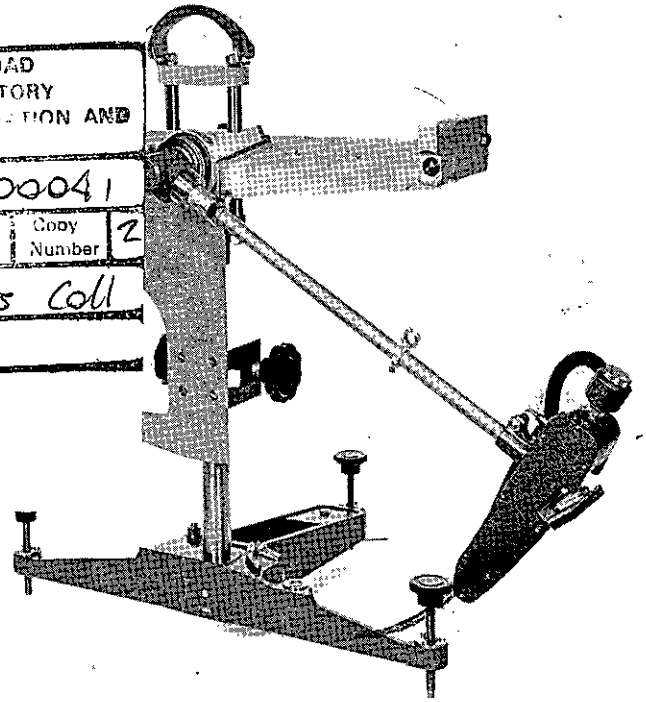
ROAD NOTE



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ROAD RESEARCH LABORATORY
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Instructions for using the portable skid-resistance tester

Introduction

A portable tester, shown in Plate 1, was developed at the Road Research Laboratory some years ago to provide highway engineers with a routine method of checking the resistance of wet road surfaces to skidding. The apparatus measures the frictional resistance between a rubber slider (mounted on the end of a pendulum arm) and the road surface.

Special attention was given to overcoming the practical difficulties met when using such an apparatus in all weathers, on rough and uneven road surfaces, and on roads having considerable gradient and camber. At the same time the characteristics of the apparatus were chosen as far as possible to simulate sliding between vehicle tyre and road at 50 km/h.

This Road Note describes the method of operation of the tester, its use on wet road surfaces, and the interpretation of the results.

Method of use

Setting the tester

(i) Set the base level by means of the spirit level and the three levelling screws on the base-frame.

(ii) Raise the head so that the pendulum arm swings clear of the surface. Movement of the head of the tester, carrying the swinging arm, graduated scale, pointer, and release mechanism, is controlled by a rack and pinion on the rear of the vertical column. After unclamping the locking

knob A at the rear of the column, the head may be raised or lowered by turning either of the knobs B/B[1]. When the required height is obtained the head unit must be locked in position again by clamping knob A.

(iii) Check the zero setting. This is done by first raising the swinging arm to horizontal release position, on the right-hand side of the apparatus. In this position it is automatically locked in the release catch. The pointer is then brought round to its stop in line with the pendulum arm. The pendulum arm is released by pressing button C. The pointer is carried with the pendulum arm on the forward swing only. Catch the pendulum arm on its return swing, and note the pointer reading. Return the arm to the release position. Correct the zero setting as necessary by adjustment of the friction rings E.* If the pointer has swung past the zero position, rings E are screwed up a little more tightly. If it has not reached zero the rings should be unscrewed a little.

(iv) With the pendulum arm free, and hanging vertically, place the spacer, which will be found attached to a chain on the base of the vertical column, under the lifting-handle setting-screw to raise the slider. Lower the head of the tester using knobs A and B so that the slider just touches the road surface, and clamp in position with knob A. *Remove the spacer.*

(v) Check the sliding length of the rubber slider over the surface under test, *by gently lowering the pendulum arm* until the slider just touches the surface first on one side and then on the other side of the vertical; the sliding length is the distance between the two points where the sliding edge of the rubber touches the test surface. (To prevent undue wear of the slider when moving the pendulum arm through the arc of contact, the slider should be raised off the road surface by means of the lifting handle.) If necessary, adjust to the correct length by raising or lowering the head slightly. When the apparatus is set correctly the sliding length should be between 125 and 127 mm; on the scale provided, the outer marks are 127 mm apart and the inner ones each indicate the 2-mm tolerance allowed.

(vi) Place pendulum arm in its release position. The apparatus is now set ready for operation.

Operation of tester (wet conditions)

(i) Wet the road surface and slider, ensuring that the road surface is free from loose grit.

(ii) Bring the pointer round to its stop. Release the pendulum arm by pressing button C *and catch it on the return swing, before the slider strikes the*

*This adjustment is necessary as the tester is used under different temperature conditions and in windy conditions: sufficient adjustment has been allowed to cover all normal ranges of temperature encountered in Great Britain, but some difficulty may be experienced in correcting to zero in very high winds—it may be necessary to operate the tester with a positive error and subtract the error from the mean value.

road surface. Note the reading indicated by the pointer. (N.B. if the slider is not wetted as well as the road surface, the reading obtained on this first swing should be neglected.)

(iii) Return the arm and pointer to the release position, keeping the slider clear of the road surface in this operation by means of the lifting handle. Repeat swings, spreading the water over the contact area with the hand or a brush between each swing (this is particularly important on smooth surfaces). Record the mean of five successive readings, provided they do not differ by more than three units. If the range is greater than this, repeat swings until three successive readings are constant; record this value.

(iv) Raise the head of the tester so that it swings clear of the surface again and check the free swing for zero error.

Procedure when testing road surfaces

(i) Inspect the road and choose the section to be tested.

(ii) Set the apparatus on the road surface in the track chosen to be tested, so that normally the slider swings in the direction of the traffic. On surfaces bearing a regular pattern, such as ridged or brushed concrete, tests should be made with the slider operating at 80° to the ridges. Take the mean of five readings, as above, at each of five locations in the test track (usually the nearside wheel-track) spaced at approximately 5- to 10-m intervals along the length under test. The mean of these readings gives a representative value of the skidding resistance of the road.

(iii) The slipperiness of some roads varies considerably across the width of the road and sometimes the crown of the road is the most slippery part. Where this is suspected, tests should also be made on the crown of the road.

Interpretation of results and recording of data

Like all skidding machines, the portable tester can only be used to the best advantage with a full knowledge of the factors influencing skidding resistance, and results must be interpreted with due consideration for all conditions obtaining at the time of the tests. Full details of performance tests are given elsewhere,[1] but the main factors influencing 'skid resistance' are outlined here.

(i) The quantity measured with the portable tester has been termed 'skid-resistance' and this correlates with the performance of a vehicle with *patterned* tyres braking with locked wheels on a wet road at 50 km/h. From measurements made at skidding accident sites and elsewhere, it has been possible to draw up a table as a guide to the values of 'skid-resistance' required for different road layouts and traffic conditions. This is shown in Table 1.

As the unit of 'skid-resistance' represents the performance of a patterned tyre, it may be found that some smooth-looking surfaces have values of

'skid-resistance' in the range of Categories B and C may be *less* satisfactory when judged from accident statistics than measurements with the portable tester would indicate. On smooth-looking roads in these Categories, therefore, when the portable tester gives high results it needs to be backed by accident studies[2] (or sideway-force measurements which give the skidding resistance of a smooth tyre). On the other hand, values of 'skid-resistance' below the suggested minimum indicate sites potentially slippery to all vehicles, whatever the surface texture or the state of their tyres.

The order of merit of road surfaces can change substantially between 50 km/h and 130 km/h.[3] Thus, 'skid-resistance' values, which represent the 50 km/h value, cannot alone be expected to give an indication of high speed performance. The fall-off in skidding resistance with increased speed on wet roads depends on the roughness of the surface texture, and is considerably less on rough surfaces than on smooth ones. If the tester is used on high speed roads, an additional criterion indicating texture is required.

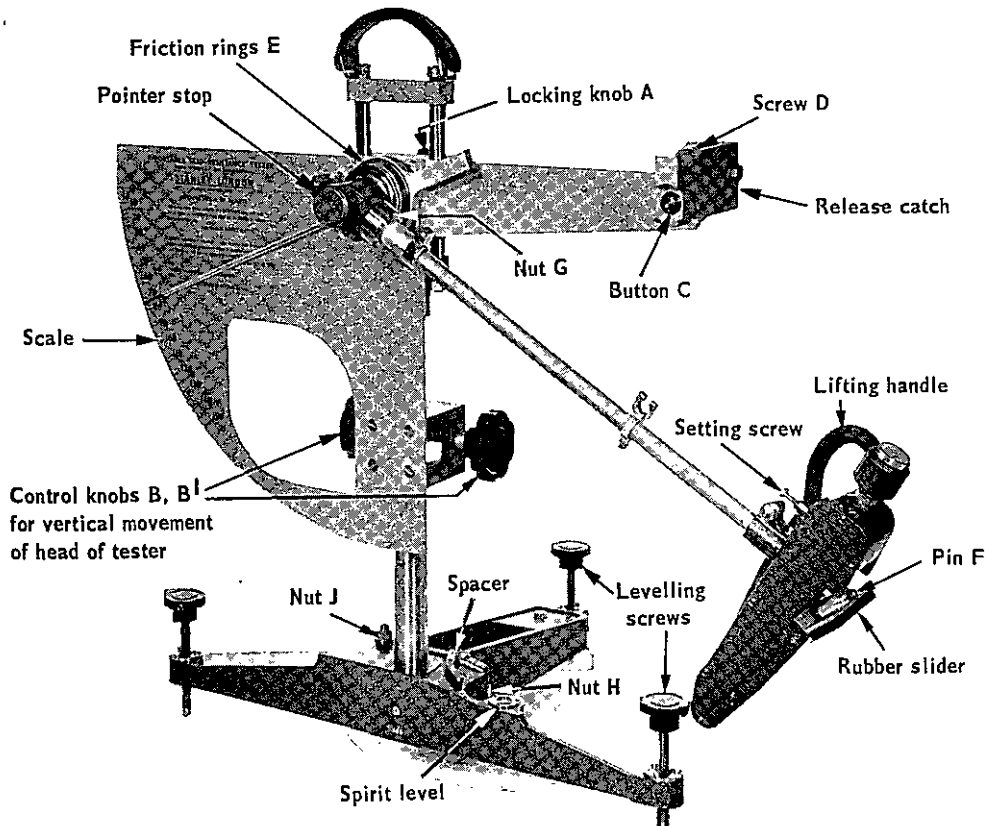
Table 1

Suggested minimum values of 'skid-resistance' (measured with the portable tester)

Category	Type of site	Minimum 'skid-resistance' (surface wet)
A	Difficult sites such as: (i) Roundabouts (ii) Bends with radius less than 150 m on unrestricted roads (iii) Gradients, 1 in 20 or steeper, of lengths greater than 100 m (iv) Approaches to traffic lights on unrestricted roads	65
B	Motorways, trunk and class 1 roads and heavily trafficked roads in urban areas (carrying more than 2000 vehicles per day)	55
C	All other sites	45

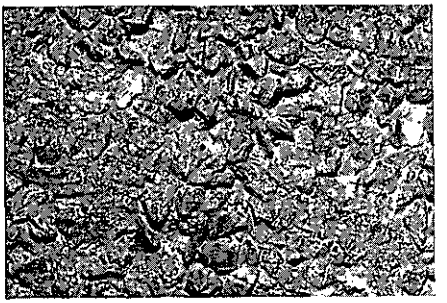
Note: For category A and B sites where speed of traffic is high (in excess of 95 km/h) an additional requirement is a minimum 'texture depth' of 0·65mm

Because the portable tester indicates the performance of patterned tyres at relatively low speeds, it is important to record the surface texture or



Portable skid-resistance tester

PLATE 1



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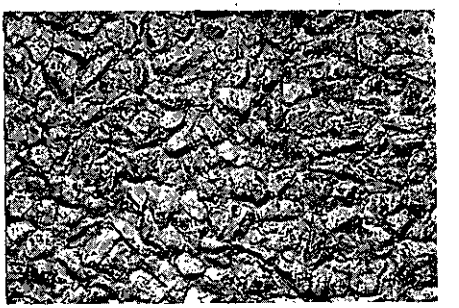

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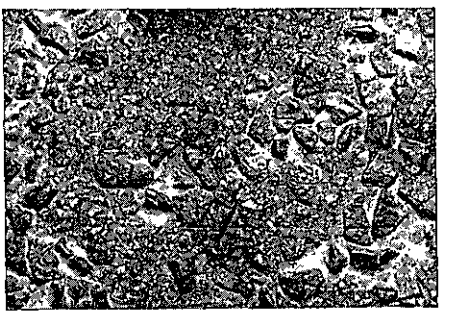
Rough-textured surfaces



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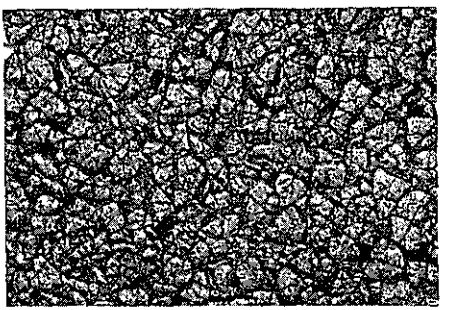

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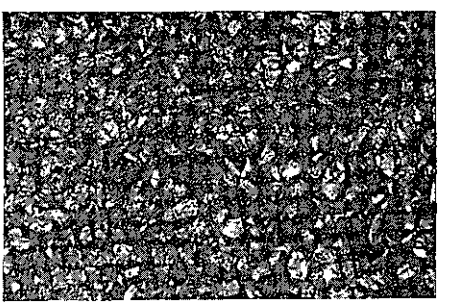
Medium-textured surfaces



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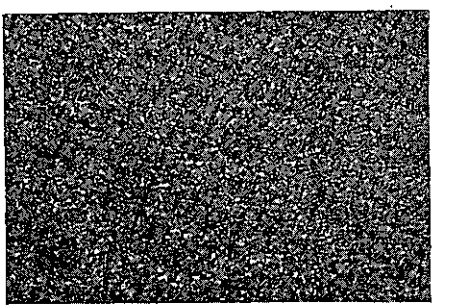

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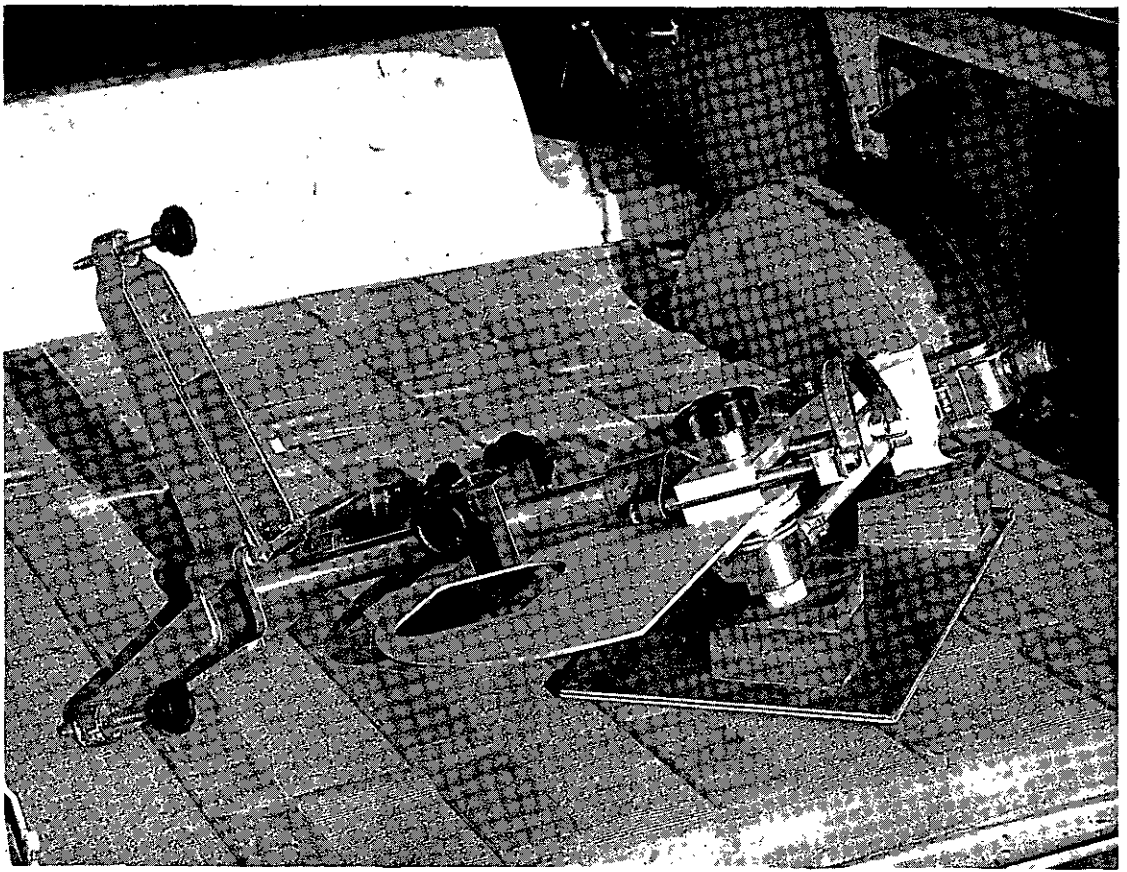
Smooth-textured surfaces

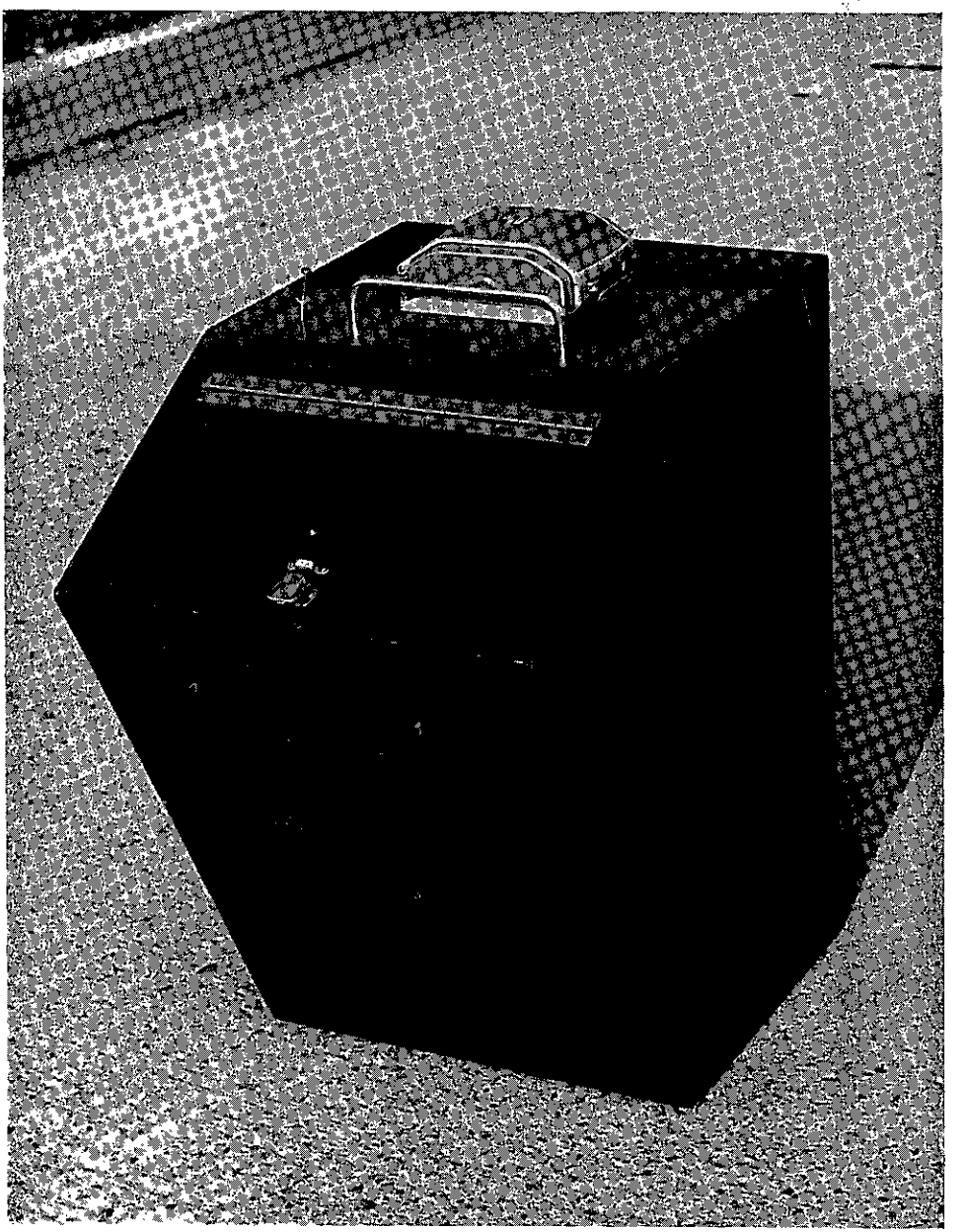
Typical surfaces having rough-, medium-, smooth-textured appearance
(Approx $\frac{1}{2}$ size)

PLATE 2



Tester supported on a small carrying board

PLATE 3



Camera unit for photographing road surfaces

PLATE 4

appearance of each road surface tested. On roads where speeds are low, it is sufficient to classify the texture from visual inspection. Plate 2 shows typical surfaces classified as follows:

Plate 2 (a) and (b): rough-textured surfaces where tyre tread pattern would have a negligible effect; smooth and patterned tyres would generally be equally effective on these surfaces.

Plate 2 (c) and (d): medium-textured surfaces where some tread pattern effect would exist; vehicles having smooth tyres would experience a skidding resistance slightly lower than the value indicated by the tester.

Plate 2 (e) and (f): smooth-textured surfaces where the effect of tread pattern may be large.

On roads where speeds are high, a simple measure of surface texture, the 'texture depth', may be determined by the 'sand patch' method: a known volume of fine sand is poured in a heap on the road, and spread to form a circular patch so that the small valleys on the road are filled to the level of the peaks; the 'texture depth' is the ratio of the volume of sand to the area of the patch (calculated from the measured radius). The additional requirement recommended for high-speed roads is then a minimum 'texture depth' of 0·65 mm, as indicated at the foot of Table 1. Details of the test are given in the Appendices, which also describe a simple method of taking close-up surface photographs with standard conditions of illumination. This provides a useful record of the appearance of the surface.

(ii) In general the skidding resistance of wet roads is higher in winter than in summer. The magnitude of the variation depends on (a) road layout and traffic conditions, (b) road surface characteristics, and (c) the weather; it varies considerably from one road to another, so that it is not possible to predict the skidding resistance at one time of year from a single measurement made at another time. However, regular movements (at two-week intervals) on a selected number of sites provide a useful basis for a seasonal guide. Based on such tests, the Laboratory now issues a 'seasonal index' to indicate changes in performance over the years.[4] Table 2 gives the index month by month for 1962 to 1968. This shows that skidding resistance of roads is at its lowest between May and September; it is also important to note that roads with satisfactory values in winter (especially in December, January, and February) may prove slippery during the summer. The date of test should therefore always be recorded.

(iii) The effect of temperature on rubber resilience exerts a perceptible influence in all skidding resistance measurements;[5] it shows itself as a fall in skidding resistance as the temperature rises. In addition, the magnitude of the variation of skidding resistance with temperature varies considerably from road to road, mainly because of the changes in road surface texture. As a rough guide, however, an average temperature correction evaluated for a range of surface textures is given in Fig. 1. From this it is apparent that a correction for the effect of temperature only becomes important

for tests made at temperatures below 10°C, and then its main use is to give a more accurate assessment of the skidding resistance which the road is likely to offer to the tyres of vehicles, since they are likely to be running at temperatures rather higher than that of the slider rubber on the portable tester.

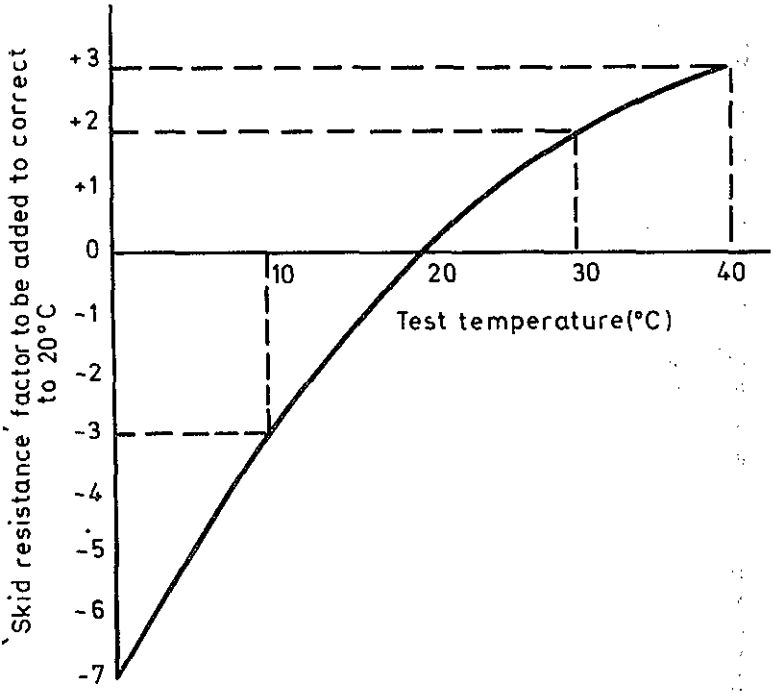


FIG. 1. Suggested temperature corrections for 'skid-resistance' values to allow for changes in resilience of the slider rubber

To help in interpreting results, therefore, the temperature of the water lying on the road immediately after test should be recorded. It must be stressed, however, that the change in state of polish of road surfaces throughout the year is a much bigger factor determining changes in 'skid-resistance' than is the change in temperature; the latter accounts for about one-quarter of the total seasonal change in 'skid-resistance', which is primarily due to real and reversible changes in the road surface.

Table 2

Monthly index of seasonal changes in 'skid-resistance'

Month	1962	1963	1964	1965	1966	1967	1968
January	119	130	114	118	116	109	109
February	112	121	114	111	110	102	111
March	110	115	107	108	103	100	105
April	99	109	104	105	103	103	102
May	99	105	96	104	100	94	98
June	89	97	93	98	90	88	99
July	92	99	83	98	93	84	99
August	90	94	92	95	94	87	98
September	94	102	96	97	91	91	95
October	97	103	102	94	103	102	93
November	110	110	105	106	105	106	102
December	114	113	112	110	108	116	109
Average	101	109	102	104	101	99	102

(iv) Owing to variations in skidding resistance across the width of the road, care should be taken in choosing the track to be tested; the actual position should be recorded for future reference.

A reminder of the essential data required is printed on the scale of the tester, and a form for recording the data is suggested in Table 3.

Maintenance of tester

The testers have been designed so that the minimum amount of maintenance is required. One or two parts, however, need some attention.

(i) Sliders should be renewed when the sliding edge becomes burred or rounded. One slider edge can normally be used for at least 100 different settings (500 swings). Each slider is fixed to a small aluminium plate, and this whole unit can easily be removed for replacement by pulling out the pin F. All new sliders should be roughened before use by swinging several times over a piece of dry road.

(ii) Care must be taken at all times to keep the slider clean and free from oil and grease, and a check should be made that the slider is free to turn on its spindle.

(iii) For ease of operation, the levelling screws, racks, and guides should be kept oiled. The release catch may also need oiling from time to time, but only a small amount of 'typewriter' oil should be used for this purpose, being applied to the wick found beneath screw D.

Table 3

Results of tests made with a portable skid-resistance tester on wet surfaces

Road Research Laboratory — Ministry of Transport

Object of experiment:

Date	Section	Test track (distance from kerb)	Surface texture	Temperature of water on road (°C)	'Skid-resistance'						Remarks
					Mean readings at individual locations					Mean	
					1	2	3	4	5		

The calibration of all testers should be checked at least once a year, and all spare sliders (whether used or unused) should be checked for hardness and resilience at the same time (at the present time this service is carried out at the ~~Road Research Laboratory for a charge of 8 gns~~). Testers should also be checked if there are doubts about the performance of the instrument, for example, if it has been damaged.

Transporting the apparatus

In transporting the apparatus it may sometimes be convenient to remove the swinging arm from the head; this may be done quite easily by undoing nut G. In a similar way, to reduce the width of the apparatus (for example, when packing it in a case), the rear leg of the base may be swung sideways by removing the fixing nut H and loosening the pivot nut J.

A convenient method of carrying the instrument from site to site on test is to place it face downwards on a simple carrying board on the floor of a van, the swinging arm being held in the release catch, and the release and head of the tester being supported in blocks on the board (see Plate 3).

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APPENDIX 1

The measurement of texture depth by the sand patch method

Apparatus and material

This consists of:

(1) A pair of dividers capable of measuring radii up to 20 cm.

(2) A rule marked off in mm.

(3) A cylinder 8 cm high with an internal diameter of 2 cm.*

(4) A flat wooden disc of 6½-cm diameter with a hard rubber disc of the same diameter stuck to one face; this rubber facing should be about 1½ mm thick. It is convenient to attach to the other face a short spigot or dowel to serve as a handle.

(5) A container for the sand. A 250 cc plastic beaker would be found convenient for this purpose.

(6) A soft hand brush.

(7) A quantity of sand which will pass a No. 52 B.S. sieve and be retained on a No. 100 B.S. sieve. Natural sand with a rounded particle shape should be used.

Preparation of a conversion table

Calculate the exact volume of the cylinder. If the volume of the cylinder is V, the texture depth, TD, will be given by $TD = \frac{V}{\pi R^2}$, R being the radius of the sand patch. Prepare a table showing TD for values of R in increments of 1 mm from 5 cm to 18 cm.

Test procedure (see Fig. 2)

The surface to be measured must be dry and should first be swept with a soft brush. Fill the cylinder with sand; when full gently tap the base of the cylinder three times on the road surface and then top up the cylinder with sand and level the top with a straightedge. Pour the sand into a heap on the surface to be tested. In windy conditions the use of a tyre to surround the sand is recommended. Spread the sand over the surface, working the disc with its face kept flat, in a circular motion so that the sand is spread into a circular patch with the surface depressions filled to the level of the peaks.

With the dividers measure the radius of the patch formed by the sand and record to the nearest mm. Carry out a number of tests at intervals along a line parallel to the kerb as required.

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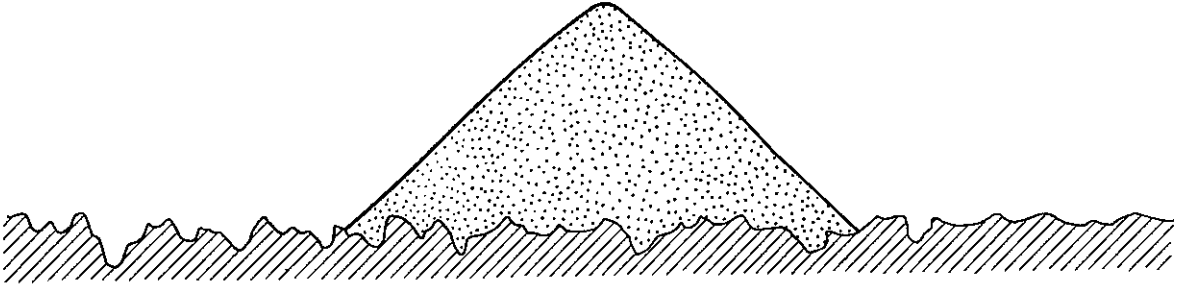
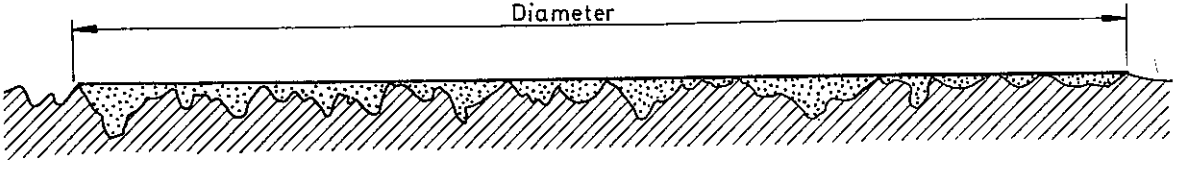
*Suitable only for texture depths greater than 0·25 mm; a smaller cylinder and finer sand are recommended for measurements on smoother surfaces.

(i) Known volume of fine sand of uniform particle size poured on road



(ii) Sand spread to form circular patch with 'valleys' filled to level of 'peaks'



(iii) Texture depth = $\frac{\text{Volume of sand}}{\text{Area of patch}}$

FIG. 2. Sand-patch method of measuring texture depth

APPENDIX 2

A simple camera unit for photographing road surfaces

Requirements

Methods of photographing road surfaces have been described elsewhere[6] but the camera units used are not suitable for use by a skidding team. Such a team requires a relatively small unit which can be carried in one piece in a car or light van, is easily transportable from one section to an adjacent section of road, and is

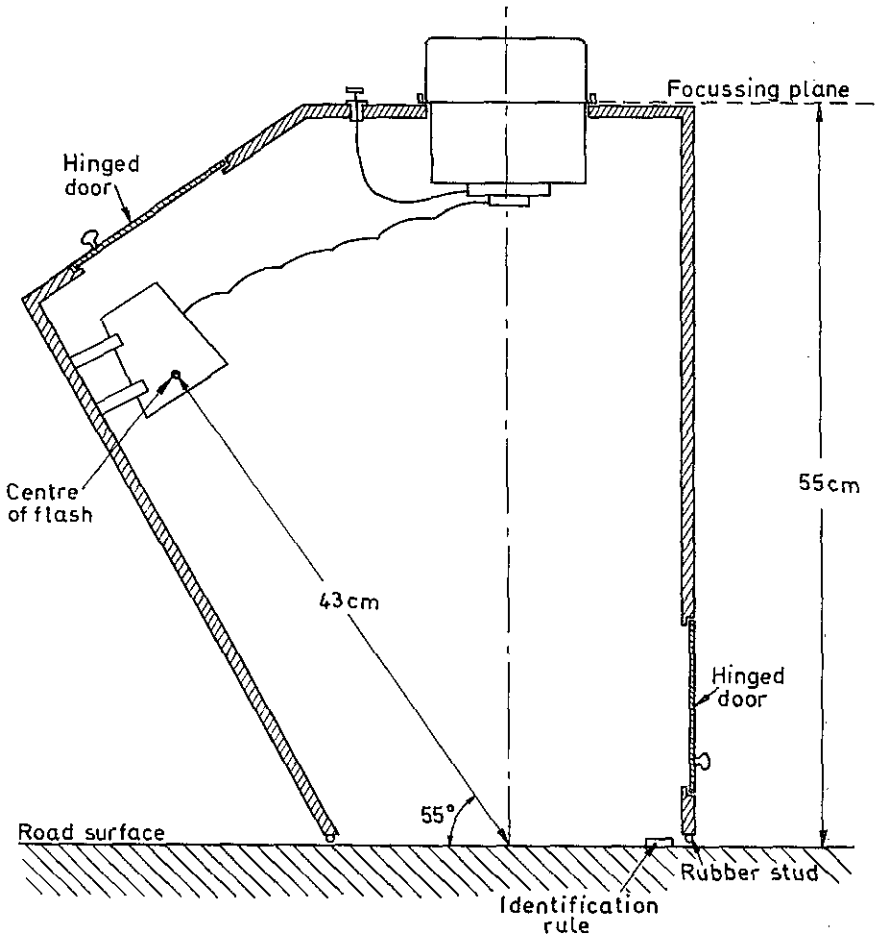


FIG. 3. Diagrammatic arrangement of surface texture camera unit

quick and easy to operate. The unit described in this Appendix fulfils these requirements and, although some of the high-quality finish of the photographs produced by the more elaborate apparatus is lost, the reproduction obtained is quite satisfactory for record purposes.

Description of apparatus

The camera unit, which is shown in Plate 4, consists of a camera with a 120 roll-film back mounted vertically with its focusing plate 55 cm from the road surface, and with a synchronized flash mounted within the same housing. The camera used had a 7·6-cm, f3·5 lens, permitting a coverage of 26 cm × 30 cm on the 120-size negative. To illuminate this area the flash is located midway along one of the longer sides of the box at a distance of 43 cm and 55° from the centre, as indicated in Fig. 3. This position was found by experiment to be the best, having regard to the essential requirement that the overall dimensions of the unit should be as small as possible; the direction of the flash is sufficiently oblique to show up details of surface texture, and the source of the flash sufficiently distant to give reasonably uniform illumination. (Ideally the direction of the incident light should be more oblique, but this requires a much more distant source.[6])

With this arrangement, the flash was used in combination with a slow panchromatic film, the camera lens being set at an aperture of f11 with a fixed focus. With this setting the depth of focus is about 4 cm, which is sufficient to accommodate unevenness and roughness in the road surface. The flash was mounted below a hinged door to facilitate replacement of the batteries. Each photograph can be identified by marking with crayon a traffelyte rule, which is also engraved with a scale in cm; this rule is placed directly on the road surface.

In operation the camera is set on the road surface, the identification rule set in position, the flash set, the door closed and the trigger fired. Thus the time taken to obtain a permanent record of the surface, showing all the details of texture and general appearance required, occupies only a few seconds at each site. Standard conditions of illumination ensure a fair comparison between different surfaces. Typical photographs showing the range in texture (taken on Pan X 120 film) are those shown in Plate 2. Experience has shown that in wet weather the road may be dried with a sponge and rag and a reasonable photograph still obtained.

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