device on a paper reel, or an electronic recorder, that records the movement of the center wheel from the established datum to create a profilogram.

2. When operating the profilograph, move at a speed no greater than a walk. Moving too fast will result in a profilogram with excessive spikes (chatter) that is difficult to evaluate. Sweep the deck surface clean of any loose material. Keep the bridge profilograph wheels clean and free of particles which may become embedded in the tires.

2B. CALIBRATION

The profilograph is calibrated both horizontally and vertically. These calibrations must be performed after each reassembly of the profilograph and when the Engineer determines verification is necessary.

1. Vertical calibration requires the following procedures:

   a) Place the profilograph on a flat, level area.

   b) Raise the profile wheel and place it on the 1 in. block. Mark the recorder pen elevation on the mechanical recorder or the record the elevation displayed on the computer.

   c) Raise the profile wheel again and insert the other 1 in. block on top of the first block. Mark the recorder pen elevation on the mechanical recorder or record the elevation displayed on the computer.

   d) Reverse the process by removing the individual blocks one at a time. Mark the recorder pen elevation on the mechanical recorder or record the elevation displayed on the computer.

   e) The calibration is considered complete if the marking pen or recorded evaluation returns to within ± 0.03 in. of the original starting position (ie., location at step b). If the reading is in error of more that ± 0.03 in., perform calibration again.

2. For the truss frame bridge profilograph, the profile wheel must be checked for trueness (roundness). Perform steps b) through d). Rotate the tire 45° and perform steps b) through d) again. Do this until the tire has rotated 360°.

3. Horizontal calibration requires the following procedures:

   a) Measure out 60 ft along a straight, flat bridge section with a measuring tape or wheel. Walk the bridge profilograph along the measured length.

b) For the rigid beam profilograph, verify the profilogram scale factor is 1 in. equals 15 ft. The measurement on the profilogram must be 4 in. ± 0.1 in. If the horizontal scale is out of tolerance, the rear wheel of the profilograph should be replaced with one of proper diameter. If the error is due to other causes, investigate and correct.

c) For the truss frame profilograph, the horizontal distance measured on the recording device must be 60 ft ± 0.5 ft.

4. Adjust the software parameters for the electronic bridge profilograph to the following:

PRI RIDE VALUE CALCULATION

SEGMENT LENGTH	100 FT
BUTTERWORTH FILTER	2.0 FT
FILTER GAIN	1.0

SCALLOP SETTINGS

MINIMUM HEIGHT	0.03 IN
MINIMUM WIDTH	2.25 FT
RESOLUTION	0.05 IN

LOCALIZED ROUGHNESS SETTINGS

BUMP LENGTH	20 FT
BUMP HEIGHT	0.25 IN

PART 3. DETERMINATIONS OF COUNTS PER 100 FT FROM PROFILOGRAMS

3A. MECHANICALLY RECORDED DATA

1. Procedure

a) To determine the "counts per 100 ft," use a plastic scale 1.70 in. wide and 6.66 in. long to represent a bridge deck length of 100 ft at a scale of 1 in. = 15 ft.

b) Near the center of the scale is an opaque blanking band 0.15 in. wide extending the entire length of 6.66 in. On either side of this band are scribed lines 0.10 in. apart, parallel to the opaque band. These lines serve as a convenient scale to measure deviations of the profile line above or below the blanking band. These deviations are called "scallops."=

2. Method of Counting

a) 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, any scallops that appear above and below the blanking band will be approximately balanced (See Figure 2).

b) 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 0.05 in. (half a tenth of an inch). 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 0.03 in. or more and extend longitudinally for 0.15 in. or more on the profilogram, they are not included in the count (see Figure 2 for illustration of these special conditions).

c) When scallops occurring in the first 100 ft 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 100 ft. If not, scale the last section to determine its length and then that portion of 100 ft will be prorated to equivalent 100 ft. For example:

Section Length	Counts (tenths of an inch per 100 ft)
100 ft	4
100 ft	3
100 ft	2
60 ft	3.33*

* Calculation for equivalent count:

Example: 2.0 counts in 60 ft prorated to 100 ft

$\frac{2.0}{60} = \frac{C}{100}$ where: C = prorated count

Therefore $C = \frac{2.0 \times 100}{60} = 3.33$

3B. ELECTRONICALLY RECORDED DATA

Print the profilogram and the summary detailing the starting and ending stations. See the manufacturer's instructions for interpreting data.

3C. LIMITATIONS OF COUNT IN 100 FT SECTIONS

When the specifications limit the profile count in "any 100 ft section," the scale is moved along the profile and counts made at various locations to find those sections that do not conform to specifications. The limits are noted on the profile and can be later located on the deck surface prior to grinding.

Profiles of the first and last 6 ft of the section being tested cannot be obtained until the adjoining pavement or bridge section is in place. At such time that the concrete bridge approach/departure pavement are to be evaluated, profiles should be obtained starting at least 60 ft prior to each structure or approach/departure pavement and continuing to at least 25 ft onto the bridge deck.

PART 4. DETERMINATION OF HIGH POINTS AND LOCATION OF POINTS IN EXCESS OF THE SPECIFIED LIMIT

4A. MECHANICALLY RECORDED DATA

Use a plastic template having a line 1.33 in. long scribed on one face with a small hole or scribed mark at either end, and a slot a specified distance from and parallel to the scribed line (See Figure 3). The 1.33 in. line corresponds to a horizontal distance of 20 ft on the horizontal scale of the profilogram.

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. Place the template along the trend line of the profile trace. The template does not need to 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 the specified limit.

There may be instances where the distance between easily recognizable low points is less than 20 ft. In such cases, a shorter chord length must be used in making the scribed line from the template tangent to the profile trace at the low points. It is the intent, however, of this requirement that the baseline for measuring the height of bumps will be as close to 20 ft as possible, but in no case exceed this value.

When the distance between prominent low points is greater than 20 ft, make the ends of the scribed line intersect the profile trace when the template is in a nearly horizontal position.

Record bump locations on profilogram and then locate them on the bridge deck prior to grinding. Refer to Figure 3 for examples of high point identification.

4B. ELECTRONICALLY RECORDED DATA

Print the profilogram and the summary detailing the starting and ending stations. The high points are highlighted or shaded areas on the printed profilogram. See the manufacturer's instructions for interpreting data.

E. 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.

Caltrans Laboratory Safety Manual is available at:

http://www.dot.ca.gov/hq/esc/ctms/pdf/lab_safety_manual.pdf

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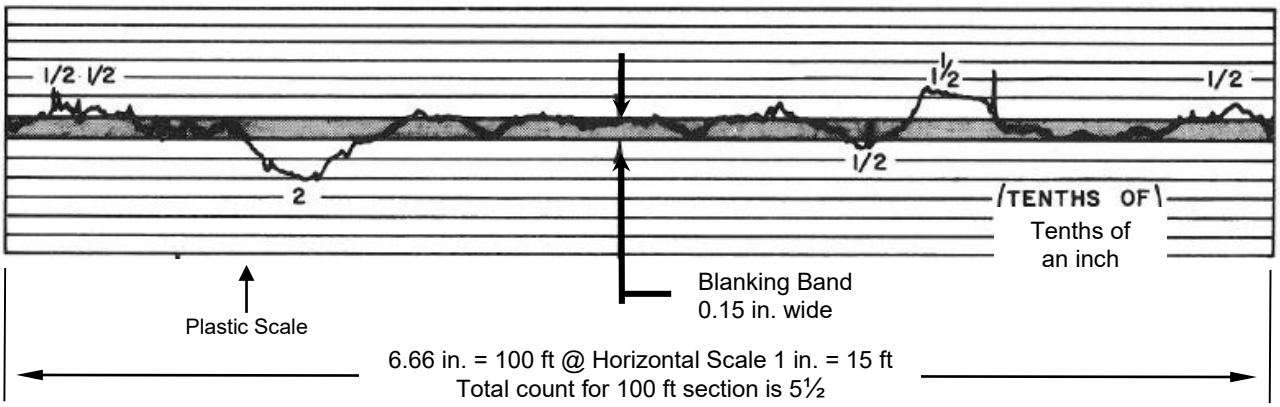
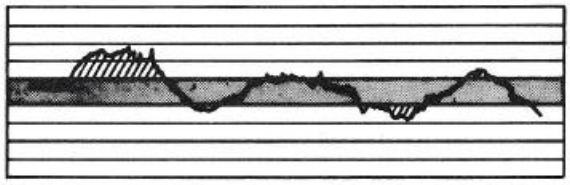
(California Test 547 contains 8 pages)



TYPICAL CONDITIONS

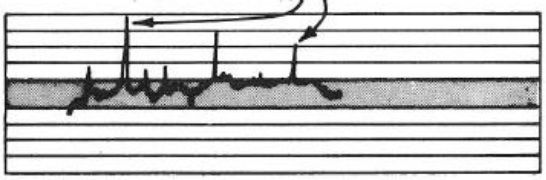
Scallops are areas enclosed by profile line and blanking band



Small projections which are not included in the count

SPECIAL CONDITIONS

Rock or dirt on deck (not counted)



Double peaked scallop (only highest part counted)

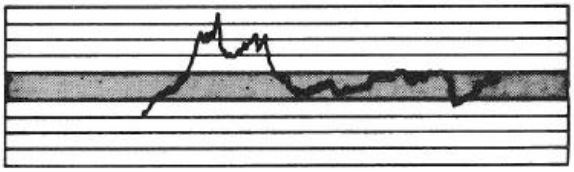
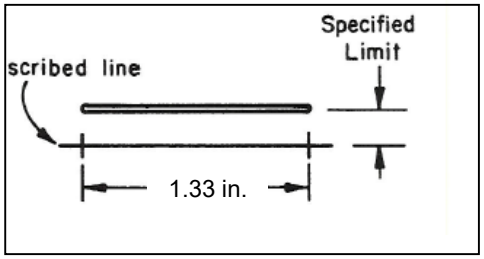
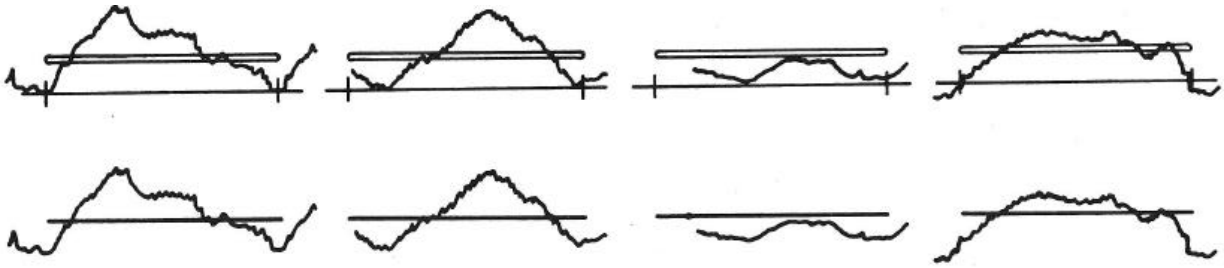


FIGURE 2. Method for Obtaining Profile Counts



Plastic Bump Template



Baseline Approx. 20 ft	Baseline Less than 20 ft	Peak Less than Limit	Baseline Greater than 20 ft

FIGURE 3. Method for Placing Template When Locating Bumps to Be Reduced