STANDARD TEST PROCEDURE FOR BENKELMAN BEAM DEFLECTION MEASUREMENTS

1.   SCOPE

1.1   This test procedure covers the determination of the rebound deflection of a pavement under a standard wheel load and tyre pressure, with or without temperature measurements.
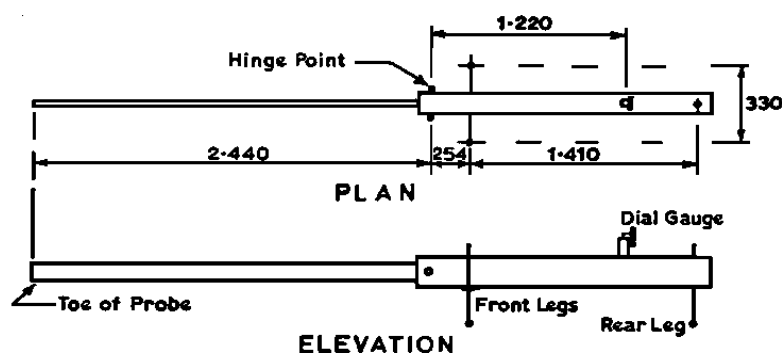

Fig 1. Diagram showing critical dimensions of Benkelman Beam

2.   EQUIPMENT

2.1   Basic equipment shall consist of:

(a)   A Benkelman beam to the Ministry of Works and Development pattern having the dimensions shown on Figure 1. The beam must be fitted with a satisfactory locking device designed to secure the beam when moving to a new site and a suitable vibrator mounted at the pivot point.

In sunny weather the beam may pass from shade into sunshine as the vehicle moves away. Therefore a shield similar to that described in Road Research Unit Newsletter No 49 should be used.

(b)   A truck or trailer with an axle load of 8.20 ±0.15 tonnes equally distributed on two dual tyred wheels operating at the inflation pressure necessary to give a tyre contact area of 0.048 ± 0.0002 m^2.[*] The tyres shall preferably be 10.00 x 20, 12 ply with tubes and rib treads.

(c)   A tyre pressure gauge graduated in 20 Kpa divisions or smaller.

(d)   A thermometer with a range of 0-6°C in 1°C divisions.

(e)   A mandrel suitable for making a 100mm deep hole in the pavement for inserting the thermometer. The diameter of the hole should be 13mm.

(f)   A can containing either glycerol or oil for filling the thermometer hole.

3.   PROCEDURE

3.1   Deflections shall be measured as follows:

(a)   The test point shall be preselected and marked. For highway pavements, test points shall be located at the distances from the edge of the lane given in Table 1.

Table 1

Lane Width (Metres)	Distance from lane Edge (Metres)
2.8 or less	0.5
3.0	0.6
3.2	0.7
3.4	0.8
3.6 or more	0.9

(b)   The tyre pressure should be checked before the first test and then at intervals not exceeding three hours.

(c)   The truck shall initially be positioned with the test wheel between 100 and 150mm to the rear of the test spot, ie position A.

(d)   The probe of the beam shall be inserted between the dual tyres of the test wheel with the toe located on the test spot.

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[*]   Tyre manufacturers provide tables which quote appropriate tyre pressures for a given load to give the specified tyre contact area.

(e)   The locking device shall be released and the rear of the beam adjusted so that the plunger is in contact with the dial gauge.

(f)   The dial gauge shall be set to read between 9 and 11mm (the actual reading need not be recorded) and the vibrator set in operation.

(g)   The truck shall be moved forward at creep speed so that the test wheel passes over the test spot and continues advancing to position 8 which is 2.7 ± 0.1 metres beyond the test spot.

(h)   The START READING, S, is the maximum dial gauge reading occurring during this movement of the truck from position A to position B, and will normally occur as the wheel passes over the test spot. This reading shall be recorded.

(I)   The INTERMEDIATE READING, I, is that figure indicated by the dial gauge at the moment the truck stops with the test wheel in position B. This reading shall be recorded.

(j)   The truck shall be moved forward until the test wheel is in position V which is not less than 10 metres from position B.

(k)   The FINAL READING, F, is that figure indicated by the dial gauge when the truck has stopped in position C. This figure shall be recorded.

3.2   Temperature measurements must be made when the top layer of the pavement consists of 40mm or more of bitumen bound material. The following procedure should be followed:

(a)   A hole should be made with the mandrel to a depth of 40mm or to such a depth that it does not break through the bitumen bound material.

(b)   The hole should be filled with glycerol or oil and the thermometer inserted.

(c)   The temperature should be recorded at least hourly, or at decreasing time intervals down to 15 minutes when successive temperatures differ by more than 3°C.

3.3   No beam readings should be made outside the pavement temperature range of 5°C to 30°C when the top layer of the pavement consists of 40mm or more of bitumen bound material.

4. CALCULATIONS

4.1 The rebound deflection of the pavement shall be calculated in the following manner:[**]

(a) Two pavement rebound indicators shall be established by subtracting the intermediate and final readings from the start reading, ie:

$$(S - I) \, and \, (S - F)$$

(b) If the indicators so obtained agree within 0.03mm the true rebound deflection at temperature T shall be calculated as:

$$X_T = 2(S - F)$$

(c) If the indicators (S - I) and (S - F) differ by more than 0.03mm[***] the initial shape of the bowl has been such as to influence the front support legs of the instrument and the calculations shall be adjusted as follows:

$$X_{(T)} = 2(S - F) + 5.82 \, (I - F)$$

(d) The pavement rebound deflection at a standard temperature of 20°C shall be calculated from the above figure by applying the formula:

$$X_{20} = X_T + \frac{20 - t}{110}$$

where X_{20} = temperature corrected rebound deflection in millimetres

and t = temperature in degrees Celsius 40mm below the surface of the pavement

5. REPORTING

5.1 All reports shall include the following:

(a) The test location (preferably by SH No, Route Position, lane, and distance from lane edge).

(b) The actual axle load used.

(c) The rebound deflection of the pavement (to 0.01mm).

[**] **Note:** If the dial gauge has been modified to read pavement deflection directly, the questions in 4.1(b) and (c) must be divided by 2. If the dial gauge is graduated in an anti-clockwise direction the terms within which the brackets will have to be reversed to give a positive value.

[***] **Note:** A larger difference can be tolerated if it is confirmed while testing that the legs of the beam are not sitting in the bowl.

        (d)   The date and time of readings.

5.2   Where temperature readings are required:

        (a)   The pavement temperature.

        (b)   The depth at which the temperature is recorded.

        (c)   The time the temperature is taken.