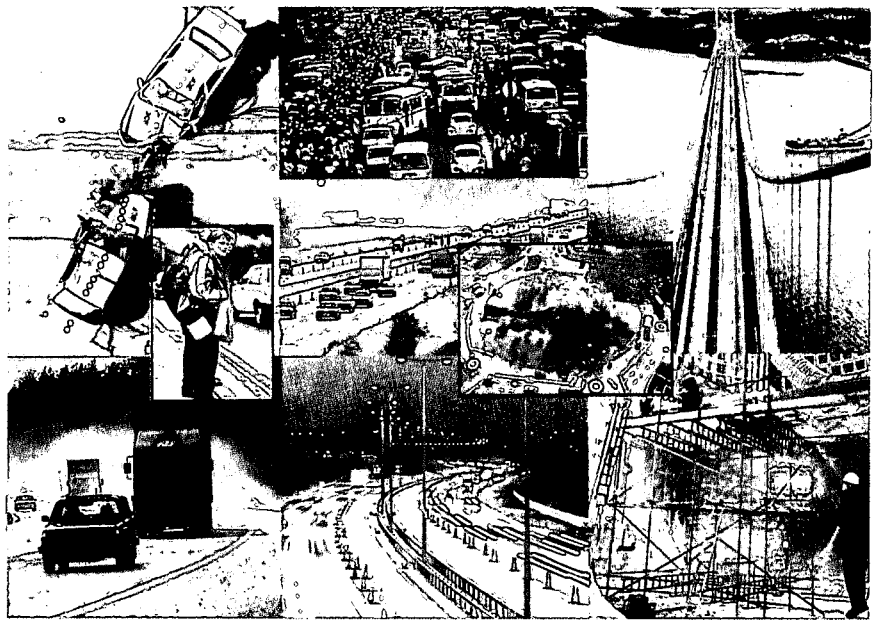

Calibration, maintenance and use of the rolling straightedge

by J C Young

Supplementary Report 290

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TRANSPORT and ROAD
RESEARCH LABORATORY

Department of the Environment
Department of Transport

SUPPLEMENTARY REPORT 290

CALIBRATION, MAINTENANCE AND USE OF THE ROLLING STRAIGHTEDGE

by

J C Young

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Highways Department
Transport and Road Research Laboratory
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CALIBRATION, MAINTENANCE AND USE OF THE ROLLING STRAIGHTEDGE

ABSTRACT

Requirements for the surface regularity of newly-constructed roads are defined in the current Specification for Road and Bridge Works in terms of the maximum permissible numbers of irregularities beneath a rolling straightedge of the type designed by the Transport and Road Research Laboratory.

This report provides a guide to the calibration and maintenance of this equipment and to its use in checking compliance with these requirements.

1. INTRODUCTION

For many years, British Standard Specifications for road surfacing materials have included a clause designed to ensure that a good standard of surface regularity or evenness is obtained on the final riding surface or on the surface of underlying layers in the road structure. Originally, these requirements took the form of specifying the maximum permissible depth of depression under a 10ft straightedge placed anywhere on the surface. Tolerances were dependent upon the type of material and the method of construction, usually ⅛in or 3/16in for riding surfaces and ¼in to ½in for base courses and prepared bases. Compliance was checked, using a straightedge, by measuring the depths of depressions between its lower edge and the surface of the road. An improvement upon this simple beam was the Ministry of Transport Specification Straightedge and Wedge Appliance. This had supports at either end to raise its lower edge above the level of the surface and, with the aid of a graduated metal wedge, bumps as well as depressions could be measured relative to its 10ft length. Both types of straightedge were moved longitudinally along the surface by distances of only a fraction of their length, measurements being taken in the rest position. In consequence, both were very slow and inconvenient to use.

In an endeavour to render this type of straightedge more mobile and to speed up the process of measurement, the rolling straightedge was designed and developed at the Road Research Laboratory. The present requirements for the surface regularity of newly-constructed roads are defined in the current Specification for Road and Bridge Works[1] in terms of the maximum permissible numbers of irregularities beneath a rolling straightedge constructed to this design. (The Straightedge and Wedge Appliance is however retained for use when testing construction of less than 75m in length or where it is impracticable to use the rolling straightedge.)

Despite the apparent simplicity of operation of the rolling straightedge, difficulties have frequently been encountered in its use, which it is considered are largely due to a lack of basic information relating to its proper calibration, maintenance and operating technique. This report therefore sets out to provide such information, which it is hoped will assist in ensuring effective and efficient use of the equipment.

2. DESCRIPTION

The rolling straightedge approximates to a 3m straightedge sliding along the road surface and consists of a rigid frame supported on 40 rubber-tyred wheels of 127mm diameter arranged in two parallel rows, 114mm apart, with the centres of the wheels in one row opposite the gaps between wheels in the other. These fixed wheels are spaced at 152mm between centres. At the mid-point of the 3m length, a sensing wheel, mounted between the two parallel rows of supporting wheels, is free to move such that it detects depressions, but not bumps, in the road surface. Vertical movements of this wheel are transmitted to two similar pointers on graduated scales on the instrument head. Rotation of the central sensing wheel drives a distance meter. In use (Plate 1), the straightedge is pushed by hand along the road surface at a slow walking pace (approximately 1-2 km/h, depending on the degree of irregularity) and the numbers of irregularities, their size and their distance from the starting point are noted. To avoid the need for continuous observation, a bell or buzzer can be set to operate when a pre-selected size of irregularity is exceeded.

The rolling straightedge is made in three separate parts (Plate 2) for ease of transport and can be quickly assembled and dismantled, the three sections, constructed of glass fibre, being designed to clamp together so that the overall alignment of the wheels remains unaffected.

3. CALIBRATION

The rolling straightedge is an accurate piece of measuring equipment and, although of robust construction, nevertheless requires care both in transportation and operational use if it is to retain its factory calibration.

3.1 *Manufacturer's calibration*

It is advisable to have the equipment checked periodically by the manufacturer[2] who operates a recalibration service. It is recommended that recalibration by the manufacturer be carried out in the following instances:

(i) At the start of a contract or testing programme.

(ii) At intervals of 6 months or on completion of 30km of testing, whichever occurs first.

(iii) If the straightedge fails to give correct readings during the user calibration check described in Section 3.2.

(iv) If it is suspected that the equipment is not functioning correctly.

To assist with (ii) above, an adhesive label with the serial number of the straightedge and the date of calibration will be affixed inside the indicating head of the equipment by the manufacturer.

The factory calibration consists essentially of checking that the 40 supporting wheels are in correct alignment according to the design tolerances and that the indicator on the instrument head reads correctly for a given vertical movement of the sensing wheel. The alignment check

entails mounting the assembled straightedge on a calibration surface table in order to check that each individual wheel is just in contact with the plane surface. Any necessary adjustments are then carried out by rotating the eccentric shaft of each wheel and locking this shaft in the correct position. Once the alignment check has been completed, a calibration of the vertical movement of the sensing wheel, with respect to the plane created by the supporting wheels, is carried out. Adjustments to the indicating pointers on the instrument head are then made as necessary and the operation of the depression selector is checked. In addition, checks are made on the locking clamps and mountings and the overall condition of the equipment. Lubrication of mechanical parts is also carried out where necessary. On completion of these checks a calibration certificate can be supplied to confirm that the equipment is within the original design standards.

3.2 *User's calibration*

In addition to the accurate calibration carried out by the manufacturer, a simple 'on-site' check can be made by the user as follows:-

Place two strips of accurately finished timber (eg marine ply), approximately 200mm wide x 3mm thick x 1.5m in length, longitudinally on a flat and even surface such as an office or laboratory floor, or a bench top. Leave a gap of about 150mm between the ends of the strips as shown in Fig 1. Stand the assembled straightedge on the timber strips so that the central sensing wheel can be lowered into the gap of 3mm depth. Check the position of the pointer relative to the 3mm mark on the graduated scale. By adding further 3mm strips, the 6mm and 9mm positions can be checked in a similar manner. Alternatively, by using 2 pairs of the 3mm thickness and 1 pair of 4mm thickness (this being a standard size and readily obtainable) it will be possible to check the readings for 3, 4, 6, 7, and 10mm depressions. The 4, 7 and 10mm depressions are the most important as these are the tolerances referred to in the Specification. It would also be advisable to check the zero position by butting the ends of the two strips together.

It is recommended that this simple calibration check be carried out before the start of each day's testing. The equipment should be expected to give the correct reading to within approximately $\pm$ 0.5mm. If it fails to do so, it should be returned to the manufacturer for service and accurate recalibration.

4. EQUIPMENT CHECKS

Before use, and prior to assembling the three sections of the straightedge, the following preliminary checks should be made:-

(i) Check that each of the three sections of the straightedge has the same manufacturer's serial number. Each straightedge is set up and calibrated as a complete unit and sections from different models should not be interchanged. This should be particularly noted where more than one straightedge is owned or where more than one straightedge is being used on the same site.

(ii) Examine the 40 fixed supporting wheels and also the central sensing wheel. Ensure that the surfaces of the wheels are free from mud, stones and other deposits and that each wheel is able to rotate freely

on its shaft. Instances have arisen where 'flats' have been worn on wheels due to seizure.

(iii) On the middle section of the straightedge, check that vertical movement of the sensing wheel is being transmitted to the pointer on the indicating head and that there is no sticking of the vertical shaft.

(iv) Rotate the sensing wheel to check that the distance meter is functioning correctly. During transit, the driving chain for this unit sometimes becomes detached from the gear wheel.

(v) While the head of the middle section is hinged open, check the battery leads and connections and the operation of the electric bell or buzzer for selected depression sizes as follows:-

Most models have a facility for lifting and locking the sensing wheel. Ensure that this mechanism is fully released. Close the hinged lid making sure that it fits squarely and securely onto its base and that the two locking catches fit tightly. Lock both of these simultaneously to avoid distortion in the side walls of the lid. Then, selecting each depression size in turn and with the power switched on, carefully tilt the straightedge middle section sideways to allow the sensing wheel to move downwards. In this way, check that the bell or buzzer operates as the pointer exceeds each selected size in turn. After checking, switch the power off, lift and lock the sensing wheel and secure the hinged lid.

(vi) The three separate sections of the straightedge can then be assembled. Note that the mating surfaces of the two outside sections are marked and that there are corresponding marks on the faces of the middle section to assist correct assembly. Make sure that the mating faces are clean before assembling. Check that all 6 locking clamps are tight and that the sections butt together squarely.

5. OPERATION

To check compliance with the surface regularity requirements as detailed in the Specification, the rolling straightedge is operated on a longitudinal test-line, or lines, parallel to the centre line of the carriageway on sections of 300m in length. Where the total length of construction is less than 300m, the measurements are taken over 75m lengths.

Having completed the preliminary checks described above, the handle assembly can be fitted and the equipment is ready for use. At the start of the test-section, the sensing wheel is lowered and the distance meter set to zero. The audible warning device is then set to the required tolerance and the power switched on. For efficient operation, the rolling straightedge normally requires two persons, one to push the equipment along the road and the other to take notes of the locations and sizes of the irregularities encountered. In use, it is pushed at a *slow walking pace* (approximately 1-2 km/h) and the movement of the pointer over the graduated scale is observed. When the selected size of irregularity is exceeded, the straightedge is moved *slowly backwards and forwards* to locate the position of *maximum* depression. At this point, the reading on the distance meter is noted and the road surface marked if required. At the end of each test-section, the depressions in each size category are totalled and checked for

compliance with the tolerances set out in the Specification.

On certain types of surface, for example concrete surfaces having a grooved or deep-textured brush finish, difficulty may be found in following the movement of the indicating pointer over the graduated scale, due to excessive vibration at the instrument head. Similar difficulties may arise when testing heavily chipped or coarse-textured flexible surfaces and can only be overcome by proceeding at a very slow pace. It should be stressed that it is not necessary to maintain a constant speed of operation but that this should be adjusted according to the type of surface under test and the prevailing conditions. In the case of brushed or grooved concrete surfaces, 'worm-casts' produced by the texturing process should be removed before making measurements. Similarly, any loose chippings should be swept from the surface when testing flexible construction.

On completion of testing, the sensing wheel should be lifted and locked and the audible warning device switched off or the battery disconnected. The straightedge can then be dismantled into its 3 sections. When moving between test areas on the same site, the equipment should not be pushed at excessive speed and on no account should it be towed behind a vehicle. If the distance is too great to allow it to be pushed at about its normal test speed, it should be dismantled and transported within a vehicle. At no stage should the assembled equipment be lifted bodily. During transport, the 3 sections should be carefully handled and well secured, especially the middle section containing the sensing and indicating mechanism. Damage to any of the supporting wheels will affect the overall alignment of the 3m beam. When transporting the straightedge any appreciable distance, the transit boxes supplied with the equipment should always be used.

6. SPECIFICATION REQUIREMENTS

The surface regularity requirements for new construction are given in Clauses 701/5 and 1023/3 of the current, 1976 edition, of the Department of Transport Specification for Road and Bridge Works; they are reproduced in Table 1. The maximum permitted numbers of irregularities for the wearing course of flexible carriageways and the surface of concrete slab carriageways are shown, together with the requirements for basecourses and hard shoulders. In this metric edition of the Specification (which supersedes the previous 1969 edition) the former $\frac{1}{8}$in and $\frac{1}{4}$in tolerances are 4mm and 7mm respectively. No irregularity exceeding 10mm is permitted. Compliance is tested along any line, or lines, parallel to the centre line of the carriageway on sections of 300m in length, selected by the Engineer, whether or not constructed in shorter lengths. Previously, a test line of 1.2m from the nearside edge of each traffic lane was specified.

An additional clause requires that the road pavement be measured transversely for irregularities, at points decided by the Engineer, using the 3m Straightedge and Wedge Appliance placed at right angles to the centre line of the carriageway. This is also to be used where construction is less than 75m in length or where it is impracticable to use the rolling straightedge.

7. CONCLUSIONS

Difficulties have frequently been encountered in the use of the rolling

straightedge in checking compliance with the tolerances and requirements for the surface regularity of new construction.

Many of these problems are considered to be due to a lack of information relating to the proper calibration, maintenance and operating instruction for this equipment.

This report provides such information to assist in ensuring that the rolling straightedge is used in an effective and efficient manner.

8. ACKNOWLEDGEMENTS

This Report was prepared in the Construction and Maintenance Division (Head P D Thompson), of the Highways Department of TRRL.

The author wishes to acknowledge the advice and assistance given by Mr J M Guthrie of Engineering Intelligence Division of the Department of Transport and also Messrs Leonard Farnell and Company Ltd for their kind co-operation in providing details relating to the manufacture and calibration of the rolling straightedge.

9. REFERENCES

1. DEPARTMENT OF TRANSPORT. Specification for Road and Bridge Works. London, 1976 (H M Stationery Office).

2. ROLLING STRAIGHTEDGE MANUFACTURER. Leonard Farnell and Company Ltd, North Mymms, Hatfield, Herts.

TABLE 1

Specification for Road and Bridge Works (1976)
Maximum Permitted Numbers of Surface Irregularities

	Flexible Wearing Courses, Concrete Carriageways				Flexible Basecourse, Surfaces of:- Hardshoulders Lay-bys Service Areas			
Irregularity	4mm		7mm		4mm		7mm	
Length (m)	300	75	300	75	300	75	300	75
Category A* Roads	20	9	2	1	40	18	4	2
Category B* Roads	40	18	4	2	60	27	6	3

Note 1 An irregularity is a variation not less than 4mm or 7mm of the profile of the road surface as measured by the rolling straightedge set at 4mm or 7mm as appropriate. No irregularity exceeding 10mm shall be permitted.

Note 2 *The category of each section of road is as described in the Contract.

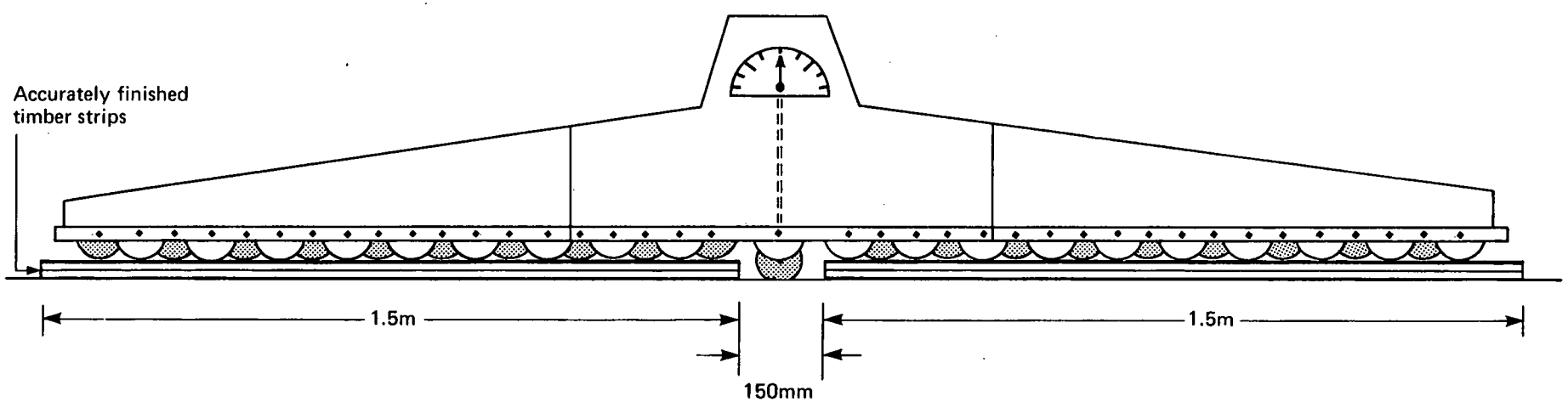

Fig. 1 USER'S CALIBRATION CHECK OF THE ROLLING STRAIGHTEDGE

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PLATE 1: The Rolling Straightedge in use

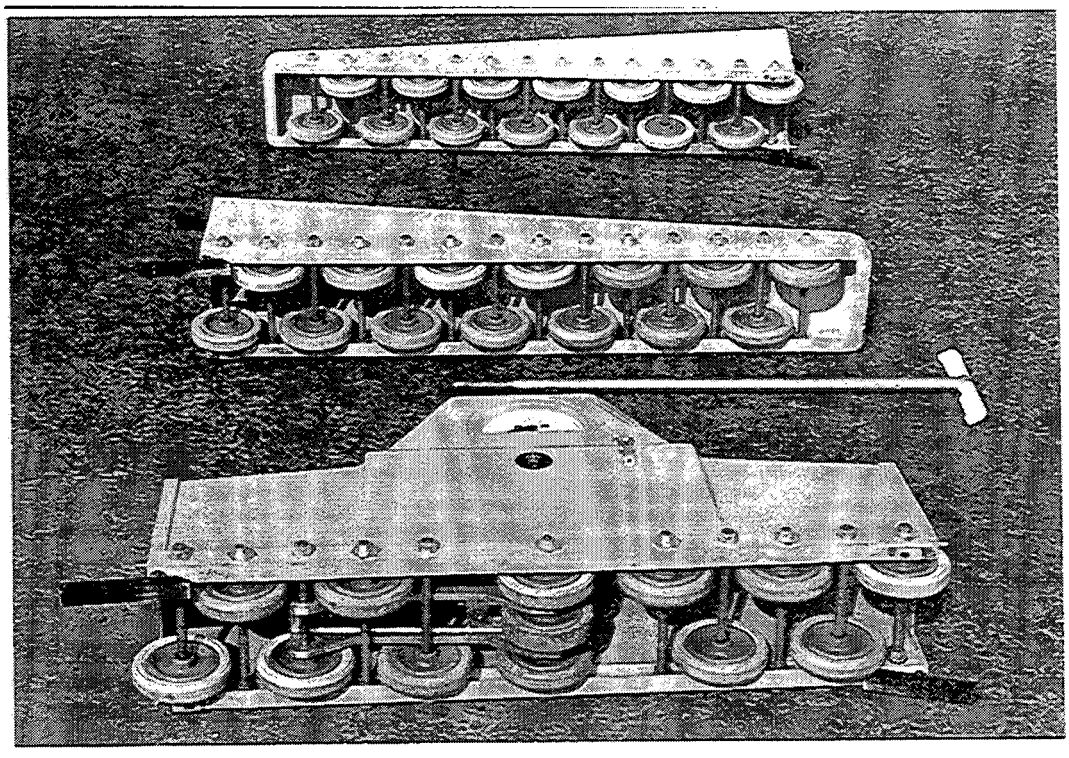

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PLATE 2: The Rolling Straightedge – dismantled for transport

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