

ATT-59, Part I

ATT-59/99, SMOOTHNESS OF PAVEMENTS Part I, Manual Profilograph

1.0 SCOPE

This method describes the procedures for:

- a) Operating the profilograph.
- b) Determining the Profile Index from profilograms
- c) Locating individual high points in excess of 8 mm.

2.0 EQUIPMENT

profilograph

profile index template (333 mm x 45 mm)

bump template

calibration equipment: chain (or tape), keel, 3 pylons, ruler

safety and accessory equipment

Data Sheet: Profilograph Index Report, MAT 6-73

3.0 PROCEDURE

3.1 Calibration of Profilograph

Calibrate the horizontal scale of the profilogram when the accuracy is out by more than 2%.

3.1.1 Horizontal Scale Calibration

Before calibrating:

- a) Ensure the tire pressure is between 275 and 310 kPa (40-50 psi).
- b) Check the profile wheel for roundness.

Calibrate the horizontal scale as follows:

1. Choose a paved stretch of road (or parking lot) at least 300 m in length. Ensure the test section is relatively flat with good visibility for oncoming traffic from both directions.
2. Ensure that the current safety regulations are followed.
3. Use the keel to mark the starting point on the pavement. Place a pylon beside the mark as a reference while chaining.

4. Use the chain (or tape) to measure a straight line distance of 300 m \pm 1 m, marking on the pavement intermediate reference points every 100 m.
5. Mark the end point with a keel and place a pylon beside the mark.
6. Carefully unload the profilograph sections, wheels and recorder.
7. Assemble the profilograph .
8. Lift the recording wheel and slowly guide the profilograph so that the profile wheel is even with the starting point. For safety, the van follows about 30 m behind the profilograph.

NOTE: The recording wheel must be in the up position when the assembled profilograph is manoeuvring (making sharp turn).

9. Insert the profile pen and reference pen into their respective pen holders. If more than one pen colour is available, use a different colour for each. Do not tighten the thumbscrew on the pen holder before lowering the wheel.
10. Gently lower the profile wheel by disengaging the wheel support clamp located above the wheel.
11. Move the pen holder into the desired position on the paper drum and tighten the thumbscrew.
12. Remove the caps from both pens and lower the profile pen onto the paper.
13. Engage the clutch by turning the knob on the right hand side of the recorder clockwise. It may be necessary to jiggle the drum handle to properly engage the clutch.
14. Lift the profile wheel slightly off the ground and spin the wheel until the paper begins to turn. This ensures that all of the internal slack has been taken up.
15. Use the knob which manually controls the reference pen and is located on the back right hand side of the recorder, to detent mark the starting point on the profilogram.
16. Slowly push the profilograph making sure the paper drum is turning.
17. Walk the profilograph along the chained straight line at a speed no greater than a moderate walk.

18. Use the detent marker to locate on the profilogram each of the 100 m reference points.
19. Stop the profilograph when the recording wheel is even with the 300 m mark.
20. Use the detent marker to locate on the profilogram the end point.
21. Cap both pens and loosen the thumbscrew on the pen holder.
22. Lift the recording wheel and move the profilograph off the road.
23. Move the paper roll drive handle forward until the profilogram is cleared.
24. Cut the paper and remove the profilogram from the recorder.
25. The horizontal scale is 1:300 (1 m = 300 m). Match one end of the profile index template with one end of the profilogram. The other end should be even with the first reference detent mark as the length of the template is 333.3 mm and represents a pavement length of 100 m. Note the difference, if any.
26. Move the template across the profilogram and scale between the next reference points, noting any discrepancies. The accuracy of the horizontal scale should be within 2%.
27. If the scale is inaccurate, adjust the horizontal scale as outlined in the manufacturers equipment manual.

Once the reason for variation is found and the problem is corrected, repeat the calibration procedure.
28. If the horizontal scale is within 2%, proceed with Section 3.1.2, Vertical Scale Calibration.

3.1.2 Vertical Scale Calibration

1. With the recording wheel raised, slowly guide the assembled profilograph to a level stretch of pavement.
2. Repeat steps 9 to 12 of Section 3.1.1.
3. Obtain and measure the thickness of two boards, approximately 25 and 40 mm thick.

4. Slide the 25 mm board under the recording wheel. The profile pen should rise a vertical distance equal to the thickness of the board.
5. Slide the board out. The profile pen should drop to its original position.
6. Use a ruler and measure the vertical line on the profilogram. The vertical scale on the profilogram is 1:1 (1 mm = 1 mm).
7. Slide the 40 mm board under the recording wheel. The profilogram will show a vertical line with its lower portion superimposing the first line.
8. Slide the board out and the profile pen will drop to its original position.
9. Use a ruler and measure the vertical line on the profilogram.
10. Compare each measured result on the profilogram to the corresponding board thickness. If they are the same, the calibration is complete.
11. If the scale is inaccurate, the cause of the incorrect height could be:
 - a) the cable is slipping; or
 - b) there is too much slack in the cable; or
 - c) the cable is stretching when the recording wheel is down.

When the cause is located, have it corrected and repeat the calibration procedure.
12. Repeat steps 21 to 24 of Section 3.1.1.
13. Disassemble and load the profilograph.

3.2 Testing a Section

Use the profilograph to obtain the profilogram of the outer wheel path (OWP). If the OWP fails the profile index (Pri) specification, the inner wheel path (IWP) must also be tested. In this case, the Pri is the average of both wheel paths.

1. After a test section is identified, drive over the section to become familiar with the area. Note all curves, hills, and potentially unsafe areas.
2. Ensure that the current safety regulations are followed. This includes the correct placement of signs, and the wearing of hard hats, vests and overalls.
3. Repeat steps 6 to 15 of Section 3.1.1.

4. Record the highway number, beginning station, locations, i.e., OWP (outer wheel path) or IWP (inner wheel path), lane and lift on the profilogram, immediately below the profile pen.
5. Slowly push the profilograph making sure the paper drum is turning. For safety, have the van follow, at a constant distance.
6. Walk the profilograph in the wheel path in a straight line at a speed no greater than a moderate walk.
7. Use the detent marker to locate on the profilogram any reference point, such as joints, culverts, approaches, kilometre markers and curves.
8. Continue pushing until the desired length has been covered.
9. Repeat steps 20 to 22 of Section 3.1.1, then move the paper roll drive handle backwards until the pens are even with the starting point on the profilogram.
10. Disassemble and load the profilograph.
11. Return to the beginning of the test section and test the other wheel path Repeat steps 6 to 15 of Section 3.1.1 followed by steps 4 to 8 above.

NOTE: If more than one pen colour is available, use a different colour for each wheel path. This may be accomplished by switching the profile pen with the reference pen.

12. Repeat steps 20 to 24 of Section 3.1.1, then disassemble and load the profilograph.

3.3 Determining the Profile Index

The Profile Index is the OWP millimetres per 0.1 km in excess of the 5 mm blanking band. If both wheel paths have been tested then it is the average of the IWP and OWP. The procedure for determining the profile index follows:

1. Place the profile index template over the profile in such a way that the opaque band "blacks out" as much of the profile as possible, balancing the "scallops", as shown in Figure 1.

NOTE: The deviations or excursions above and below the blanking band are referred to as "scallops". Scallops are the "white areas" between the blanking band and the profilogram.

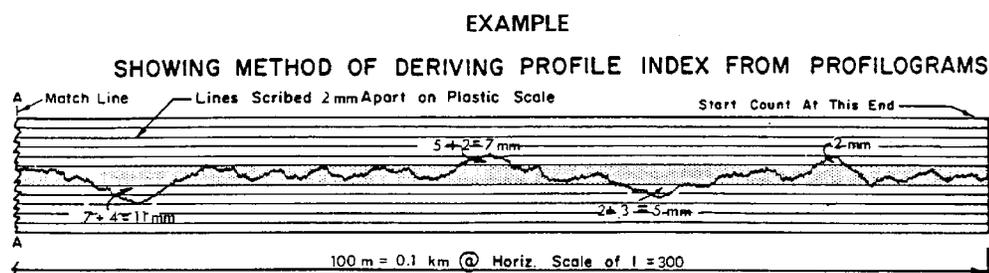


Figure 1

2. If the profilogram includes superelevated curves, the profile trace will slant

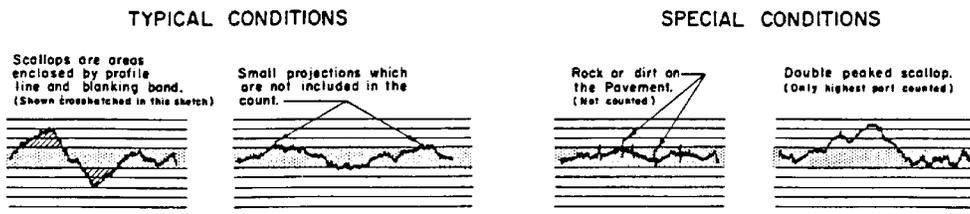
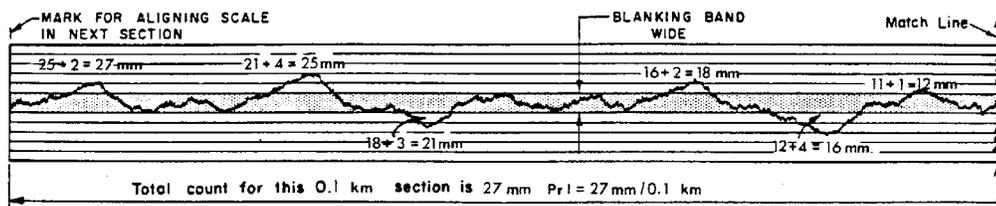


Figure 1 (cont.)

from the generally horizontal position. This will make it impossible to blank out the central portion without shifting the scale. When such conditions occur:

- a) Break the profile into short sections, and
 - b) Reposition the blanking band on each section while counting, as shown in Figure 2.
3. Start at the right side of the template, and measure to the nearest 1 mm the

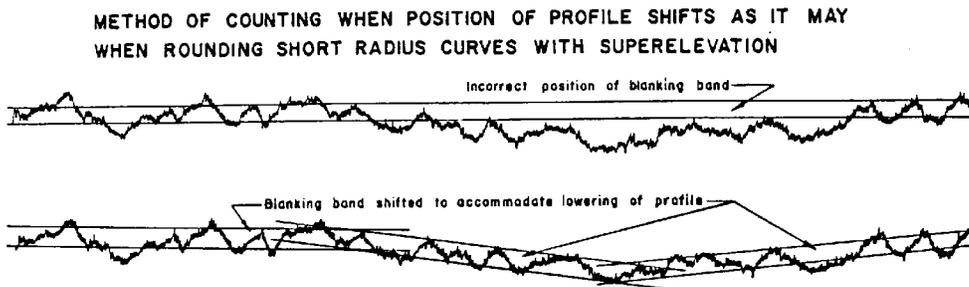


Figure 2

height of each scallop appearing above and below the blanking band. Record the measurement above the scallop, as shown in Figure 1.

NOTE: Scallops, which project less than 0.5 mm above the blanking band and extend longitudinally for less than 2 mm on the profilogram (0.6 m of highway) are shown in Figure 1 and are referred to as small projections. The small projections are not counted.

4. Add the height of the first scallop to the height of the second and record the total immediately below the second scallop.
5. For the section covered by the template, keep on adding the height of the next scallop to the total and record the new total immediately below the next scallop.
6. At the left end of the template and above the scallops make a small mark, so that the template can be aligned when moving to the next section. Record the completed section number above this line and this number is the total count for this 0.1 km of the wheel path.
7. Slide the template to the left aligning the right end of the template with the small mark previously made.
8. Repeat steps 3 to 7 to the end of the profilogram.

NOTE: If the last section is less than 0.1 km (full scale), align the left end of the template with the end of the section and measure the scallops for the entire 0.1 km section, including the over-lapping portion.

9. Complete the heading portion of the Profile Index Report sheet, as shown in Figure 3.
10. For each 0.1 km record on the sheet the following:

R: Enter an R if the information is for a retested section.

LANE: Enter E, W, S, or N for east, west, south or northbound lanes.

MAT: Enter C for centre mat, R for the mat right of centre line, RS for the right shoulder mat, L for the mat left of centre line, LS for the left should mat.

FROM: Record the beginning chainage of the 0.1 km section.

TO: Record the ending chainage of the 0.1 km section.

COUNTS (mm): Record the total count obtained on the outer wheel path under (OWP) and on the inner wheel path under (IWP) if the OWP does not meet specifications.

PROFILE INDEX (mm/0.1): Record the "Profile Index" to the nearest 1 mm. The "Profile Index" is the OWP counts per 0.1 km.

If both wheel paths were tested the "Profile Index" is calculated as follows:

$$PROFILE\ INDEX = \frac{OWP\ Count + IWP\ Count}{2}$$

Compare each PROFILE INDEX (Pri) to the specifications and enter the appropriate assessment. (All assessment are subject to confirmation and are finalized in the final details.

STATION LOCATION OF BUMPS AND DIPS OVER 8 mm: Record the chainage where the bump or dip is located to the nearest 1 m.

Enter "I" for inner wheel path(only if tested) or "O" for outer wheel path. If a bump or dip occurs at the same location in both wheel paths assess only once.

D or B: Record D for Dip or B for Bump

SIZE: Record the height of the bump or dip in mm.

When more than two bumps or dips are located in a test section, complete on the next line.

| | | | | | | | | | | | | | |
|---|------|--|---------------|------------------------------------|--------|--------------------------|----------------------------|--|---------------------------------|-------------------------------------|----------|------------|---------------------------------|
|  | | PROFILOGRAPH INDEX REPORT | | | | | | | | | | | |
| | | SHEET 1 of 1 | | | | | | | | | | | |
| | | CONTRACT NO. 9999/99 | | PROJECT NO. Hw 99/99 | | CONTRACTOR Good Roads | | | PRIME CONSULTANT Format Good | | | | |
| | | PROJECT FROM Here | | | | PROJECT TO There | | | | PROFILOGRAPH CONSULTANT Smoothie | | | |
| RETEST | LANE | MAT | SUBLOT LIMITS | | COUNTS | | PROFILE INDEX mm/0.1 km | PRI ASSESSMENT (\$) | STATION | WP | D or B | SIZE mm | BUMP/DIP ASSESSMENT PENALTY(\$) |
| | | | FROM | TO | IWP | OWP | | | | | | | |
| | W | R | 14+000 | 14+100 | | 6 | 6 | \$0.00 | | | | | |
| | W | R | 14+100 | 14+200 | 17 | 11 | 14 | -\$115.00 | 14+125 | O | D | 12 | -\$100.00 |
| | W | R | 14+200 | 14+300 | | 8 | 8 | | | | | | |
| | W | R | 14+300 | 14+400 | | 5 | 5 | | | | | | |
| | W | R | 14+400 | 14+500 | | 0 | 0 | \$25.00 | | | | | |
| | W | R | 14+500 | 14+600 | | 0 | 0 | \$25.00 | | | | | |
| | W | R | 14+600 | 14+700 | | 0 | 0 | \$25.00 | | | | | |
| | W | R | 14+700 | 14+800 | | 0 | 0 | \$25.00 | | | | | |
| | W | R | 14+800 | 14+900 | 12 | 14 | 13 | | 14+800 | I | B | 14 | -\$100.00 |
| R | W | R | 14+800 | 14+900 | | 10 | 10 | \$0.00 | | | | | |
| | W | R | 14+900 | 15+000 | | 6 | 6 | | | | | | |
| | W | R | 15+000 | 15+100 | | 4 | 4 | | | | | | |
| | W | R | 15+100 | 15+200 | | 5 | 5 | | | | | | |
| | W | R | 15+200 | 15+300 | | 8 | 8 | | | | | | |
| | W | R | 15+300 | 15+400 | | 10 | 10 | | | | | | |
| | W | R | 15+400 | 15+500 | 12 | 14 | 13 | -\$90.00 | 15+483 | I | B | 12 | -\$100.00 |
| | W | R | 15+500 | 15+600 | | 3 | 3 | | | | | | |
| | | | | | | | | TOTAL(S) | | | TOTAL(S) | | |
| | | | | | | | | | -\$105.00 | | | -\$300.00 | |
| DATE TESTED | | June 11/99 | | PROFILOGRAPH TYPE | | Cox | | OPERATORS | | B. Good | | | |
| LIFT TYPE | | Multi | | (MULTI, SINGLE or CURB AND CUTTER) | | PROJECT MANAGER | | Rudy Roads | | | | | |
| COMMENTS | | 14+800 TO 14+900 RETESTED AFTER BUMP ROLLED. | | RECEIVED BY | | Best Roads | | | | *** Contractor's Representative | | | |
| DATE RECEIVED | | June 12/99 | | TIME | | 8:00 AM | | | | | | | |
| 1. IF REQUIRED ACCORDING TO ATT58 2. USE SEPARATE SHEET FOR EACH LIFT TYPE | | | | | | | | *** Signature indicates receipt of data on the date and time indicated | | | | | |

Figure 3

3.4 Determining the High Points in Excess of 8 mm

Both bumps and dips are measured the same and are subject to penalty assessments according to the specifications.

1. At each prominent peak or high point on the profile trace, place the bump template so that the scribe marks at each end of the scribed line intersect the profile trace to form a chord across the base of the peak or indicate a bump, as shown in Figure 4.

NOTE: The template does not have to be in a horizontal position.

2. With a pencil draw a line through the narrow slot in the template. Any portion of the trace extending above this line will indicate the approximate length and height of the deviation in excess of 8 mm.
3. If the distance between easily recognizable low points is less than 25 mm (7.5 m), use a shorter chord length in making the scribed line on the template tangent to the trace at the low points. The base line for measuring the height of bumps must be as near 7.5 m (25 mm) as possible, but in no case to exceed this value.
4. If the distance between prominent low points is greater than 7.5 m (25 mm),

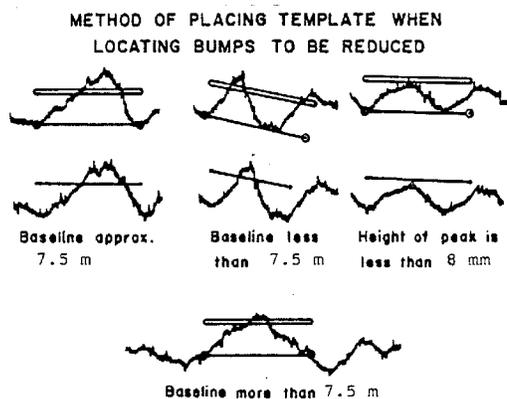


Figure 4

make the ends of the scribed line intersect the profile trace when the template is in a nearly horizontal position.

5. Record the station and location of each bump on the Profile Index Summary data sheet.

For a further explanation of bumps/dips refer to "Bump Locations" Section 3.2.2 of ATT-59 Part II.

3.5 Airports

The procedure and specifications for testing airports may vary from those for highways. Refer to the specifications in the contract for this information.

3.6 Transverse Joints

In general, the paving contractor is responsible for the smoothness of joints if he places the asphalt 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 pavement placed under another contract.

Therefore, the Engineer must use some discretion when testing the first and last 5 metres of a contract.

When counting profiles, a day's paving is considered to include the last portion of the previous day's work. This includes the daily transverse joints, as the last 5 to 10 m of a day's paving cannot usually be obtained until the following day.

4.0 HINTS AND PRECAUTIONS

1. It may be necessary to jiggle the drum handle in order that the clutch be properly engaged.
2. The recording wheel must be lifted and secured at all times and only lowered into position immediately before testing.
3. Upon completion of a test, always loosen the thumbscrew on the recording pen before lifting the recording wheel.
4. Maintenance should be carried out on a regular basis, approximately every 2 months as outlined in manufacturers equipment manual.