

No. RW/NHIII/P/10/84

Dated the 19th May, 1984

To

All Chief Engineers, P.W.Ds, in the States and Union Territories dealing with National Highways and State Sector Roads

Sub : Guidelines for the use of Roughometres for measuring road roughness

I am to refer to Ministry's letter of even number dated 3.4.1984 addressed to all the State Govts. and Union Territories regarding the use of roughness measurements by means of roughometres. Guidelines for the use of Roughometres prepared in the Ministry are enclosed herewith for adoption.

GUIDELINES FOR THE USE OF ROUGHOMETRES

1. Roughness measurements are extremely important since they give a quantifiable measure of the riding quality of a road. The roughness of the road surface determines vehicle's speed, road safety and vehicle operating costs. The quality of construction and maintenance of a road is reflected in the roughness measurements. A periodic measurement of roughness is therefore of vital importance to a highway engineer.

2. Description of the Roughometre (Bump-Integrator)

2.1. There are various instruments for measuring the roughness of a road. An important group of such instruments is known as the response-type instruments which measure the response of a mechanical system to the unevenness of a road. The Roughometre also known as the Bump-Integrator is one of the popular response type roughness measuring instruments. It is a towed fifth wheel. The instrument available in India is based on the design standardised by the Transport and Road Research Laboratory, U.K. The instrument is towed by a jeep.

2.2. Frame

The Bump Integrator consists of a trailer of a single wheel mounted within a rectangular steel frame. The wheel is of pneumatic tyre of a standardised size of 6.00X16 (4 ply). The wheel is carried on the centre of the axle by a pair of taper rolling bearings which can be adjusted to prevent and play. The wheel itself supports the chassis through two leaf springs anchored to the front and shackled to the rear end of the frame through ball bearing fixtures. The ends of the axle are locked up by means of clamp blocks on the centre of the two leaf springs.

2.3. Towing Hitch

The members which are attached to the sides of the frame form a tongue at the forward end which carries a hitch for connection to the towing vehicle. The towing hitch maintains the frame in an upright position but provides freedom of movement in either direction by means of a universal joint fitted with ball bearings.

2.4. Shock Absorbers

In order to dampen the vertical movement, a frame is provided over the wheel to form an anchorage for the piston rods of two dash pots. A standard fluid is provided in the dash pot for this purpose.

2.5. Mud Guard

A mud-guard is provided over the wheel.

2.6. Castor Wheels

3 adjustable castor wheels are fitted to the frame for parking, 2 being attached to the tongue in the front and one being attached at the rear of the frame.

2.7. Integrator

The uni-directional movement between the Axle of the wheel and the chasis is recorded by an Integrator unit. This unit performs the function of closing a pair of contacts inserted in the circuit of an electro-magnetic counter, one for every 2.5 cm. of integrated uni-directional movement. These contacts are actuated by a 6-lobed cam mounted on a shaft which is driven in one direction through a wedging-ball type of over-running clutch, by the movement of a small cylindrical drum which reciprocates in accordance with the movement of the axle to which it is connected by a cord. The tension in the cord is maintained by a spring inside the drum.

2.8. Wheel Revolution Counter

The distance traversed by the integrated unit can be measured by counting the number of revolutions of the wheel. A cam fitted to the hub of the wheel actuates a contactor fitted in close proximity which closes the circuit of a second Electro-Magnetic counter, once for each revolution of the wheel.

2.9. Panel Board

Four Electro-Magnetic counters are put into electric circuit. The electric supply to the system is from the 12 Volt battery of the vehicle. For every 2.5 cm of bumps, the bump recording counter registers one unit. The second counter registers the number of wheel revolutions. A duplicate pair of counters is provided for facility of reading. Switch over from one set of counters to the others is effected by means of a switch.

If W indicates the wheel revolutions and B indicates readings, then the Unevenness Index value is $= \frac{B \times R \times 2.5}{W}$ cms/km. For the particular unit 460 revolutions of the wheel denote 1 km length of travel (i.e. R=460).

2.10. Recording Chart

An optional recording chart is provided for the recording the unevenness values. This unit is mainly needed by Maintenance Engineers to locate the exact spots where the surface is extremely bad.

2.11. General Specifications

The general specifications of the equipment are given below :

GENERAL SPECIFICATIONS

Overall length	: 2400 mm
Overall Width	: 700 mm
Height	: 1100 mm
Weight	: 350 kg (approx.)
Tyre Size	: 6.00 X 16 (4 ply)
Inflation pressure	: 2.1 kg/cm ² (30 lb/sq in)
Standard operating speed	: 30 ± 1/2 km/hr.
Dashpot fluid	: 50% by volume, paraffin 50% refrigerating machine oil (Shell clavus Oil-17 or Bharat Freezol -17)
Capacity of dashpots	: 1.2 Litres each
Contacts for integrator Unit and wheel revolution contactor	: Lucas car contact breaker set No. 407-050
Electromagnetic counters	: Keltron, 6 digit with zero setting 12 Volts.
Oil for Integrator	: Light mineral oil, generally used for human consumption.
Bearings	: In the integrator, recording device numerating device, towing hitch and in brackets and shackles are grease packed ZZ type.

3. Operation of the Equipment

3.1. The Bump Integrator should be towed by a suitable vehicle at a speed of 30 KMPH. A jeep with a canvass body is eminently suitable because it affords opportunities for the driver to keep a watch on the Integrator Unit.

3.2. The following operating instructions have been prescribed by the manufacturers.

1. Before putting into operation for test, check the following :—
 - a. Integrator cord is removed from axle;
 - b. Carry necessary data sheets, tool kit and spare parts.
2. To keep machine ready for use.
 - a. Fix the towing bracket with the towing vehicle.
 - b. Fit the towing hitch with the towing bracket fitted with the towing vehicle.
 - c. Remove the castor wheel assemblies.
 - d. Check and adjust tyre pressure to 2.1 kg/cm² (30 lbs./sq. in)
 - e. Check and maintain damping fluid level to 3 cms. below the cylinder cap.
 - f. Set the integrator cord in operative position.
 - g. Check up that the flexible cable is fitted from the integrator unit to the numerating device.
 - h. Fit the two pin flush mounting plug in the panel board, and give supply from the 12 volt battery (with the main switch on the panel board "off"). With the help of battery clamps provided at the end of the wire.

N.B. : If the battery of the towing vehicle is of 12 volt the same could be used, otherwise a separate 12 volt battery may be used.

- i) Fit the three pin flush mounting plug in the panel board and tighten the earth terminal to any convenient point on the machine. Then connect one Wire each to the integrator unit and the wheel revolution contactor with the help of crocodile clips provided at the other two ends of the wire and check the working of the integrator unit.
- 3 Comprehensive notes should be taken giving particulars of test length, width of road, type of surfacings, data and any other relevant detailed needed.
- 4 The procedure is to drive over the test section at a speed of 30 ± 1/2km./hr. keeping to a steady position in the testing track, and

avoiding swerving. The observer having set the counters to zero, closes the main switch on the panel board at the beginning of the section and switches it off at the end. The readings of the wheel revolution counter and integrator counters are noted and entered on the form giving the results.

- 5 When testing a series of consecutive sections of road, the tests should be arranged so that the measurements are made on alternate sections on each run, so that the observer has time to write down the readings and re-set the counters to zero between sections. Since the instrument board is equipped with two pairs of counters and a change over switch, consecutive measurements can be made continuously with a substantial saving of time.
- 6 During operation, checks of the tyre pressure should be made, so that the pressure is maintained preferably at 2.1 kg/cm² (30 lbs./sq. in.)
- 7 After testing following may be done.
 - a. Flexible cable from the driven sprocket shaft to the gear box should be removed.
 - b. The end of the cord which actuates the integrator unit should be removed from the axle.

3.3. The manufacturers have prescribed that the following spare parts should be carried alongwith the vehicle :

1. Cord for axle-integrator unit connection in correct length ready for fitting—1 No.
2. Blade-hinges for the flexible couplings which support the dashpots—8 Nos.
3. Dash pot fluid, small funnel, dip rod (for journeys of appreciable duration).

3.4. A suitable form which has been devised for recording the unevenness values and the distance traversed is given in Appendix-I. The vehicle is driven over the test section at a constant speed of 30 KMPH \pm 1 KMPH. Care has taken to keep the instrument in a steady position. The observer sets the counters to 0 and at the commencement of the section operates the switch for recording the values. It is preferable to record the Bump Integrator values when the wheel revolution counter records 460 units, which corresponds to 1 km of travel. The Bump Integrator values are noted whenever the distance counter measures 460 units. The brief description of the surface should be noted by the Observer as the instrument travels over the road section.

3.5. Maintenance

The following instructions have been supplied by the Manufacturers for the periodic maintenance of the equipment :—

To ensure reliable and consistent results, it is essential to maintain the machine efficiently. The following schedule of operations is recommended:

Daily	Tyre	Check and maintain tyre pressure at 2.1 kg/cm ² (30 lbs./sq.in)
	Dashpots	Check and maintain fluid level to 3 cm. below the cylinder cap.
Every 1500 kms or four months	Dashpots	Drain and refill with fresh fluid.
	Towing hitch	Lubricate with grease gun.
	Spring Clamping Bolts	Check for tightness.
	Numerating device	Check all the screws and bolts for tightness.
Every 3000 kms. or 6 months	Dashpots	Drain, detach, remove end-caps inspect and clean if necessary.
	Towing hitch	Lubricate with Grease Gun.
	Integrator Unit	Lubricate by pouring thin oil through the hole (normally sealed by a screw) on the top of the unit, while the screw sealing the side hole is removed, the unit being horizontal, oil will then drain to the correct level, inspect contacts and adjust so as to equalise 'make' and 'break' periods if necessary.
	Wheel revolution contactor	Check that 'make' and 'break' periods are equal and adjust contacts if necessary.
Every 4000 kms	Wheel	Determine variation of effective radius, re-determine the distance corresponding to one revolution.
Every 7500 kms	Wheel Hub	Fill with good quality bearing grease.
Every 15000 kms		Dashpot inspection. Tractor wheel assembly Lubrication.
Every 50000 kms		Recalibration of leaf springs. Inspection of spring mountings.
Annually		Towing hitch inspection Integrator inspection.

N.B. Bearings fitted in the integrator unit, recording device, numerating device, towing hitch, brackets and shackles are grease packed of the ZZ type and are not likely to need any attention for several years.

4. Calibration

It is of extremely great importance to keep the instrument in proper calibration. The precautions to be observed indicated in Section 3 above will generally ensure that the instrument is in calibration. However, it is necessary to check the calibration of the instrument once in a month. This can be done by running the instrument over surfaces of constant roughness, such as the cement concrete road, bridge decks, newly laid WBM surfaces and establishing conversion factors if the readings observed during calibration are different from those when the instrument was new. It is therefore suggested that as soon as the instrument is procured, the measurements should be taken on standard surfaces of known roughness and a permanent record of these readings should be kept. Subsequent readings on the surface will enable calibration equations to be developed.

APPENDIX I

BUMP INTEGRATOR MEASUREMENTS

Read :

Date :-

Section :

Weather

Code

From :

Dry

1

Wet

2

To :

Type of Surface :

Surface Dressing

Premix Carpet

Ashphaltic Concrete

Cement Concrete

W.B.M.

Gravel

Not specified

Code

1

2

3

4

5

6

9

Recorded by

Wheel Rev :

Integrator counter Readings*

Unevenness Index .
mm/km

Remarks

(1)

(2)

(3)

(4)

5100-3

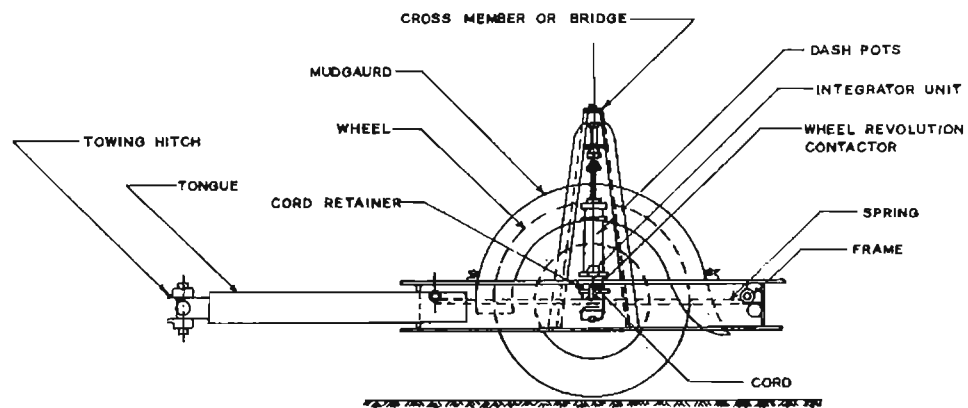


Fig.1 DIAGRAMMATIC SKETCH OF THE BUMP - INTEGRATOR