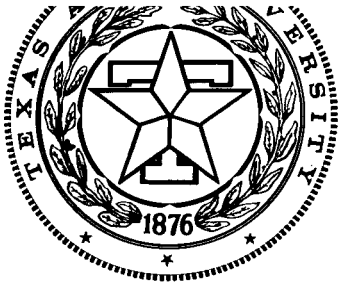

TEXAS TRANSPORTATION INSTITUTE

TEXAS HIGHWAY DEPARTMENT

COOPERATIVE RESEARCH

PROFILOMETER
2-8-54-1

in cooperation with the
Department of Commerce
Bureau of Public Roads

BIBLIOGRAPHY (64-1)
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PROFILOMETER

Compiled by
Texas Transportation Institute
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1. Abbott, E.J., S. Bousky and D.E. Williamson,"Profilometer" Mech Eng 60: n 3, Mar 1938, p 205-16.

   New instrument for rapid measurement of surfaces; greatest limitation is that it is essentially high speed device and cannot be used for static measurements of dimension: profilometer is particularly designed for measurement of finest irregularities in large expanse of surface in short time; characteristics of profilometer. Before Am Soc Mech Engrs.

2. Adams, F.W., L. Devol and H.R. Letner," Instrument for studying topographies of fine textured surfaces." Rev Sci Instruments 12: n 8, Aug 1941, p 409-11.

   Profilograph, using tracing point and optical lever system, makes profiles of fine textured surfaces, magnifying elevationa and depressions by as much as 6000 X: instrumentdetects surface variations by as small as 0.04 micron; series of profiles along parallel paths from which topographic or relief maps can be prepared; uses include study of machined , lapped, and etched surfaces.

3. Astrov, V.A. and G.P. Filina, "Instruments for measuring the eveness and skid resistance of road surfacing." Avtom Dorogi 23: n 1, 1960, p 19-20 (In Russian).

   An illustrated review is presented of research carried out by the U.S.S.R. Road Research Institute (Soyuzdornii) on the design of profilometers and skid resistance meters. The MP-1 and MP-2 pendulum instruments measure the frictional resistance of the road surface to the bob of a pendulum released from a horizontal position; the limit of its swing is registered by a needle moving over a graduated arc. Three types of profilometer have been successfully developed. The "Rovnomer" tricycle profilometer has a three-metre long frame with the datum wheel mounted centrally and linked to an electronic and graphical recording mechanism. The frame of the "Volnograf" profilometer is six metres in length and is supported at each end by two pairs of independently sprung wheels; 12 pairs of measuring wheels mounted transversely across the middle of the frame record surface irregularity

over a 3.5-m strip. A paint spray device can be attached to mark sections where irregularity exceeds the acceptable limit. As these instruments can only operate at 3 to 4 km/h a trailer mounted single wheel profilometer of the ultrasonic type has been devised. Ultrasonic impulses reflected from the road surface are recorded on an oscillograph in the towing vehicle. The same principle is applied in the M-20 instrument which records surface irregularity beneath the test vehicle and vibration in the vehiclebody and chassis.

4. Boyarov, A.I., L.A. Vyatich Yu. V.Kleimenov, G.I. Ovcharenko. Stanki i Instrument 32: Feb 1961, p 16-19; see also English translation in Machines & Tooling 32: n 2, 1961, p 17-21.

New profilograph-profilometer described is used to measure surface roughness according to criterion Ra, with profile registered by electrothermal method on metallized paper 3.937 in. wide, in rectangular system of co-ordinates, with vertical magnifications from 1000 to 200,000; design of pick-up which must insure high resolving power; other components of instrument and its operation described.

5. Dodd, L.S. and J.L. Shelbourne,"Measurement of road surface irregularities. Assessment of riding qualities: use of traveling self-recording straight edge." Surveyor, London 120: n 3594,, 1961, p 512-3.

The machine described has a frame of steel tube 3 in. in diameter with a welded cross-member at the rear end. There are two wheels at the rear, with a lateral spacing of 1½ ft; the axes of front and rear wheels are 10 ft. apart, with the registering wheel mounted at the centre. A locking device restricts the rear wheels to either the longitudinal or transverse position. The machine is pushed by a steering arm from the rear. The central registering wheel moves vertically and actuates a lever mounted so that a vertical exaggeration factor of 6.1 is introduced between fulcrum and recording end. A ball-point pen, fitted to the recording arm, moves over recording paper pulled from one wooden drum to another by the driving wheel tracking along the road surface. This wheel can be set to track at 90^0 to the axis of the machine if lateral checking is desired. After completion of any run, the paper can be wound back to enable a record profile to be obtained for a different lateral position on the carriageway. The graph obtained can be used to determine the riding quality of the surfacing by calculating an empirical irregularity factorS, based on a count of the number of deviations from zero on a 1000-ft. length of carriageway in separate amplitude ranges multiplied by the average deviations within the range.

A reasonable relationship was found between A and the irregularity index Q, recorded by the Road Research Laboratory's multiwheel profilometer.

6. Dubois, F." Nouveaux appareils pour operations mathematiques." Genie Civil 130: n 7, 8,9 Apr 1, 1953, p 123-25, Apr 15 p 150-3, May 1 p 169-71; see also Spanish abstraat in Ingenieria Naval 21: n 222, Dec 1953, p 730-7.

New mathematical machines of different types described such as Borgeaud-Amsler profilograph. Amsler's integraphs and planimeter, SNCF-Amsler apparatus for automatic time scheduling, etc.

7." Field tests show new profilometer accurate and a great timesaver." Highway Highlights (Kansas State Highway Commission, Topeka, Kansas), 16: n 6, p 3, March 1956.

Initial field tests indicate that the equipment built by the Kansas State Highway Commission's research department to record the profile of the land automatically on standard profile paper while rolling at two to four miles per hour will be reasonably accurate.

It is called a profilometer. The research staff built the trailer. The frame is made of aluminum I-beams and it rolls on heavy duty bicycle wheels.

To give an idea of the accuracy needed in building the equipment, it was found that the diameter of a drum which controls the movement of the paper was .005 of an inch too small. This produced an error of several feet per mile in the horizontal distance recorded. Strips of plastic tape have been applied to the drum to compensate for the difference. Air pressure in the tires of the trailer is another item that is critical. A soft tire or two would cause errors in both the horizontal and vertical measurements.

The sensing unit on the trailer and the recorder in the towingvehicle ate connected by an electrical cable. The assembly is designed to use 110 volt alternating current. This is now supplied by a portable motor generator. When a permanent vehicle is obtained the power will be obtained from the vehicle's battery through an inverter.

Measurement of the road distance is made by a pedometer drive operating off of one wheel of the trailer. This rotation is applied to the drum which moves the paper and also to an integrator in the sending device. The vertical dimension for the profile comes from the sensing device that measures the angle of slope between the

trailer and the true horizontal and integrates this angle over the distance traveled. The mechanical rotation from the integrator is fed to a drum in the recording device which controls the movement of the pen.

When it is in operation, the towing vehicle must be driven at a constant speed. The paper is held in contact with the drum and moves through the recording device a proportionate amount. The inking pen draws a line on the paper according to the directions it receives from the sensing unit.

8. Fisher, J.M., "Riding quality of roads and runways." Surveyor 116: n 3402, July 6, 1957, p723-5.

Riding quality considered as measurement of irregularities on surface; various devices such as multiwheel profilometer and bump integrator have been developed as result of Road Research Laboratory's work to establish suitable methods of measuring riding surface quality; bump integrator is coming to be widely accepted as standard device; specifying riding quality.

9. Goodman, A.A., "Mobile laboratory measures surface finish in shop." Am Mach 91: n 22, Oct 23, 1947, p 104-4.

Features of small analyzer installed at Steam Div Westinghouse Electric Corp; standard complement carried in mobile unit consists of: type "Q" profilometer, type "V" Motorace for machine controlled operation of various profilometer tracing heads.

10. Housel, W.S. and O.L. Stokstad, "Pavement profile surveys to correlate Michigan design practice with service behavior." Nat'L Research Council--Highway Research Board Proc 38: 1959, p 149-77; Discussion, 177-82.

A profilometer mounted on a lorry is being used by the University of Michigan to obtain profiles of each wheel-track of a carriageway. Two sets of small wheels, 30 ft. apart, at the front and back of the lorry provide reference points on the surface from which vertical displacement is measured by a recording wheel midway between these reference points. Profiles are recorded on a continuous chart; cumulative vertical deflection expressed inin/ mile (roughness index) is marked on the profile chart for each quarterof a mile. Equipment is also provided for measuring and recording uracks and joints and another device (roll indicator) records the relative elevation of the wheel tracks.Selected examples of profiles are presented together with information on pavement design, drainage conditions, traffic and service life. The effect of these factors on surface profile is discussed. It is concluded that such profiles reveal the direct correlation between service behaviour under normal traffic, and soil conditions, drainage and climatic conditions and serves to identify

those factors responsible for differences in behaviour.

11. Hveem, F.N.,"Laboratory builds profilograph to measure pavement roughness." Calif Highways & Pub Works 22: n 3, 4, Mar-Apr 1944, p 6-9.

Machine described in which 16 small pneumatic tired wheels are provided, each free to move indenpendently in vertical plane; carrier wheels are fixed in staggered arrangement so that no two wheels will strike transverse ridge or inequality at same time; apparatus may be dismantled into units not over 40 in. in length and entire assembly stowed in trunk and tonneau small sedan.

12. Hveem, Francis N.,"Profilograph--1." California Highways and Public Works January-February 1960, p47. Profilograph--2, California Highways and Public Works March-April 1960,p51. Devices for recording and evaluating pavement roughness, F.N. Hveem. Nat'l Research Council--Highway Research Board Bulletin 264, September 1960, p1-27.

Reviews the history of pavement roughness measuring devices and the development of such measurements for analytical purposes by the California Division of Highways.

13. Ingimarsson, G. Ragnar, "Determination of true pavement profile from profilometer." Nat'l Research Council--Highway Research Board Abstracts 33: n 12, December 1963, p 20.

This paper presents the mathematical development of and the procedure for the conversion of the modified pavement profile recorded by symetrical elevation profilometers to a "true pavement profile." The advantages of using a "true pavement profile" as a basis for performance evaluation of pavements are discussed and examples are presented.
The feasibility of extending this procedure to obtain a continuous load-deflection profile and themodification of presently available equipment to accomplish this objective are discussed.

14. Milligan, L.H. "Surface finish, What it is." Grits & Grinds 34: n 10, Oct 1943, p 1-10.

Author defines surfce finish, explains how it acts in use, and what to do about it; surface finish standards; surface roughness defined; profilometer and brush surface analyzer; uniform roughness vs duplex surfaces; "waviness" and "lay" of surfaces; accuracy and dimeasional truness of surfaces.

15. Mondon, R.,"Polissage electrolytique et superfinition." Technique Modern 38: n 23-24, Dec 1-15 1946y p 281-6, v 39 n 1-2, Janl-15 1947 p 17-21.

Electrolytic polishing and superfinishing; various types of finishing; application of profilometer to surface testing; influence of electrolytic polishing on mechanical properties; application to detection of surface defects.

16. Neumann, E., "Die Begriffsbestimmung von Welligkeit und Raughigkeit." Strasse u Autobahn 2: n 10, 11 Oct 1951, p 374-8.

Definitions and methods of measuring surfaces waviness and roughness; apparatus employed; Viagraph used in France; Profilograph in Switzerland; Ostwald telescope; roughness tester employed in United States; determination of friction by Rieckert system; measurements carried out by Shell in Netherlands, and by Highway REsearch Board in United States; use of Stradograph in France; illustrations, diagrams.

17. Obertop, D.H.F, "A recording profilometer." Wegen 34: n 11, 1960, p 326-8 (In Dutch).

An illustrated account is given of a device for recording surface irregularities just after construction. It consists essentially of a 12-ft beam on supports, which serves as a rail for the recording apparatus. Its application is claimed to be quicker than the usual methods of construction control.

18. Portevin, A.,"L'etude des etats et proprietes de surface des metaux," Societe Royale Belge des Ingenieurs et des Industriels--Memoires Series B 7: n 3, 1948, p 267-79.

Study of state and properties of metal surfaces; microgeometric status; use of electron microscope for study of film of anodic oxidation; profilograph for determining surface roughness; effect of different finishing processes; X-ray analysis; fatigue and corrosion; photographs, diagrams.

19. Sawyer, J.W., "Examination of surfaces." Am Soc Naval Engrs--J 61: n 4, Nov 1949, p 819-27.

Permanent and accurate 3-dimensional records of surface finish and damage can be made; record made by casting onto surface, resin which hardens in about 20 min after addition of catalyst; resin and catalyst are preweighted snd packaged ready for immediate use;

external heat and pressure not required; after resin hardens casting is removed for study; negative replica may be tested with profilometer or similar surface measuring instrument without damage to casting.

20. Schwaderer, W., "Measurement and observation of cross-sectional road profiles." Strasse u Autoban 10: (1), 1959, p 9-12, (In German).

Details are given of the Stuttgart profilograph developed by the Technische Hochschule Stuttgart. The instrument consists of a 16-ft long metal tube with a diameter of about 4 in and a sliding unit which contains the measuring device. The tube is supported by two legs, the rigid one resting at the edge of the carriagway, the other being adjustable. Surface irregularities occuring within the range of the instrument cause vertical movements of a small wheel which are recorded by the measuring device in the sliding unit. The paper describes measurements carried out with the profilograph on experimental road sections at Gruncack and Lahr.

21. Schwaderer, W., "Messung und Beobachtung von Strassenquerprofilen."Strasse u Autoban 10: n 1, Jan 1959, p 9-12.

Measurement and study of transverse road profiles; use of Stuttgart "prolifograph" for continuous graphic recording of uneven portions; during subsequent tests, same tape is used and parallel recordings are shown in different colors; each lane of road is tested separately.

22. Scott, W.J.O., "Roads and their riding qualities." Instn Civ Engrs Road Paper n 25, 1948, p 3-32 (discussion) 32-55; see also abatracts in Surveyor 107: n 2943, July 2, 1948, p 343-4.

Classification of road surface irregularities illustrated description of apparatus developed for study and measurement of road uneveness; derivation of numerical criteria of uneveness; results of tests which concrete and bituminous surface; major factor affecting surface irregularity. Bibliography.

23. Withers, R.M.J.,"Wire-drawing die bores." Metal Treatment & Drop Forging." 18: n 68, May 1951, p 191-4.

Various techniques for examining profiles of small bores critically surveyed; gages and replica techniques; optical projection methods; use of mechanical feeler arm; Askania micro bore tester; BISRA bore profilometer; illustrations. Bibliography.

24. Withers, R.M.J., "Wire-drawing-die profilometer." Iron & Steel Inst--J 164: pt. 1, Jan 1950, p 63-6.

[illegible] road [illegible]

Instrument, developed to measure and reproduce profiles of bore of wire drawing dies, is intended for use with die bores with throat diameters in range of 0.02 to 0.25 in.; it can also be used to measure accurately bore diameter; limit of measurement is 0.0001 in.