

ALDOT-335-83
MEASURING PROFILE INDEX OF A PAVED SURFACE

1. Scope

- 1.1. This method covers the profile measurement of hot mix asphalt and Portland cement concrete pavement and the determination of profile index.

2. Referenced documents

- 2.1. "ProScan™ User's Guide," Devore Systems, Inc., 1994.

3. Apparatus

- 3.1. The device used to measure the profile shall be a California-type profilograph with a mainline section or truss of approximately 24.6 ft in length supported by clusters of support wheels located at either end and having a measuring wheel at the center point of the span. The profilograph shall be assembled and operated according to the manufacturer's specifications.
- 3.1.1. Before a pavement surface profile is measured, the profilograph shall be inspected by the Engineer or his representative to determine its mechanical condition.
- 3.1.2. Calibration, horizontal—The Engineer or his representatives should check the profilograph for accuracy before being used on the project. The horizontal distance should be checked by traversing a known distance of 300 ft on a straight, level surface and measuring the length of chart paper used. Care should be taken when beginning the calibration section to eliminate any slackness in the gearing of the profilograph by raising the distance wheel slightly off the surface and turning it in the forward direction with the recorder in gear, then lowering the measuring wheel carefully back to the surface. A beginning point is marked on the profilogram, the test section traversed, and then the ending point is marked. The length of trace between the points should be 12 in. plus or minus 0.1 in.
- 3.1.3. Calibration, vertical—The vertical calibration should be checked using three ¼-inch thick plates of metal or other hard material approximately 3 in. wide and 6 in. long. The profilograph should be positioned on a level flat section of paved surface with the profile measuring wheel resting on a smooth piece of ⅛-inch Formica or sheet metal approximately 12 in. square such that it will not rock or tilt. Advance the profilogram (chart) at least ½ in. without moving the profile measuring wheel. Lift the profilograph measuring wheel and place one of the ¼-inch blocks under it, carefully lower the wheel and again advance the chart. Continue with the above sequence until all three of the ¼-inch blocks are under the wheel, one on top of another. Remove all the plates and return the measuring wheel to the base plate. Advance the profilogram again. Remove the profilogram and measure the deviations. If the deviation of the

measured trace is greater than $\frac{1}{32}$ in. from the correct thickness, then adjustments must be made to the profilograph.

4. General

- 4.1. Test Section—A test section shall be defined as a single lane (normally 12 ft wide) of main line pavement surface where the posted speed will be 40 mph or greater beginning at a point where the rear wheels of the profilograph are located just on the new surface (the profile measuring wheel will then be approximately 16 ft onto the new surface). The test section shall continue for a distance of 0.1 mile unless altered by Section 3.3 or 3.4.
 - 4.1.1. If the contractor is responsible for the adjoining existing surface, the profile shall include the last 16 ft of existing roadway surface.
- 4.2. When a test section begins or ends at a bridge and there is no bridge end slab or if the bridge end slab is recessed and overlaid with plant mix, the measuring wheel of the profilograph shall be approximately 16 ft from the bridge end when beginning or completing the test section.
 - 4.2.1. If there is a bridge end slab to which the pavement abuts, the measuring wheel shall be approximately 16 ft from the bridge end slab when beginning or ending the test section.
- 4.3. A test section shall be 0.1 mile in length unless altered by a bridge or the end of the paved surface. When a profile is terminated at a point where it is less than 250 ft long, it shall be included with the previous section. If the section is greater than 250 ft in length, it shall be considered a test section.
- 4.4. If a section is isolated where neither end joins another section (i.e., between bridges or between a bridge and the end of the paved surface) and it is less than 0.1 mile long, it shall be considered a test section.

5. Testing Procedure

- 5.1. Surface Preparation—The paved surfaces to be profiled shall be reasonably cleaned by the contractor of all mud, loose gravel, debris, etc., before the profile is made.
- 5.2. Pavement profiles shall be taken in the right wheelpath of the right lane, in the left wheelpath of the left lane and in the wheelpath that the Engineer chooses if the paved surface is wider than two lanes.
- 5.3. The profilograph shall be manually propelled longitudinally along the pavement at a speed no greater than 3 mph in the direction that the pavement was placed. That test section shall be repeated only to define the limits of an out of tolerance surface variation or as requested by the Engineer.
- 5.4. The trace should be preceded and followed by at least 12 inches of blank paper.

6. Analysis Procedure

- 6.1. The ProScan™ system must be properly configured and calibrated before use. A suggested configuration file is shown in Figure 1. The “Scanner scan lines” entry (shown on line 5 in Figure 1) should be changed to match the number shown on the sticker affixed to the scanner; alternatively, this number can be determined by following the instructions in the ProScan™ User's Guide. The blanking band number should be set at zero.

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4.xx      Version (only first two digits are verified)
Section   Mode of Operation
1         COM Port for Powe Scan Control
AL        State Form For Reports
####     Scanner scan lines for 30 inch calibration tape
15        Filter length
English   Unit System [English or Metric]
528      Length of normal length segment (ft for Engl - meters for Metric)
0         Blanking Band
.01       Scallop resolution (inches for Eng - cm for Metric)
.03       Minimum scallop height (inches for Eng - cm for Metric)
.08       Minimum scallop width (inches for Eng - cm for Metric)
.3        Template height for grind point identification (in or cm)
.4        Minimum spike height (in or cm)
Full      Scan area (full or varying)
Plotter   PCL 5 Letter
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FIGURE 1
SUGGESTED PROSCAN™ CONFIGURATION FILE

- 6.2. The unit sits on a table on four plastic feet. The back of the unit has a $\frac{5}{8}$ -inch diameter aluminum rod that serves as the McCracken paper dispenser. Profilograms feed from the back of the unit, over the top, between the tall side edges, and off the front of the unit (the edges are named from the perspective of paper going through the unit). When the McCracken paper dispenser is facing the user, the motor housing and cords are attached to the edge facing away from the user (the right side of the unit). The left side faces the operator when the unit is in the standard operating position.
- 6.3. Mark the ends of the section to be processed by drawing two three-inch demarcation lines across the profilograph trace such that they are square with the edge of the paper. The lines should be dark and approximately $\frac{1}{16}$ in. thick. The trace should intersect near the center of each mark. It is not necessary to delineate each 0.1-mile segment. A two-inch “leader line” should be drawn before the trace begins to allow the scanner to locate the trace. The suggested minimum dimensions of these marks are shown in Figure 2.

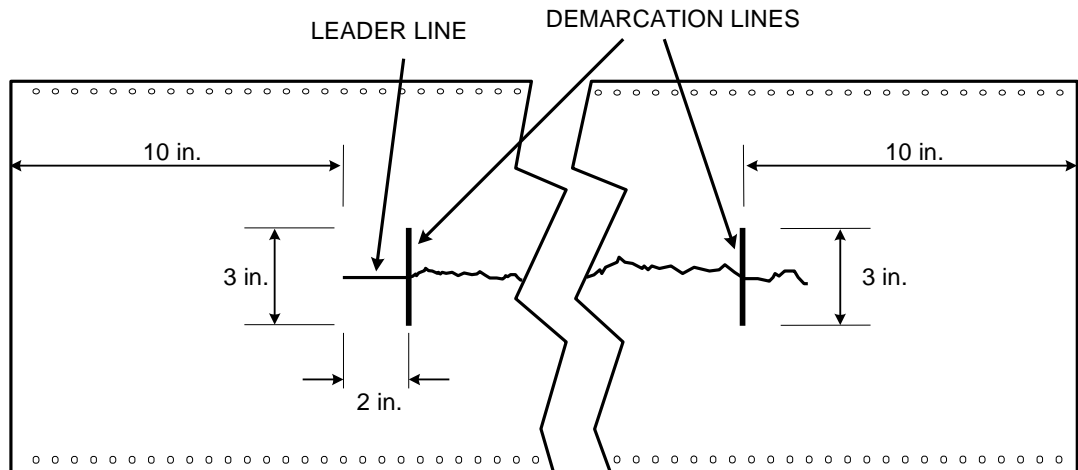


FIGURE 2
PREPARING THE TRACE FOR PROCESSING

6.4. Loading the Trace into the Paper Transport Unit.

- 6.4.1. Both the Ames and McCracken profilograms are supported by the paper transport unit. The aluminum idler roller assembly and the scanner are removed from the unit prior to loading either type of profilogram paper. The idler roller assembly is removed by pulling out the idler assembly release knob located on the left side panel. Set the assembly aside. Remove the scanner by lifting it and the attached mounting assembly straight up.
- 6.4.2. McCracken Profilograms—Close the two black plastic tractor feed assemblies that are located near the base of the scanner mount slots. The assemblies are closed if their outside edge is not sticking more than $\frac{3}{4}$ in. above the top surface of the unit. Place the profilogram roll on the McCracken paper dispenser at the rear of the unit. Feed the paper over the top of the unit so that it lies flat between the scanner mount slots and passes over the friction drive roller near the front of the unit. The first mark across the trace should be at least six inches back from the front edge of the paper transport unit. Replace the idler roller assembly by inserting the tabs on one end of the assembly into the holes opposite the idler release knob and inserting the pin attached to the idler release knob into the other end of the assembly. It may be necessary to turn the idler release knob to get the pin to seat completely. Make sure that the paper is flat between the scanner mount slots. If it is not flat, the roller idler assembly must be released and assembled again.
- 6.4.3. Ames Profilograms—The idler roller assembly will not be needed for the Ames tractor paper unless the edges of the paper are very worn or the tractor holes have been removed. Locate the two black plastic tractor feed assemblies that are near the base of the scanner rod mount slots. They operate similarly to the ones found on the Ames profilograph. Mount the profilogram so that the first mark across the trace is at least six inches back from the front edge of the paper transport unit.

6.4.4. For both types of paper, the scanner must be placed flat on the paper. The scanner cord should drape over the side of the scanner to avoid interfering with paper movement.

6.5. Scanning a Section of Profilogram

6.5.1. The scanning of the section will proceed automatically after the ProScan™ program is started. After the initial user entry, the user is required to provide responses to the computer prompts as shown below.

User	proscan (Enter) <i>or</i> proscan config_file where <i>config_file</i> specifies the name of the configuration file matching the desired scan parameters
Computer	(Fills computer screen with ProScan™ copyright and configuration information)
Computer	Enter file name for this session:
User	Enter file name (≤ 8 characters) (Enter)
Computer	Creating new files Reading rptinfo.gen for report header information Enter Date Paved:
User	Enter date (Enter)
Computer	Enter Date Tested :
User	Enter date (Enter)
Computer	(Displays Current RPI [report header information]) Modify report information ? (y or [n])
User	Press Enter (to proceed without changing report header information)
Computer	Enter track number ([1], 2, or 3):
User	Enter track number (or Enter or Space Bar to accept track 1)
Computer	Is up to the left or right of scanner? (l or [r])

User **Press Enter or space bar** (see Sect. 6.8.1 for further discussion)

Computer Is scan up station or down station? ([u] or d):

User **Press Enter or space bar.**

Computer Enter beginning station number for track 1 segment 1 (nnnn+nn):

User **Enter beginning station in *nnnn+nn* format.**
ProScan™ will accept values to the tenth of a station (i.e., nnnn+nn.n format).

- 6.5.2. Scanning begins immediately after entering a response to the final information request. The paper transport unit will start moving the paper and the text on the monitor will be replaced with graphics. As the paper transport unit moves the paper, an image of the area that is being scanned scrolls up from the bottom of the screen. If this scrolling does not occur as soon as the paper transport starts moving paper, it means that the scanner is not in scan mode. This can be corrected by pressing the scan button on the scanner. **If anything appears to be going wrong at any time during the scanning process, the system can be stopped by pressing any key on the keyboard.** Restart the scanning by pressing “c” (Continue previous activity).
- 6.5.3. The computer screen must be closely monitored during the scanning process. The newly scanned area should scroll up from the bottom of the screen, scrolling to disappear off the top. The image on the screen is greatly magnified, especially in the vertical dimension. A 4-inch wide strip of profilogram is shown over the entire width of the screen. A 1.75-inch high section of the strip fills the screen from top to bottom. If the scanner contrast is set correctly, the trace itself should be black and very distinct on a white background.
- 6.5.4. When the program recognizes the first demarcation line (constructed in step 6.3) across the trace, it will sound a beep to indicate that the processing of a segment has begun. If an audible alarm is not heard, then the scanning must be stopped and the paper reversed. To reverse the paper, stop the scanning by pressing the space bar, remove the scanner and release the paper from the feed mechanism. If the demarcation line is visible on the screen but the audible signal fails to sound, the line must be made thicker and of equal length on both sides of the trace.
- 6.5.5. During the scrolling process, the program adds a thin line to the display that does not appear on the profilogram itself. This line runs beside, and slightly to the right of, the trace being processed and represents what the program has determined to be the center of the track. It is offset to prevent obliterating any of the trace. One of the principal duties of the user is to verify that the line does in fact parallel the actual track.

- 6.5.6. After 20 seconds of scanning, the paper transport unit will pause for about one second while the 0.1-mile segment just scanned is processed and written to disk. This pausing action should occur three times. After the last pause, the end mark will be encountered in a few seconds. At that time the paper transport unit will stop, the screen will freeze, the short segment will be analyzed and written to disk, and the program will wait until a key is pressed.
- 6.5.7. Slight variation in the roughness measures will occur between scans on the same trace. This is due to the physical variance in the scanning process and rounding of values for each scallop. It is impossible to eliminate all variation from one scan to the next. This variation is extremely small, however, when compared to the variations obtained by manual reduction of profilograms that are performed by different people. It is even small compared to the variation obtained when the same person reduces the same trace multiple times. Successive profile index averages obtained by ProScanTM over a long section are always nearly identical.

6.6. Printing a Report

- 6.6.1. A report can be printed by selecting the "Generate Report" (r) option. When it is specified, the user will be asked to select a report type. The options are inforMation, Initial, inTermediate, or Final (m,i,t or f). The only difference between them is that one of those four words will appear at the top of the report. The report itself is printed in a convenient form and contains several additional pieces of information. Segments are numbered sequentially for each track, beginning at 1, in the order they were scanned.
- 6.6.2. Track one segments will always appear in ascending order. The other tracks will not necessarily be in that order, but generally so. The actual order will be determined by matching each segment with a corresponding segment from a previous track, if possible. If each track was scanned in the same direction, then all track segment numbers should match up. If one track was scanned in the opposite direction, then its numbers will be reversed.
- 6.6.3. The bump locations appear in ascending station order and, in the case of identical station numbers, in ascending track number order. In parentheses following the station number of each bump is the track and segment in which it is located. This makes it easy to know which segment to plot to obtain a detail of the bump. When segments are plotted, the grid lines are drawn on the bumps to show the amount of corrective action that is required.
- 6.6.4. When the printing of the report is finished, ProScanTM returns to the main menu.

6.7. Plotting Segments

- 6.7.1. Plotting segments is the most time-consuming aspect of the program. It takes five to six times longer to plot a segment than it does to scan and reduce the segment. The

segment of the trace is plotted in 180 dpi resolution, with station marks shown every .25 sta. Marks showing the beginning and ending of the segment and ¼ in. of trace beyond each are shown. Strum lines that were detected are plotted and the measured roughness of each scallop is given beside it. In addition, all the parameters in effect for the reduction, the final reduction value, and the filename of the ProScan™ data (.psd) file containing the raw data are given.

- 6.7.2. A single segment, all segments of a track, all tracks for a given segment number (not necessarily corresponding station number), or all segments in the current file can be plotted from a single command. If the file contains a considerable number of segments (80 would not be unreasonable for one day's asphalt paving), a several-hour print job could be requested. Unlike the scanning process, the printing can occur in an unattended mode. Should a multiple segment job be requested, it can be interrupted by pressing a key on the keyboard. Please note that the plotting of the current segment will complete, even if the job is interrupted with a keystroke. Therefore, it may be as much as two minutes before it is obvious that the interruption has worked.
- 6.7.3. To specify a single segment, enter the track and segment number. To get all the tracks of a segment or all the segments of a track (or both), use an asterisk (*) instead of a number.
- 6.7.4. When the plotting of the segments is finished, ProScan™ returns to the same menu.
- 6.8. Additional suggestions for using the ProScan™ system
 - 6.8.1. The terms “up station” or “down station” refer to whether station numbers are increasing or decreasing as the trace progresses. If the station numbers are increasing, the scan is considered “up station.” Likewise, if the station numbers are decreasing, the scan is “down station.”
 - 6.8.2. Marks locating various points of interest on the trace (such as pavement joints, stations, debris, etc.) can be made by stopping the profilograph and pulling down on the cable linking the wheel and the marking apparatus (“strum” marks). These marks typically do not affect the scanning procedure or results, but will be indicated on the plotted output from ProScan™.
 - 6.8.3. To avoid errors in processing the trace, do not make marks within 1 inch of the trace, with the exception of the leader line and demarcation lines discussed earlier.
 - 6.8.4. Additional reports can be printed by restarting ProScan™ and selecting a file name corresponding to a previous scan.