IS 12023 (1987): Code of practice for field monitoring of movement of structures using tape extensometer [CED 43: Soil and Foundation Engineering]

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Indian Standard

CODE OF PRACTICE FOR FIELD MONITORING OF MOVEMENT OF STRUCTURES USING TAPE EXTENSOMETER

UDC 624·620·172·2·087·45 : 006·76

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

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Indian Standard

CODE OF PRACTICE FOR FIELD MONITORING OF MOVEMENT OF STRUCTURES USING TAPE EXTENSOMETER

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Indian Standard

CODE OF PRACTICE FOR FIELD MONITORING OF MOVEMENT OF STRUCTURES USING TAPE EXTENSOMETER

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 22 January 1987, after the draft finalized by the Foundation Engineering Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 One of the instruments which is used for the measurement of movement of structure is tape extensometer. The tape extensometer is capable of measuring changes in distance between two points and, therefore, is utilised for the measurement of movements/deformations/displacements for different structures like slope surface, tunnels, underground power houses, bridges and buildings. This standard has been formulated to give guidance in regard to the field monitoring of various movements of such structures with the help of this instrument including its maintenance.

0.3 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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1. SCOPE

1.1 This standard covers the details of the installation and monitoring by tape extensometer for observing slope surface movement, radial movement of lining of tunnels, deformations of excavation, and displacement of various structures.

NOTE — This instrument is not suitable for continuous recording and monitoring.

*Rules for rounding off numerical values (*revised*).

2. GENERAL

2.1 The measurements should be made with the help of steel tape which has precision punched holes at regular intervals of 5 cm. The measurement can be made in any direction — vertical, horizontal or inclined. The comparison of the current reading with initial reading should give the measurement of movement. The displacement is measured between pair of identical ball reference studs or hooks grouted into shallow holes in the structure.

2.2 The free end of the tape should be attached to a spring loaded connector which rotates on a ball reference stud/hook. The fixed end of the tape should be fitted to the tape reel fixed in the body which has a ball location assembly/hook identical to that on free end of the steel tape.

2.3 The tape tensioning should be achieved by rotating the knurled section of the instrument after engaging and looking the location pin into appropriate tape hole. The correct tape tension is indicated when the index mark on spring plunger concides with the index mark in the window.

3. EQUIPMENT

3.1 Tape Extensometer (*see* Fig. 1)

3.1.1 The measuring range of the instrument shall be between 1 to 30 m in any direction and the accuracy shall be $\pm$ 0·1 mm.

3.1.2 It shall be robust and strong against mechanical damage under field conditions.

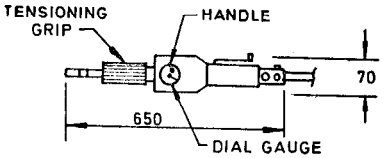
3.1.3 The reading time shall be between 2 to 3 minutes.

3.1.4 It shall consist of the following:

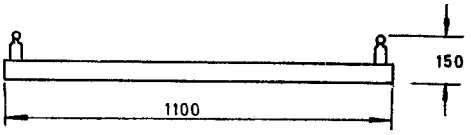
a) Tape extensometer unit (*see* Fig. 1A),
b) Portable calibration frame (*see* Fig. 1B),
c) Replaceable steel tape (*see* Fig. 1C),
d) Replaceable dial gauge (*see* Fig. 1D), and
e) Tape adopter hook (*see* Fig. 1E & 1F).

3.2 Permanent Reference Studs/Hooks — It shall consist of the following:

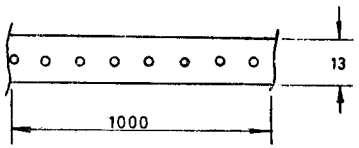
a) Permanent reference Stud Hook (*see* Fig. 2A), and
b) Protective plug/cap (*see* Fig. 2B and 2C).



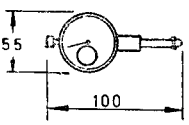
1A TAPE EXTENSOMETER UNIT



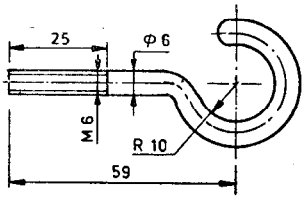
1B PORTABLE CALIBRATION FRAME



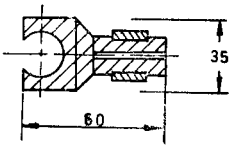
1C REPLACEMENT STEEL TAPE



1D DIAL GAUGE



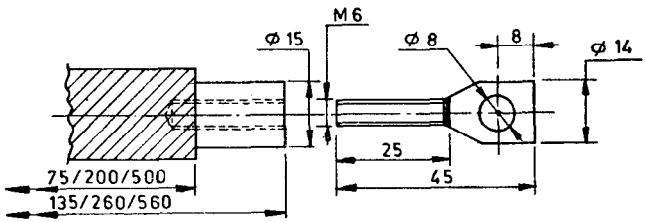
1F TAPE ADAPTOR (HOOK)



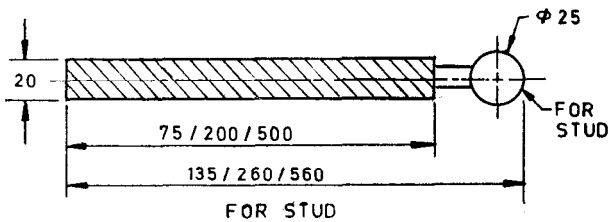
1E TAPE ADAPTOR (STUD)

All dimensions in millimetres.

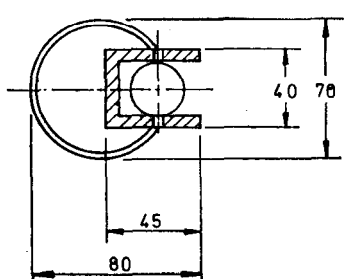
FIG. 1 TAPE EXTENSOMETER



FOR HOOK



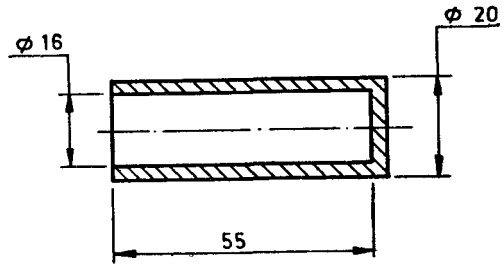
2A PERMANENT REFERENCE STUD/
HOOK ANCHOR



2B PROTECTIVE PLUG

All dimensions in millimetres.

FIG. 2 PERMANENT REFERENCE STUDS — *Contd*



2C PROTECTIVE CAP

All dimensions in millimetres.

FIG. 2 PERMANENT REFERENCE STUDS

3.3 Installation Equipment — It shall consist of the following:

a) Resin/cement,
b) Installation spanner, and
c) Fixing key.

4. CALIBRATION

4.1 The instrument should be calibrated before and after every set of reading to ensure accurate and reliable results with the help of portable calibration frame (*see* Fig. 1B).

5. INSTALLATION

5.1 The reference studs/hooks should be stalled in pre-determined patterns, that is, radially or in a triangular grid for monitoring convergence of the lining (*see* Fig. 3).

5.2 The anchor length should be selected to suit the nature of the material in which they should be stalled, that is, longer length should be required for monitoring of lining of tunnel shafts while shorter lengths should be required for bridge piers, etc.

5.3 The anchor should be installed in drill holes of diameters not less than 25 mm and should be fixed with the help of cement or resin grout.

5.4 The protective plug should be fitted to the anchor before installation to prevent grout entering the threads.

5.5 In order to take readings the plug should be removed using a special key and is replaced by the reference stud.

6. OPERATION

6.1 The operation of tape extensometer should be done as under.

6.1.1 Engage the thrust bearing assembly on to the reference stud/ hook.

6.1.2 Stretch the free end of the steel tape to the second reference stud/hook.

6.1.3 Engage and lock the pin into the appropriate tape hole.

6.1.4 Achieve the required tension by rotating knurled handle till the index mark on the spring plunger lines up on the window of spring housing.

6.1.5 The reading should be taken by noting the visible pin hole position from the tape at the instrument nose followed by the reading shown in the dial gauge (*see* Fig. 1).

7. RECORD OF OBSERVATIONS

7.1 The observations should be recorded in the proforma given in Appendix A.

8. SOURCES OF ERROR

8.1 The sources of error like loose connections of reference studs/hooks and anchor rods, the perfect alignment of tape and instrument from lack of proper matching of points and reference holes, loose tensioning spring, etc, shall be guarded (*see* Fig. 4).

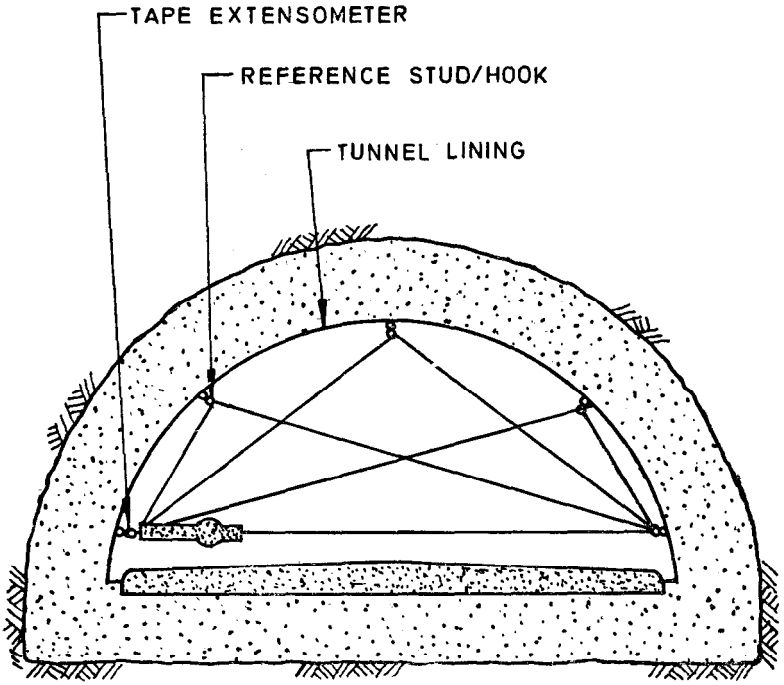


FIG. 3 PATTERN OF RADIAL GRID FOR MONITORING CONVERGENCE OF LINING

9. MAINTENANCE

9.1 The instrument should be kept clean. The tape should be lightly oiled, However, the spring plunger or tension screw should not be oiled as otherwise dirt would adhere to the instrument. The tension spring should be checked in the calibration frame (*see* Fig. 1B) for the fatigue which may occur in course of use. When the instrument is required to be dismantled for cleaning, its length should be checked with the help of portable calibration frame before dismantling and after reassembly so as to prevent alteration in its length.

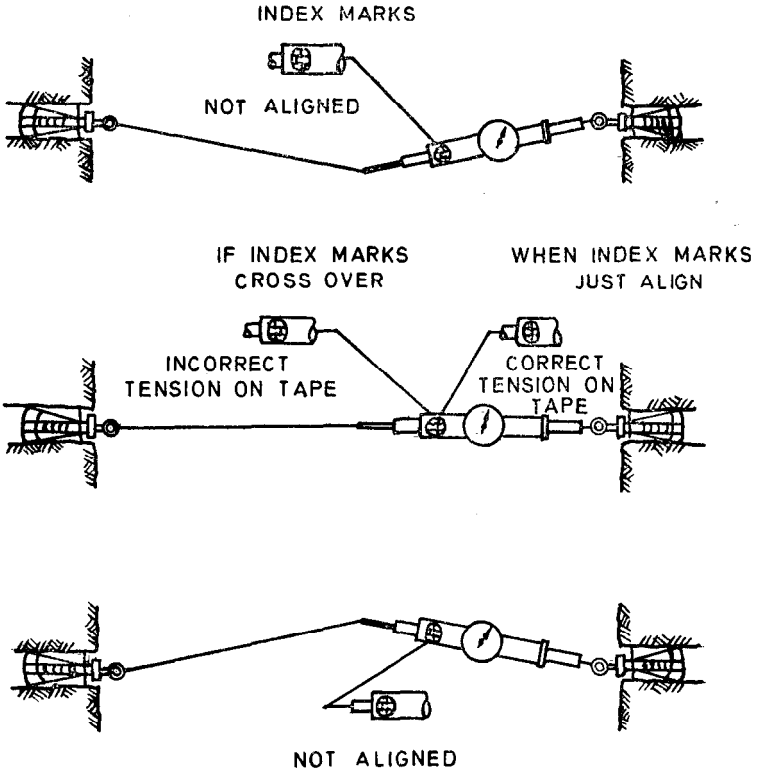


FIG. 4 ALIGNMENT PATTERN OF TAPE EXTENSOMETER

APPENDIX A

(*Clause* 7.1)

PROFORMA FOR RECORD OF OBSERVATIONS OF TAPE EXTENSOMETER (CONVERGENCE READINGS)

INSTRUMENT NO. .....

PROJECT .....

LOCATION .....

CORRECTION FACTOR k .....
(Calibration result)

DATE OF INITIAL OBSERVATION...

DATE OF FINAL OBSERVATION .....

OBSERVATIONS BY .....

OBSERVATIONS BY .....

Sl No.	A_1	C_1	A_2	C_2	$A_1 - C_1$	$A_2 - C_2$	$(A_1 - C_1) - (A_2 - C_2)$	*Remarks*
	Initial dial reading	Initial dial gauge reading	Final tape reading	Final dial guage reading	Initial distance between two reference studs	Final distance between two reference studs	Relative convergence or movement between two reference studs under observation	

(*Continued from page* 2)

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INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	*Unit*	*Symbol*
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	*Unit*	*Symbol*
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	*Unit*	*Symbol*	*Definition*
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2