



सत्यमेव जयते
Government of India
Ministry of Railways

GUIDELINES ON USE OF MICRO-COVERMETER

BS-42

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**RESEARCH DESIGNS & STANDARDS ORGANISATION
MANAK NAGAR, LUCKNOW-226011**

PREFACE

Nowadays RCC and PSC structures are becoming more common in construction of buildings and bridges in Indian Railways. Insufficient thickness of concrete cover to reinforcement may effect durability of structure and can lead to corrosion of the structure.

Micro-covermeter is a handy and simple instrument to assess the concrete cover to reinforcement in structure that is otherwise need destructive methods. These are available in different brand names in the market with various facilities such as digital display, storing of data, etc.

This equipment is going to be very useful in assessing the concrete cover to reinforcement, location of reinforcements, etc

INDEX

S. No.	Description	Page No.
i)	Introduction	1
ii)	Micro cover meter	1
iii)	Principle	2
iv)	Specification	2
v)	Use of Micro-cover meter	3
vi)	Field measurement of cover	4
vii)	Precautions	5
viii)	Source	5
ix)	Annexure-I Specification of Micro-covermeter procured by RDSO	6
x)	Annexure-II – Operating manual of Micro-covermeter available with RDSO	7

Guide lines on use of Micro-covermeter

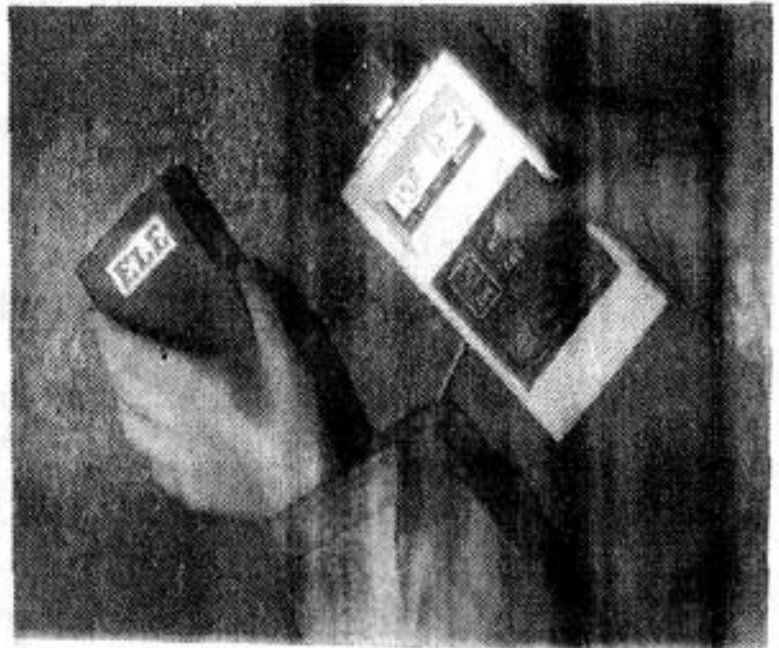
1.0 INTRODUCTION

Now a days RCC and PSC structures are becoming more & more common in buildings / bridge construction all over the country. In these structures, concrete cover plays an important role. Less cover may cause corrosion of reinforcement. In coastal areas, it has more important role to play as compare to other areas. It should be enough thick and dense, other wise corrosion is likely to occur & cause damage.

The cover thickness is an important aspect of construction and should be known correctly to be assured about integrity of structure. Previously, no non-destructive instrument was available and it was very difficult to know the cover of the structure without damaging the structure. Nowadays instruments are available in the market for this purpose. Micro-cover meter is one of them. It is useful field instrument to measure cover of reinforcement bars used in RCC / PSC structures.

2.0 MICRO-COVERMETER

2.1 Micro-cover meter is a portable and handy instrument weighting about 0.5 Kg having the dimensions 180 mm x 100 mm x 45 mm approximately. It is normally provided with two types of search heads one for parallel bars having range approx. 360 mm and other for mesh & closed spaced bars having range of approx. 120 mm. It can function over the temp range 0 ° C to 45 ° C. It is also available with volatile memory that helps in storing data while taking measurements.



2.2 The principal applications of micro-covermeter are to locate reinforcement and estimation of its cover. The equipment is quite reliable for lightly reinforced structures and can be used for the following:-

- a) Check to ensure location and cover of reinforcing bars.
- b) Investigation of reinforced concrete members.

2.3 The micro-covermeter are sensitive to steel type, bar diameter, aggregate and type of cement. Commercially available micro-covermeter is calibrated for medium size mild steel round bar in ordinary port land cement concrete.

2.4 Normally Micro-cover meters are available catering for bar sizes 6mm to 40mm. The range of the equipment is limited according to type but care and experience in interpretation of data are required in following cases:

- a) Multiple Bars e.g. laps, transverse steel light wire mesh, buried nails
- b) Other metals between the reinforcing bars and the surface
- c) Aggregates with magnetic properties
- d) Stability of calibration

3.0 PRINCIPLE

Micro-covermeter consists of a highly permeable U-shape magnetic core on which two coils are mounted. When an alternating current is passed through one of these coils, the current induced in the other coil can be measured. The presence of steel affects the electromagnetic field. The induced current depends upon the mutual inductance of the coils and the nearness of the steel bars. A moving coil meter measures the current. The cover is measured by placing the probe over surface of the reinforced concrete under test and moving it slowly, until a reading is obtained on the dial. The probe has to be parallel to the length of rebar. Depending on the diameter of the bar the dial readings gives directly the cover to the reinforcement.

4.0 FUNCTIONAL REQUIREMENTS

Now-a-days many brands of micro-cover meter are available in market. For the purpose of monitoring concrete structure the basic functional requirements of micro-cover meter should be as under:-

4.1 The preferable measurement range of small search head for normal purposes is zero to a maximum as given below:

- | | | |
|---------------|---|---------|
| for 6 mm bar | - | 100mm |
| for 40 mm bar | - | 120 mm. |

4.2 The preferable measurement range of large search head for normal purposes is zero to a maximum as given below:

- | | | |
|---------------|---|---------|
| for 6 mm bar | - | 220 mm |
| for 40 mm bar | - | 360 mm. |

4.3 The accuracy of measurement should be $\pm 2\text{mm}$.

4.4 It should preferably have bar selection range covering various commonly used and available bar diameters such as 6, 8, 10, 12, 16, 20, 25, 32 & 40mm.

- 4.5 It should be possible to use it at complete temperature range of the region.
- 4.6 The specification of micro-covermeter procured by RDSO is placed as Annexure -I

5.0 Use of Micro-cover meter

- i). For proper and effective use of micro-cover meter, proper study and understanding of equipment is desirable. The same can be achieved by proper study of it's operating manual and actual practice and experience of user. The copy of operating manual supplied alongwith micro-covermeter procured by RDSO is placed as Annexure -II.
- ii). The under standing of structure helps in efficient use and quick working. It is always desirable to go through the drawing of the structure before actual measurement of cover using micro-cover meter.
- iii). As pointed out earlier, type of steel and bar diameter effects the results of micro-covermeter. It requires to feed data regarding type of steel and bar diameter. This can be done accurately by proper study of drawing or by experience .The diameter of bar displayed in the central digit in mm should be adjusted for actual diameter of reinforcement bar for which cover is to be measured.
- iv). *Calibration* To ensure accuracy and satisfactory working of micro-cover meter, it should be calibrated before starting the observations and at the end of the test . For this purpose, one spacer is provided with each equipment. For calibration purpose , the cover should be measured at one location and then it is remeasured after placing the spacer between the concrete surface and probe. The difference between two readings should not vary more than +/- 5% of the thickness of the spacer.
- v). *Location of bar* The search head should be placed on the surface of concrete such that the length of search head should be parallel to the reinforcement provided in the structure. The location of main reinforcement should be decided based on geometry of the structure. The search head is moved slowly from one end to another end in perpendicular direction to main bars. The sound of the buzzer/beep will be strongest when the bar will come just above or below the prob. Thus the location of main bars is detected.
- vi). *Measurement of cover* While moving the search head on surface the cover displayed on screen reduces and the sound of the buzzer/beep increases when probe comes near reinforcement bar. The cover displayed is minimum and the sound of buzzer is strongest just below the reinforcement bar.

6.0 FIELD MEASUREMENT OF COVER

6.1 Slab

A platform of suitable height should be made to have an access of the measuring locations. The locations of main bars should be marked with chalk or similar thing prior to actual measurement with the help of drawing on the surface and covers should be measured at pre decided locations. In case, the drawing is not available, the location of the cover can be identified as mentioned in para 5(v).

In case of two-way slabs, the main reinforcement bars are in both directions. If the bars are closely spaced, the small search head should be used to measure the cover thickness of the slab. To detect the location of main bars search head should be moved slowly on the surface from one end to another end.

6.2 RCC / PSC Girders

The procedure for measurement of cover is almost same as mentioned in para 5 (vi). Suitable platform is to be made to have an access to measuring locations. The location of steel and tendons should be marked on the top / bottom surface of the girder after study of drawing. Cover should be measured at pre-decided interval in the direction of main reinforcement. Care should be taken near the support where the main bars are bent upwards to take up shear force.

6.4 Pier

In the case of pier, suitable arrangements should be made for access to site of measurement. The location of bar should be marked on the pier with the help of drawing or as mentioned in para 5(v). Measurement of cover can be taken on marked location. Arrangement should be such that the instrument and search head both can be handled at a time

7.0 PRECAUTIONS

- i). The search head should be kept minimum one meter away from metallic things at the time of taking measurement. It should be used carefully otherwise the material of search head can be damaged. When micro cover meter is off, its search head should be disconnected.
- ii). The battery should have full voltage. The exhausted batteries should not be left in the instrument as, it may damage the equipment.
- iii). The long side of the search head should always be parallel to the reinforcement bar,
- iv). Complete set of batteries should be replaced simultaneously by another set. Mixing of battery types should be avoided.

8.0 SOURCES

The addresses of some of the firms supplying micro-covermeter are as under:

- i) M/s AIMIL Ltd.,
A-8, Mohan Cooperative Ind. State, Mathura Road, New-Delhi – 110044
- ii) M/s Ultra Technologies Pvt. Ltd.,
B – 85, Kalkaji, New-Delhi – 110019
- iii) M/s Hilti India Pvt. Ltd.,
8-Lsc Pushp-Vihar Community Centre, New-Delhi 110062,
- iv) M/s James Instruments Luc. 3727
North Aedzie Avenue, Chicago ILLINOIS 60618, USA
- v) PROCEQ USA
Riesbach Strasse 57CH – 8034 Zurich , Switzerland
- vi) ELE International Ltd.
Eastman Way, Hemel Hempstead Hertfordshire HP2 7HB England
- vii) Koelectric Limited
International House , Thame Station Industrial Estate OXON, OX 93 PY
England
- viii) Colebrand Limited
Colebrand House, 18-20 Warwide Street Regent Street London W1R 6
BE England

SPECIFICATION OF MICRO-COVER METER PROCURED BY RDSO

1. Micro-covermeter should confirm to BS : 1881:204
2. Depth Range:
 - a) Upto 6 mm Bar 220 mm
 - b) Upto 40 mm Bar 360 mm
3. Display Metric
4. Accuracy ± 2 mm or $\pm 5\%$
5. Battery Life More than 50 hrs.
6. Operational temperature 0°C to 45°C
7. Humidity 20% to 85 %
8. Should be supplied complete with the following:
 - a) Max. Probe search Head
 - b) Mini. Probe search Head
 - c) Carrying case
 - d) Instrument cover
 - e) Spare Batteries
 - f) Bar sizing spacer
 - g) Instruction manual

MICRO COVERMETER™

The world's first microprocessor-controlled reinforcement bar locator

Instruction Manual



BS EN ISO 9002 Certificate No. 8888/1

7000-MC-98-9

CONTENTS

	Page
1. Unpacking	2
2. Operation	2
3. Batteries	5
4. Fault finding	6
5. Low Cover Alarm	6
6. Revised Operation on Switch-on	8
7. Small Search Head	8
8. Cable	9
9. Small Search Head / Specification ...	9
10. Large Search Head / Specification ...	10

1. Unpacking

On receipt of your new Micro Covermeter, unpack carefully and examine items for damage. Any damage should be notified to your supplier immediately.

The following items are included:

- Micro Covermeter with batteries
- Search head and cable, and spacer block
- This Manual
- Protective carrying case
- Set of four alkaline batteries*

* Batteries are not supplied in some countries.

Check the instrument functioning as in 2.1.

2. Operation

2.1 Basic operation and functional check.

- Fit a set of batteries (see section on batteries).
- Connect search head. Squeeze the metal retaining latches while engaging or disengaging the connector.
- Press **ON** key. For two seconds after switch on, the display shows the Micro Covermeter version number.

This instruction manual applies to version 1.3, other versions may differ in minor or major detail. See page 11.

- Hold the search head in mid-air and press **CAL** key. The instrument's internal beeper will give a short high pitched tone when the key is pressed, and again after two seconds to indicate the **CAL** function is finished. The display should be:

360 or 120 12 1

- Press the **AUDIO** key. A low pitched click should result.
- As the search head is brought near metalwork, the maximum distance display of 360 (120) will reduce, and the audio pitch should rise.
- Press each of the other keys, leaving **AUTO** until last, checking each one gives at least one beep. The only operational key that will work after **AUTO** is **SIZE**.
- Switch **OFF** and disconnect search head.

2.2

Measuring cover - manual bar selection.

- Connect search head and switch **ON**;
- Check that the version number shows on the display before reverting to the operational display.
- Hold the search head at arms length, at least one metre from any metal work. Keep the search head still and press **CAL**. Do not move the search head until the second **CAL** beep.

This basic **CAL** operation should be repeated before deep cover measurements and at regular intervals anyway.

- Use **SIZE** and **TYPE** keys to select the reinforcing bar required. **TYPE** selects the bar material, as displayed in the right hand digit.

TYPE 1

High Tensile bars

TYPE 2

Mild Steel bars

SIZE selects the bar diameter, as displayed by the centre digit pair. The diameter is displayed in millimetres. The following selections are available for both bar types:

5 6 8 10 12 16 20 25 32 40

SIZE alters the diameter selection sequentially.

- Measure cover. Cover is measured over the full range using the one working face of the search head.
Identify the normal working face of the search head, and explore the concrete surface. In correct use the operator should be able to read "Top" on the search head. The search head is correctly located when the audio pitch is maximum. Both move and rotate the search head to achieve this. When carefully positioned in this way, the reinforcing bar will be parallel with the long axis of the search head.
- Read the cover in millimetres at the left hand part of the display.
- Press the **INCH/MM** key to select cover in inches. The bar diameter is still displayed in millimetres.
- Press **INCH/MM** again to change back to metric cover display.
- Press **AUDIO** again to turn off search tone if not required.
- To hold a reading, press and hold down the **MEMORY** key.
- After making measurements, confirm that **CAL** is correct by holding the search head in mid air again and check a reading of 360mm (except for small diameter bars, which have smaller maximum ranges).

2.3

Automatic Bar Diameter measurements

Important Note. Automatic bar diameter measurement requires great care to achieve accurate results, and anyway can be influenced by normal material variations from bar to bar. Experience shows that errors of one bar size are the worst likely in normal practice by an experienced operator, although it is not impossible for material variations to cause an error of two bar sizes.

WHERE BAR SIZE IS AN IMPORTANT PARAMETER (e.g. for structural calculations), IT IS VITAL TO CONFIRM THE MICRO COVERMETER MEASUREMENT BY EXPOSING A BAR.

The automatic diameter measurement can still be of great benefit to check for consistency in different parts of the structure.

To confirm that the correct technique is being used, repeat the **AUTO** measurement several times to check for consistency of reading. **AUTO** does not work on *Type - Select Type* first.

The automatic sequence is:

- Select **TYPE**
- **CAL** with the search head still in mid air. Avoid wearing watches etc.
- Search very carefully for accurate search head location over a bar. Do not try auto on close-spaced multiple bars. Note: the search head position (ideally, mark it) and hold still. Press **MEMORY**.
- Lift the search head and place the 32mm spacer under it. Ensure the search head is in the same orientation as before. Press **MEMORY** again.
- Press **AUTO**.

The size display now indicates the calculated bar diameter. The **AUTO** chevron is displayed to indicate an automatic measurement.

The **MICRO COVERMETER** makes various checks on the search head readings during **AUTO**, and may come up with an error code:

- | | |
|-----------|---|
| E1 | Bar too close - see below |
| E2 | Readings too similar (eg forgot to insert spacer) |
| E3 | Readings too dissimilar |
| E4 | Bar too far for reliable results |

E3 and **E4** indicate an operator error in positioning the search head. **E4** indicates that the cover is too great to reliably calculate diameter.

AUTO cannot work with cover less than 20mm using the normal working face of the search head. **E1** shows this. The opposite face of the search head has a 20mm space built in. Repeat **AUTO** using this face.

- Cancel error reading by pressing **SIZE**.
- Cover measurement is unaffected by **AUTO**, operating as though the bar diameter was selected manually.

NOTE: Experience shows that, when the Micro Covermeter consistently calculates an incorrect bar diameter, the actual cover readings are more accurate when made using the instrument's own estimate of the bar diameter than when the correct diameter is selected manually.

2.4 Searching techniques

The Micro Covermeter search head is designed to assist searching for close-spaced bars or mesh elements by operation end-on to the concrete surface.

NOTE: The instrument is not calibrated for this mode of use. It is calibrated only for

single bars with the search head placed with its normal operating (i.e. larger) face to the concrete.

When used as a probe in this way, the search head is most sensitive to bars parallel to its width, but still responds to bars parallel with its thickness. Note that the most sensitive position is not in the centre of the head thickness, it is 10mm from the normal operating face (i.e. offset 10mm from the midway position between the largest surfaces).

3. Batteries

3.1 Type

Four AA pen cells. Alkaline types are recommended, and give in excess of 50 hours operating life in normal temperatures. Other types can be used, with reduced operating life BUT *may be prone to leakage when exhausted*. Nickel Cadmium rechargeable batteries can also be used, with about 15 hours operating time between charges. Recharge out of the instrument with a suitable charger unit.

NEVER leave exhausted batteries in the instrument (except rechargeable types). Any consequent corrosion damage caused by leakage is NOT covered by the warranty.

3.2 Battery Indication

Battery state is indicated by a moving chevron above the battery life symbol at the base of the display.

The LEFT HAND position indicates New to 10-15 hours gone.

The CENTRE position indicates 10-15 hours to 40-50 hours gone.

The RIGHT HAND position indicates up to 5 hours remaining.

The times are approximate, and apply to alkaline batteries at room temperature.

3.3 Performance Characteristics

The instrument operation is fully stabilised against battery voltage reduction from new, until close to the point of exhaustion, but becomes unpredictable for the last half-hour so.

It is recommended to replace batteries when the RIGHT HAND chevron shows.

3.4 Battery replacement

Most important. Avoid touching battery end caps and instrument battery contacts. Natural skin secretions cause corrosion and bad contact. If in doubt, wipe contacts with a lint-free cloth. Do not use solvents.

Make sure the Micro Covermeter is **OFF**, and search head disconnected. Slide the

battery compartment cover towards the search head connector and release. Prise out old batteries and observe polarity when fitting replacements.

Push fully home. Maintain pressure on battery cover when replacing, to compress retaining foam.

Replace all four batteries as a set of the same type. *NEVER* mix battery types or batteries in different states of discharge. The instrument will only operate with all four batteries inserted correctly; however no damage will result by any combination of wrong insertion.

4. Fault finding

If operation does not appear normal, check the following:

- Switch **OFF**. Disconnect search head. Wait five seconds. Switch **ON**. Instrument version number should be displayed for two seconds.
- If not, batteries may be nearly exhausted. Try replacement set, otherwise the Micro Covermeter is faulty.

NOTE: Faulty operation can be induced by switching **ON** too soon after switching **OFF**. If in doubt, switch **OFF** again and wait five seconds.

- If instrument operates correctly above, repeat with search head connected. This should make no difference apart from the cover measurement function.
- If a fault is indicated, it is difficult to tell whether the search head or the Micro Covermeter is to blame. If substitutes are not available for a comparative test, return *both* for service.

5. Low Cover Alarm/Quick Scan Mode

5.1 Function

This mode allows a cover value to be entered into the memory. When a quick scan made over the area under test an audio alarm will sound when steel reinforcement is found closer to the surface than the preset value. The lowest cover at which such reinforcement is detected is also shown in the display, together with symbol LO.

5.2 Selection of Low Cover Alarm Mode

The function is selected using the **AUDIO** key which sequences between three states:

AUDIO off

AUDIO on

ALARM quick scan low cover mode

With the instrument switched on, hold the search head away from metalwork and depress **AUDIO** twice.

The display will read (if **MM** is selected)

360 50P or 120 25P

and will alternate with (unless the **SIZE** and **TYPE** defaults have been altered).

360 12 1

This indicates that, when searching for reinforcement, no alarm will sound whilst selected size reinforcement is at a greater depth than 50mm (25mm*).

Should reinforcement be found at a lesser depth than 50mm the **AUDIO** alarm tone will sound continuously and the display will show the lowest cover at which the reinforcement bar was located together with the legend **LO**.

Example:

19 LO

5.3 Changing Low Cover Depth Setting

To change from the default setting of 50mm (25mm*) it is necessary to depress either the **AUTO SIZE** key to increase the value or the **MEMORY** key to decrease the value. One single press of either key will change the value by 1mm. However, depressing and holding down either key will enable changes to be made more rapidly.

125 103P

* this display will appear when small search head is connected.

5.4 Reselection of Normal Mode

With the instrument in Low Cover Alarm Mode, but without the alarm sounding, one key press of **AUDIO** will return the Micro Covermeter to Normal Searching Mode. To select Normal Mode whilst Alarm Tone is sounding - depress **AUDIO** key twice.

Low Cover Alarm Mode is again used before the instrument is turned completely **OFF** then the last set depth will be shown. Only if the instrument has been turned off will the standard default setting of 50mm (25mm*) be obtained.

Note:

If the instrument is switched on and **INCH** is selected then the depth of **LOW COVER** shown will be

14.0 1.95P

Pressing the **AUTO/MEMORY** keys will change this value in units of 0.05 inches.

6. Revised Operation on Switch-on

When the instrument is switched on the display will be:

-- 12 1

On pressing CAL (with the search head held in mid-air) the display should indicate either 360mm or 120mm depending on the search head connected.

It should be noted that the instrument automatically determines which search head is connected. If no head is connected it will display dashes. Whenever the search head is changed, CAL must be pressed (with the search head in mid-air) before readings can be taken.

7. Small Search Head

7.1 Function

The small search head is intended for use with mesh and closely spaced reinforcing bars, when the standard search head is unable to provide discrimination. All functions (eg AUDIO, QUICK SCAN, AUTO) are available with the small search head, but to a reduced range. However, cover readings, and in particular AUTO, are valid only for single bars - other nearby metalwork will have an effect depending on size, cover and spacing.

7.2 Operation

Operation is very similar to the large search head. The flat circular face should be placed on the concrete surface under investigation. When over a bar the head should be rotated for maximum audio tone. Bar alignment is then along the hand grip, as shown by the long white grooves and the white arrow.

NOTE: The basic CAL operation must be repeated before deep cover (eg > 75mm) or AUTO measurements are made, and at regular intervals anyway.

7.3 Low Cover Alarm/Quick Scan Mode

This mode operates exactly as with the standard search head apart from the default setting. When switched on, the default setting will depend on which head is connected at the time, or which is first connected. The default setting is 50mm (1.95 inches) for the standard search head or 25mm (1.00 inches) for the small search head. This value will not subsequently change if the head is changed whilst the instrument remains switched on. The maximum preset depth that can be set is 100mm (3.95 inches) with the small search head.

7.4 Auto

AUTO measurements may be made using the small search head and the small (20mm)

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1. Cover measurement

Range	0, to a maximum that varies with bar size. 6mm bar - 220mm 40mm bar - 360mm Measurement is to the bar surface, ignoring ribs.
Accuracy	+/- 2mm +/-5% for up to 75% of the maximum range. To BS 1881.Pt 204.
Display	Metric display - whole mm Imperial display - inches, with 10ths displayed above 9.5 inches and 100ths below 9.5 inches (resolution 0.05 inches). Display hold-function.
"Zeroing" method	Single button push with search head in air.
Ferrous aggregates	Ferrous concrete effects are completely compensated and cause no significant errors.
Search method	Inbuilt variable pitch audio.

2. Bar Selection

Range	High tensile and mild steel bars in the following metric diameters. 5 6 8 10 12 16 20 25 32 40
Display	Metric only, in mm as above.
Selection method	Manual or automatic.
Automatic selection method	By insertion of spacer and recording two cover readings, according to BS 1881.Pt.204.

Automatic accuracy	±1 bar size typical. ±2 bar sizes possible in cases of extreme material abnormality.
Cover range for automatic	20mm to a maximum dependent on bar diameter. 6mm bar - 130mm 40mm bar - 210mm Checked automatically, with display of error conditions.

3. Power

Battery type:	Four AA pen cells. Alkaline types recommended.
Life	Greater than 50 hours in normal room temperatures.
Battery state	Continuously checked and indicated on display.

4. Physical

Size and weight of	Micro Covermeter 180 x 100 x 45 500gm. (Incl. Batts.) Standard search head 130 x 70 x 40 550gm. Cable length 1.5m.
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5. Environmental

Temperature	Operating 0°C - 45°C Storage - 25°C - 60°C (batteries must not be fitted).
Humidity	20% 15% (non condensing).

NOTES

UK/European Software 1.4-1

Additions to basic operating instruction booklet

Instruments incorporating a microprocessor 1.4-1 shown in display when first switching on, have the following mm bar sizes: 5,6,8,10,12,14,16,18,20,22,24,25,26,28,30,32,40. To select bar size the keypad can either be pressed once at a time for size increments, or held down for continuous bar size change until required size is indicated in middle of display.

All other operations are as per Instruction Book.

VERSION 3.1-1 Additional Features

In normal use the software behaves exactly like version 1.4-1. However the program contains additional routines to alter the display / output scaling for uses other than rebar location / depth determination.

The routines can only be activated by holding the type button on the keypad down during the Power up - Display test, the instrument then works in arbitrary mode.

In this mode the TYPE and SIZE displays are not used and are replaced by dashes.

The depth display initially shows dashes also but pressing CAL button will produce a reading of 999 on this display. This reading decreases to zero as the probe approaches a metal structure.

Pressing the AUDIO / ALARM button as in earlier versions will enable audio output whose pitch is proportional to the reading. A second press on this button enables the LOW LIMIT ALARM, in this case the default setting is 250 and pressing the UP or DOWN buttons will cause this to change by steps of 5 units.

The other buttons viz. SIZE - TYPE - MM / INCH do not function in this mode.

The MEMORY and AUDIO-SIZE buttons also do not function except when used in LOW LIMIT ALARM mode.

The only exit from this mode is to switch off the instrument.

This scale is intended as a tool to allow the user to produce data to enable custom scales and calibration of the Micro Covermeter.

British Patent no. 2200216. Software copyright. MICRO COVERMETER is the trade mark of Kolectric Ltd

The guidelines are based on the studies conducted by Bridges & Structures Directorate of RDSO. The views expressed are subjected to modifications from time to time. Further they do not necessarily represent the views of the ministry of Railways (Railway Board) Government of India.

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