GUIDELINES ON USE OF CORE CUTTER AND OTHER MISC. TOOLS ON RAILWAY BRIDGES

1. INTRODUCTION: -

The examination and compression testing of cores, extracted from hardened concrete is a well-established method, which enables visual inspection of the interior region of a structural member. This can be coupled with strength estimation and physical properties such as density, water absorption etc. The cores can be used as samples for chemical analysis subsequent to strength testing. (IS: 1199-Methods of sampling and analysis of concrete) gives information regarding securing and preparing test specimens from hardened concrete. For extracting the core from the concrete structure, some special equipment is needed which should be firmly supported and braced against concrete to prevent relative movement which will result in a distorted or broken core. Uniformity of pressure is important, so it is essential that drilling is performed by a skilled operator. Guidelines on use of other instruments like crack detection microscope, digital ultrasonic measuring tool and digital inclinometer are also given in this report.

2. OBJECTIVE:-

To prepare guidelines for using the instrument for taking out core of different sizes from the hardened concrete structures for conducting different physical, chemical analysis and to estimate the compressive strength of concrete and use of other instruments required in bridge testing.

3. INSTRUMENTS:-

Guidelines of the following instruments have been prepared for their use on bridges.

i) Core-cutter
ii) Digital Ultrasonic Measuring tools
iii) Crack detection microscope
iv) Digital inclinometer

4. CORE-CUTTER

RDSO has the core cutting machine of model DD100MEC of HILTI make. It is equipped with mechanical, electronic and thermal overload protection devices. This machine has two different types of diamond cutters of size 52 mm and 78 mm. The maximum length of the core which can be cut by both the cutters is upto 430 mm approx. The core cutter and its accessories are shown in the photograph. The technical details of core cutter are given below:

Voltage – 230 - 240 V
Power input – 1700 Watt
Current input – 8 A.
Frequency – 50–60 Hz.

4.1 PRINCIPLE-

A core is usually cut by means of a rotary cutting tool with diamond bit. Water supply is also necessary to lubricate the cutter.

4.2 OTHER IMPORTANT ACCESSORIES.

4.2.1 Rotary Hammer Drill:
Rotary Hammer Drills with selectable pneumatic hammering mechanism are electrically-powered tools for drilling in concrete, masonry, plasterboard (drywall), wood, plastics and metal to fix the instrument on the surface from which the core is to be extracted. Technical data of Rotary Hammer Drill are given below:

Technical Data

Nominal power input	650 W
Nominal voltage	100V, 110V, 120V, 220V, 230V, 240V
Nominal current	6.5A, 5.9A, 5.4A, 3.0A, 2.8A, 2.7A
Mains frequency	50-60 Hz
Weight of tool	2.8 Kg
Dimensions(lxwxh)	320x215x75 mm
Speed	0-880 r. p. m.
Hammering speed (full hammering action)	0-51001/min.
Hammering speed (reduced hammering action)	0-27001/min.
Single impact energy (full hammering action)	1.8Nm(J)
Single impact energy (reduced hammering action)	0.6Nm(J)
Drilling dia. range in concrete/masonry (hammer drill bits)	4-24 mm dia.
Drilling dia. range in wood (wood drill bits)	5-20 mm dia.
Drilling dia. range in wood (hole saws)	25-68mm dia.
Drilling dia. range in metal (solid metal)	5-13 mm dia.
Drilling dia. range in metal (sheet metal, max. 2mm thick)	5-22 mm dia.
Drilling dia. range with thin-walled diamond core bits (reduced hammering action)	25-200 mm dia.
Drilling performance in medium-hard concrete	8 mm dia. =28 cm^3/min. 12 mm dia. =45 cm^3/min. 16 mm dia. =49 cm^3/min.
Double insulated (as per EN 50144)	Protection class II (double insulated)
Interference immunity	As per EN 55014-2
Radio and television interference suppression	As per EN 55014-1
Typical A-weighted sound power level	100 dB(A)
Typical A-weighted emission sound pressure level	87 dB(A)
Typical weighted vibration at the handles	8 m/s^2

4.2.2 Water supply unit:

This unit must be used solely for supplying water to diamond drilling ring to lubricate the cutter. The photograph of water supply unit is shown below:

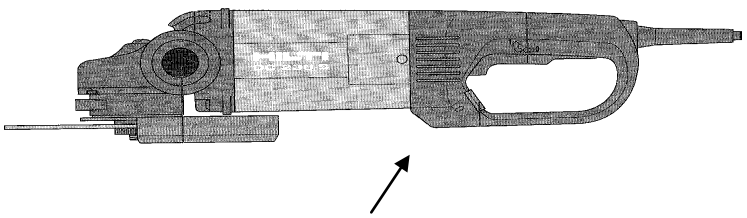
WATER SUPPLY UNIT

Technical Data

Unit water capacity:	10 litters
Total container volume;	13.7 litters
Safe-working operating pressure:	6 bar
Safe-working operating temperature:	50^0C
Safety valve:	Setting nut with two bores (2mm dia.)
Accessory	Supplied connecting hose

4.2.3 Diamond Cutter

The Diamond Cutter is an electrically powered for professional use in construction. In core testing it is used for finishing the core edge. The photograph of Diamond Cutter is shown below:



Diamond Cutter

Technical Data:

Rated voltage:	240 V
Rated current	10.0 A
Rated power input:	2500 W
Rated power output:	1750 W
Mains frequency:	50 Hz
Speed under no load:	6500 rpm
Drive spindle thread:	M14
Cutting disc diameter:	Max. 230 mm
Approx. weight (without accessories):	5.1 kg
Insulation class:	II (double insulated)

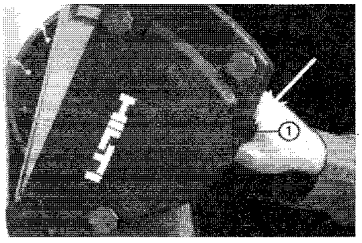
Basically, two working movements are possible:

a) Pulling the cutter/ grinder e.g. for vertical cuts in walls.

b) Pushing the cutter/grinder e.g., for cuts in floors or horizontal cuts in walls.

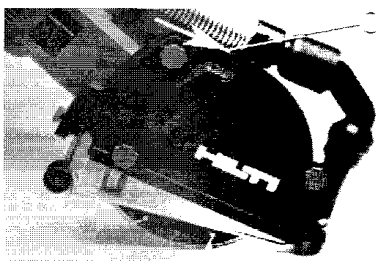
To ensure absolutely dust-free working in both cases, the following must be observed.

4.2.3.1 Pulling the cutter/ grinder (for vertical wall cuts): Cutting of cores in vertical cuts in wall is shown in the photograph.



To cut a wall vertically, the cutter/grinder must be drawn down from top to bottom.
The arrow (1) must always point in the direction of movement.

4.2.3.2 Pushing the cutter/ grinder (for floor cuts and horizontal cuts in walls): Cutting of cores in horizontal cuts wall is shown in the photograph.



When cutting a floor, the cutter/ grinder is pushed forwards.
The arrow marks (1) must than points forward.

4.3 PREPARATIONS BEFORE BEGINNING THE WORK

In addition to the safety precautions, the following preparations at the job-site must be made.

a) Make sure that a water connection or pressurized container with continuous water flow is available.

b) Make preparations for the flow of water. If necessary, install water extraction equipment. When drilling into hollow building components, find out where the drilling water is likely to flow, in order to avoid damage.

c) A power supply with earth/ground connection must be available for use.

d) Safe electrical operation of the core cutter machine can only be guaranteed as long as moisture is prevented entering in the motor. These precautions can only reduce the consequences of water entering in to the motor, but does not eliminate it. If the motor become wet it must be serviced by the electrical specialists at a company's center.

4.4 EXTRACTION OF TEST SPECIMENS FROM HARDNED CONCRETE: -

4.4.1 Precautions

The clause specifies the procedure for securing and preparing test specimens from hardened concrete in structures and pavements. A specimen to be tested for strength shall not be removed from the structure until the concrete has become hard enough to permit its removal without disturbing the bond between the mortar and the coarse aggregate. Normally, the concrete shall be 14 days old before the specimens are removed. Specimens that show abnormal defects or that have been damaged in removal shall not be used.

4.4.2 Apparatus

4.4.2.1 Drills- A core drill shall be used for securing cylindrical core specimens. For specimens taken perpendicular to the horizontal surface, a short drill may be satisfactory. For inclined holes, a diamond drill is normally required.

4.4.2.2 Saw- A saw shall we used for securing beam specimens from the structure or pavement for flexural strength tests. The saw shall have a diamond or silicon carbide cutting edge and shall have adjustments that permit of cutting specimens confirming to the dimensions specified.

4.4.3 Test Specimens

4.4.3.1 Core Specimens - A core specimen for the determination of pavement thickness shall have a diameter of at least 10 cm. A core specimen for the determination of compressive strength shall have a diameter at least three times the maximum nominal size of the coarse aggregate used in the concrete, and in no case shall the diameter of the specimen be less than twice the maximum nominal size of the coarse aggregate. The length of the specimen, when capped, shall be a nearly twice its diameter.

4.4.3.2 Beam Specimen - The beam specimen for the determination of flexural strength shall normally have a cross section of 15 x15 cm and shall be at least 70 cm in length.

4.4.4 Procedure

4.4.4.1 Core Drilling - A core cutter shall be located perpendicular to the horizontal surface, when possible, with its axis perpendicular to the bed of the concrete as originally placed. A specimen taken perpendicular to a vertical surface, or perpendicular to a surface with a batter.

4.4.4.2 Beam Sawing – The sawing operation shall be so performed that the concrete is not weakened by shock or by heating. The sawn surface shall be smooth, plane, parallel and shall be free from steps, ridges and grooves. Care shall be taken in handling the sawn beam specimens to avoid chipping or cracking.

4.5 MEASUREMENT OF DRILLED CORE SPECIMENS

4.5.1 Mean Diameter: -

The mean diameter shall be determined to the nearest millimeter from three pair of measurements. The two measurements in each pair shall be taken at right angles to each other , one pair being taken at the middle of the core and the other pairs at the quarter points of the depth. The mean of six readings shall be taken as the diameter.

4.5.2 Height

The height of the core shall be determined by measuring the maximum and minimum heights, which shall be reported to the nearest millimeter.

4.5.3 Position of reinforcement

The positions of any reinforcement shall be determined by measuring to the nearest millimeter from the center of the exposed bars to the top of the core. The diameter and, if possible, the spacing of the bars shall be recorded, and also the minimum top and bottom cover.

4.6 USES:

Core Cutter is used to cut the core from the existing concrete structure for testing the physical properties of the concrete like compressive strength, density, water absorption, crack depth and chemical test like depth of carbonation and chloride content etc. It can also be used to inspect the interior region of the structural members.

5. DIGITAL ULTRASONIC MEASURING TOOL

There is a large population of concrete / steel bridges on Indian Railways. Some times it is very difficult to measure unreachable second point of the girder length of the bridges with the help of measuring tape. Digital Ultrasonic Measuring Tool is a measuring device that can carry several measuring operation such as length, surface area and volume of unreachable surfaces with the use of ultrasonic waves. Its measuring range is 0.6 m to 20 m. On switching the unit it is automatically in the operation mode “Length Measurement” and measurements can be recorded.

5.1 PRINCIPLE:

LASER INDICATOR**:**

During the measuring procedure , a laser indicator (7- point laser) is also activated, which indicates if the unit is pointed at the desired target surface . The laser points are arranged circular and outline the measured surface. If the ambient light conditions are too bright, the visibility can be increased by using the laser spectacles.

MEASURING DISTANCES:

The running period of the conical expanding ultrasonic waves used for measurement of distance . The respective measuring surface is market by the laser indicator. The measurements can only be carried out on targets with even and smooth surface.

5.2 MEASURING OPERATION :

The measuring tool can carry out several measuring operations, which can be chosen by repeated pressing of the “ Measuring operation” push button 1. Sequence of the types of measurement: Length, Surface, Volume. Upon switching on the unit, it is automatically in the operation Mode “Length measurement”.

5.2.1 LENGTH MEASUREMENT:

In the length measurement operation mode, a line is indicated in the lower left corner of the display. Place the bottom side of the unit on the starting point of the measurement (i.e. against a wall) . Aim the unit towards the target surface at a right angle. To measure, press the “Measure” knob no.2 provided in the instrument. The completion of the measurement is indicated by an accoustic signal and the measured value appears on the bottom right side of the display. The maximum possible length per measurement is 20 meters.

5.2.2 SURFACE MEASUREMENT:

To access the surface measurement mode, repeatedly press the “Measuring operation” push button 1, until a square appears in the lower left corner of the display. Carry out the measurement by pressing the “measure” knob. The measured value appears on the upper right side of the display. With the next measurement, the surface is immediately calculated and the result appears on the bottom right side of the display 4. At the same time, the last length measurement is indicated on the upper right side of the display. The flashing bars of the unit indicate which measured length value it expects. The maximal possible surface value per measurement is 400 m^2.

5.2.2 VOLUME MEASUREMENT:

To access the volume measurement mode, repeatedly press the “measuring operation” push button 1, until a cuboid appears in the lower left corner of the display. Carry out the measurement by pressing the “measure” push button 2. The measured value appears on the upper right side of the display. With the next measurement, The surface is immediately calculated. To receive the volume, a third measurement must be carried out. The result of the volume appears on the bottom right side of the display 4, while the last length measurement is indicated on the upper right side. The maximal possible volume per measurement is 8000 m^3.

5.3 MEMORIZING THE MEASURED VALUE, “ADD TO” FUNCTION:

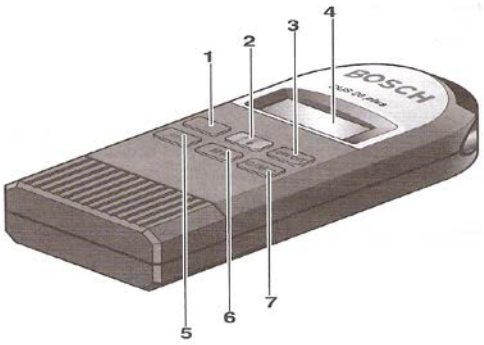
By pushing the (M+) “Add to memory” push button 6, the value on the bottom right side of the display – depending on the current measuring operation a length-, surface- or volumetric value – is memorized and an “M” appears on the bottom right side of the display. If another value has already been memorized, the new value is added to the contents of the memory, however, if the units of measurement correlate. For example: if the square value is in the memory and the current measured value is volumetric, the addition can not be carried out . In this case “ERROR” will blink on the upper right of the display.

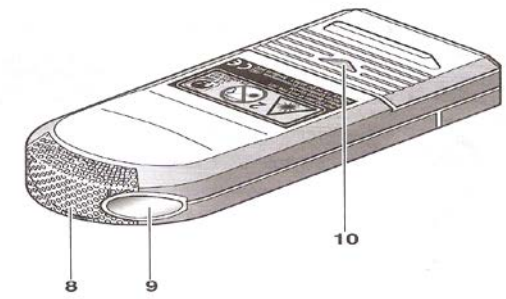
5.4 MEMORY RECALL:

By pressing the (MR) “Memory recall” push button 5, the memorized contents can be checked on the display at any time for a duration of three seconds. When doing so, the memory symbol “M” blinks together with the length-, surface- or volumetric symbol, depending on type of measured value in the memory. Afterwards, the display automatically switches back to the current measuring value.

5.5 TOOLS SPECIFICATIONS:

Digital Ultrasonic Measuring Tool	DUS 20 plus
Part No.	0 603 096 202
Measuring Range	0.6 - 20m
Measuring Accuracy (+10up to +40 ^{0}C) (-5 upto +50 ^{0}C)	 $\pm$ 0.5 % $\pm$ 1%
Smallest unit of measurement	1 cm
Ultrasonic divergence angle Approx.	 $\pm$ 5 ^{0}
Battery	9 V , alkaline – managanese 6LR61
Laser class	2
Temperature range for operation	-5 to + 50 ^{0}C
Temperature range for storage	-20 to + 85 ^{0} C





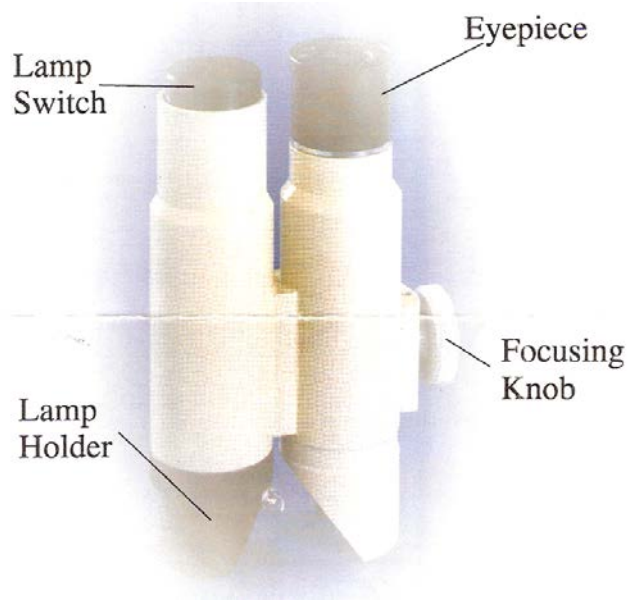
5.6 USES:

It can be used to measure the distance of unreachable points. It directly give the surface Area and Volume of the rectangular structures by measuring the required dimensions.

6. CRACK DETECTION MICROSCOPE:

RDSO has a crack detection pocket microscope which is shown below. It has an eyepiece , focusing knob, lamp switch and lamp holder. In order to illuminate the field of view loose the Knurled ring slightly and twist lamp unit until the beam of light is centralized and tighten the ring. The microscope is focused by turning the black knob on the side of the instrument. The eyepiece scale can be rotated to align with the direction of the crack. The optical magnification of the microscope is x40 and its least count is 0.02 mm. Use of leak proof type battery i.e. Duracell should be ensured. If the microscope fails to illuminate following check should be made:

1. Battery is in good condition.
2. Lamp is screwed in tightly
3. Lamp has not blown
4. Knurled ring is tightened.
5. Battery contacts are clean



6.1 USES:

It is used to measure the width of very fine cracks up to 0.02 mm present in any structures easily as its has a optical magnification factor of 40.

7. DIGITAL INCLINOMETER

There is large population of concrete as well as steel bridges on Indian Railways. Some times it is very difficult to measure inclination angle of different members viz., horizontal, diagonals and verticals in the steel girder bridges and concrete bridges. While showing position of cracks or defects in the members in preparation of reports, it is essential to measure inclination of members for which digital inclinometer (DNM 60 L) has been procured for precious measurements. It can also be used for leveling, alignment aids and indicate the gradient of specimen as well as the deviation of rotation of unit ($0 – 45^0$) to the horizontal and $45^0 – 90^0$ to the vertical. For 0 & 90^0 the arrow disappears. Acoustic signal also make sounds for 0 & 90^0 when it is in on mode. Its operation is very simple and is describe below.

7.1 OPERATION:

Before using for the first time, connect to the battery.

Switching	-	ON/OFF
Switching on	-	Press button 5
Switching off	-	Press button 5 again

7.1.1 Calibration Test - A

Before starting to work, after large temperature changes as well as after a hard impact (e.g. which dropped), the accuracy of the unit should be checked: Switch on the unit and place on a surface that is as horizontal or as vertical as possible. Wait 10 seconds. Note the measured value, owing the unit around 180 0, again wait 10 seconds and read the measured value. If the difference (Δ) is greater than 0.1° (0.2 %) , recalibrate the unit (See below).

Note : calibration test can be performed in the horizontal position (normal or head position) or in the vertical position. If measurement are made primarily in one position, the calibration test should be performed in that position, that, is , for horizontal measurement → calibration test in the horizontal position, for vertical measurement → calibration test in the vertical position. For alternating usage, always perform the calibration test in both positions.

7.1.2 Calibration Test -B

If the calibration test indicates a difference of more than 0.1^o (0.2%), a recalibration must be made.

The unit can be calibrated independently for vertical or horizontal usage. The procured is the same as for the calibration test: Switch on the unit and place on a surface that is as horizontal or as vertical as possible.

Wait 10 seconds and press “CALIBRATE” button7 until CAL1 appears in the display. Swing the unit around 1800, again wait 10 seconds and press the “ CALIBRATE” button 7 until CAL2 appears in the display.

The unit can also be calibrated in the same manner in the horizontal or the vertical head position.

Note : when calibrating the inclinometer, the deviation from the vertical or horizontal must not exceed 5^0 . For larger deviations, the calibration cannot be performed and three dashes(- - -) appears in the display field.

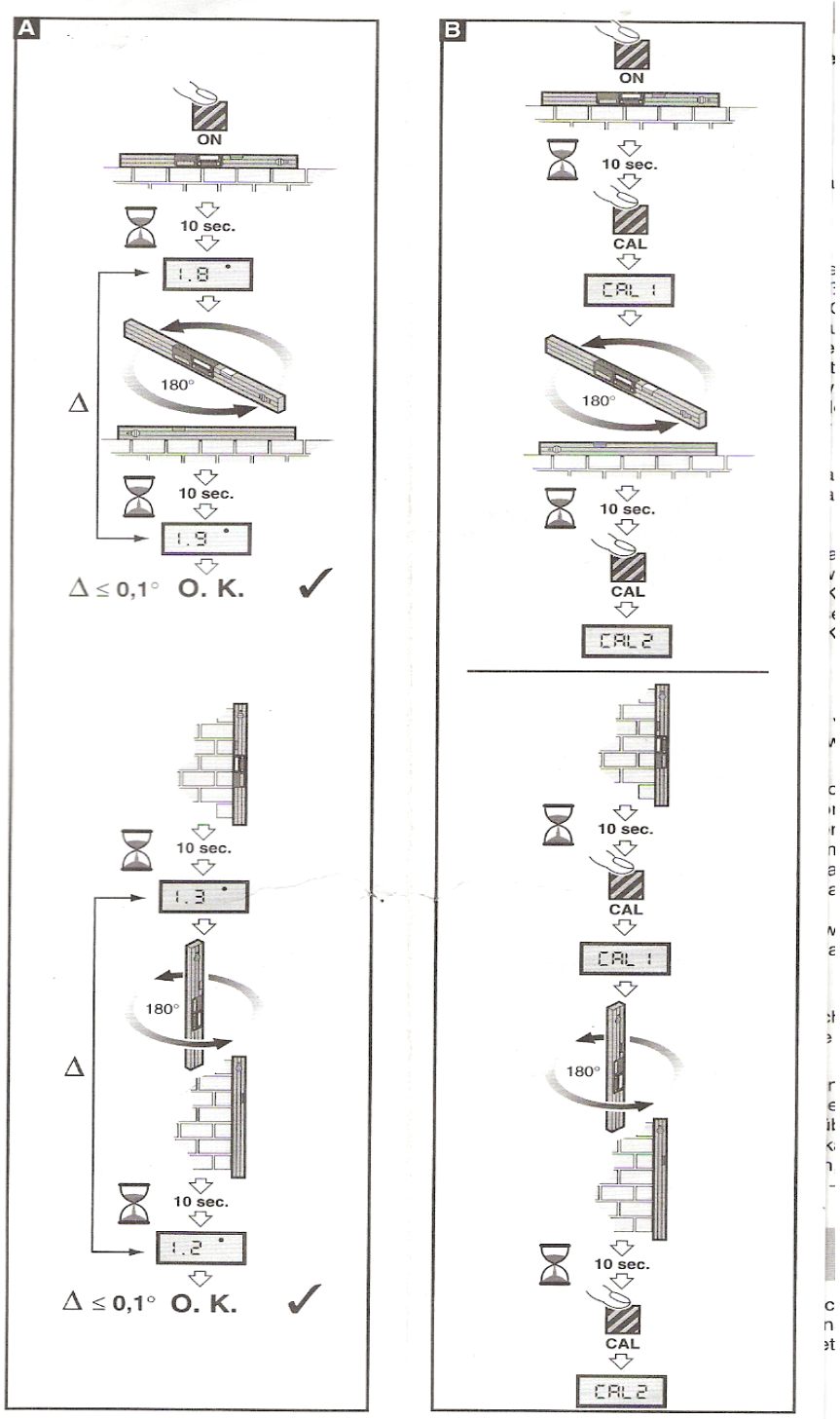
7.2 TOOL SPECIFICATIONS

Type	-	DNM 60 L
0 603 096		….105
		…107*
Length	-	600 mm
Measuring accuracy		
For 0 & 90 degrees	-	$\pm$ 0.05^0
For 1 to 89 degrees	-	$\pm$ 0.2^0
Accuracy (bubble level)		$\pm$ 0.057^0(corresponds to 1mm/m)
Allowable		
Operating temp.		-5^0C to + 50 ^{0}C
Allowable storage temp.		-20^0 C to + 85 ^{0}C
Battery		9 V(6LR61)
Switch -off Automatic		After approx. 6 min.

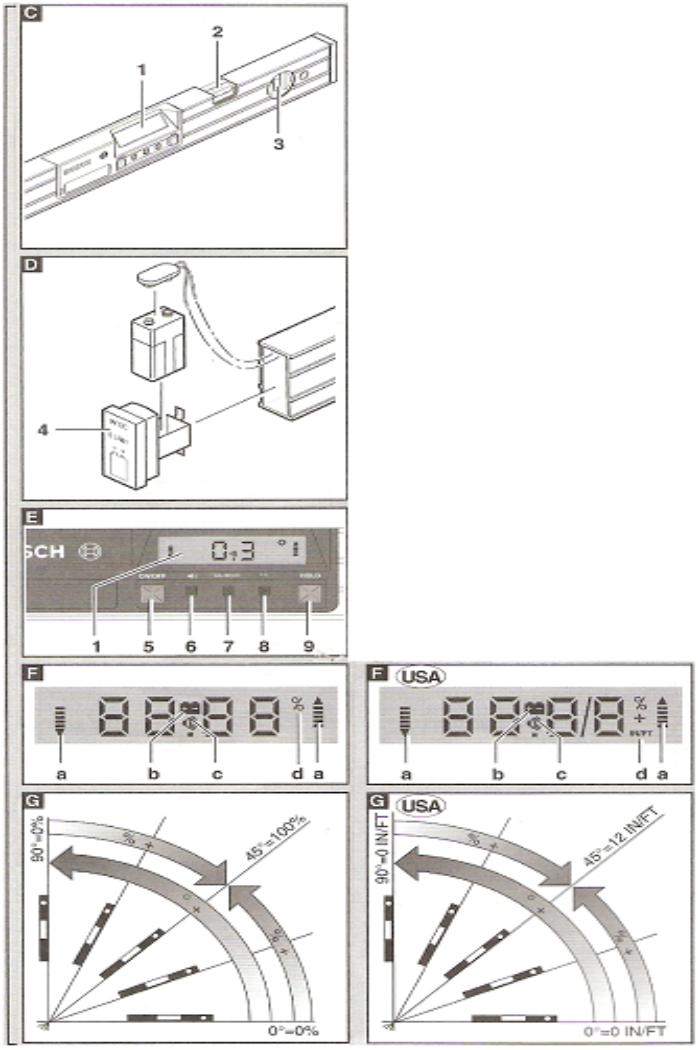
7.3 USES:

It can be used to measure inclination angle of different members viz. Horizontal, diagonals and verticals in the steel girder bridges and concrete bridges. It can also be used for leveling, alignments aids and measuring the gradient.

Calibration Procedure : A & B



Operating Controls & Display Elements



Operating Controls C-E	Display Elements F
1. LCD display field 2. Bubble level for horizontal alignment 3. Bubble level for vertical alignment. 4. Battery compartment 5. ON/OFF button 6. "Acoustical signal" On/Off Button (→ display C) 7. Calibration function button 8. Measuring unit selection button – Degree (^{0}) / Percent (%) 9. Hold Button	a. Alignment aids b. Weak battery symbol is displayed c. Acoustical signal On symbol the signal sounds for 0 & 90^0 d. Measuring units of the display (^{0} & %)

8. REFERENCES

a) IS : 456:2000
b) IS : 516 -1959
c) IS : 1199 –1959
d) Catalogue of Core Cutter supplied by M/S Hilti India Pvt.Ltd.
e) Manual of Core Cutter supplied by M/S Hilti India Pvt. Ltd.
f) Manual of Digital Ultrasonic Measuring Tool supplied by M/S BOSCH India Ltd.
g) Operating Instructions supplied by M/S ELE International Limited, Eastman Way, Hemel Hompstead, Hertfordshire HP2 7HB, England, U.K.
h) Manual of Digital Inclinometer supplied by M/S BOSCH India Ltd.

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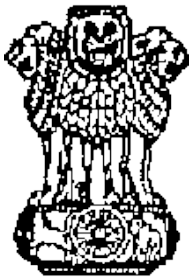
PREFACE

Importance of condition assessment of the Railway Bridges scientifically increasing as bridges are getting older and condition of the bridges are deteriorating due to increase in axle load day by day. In condition assessment NDT is becoming more and more important . In this regard B&S Directorate of the RDSO is assisting Zonal Railway in NDT inspections of bridges, and also making them aware of the usefulness of different NDT equipment available in the market.

RDSO has procured different kinds of such equipments and guidelines have been issued time to time to the Railways. Recently core cutter and other useful miscellaneous tools such as crack detection Microscope, digital ultrasonic measuring tool and digital inclinometer have been procured. Guidelines for their use is prepared by Sh.J.P.Meena, SSRE and Sh. R.R.Sinha, JRE-I under the guidance of Sh. S.C.Gupta, Director B&S/Testing.

The work done by the team is sincerely acknowledged and I hope that these guidelines will be more helpful to the Zonal Railways in using similar equipments and tools.

(PIYUSH AGARWAL)
EXECUTIVE DIRECTOR
B&S/RDSO



Government of India
Ministry of Railways

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