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मानक

IS 14436 (1997): Method of test for laboratory determination of resistivity on rock specimen [CED 48: Rock

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# शैल प्रतिदर्शी की प्रतिरोधिता ज्ञात करने के लिए मार्गदर्शी सिद्धान्त

Indian Standard

## GUIDELINES ON DETERMINATION OF RESISTIVITY OF ROCK SPECIMEN

ICS 93.020

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BUREAU OF INDIAN STANDARDS MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG NEW DELHI 110002

Price Group 4

#### AMENDMENT NO. 1 DECEMBER 2006 TO IS 14436 : 1997 GUIDELINES ON DETERMINATION OF RESISTIVITY OF ROCK SPECIMEN

(Page 1, clause 2, line 8) - Substitute 'standards' for 'standard'.

(Page 1, clause 3.1, line 4) --- Substitute 'between 2.5 to 3.0' for '2.5 : 3.0'.

(Page 2, clause 5.5, line 2) - Substitute 'be provided' for 'befitted'.

(Page 2, clause 5.7, lines 1 and 2) — Substitute 'The calibration of the equipment should be done with standard resistance test box' for 'The equipment should have a test box as auxiliary unit'.

(Page 2, clause 6.1, line 2) - Insert 'kept' after 'been'.

(Page 2, clause 6.2, line 1) --- Substitute 'cross sectional area' for 'area'.

(Page 2, clause 6.6, line 5) - Substitute 'sounded' for 'issued'.

(Page 2, clause 6.10, heading) — Substitute 'Precautions' for 'Precaution'.

(Page 2, clause 7.1, line 1) — Substitute 'influence the' for 'control the results of'.

[Page 3, clause 7.2(c)] — Delete 'and its reproducibility'.

(CED 48)

Reprography Unit, BIS, New Delhi, India

#### Rock Mechanics Sectional Committee, CED 48

#### FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by Rock Mechanics Sectional Committee had been approved by the Civil Engineering Division Council.

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In order to assess the various porperties of rock, Indian Standards covering standard method of test are being formulated and this standard provides guidelines on laboratory determination of resistivity on rock specimen. It is a Non-Destructive Test. Quick determination of Resistivity helps in classification. The laboratory measurement will help in assessing the field resistivity test result. However, the design should be based on field test results.

There are number of ways in which electric current can be employed to investigate the conditions of rock in an area. In the most commonly used method, the current is driven using a pair of electrodes and the resulting distribution of potential is mapped by using another pair of electrodes connected to a sensitive voltmeter. The electrical resistance of a material is usually expressed in terms of its resistivity. The resistivity can be measured in the field as well as in the laboratory. The interpretation of electric measurements in geological terms is based on resistivity contrast between different rock types. Rock resistivities vary widely from a fraction of an ohm-metre to millions of ohm-metre. The various engineering parameters can be correlated with the resistivity results for engineering judgement.

Technical Committee responsible for the formulation of this standard is given in Annex B.

In reporting the result of a test or analysis in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

## Indian Standard

## **GUIDELINES ON DETERMINATION OF RESISTIVITY OF ROCK SPECIMEN**

#### **1 SCOPE**

1.1 This standard provides guidelines for the laboratory determination of resistivity on rock specimen.

1.2 The test may be carried out either in the laboratory or at the site.

#### **2 REFERENCES**

The Indian Standards given below contain provisions which through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standard indicated below:

IS No.	Title			
9179 : 1979	Method for the preparation of rock specimen for laboratory testing			
13030 : 1991	Method of test for laboratory determination of water content, porosity, density and related properties of rock material			

#### **3 TERMINOLOGY**

3.0 For the purpose of this standard, the following definitions shall apply.

#### 3.1 Core

It is any single cylindrical piece of rock obtained from drilling process. The diameter of the core should preferably be of Nx size. The ratio of length to diameter may preferably be 2.5 : 3.0.

#### **3.2** Disc

It is any single circular solid piece cut out of the rock core.

#### 3.3 Rock Prism

It is any single solid prism of rock cut out of rock.

#### 3.4 Resistivity

If the resistance between opposite faces of conducting material of lenght L and cross-sectional area A is R, then the resistivity is expressed as  $\rho =$ RA/L.

#### **4 PREPARATION OF SAMPLES**

4.1 The specimen shall be selected to represent average of the type of rock under consideration and shall be prepared as per IS 9179. Samples shall be protected from frost and extreme heat at all times during sampling and transportation.

4.2 In the laboratory, the rock specimen shall be obtained from the same block of rock as on site and drilled in the same direction.

4.3 In the field, the rock specimen shall be obtained from the same bore hole and geological horizon and within the shortest possible difference in their elevations in the bore holes.

4.4 The total number of specimens should be such that at least 10 tests of any one of the types under consideration are possible.

4.5 The specimen should be submerged preferably in formation water for atleast 24 hours before measurement. In case of rock liable for disintegration under saturation, tests may be carried out at the natural moisture content itself.

4.6 The dimensions of the test specimen shall be measured to the nearest 0.1 mm. The thickness shall be measured at or near the centre.

#### **5** APPARATUS

5.1 Any equipment having the following basic facilities can be used for the measurement of resistivity in laboratory or at the site,

5.2 A commutator (transmitter) to transmit pulse train to the sample, which is mounted between electrodes. A receiver to measure the voltage drop across the sample due to pulse train passing through the sample. The voltage at the receiver terminal should be read from the digital equipment. Alternate current should be preferred to overcome surface impedance problems.

5.3 The equipment should have sufficient number of controls and indicators for proper operation like:

- Acoustic alarm to indicate that the current i) through the sample is constant or not;
- ii) Indicators for checking battery condition;

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- iii) Overload signal lamps to indicate too high voltage at receiver terminal due to high commutator current;
- iv) Polarity indicator to show the polarity (+/-) of the voltage read by an analog meter; and
- v) Various switches like commutator and receiver 'ON/OFF', current range, voltage range, etc.

5.4 The following technical specifications may be used as a guide:

a) Commutator

Output current	:	$0.05 \mu a$ -10 mA, select- able in 12 steps
Current stability	:	0.05 percent short term, and 0.25 percent long term, checked by LED indicator
Current cycle time setting.	≤	1.96 seconds standard

b) Receiver

Input impedance	:	10 <sup>12</sup> ohms
50 - 60 Hz rejection	:	60 db
Primary voltage range	:	40 mV - 10 V, selec-
		tion in 6 steps
Resolution	:	0.4 mV
Accuracy	:	1.5 percent of full scale
Polarity indication	:	Automatic
Weight	:	6 kg approx
Power supply	:	Rechargeable battery packs

5.5 It is preferable but not obligatory that the apparatus befitted with automatic data acquisition system and computing facilities to aid in the interpretation of the test results.

5.6 The apparatus should have detailed operation and maintenance manual.

5.7 The equipment should have a test box as auxilliary unit to check proper functioning and measurement of parameters.

5.8 The equipment must be used at a site where there is very little electromagnetic disturbance caused by the mains (50 or 60 Hz).

#### **6** TESTING PROCEDURE

6.1 The rock samples shall be removed from the water in which it has been for at least 24 hours, in a

room, where the temperature is maintained at 27  $\pm 2^{\circ}$ C. The water used shall be either from the site or distilled water. The test shall be conducted in an environment, where the ambient temperature is maintained at 27  $\pm 2^{\circ}$ C.

6.2 The number, length and area of the sample shall be entered into the data sheet (Annex A).

6.3 The sample shall be dried carefully using a towel.

6.4 The rock specimen shall be inserted between the electrodes after making certain that the battery charger is disconnected. Arrangements for preventing the drying out of sample shall be made in the flexible tube.

6.5 The commutator switch is then set to the 'ON' position.

6.6 Full contact between electrode plates and end faces shall be ensured. The desired current shall be set using current selector switch. The acoustic alarm sounds if constant current is not being sent through the sample. If this alarm is issued, a lower current setting may be selected and the current shall be noted

6.7 The selector switch shall be set to primary voltage position and the receiver switch be set to 'ON' position.

6.8 The scale range and the setting of switches shall be selected to minimise the effects of disturbances on measurements. The note of which shall be made on the data sheet.

6.9 A typical measurement set up is shown in Fig. 1.

#### 6.10 Precaution

6.10.1 The following precautions shall be taken:

- a) The battery shall be recharged regularly, and
- b) The battery charger must be disconnected before measurement.

6.10.2 The equipment should be tested and calibrated using a standard resistance Test Box before the actual operation.

#### 7 FACTORS AFFECTING THE TEST RESULTS

7.1 Several factors control the results of measurements of resistivity, some of them are hard to control, as such sufficient precautions should be taken:



4& <i>B</i>	 Commutator terminals.
M & N	 Receiver input terminals.
-1	 Battery lamp when commutator battery needs charging.
-2, L3, L4, L5	 Lamps provide time reference system indications.
-8	 Overload lamp.
7, La, and La	 Battery lamps when all three receiver batteries need charging.
Κ1 .	 Commutator 'ON/OFF' switch.
K2	 12-step current selector.
<b>(</b> 3	 6-step range selector for V and Vp.
K4	 6-step range selector for Vip.
<b>K</b> 5	 Function selector for V, VP, SP and VIP.
<8	 2-step range selector for SP.
<b>K</b> 7	 Receiver 'ON/OFF' switch.
POL	 Polarity indicator (+ -) shows the polarity of the values presented on the receiver analog
	meter.

FIG. 1 CONTROLS, INDICATORS AND NORMAL MEASUREMENT SET-UP (TYPICAL)

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<ul><li>7.2 The factors affecting the test results are:</li><li>a) sample holder,</li></ul>	$\rho = \frac{V}{I} \times \frac{A}{L}$				
<ul> <li>b) sample preparation routine,</li> <li>c) sample measurement and its reproducibility,</li> <li>d) degree of electrolyte saturation,</li> </ul>	<ul> <li>ρ = resistivity in ohm-metre,</li> <li>V = voltage indicated on receiver analog meter in mv,</li> </ul>				
e) electrolyte composition, and	I =  current through the sample in mA,				
<ul> <li>f) porosity of the rock sample.</li> <li>8 CALCULATION</li> <li>8.1 Resistivity of the rock shall be calculated from the following support in the following suppor</li></ul>	<ul> <li>A = mean cross sectional area of the sample in m<sup>2</sup>, and</li> <li>L = overall length of sample in m.</li> </ul>				
the tonowing expression :					

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#### **9 REPORTING OF TEST RESULTS**

9.1 The report of test shall include the following information:

- a) Lithologic description of the rock.
- b) Orientation of sample with respect to specimen anisotropy.
- c) Source of sample, depth and geographic location, method of sampling and environment.
- d) Number of specimens tested.
- e) Specimen diameter and length.

- f) Water content and degree of saturation at the time of test shall be determined as per IS 13030.
- g) Test duration.
- h) Date of testing and type of equipment used.
- j) Any other observation or available physical data.

9.2 The resistivity for each specimen in the sample calculated on the basis of the formula in 8.1 expressed to two significant places together with the average result for the same.

9.3 Range of resistivity for different rocks are shown in Fig. 2.

ROCK	10 <sup>-3</sup>	10 <sup>-2</sup>	10	) <sup>-1</sup>	1	10	10	$)^2$	10 <sup>3</sup>	104	10	) <sup>5</sup> 1	0
ANHYDRITE	Γ								T	F			]
BASALT	Τ							•	+				]
GABBRO								•	-		-		]
SHALE	T					+			T			_	]
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ROCK SALT										1			ן ב
SULFIDES	-	!						.8					
ANTHRACITE COA	4	-	-		Ī	Т			T		1		]

#### RESISTIVITY (ohm-m)

FIG. 2 ROCK RESISTIVITIES (TYPICAL)

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### ANNEX A

## (*Clause* 6.2)

## LABORATORY DETERMINATION OF RESISTIVITY ON ROCK SAMPLES

#### Data Sheet

Project	:		
Location	:		
Rock type	:		
Physical properties (Use separate sheet)	:		
Test conducted by	:		
		Dațe :	

Sl No.	). Sample		Current Voltage Vp			Resistivity		
	No.	Length (m)	Diameter (m)	Area (m <sup>2</sup> )	μΑ	Division	Range (mv)	(Ohm -m)

#### ANNEX B

#### (Foreword)

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This Indian Standard has been developed from Doc: No. CED 48 (5596).

#### Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected
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