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CODE OF PRACTICE FOR FIELD INSTRUMENTATION OF SWELLING PRESSURE IN EXPANSIVE SOILS

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Indian Standard

CODE OF PRACTICE FOR FIELD INSTRUMENTATION OF SWELLING PRESSURE IN EXPANSIVE SOILS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 30 November 1985, after the draft finalized by the Foundation Engineering Sectional Committee, had been approved by the Civil Engineering Division Council.

0.2 Most of the swelling pressure measurements on black cotton soils have been made on remoulded specimens with values ranging between 0·2 and 1·1 N/mm^2 depending upon the soil characteristics, compaction condition and the manner and method of conducting the test. These values are, however, of little relevance in evaluating the behaviour of foundation in region ground. Keeping this in view, *in-situ* measurement of swelling perssure which give the realistic value, is significant.

0.3 In the formulation of this standard considerable assistance has been given by Central Building Research Institute, Roorkee.

0.4 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.

1. SCOPE

1.1 This code deals with field instrumentation for measurement of swelling pressure in expansive soils in relation to design of foundations of single/double storey buildings and other allied light structures.

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

2. GENERAL

2.1 Before conducting the test, the limit tests in accordance with IS : 2720 (Part 5) - 1986* and IS : 2720 (Part 6) - 1972† and free swell in accordance with IS : 2720 (Part 40) - 1977‡ should be carried out to classify the soil for its expansiveness. Measurement of *in-situ* swelling pressure in expansive soils at varying depths should be made by recording the upward thrust exerted by the swelling of the soil generated at the interface of a rigid steel plate placed in a bore hole at a particular depth. The *in-situ* swelling pressure test is a simple form of modified laboratory swelling pressure test with the difference that in the field test the soil sample is not confined.

3. EQUIPMENT

3.0 The assembly used for the measurement of *in-situ* swelling pressure should consist of the following:

a) Rigid plate and chamber assembly,

b) Proving ring with dial gauge,

c) Dial gauge and magnetic base,

d) Screw jack,

e) Guide frame for the central and the encasing pipe,

f) Reaction beam anchoring assembly,

g) Plate bucket auger, and

h) Spiral auger, 15 cm diameter with extension rod.

3.1 Rigid Plate and Chamber Assembly — A rigid circular plate of 15 mm thickness and 11·2 cm in diameter with a truely levelled interface should be welded with a socket having 20 mm internal diameter and 40 mm height, and having threads at the internal face exactly in the cente of the circular plate. Due care should be taken to ensure the verticality of the socket during welding. A galvanized iron pipe of 20 mm outside diameter should be screwed firmly in the socket provided in the centre of plate (*see* Fig. 1). The length of the pipe should be in accordance with the depth at which the measurement is to be made. The plate and central pipe assembly should be enclosed with a 4 mm thick galvanized iron sheet chamber having internal diameter such that a clear gap of 3 mm

*Methods of test for soils: Part 5 Determination of liquid and plastic limits (*second revision*).

†Methods of test for soils: Part 6 Determination of shrinkage factors (*first revision*).

‡Methods of test for soils: Part 40 Determination of free swelling index of soils.

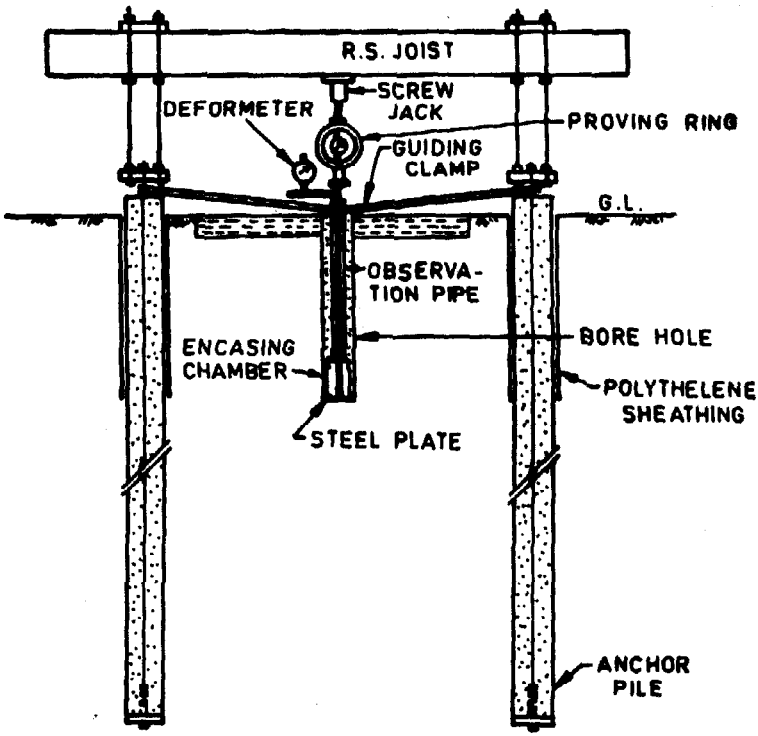

FIG. 1 A SET-UP FOR SWELLING PRESSURE MEASUREMENTS

FIG. 2 BUCKET AUGER FOR CLEANING BASE OF THE BORE HOLE

around the mild steel plate is left. The height of the chamber should not exceed 15 cm. The top of chamber should be closed with a 4 mm thick galvanized iron sheet having a suitable socket, welded in the centre. To enable the central pipe connected with the circular plate pass through the socket without any friction a clear gap of 2 mm should be kept.

3.2 Proving Ring with Dial Gauge — For the measurement of the intensity of pressure a proving ring of 200 kg maximum capacity with a sensitive dial gauge (0·001 mm) with a travel of 25 mm should be used. The proving ring should be placed on a 50 mm dia, 10 mm thick mild steel plate, 50 mm long mild steel pin of the diameter exactly equal to the internal diameter of the central pipe welded at its bottom, centrally, to ensure push fit into central pipe. The top of this circular plate should be provided with recess in the centre to house a 12 mm diameter steel ball.

3.3 Dial Gauge and Magnetic Base — The dial gauge and the magnetic base should be in accordance with IS : 1888-1982*.

3.4 Screw Jack — A simple screw jack having 300 kg capacity should be used to maintain the no volume change conditions below the test plate.

3.5 Guide Frame Reaction Beam and Anchoring Assembly — A guide frame should be used to maintain verticality of the central rod during the test. The guide frame should consist of 5 mm wide and 3 mm thick steel flats having semi-circular support of the diameter equal to the encasing pipe used to encase the central pipe for any kind of disturbance. The reaction beam and the anchoring assembly should be in accordance with IS : 1888-1982*.

3.6 Plate Bucket Auger — In order to keep the bottom of the bore hole completely levelled, a suitable plate bucket according to details given in Fig. 2 should be used.

4. EXCAVATION OF PIT AND BOREHOLE INSTALLATION

4.1 To carryout the test successfully a pit 1 × 1 × 0·25 m should be excavated and levelled. In the centre of the pit a bore hole shall be made by a spiral auger (*see* IS : 10442-1983†) having 15 cm diameter. The verticality of the bore hole should be maintained by using auger boring guide [*see* IS : 2720 (Part 40)-1977‡] and the desired test depth of the bore hole should be reached by adding extension rods to the

*Method of load test on soils (*second revision*).

†Specification for earth augers (spiral type).

‡Methods of test for soils: Part 40 Determination of free swell index of soils.

auger. After reaching the desired depth the bottom of the bore hole should be thoroughly cleaned by removing any loose material and perfectly levelled.

5. METHOD OF INSTALLATION AND PROCEDURE

5.1 The plate and the chamber assembly should be lowered carefully in the prepared bore hole. The circular plate should be made to rest on the base of the bore hole. This should be followed by checking the verticality of the central pipe using a spirit level. The central pipe should be encased with a 40 mm diameter pipe. The lower end of the encasing pipe should be pushed into the socket welded to the chamber. This pipe should be held suspended with suitable clamps at the ground level to ensure free movement of the circular plate. The guide clamp should be fixed to the central pipe. This should be followed by placing the plate. The steel ball be placed over the plate in the recess already provided, followed by placing of the proving ring and the screw jack. The screw jack should be operated to butt against the bottom of the reaction beam which is fixed in accordance with IS : 1888-1982*. The base plate should be applied with the initial pressure with the help of screw jack through the proving ring. This pressure should not exceed the initial overburden pressure at the bottom level of the bore hole. This should be followed by filling the pit with water up to the ground level. The dial of the proving ring should be set at zero and the dial gauge which is placed against a bracket attached to the central pipe and supported on an independent datum bar through a magnetic base. This dial gauge should be used to measure the upward movement of the plate due to swelling of the soil.

6. RECORDING OF SWELLING PRESSURE

6.1 The reading of the proving ring dial gauge and the heave dial gauge should be recorded every week. The recording of these readings should be carried out for a period of three months or till such time when the reading in the proving rings becomes constant whichever is earlier.

6.2 The readings should be recorded in the form given below. During recording of the each reading the proving ring reading shall be recorded only after loading with the screw jack, till the heave dial reading becomes equal to the initial reading thus ensuring that the pressure is being measured with no volume change.

*Method of load test on soils (*second revision*).

Test No. Location
Depth of Test

Sl No.	Date	Time	Proving Ring Reading in	Stress in N/mm^2	Heave in Division of Dial Gauge	Heave in mm

7. PRECAUTIONS

7.1 The anchoring assembly of the set up should be rigid and liable to no movements throughout the test.

7.2 The base of the bore hole should be levelled before lowering of the test plate.

7.3 Perfect care should be exercised in ensuring verticality of the observation rod throughout the test.

7.4 Care should be taken to grease the central rod and the chamber socket from inside and the chamber to eliminate friction between the assembly components.

7.5 The dial gauges used should be cleaned daily with a hair brush and kept loosely covered with polythene covers to protect them against dust.

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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