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To

The All Chief Engineers, Public Work Departments of all States/Union Territories (dealing with National Highways); Chairman, National Highways Authority of India

Subject: Ministry's Research Scheme R-66-Automation of Benkelman Beam

Under Ministry's above Research Scheme, CRRI has conducted the research study. The findings of the research study are enclosed for your information and guidance.

2. This new device is being patented by CRRI, who will sell the technology for its commercial production in private sector. CRRI may please be contacted for further information in this regard.

Findings of the Study

1. Title of the Research Scheme (R-66)

Automation of benkelman Beam

2. Implementing Agency

(a) Central Road Research Institute, New Delhi

(b) MOST

3. Objective and Scope

Development of U.P. based Benkelman Beam for pavement evaluation/overlay design. Automation of Benkelman beam leads to storage and display of measured deflection, corrected deflection and overlay thickness. Using a printer, a hard copy (data sheet) can also be obtained which provides road details, deflection data, charcteristic deflection and overlay thickness.

4. Methodology

Benkelman beam deflections under standard axle load and standard tyre pressure provide structural condition of the road. Deflections are used for evaluating the road and are further used for overlay design.

Dial gauge used for deflection measurement conventional beam has been replaced by a transducer (LVDT, Linear Variable Differential Transformer) which provides electrical signal proportional to the vertical displacement of the tip of the beam. Output from the transducer is fed to the up based system which has been developed under the project. Deflections are measured and are stored by the system. These are averaged by the system after temperature corrections are made by it. Overlay thickness is then computed by the system taking weather condition (pre-mansoon/monson/post-monsoon) and soil type into consideration. Mean deflection, characteristic deflection and overlay thickness are displayed by the system just after the testing is completed in the field. The computations are done as per IRC Standard (IRC:81-1981).

Automated Benkelman Beam

Automated Benkelman beam consists of three parts namely Benkelman beam, deflection measuring system and μ P based system. (Fig. 1).

Benkelman beam: It is a standard equipment easily available in the market.

Displacement Measuring System : In the developed system the dial gauge has been replaced by a spring loaded LVDT. Output of the LVDT is fed into a calibrated meter which indicates exact displacement in mm.

μ P based system : μ P based system has been designed using 8085 μ P. A menu driven software has been used in the system Display is 16x2 line alpho-numeric LCD. The major functions of the system are:

(a) Receiving inputs regarding site of testing, such as:

Test No.	-	Single digit
Road Code No.	-	Two digits
Section Length	-	Four digits
Traffic Counts	-	Four digits
No. of lanes	-	Single digit
Climatic condition	-	Pre-monsoon/Monsoon/Post-monsoon
Temperature Correction	-	Yes/No
Weather correction	-	Yes/No
Clay subgrade	-	Yes/No
Calibration Factor	-	Value to be fed

(b) At each testing point, the following inputs are also made

S.No.	-	Two digits
Location of test point	-	Four digits
Pavement Temp	-	Two digits
LVDT readings	-	Initial, intermediate and final readings in a sequence

After receiving such inputs the system computes deflection, d(mm). Temperature correction is then applied by the system to each of the above computed deflection, d. A set of readings are thus obtained on a test section at points at an interval of 50M. After tests are completed, the system computes mean deflection (D), standard deflection (σ) and characteristic deflection (Dt). These parameters are displayed by the system in a sequence as enter key is pressed.

Based on the information fed into the system at the start of the testing, weather correction for seasonal variations is applied to the characteristic deflection, Dt. to get corrected characteristic deflection, Do. The system finally computes and displays overlay thickness, h(mm), using the inputs fed into the system in the beginning of the testing.

The data and the computed values stay in the memory of the system. Output data sheet (hard copy) can be obtained using a printer.

Working of the system: The system works on 230 ± 10% v. 50 Hz AC or on 12 v DC battery. The operation of the equipment is user friendly. The key board comprises 7 keys having the following functions.

1.	PROG	-	To program test parameters
2.	MEAS	-	To measure input signal
3.	ENTER	-	To enter parameters
4.	INR	-	To increase the display count

5. DEC - To decrease the display count

6. PRINT - To display and print results

7. STORE - To store data.

Before starting the test at a road site, road parameters, as described before, are entered into the system. Also, entered are climatic condition and subgrade type. These are stored in RAM which is powered from rechargeable Ni-Cd battery and remain in the memory even if the power goes off.

Tests are performed on the road surface at an interval of 50m. For each test point, location of test point and pavement temperature are entered into the system through keys. Initial, intermediate and final LVDT readings are measured by it, as described in the IRC standard, and are stored. Deflection(d) and temperature in the IRC standard, and are stored, Deflection(d) and temperature corrected deflection(D) are computed and displayed. This sequence is repeated at each test point. After all the points are tested, the system displays mean deflection (D), Std. deviation (σ), characteristic deflection (Dt), corrected characteristic deflection (Do) after applying correction due to climatic condition and subgrade type and finally overlay thickness in mm is displayed. If a printer is connected to the system, a data sheet for permanent record can be obtained.

Voltage and Temperature effect on LVDT readings :

(a) AC voltage : AC voltage should be kept between 220 and 240V as far as possible.

(b) DC Voltage : DC Battery voltage from battery should be between 11.5 and 12.5 V.

(c) Temperature Effect : Temp. effect on LVDT reading is negligible.

Field Trials:

Two sites were selected for field trials (Photo 1) with the developed system vis-a-vis conventional beam. These were on NH-2 (in front of CRRI) and on Sarita Vihar Road (connecting NH-2 to NOIDA) respectively. A comparison of results using the two beams is given below:

S.No.	Site	Mean Def (mm) in case of		Char. Def. (mm) in case of		Overlay thickness (mm) for 4000 CV/D	
		Auto.beam	con. beam	Auto beam	Con. beam	Auto Beam	Con. Beam
1.	NH-2	0.44	0.45	0.44	0.56	0.00	0.00
2.	Sarita Vihar	0.43	0.50	0.43	0.64	0.00	0.00

The two systems gave identical mean deflections and overlay thicknesses, etc.

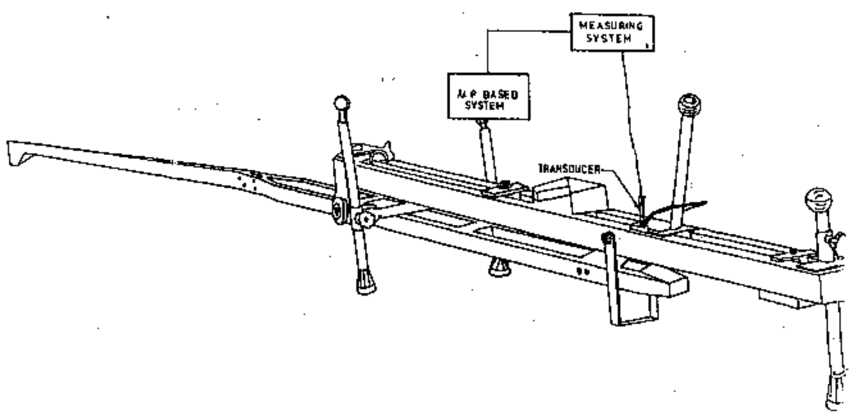

Fig. 1. Automated Benkelman Beam

Photo 1. Field testing with automated benkelman beam

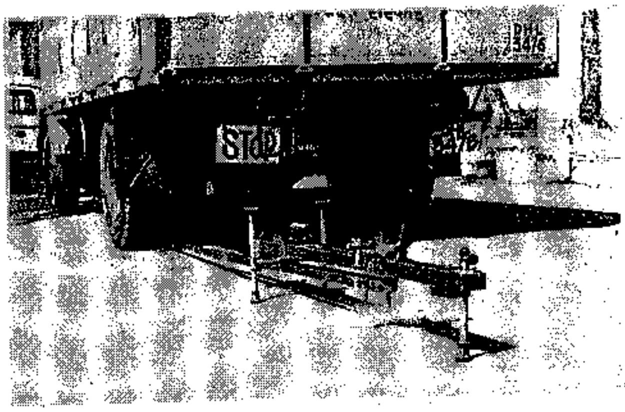

Photo 2. Field testing with conventional benkelman beam