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Indian Standard

CODE OF PRACTICE FOR INSTALLATION AND OBSERVATION OF BASEPLATES FOR MEASUREMENT OF FOUNDATION SETTLEMENT IN EMBANKMENTS

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CODE OF PRACTICE FOR INSTALLATION AND OBSERVATION OF BASEPLATES FOR MEASUREMENT OF FOUNDATION SETTLEMENT IN EMBANKMENTS

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0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 16 September 1976, after the draft finalized by the Hydraulic Structures Instrumentation Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Foundation settlement (baseplate) apparatus are installed on the foundation under dams and embankments to permit measurements of vertical settlement of the foundation during construction and later during operation. This type of apparatus generally is used where the height of the dam or embankment is relatively low and where the foundation is unconsolidated sand, silt, or clay material. This installation is similar to the cross arm installation for measurement of internal vertical movement in earth dams (*see* IS : 7500-1973*) For the choice and location of instruments in earth dams reference may be made to IS : 7436 (Part I)-1973†. An electrical probe with PVC casing pipe as described in IS : 7500-1973* may also be used for the baseplate installation. The pipe system installed for the baseplate system can be usefully utilized for measurement of the water level, if any, at that point.

0.3 In the formulation of this standard due weightage has been given to international coordination among the standards and practices prevailing in different countries in addition to relating it to the practices prevailing in this field in this country.

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, 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.

*Code of practice for installation and observation of cross arms for internal vertical displacement in earth dams.

†Guide for types of measurements for structures in river valley projects and criteria for choice and location of measuring instruments: Part I Earth and rockfill dams.

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

1. SCOPE

1.1 This standard gives the details of the installation and observation of baseplate apparatus for observing foundation settlement of dams and embankments resting on soil strata. For the purpose of this standard the word embankment includes earth and rock-fill dams.

2. EQUIPMENT

2.1 Components of Installation

2.1.1 The foundation settlement apparatus consists of a baseplate placed on the foundation excavation line and a vertical column of steel pipes (*see* Fig. 1). The apparatus comprises a base section of 50-mm steel pipe, a crossarm measuring unit (baseplate), and anchor crossarm and an extension of 50-mm pipes to the surface of the embankment.

2.1.2 *Base Section* — The base section is made of two pieces of 50-mm pipe, one 600 mm long and one 1 500 mm long, joined by a pipe coupling. A perforated latching plate (*see* Fig. 2) is inserted into the coupling between these two sections of pipes.

2.1.3 *Baseplate* — The baseplate is a modified crossarm with two 300 × 375 mm steel plates welded to the base of a 75-mm channel section. The base-plate unit is bolted and welded to a 40-mm pipe which telescopes between lengths of 50 mm pipe in the system. Settlement readings are taken only on the baseplate measuring point which is the bottom of the 40-mm pipe.

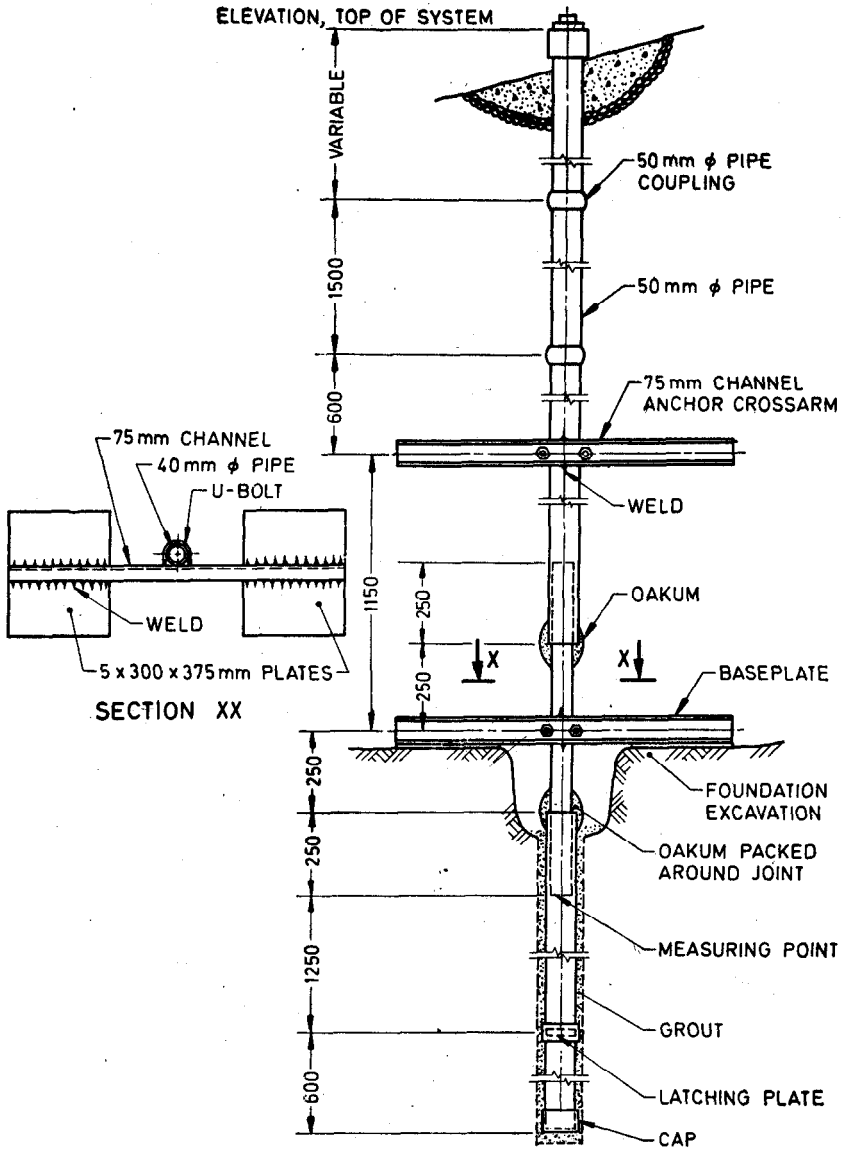
2.1.4 *Anchor Crossarm* — At 1 150 mm above the elevation of the baseplate, an anchor crossarm is placed to prevent the vertical pipe column from sliding down on the baseplate. The anchor crossarm is a 1 000 mm length of 75-mm channel, bolted and welded to a 1 500 mm length of 50-mm pipe.

2.1.5 *Extension Pipe* — To complete the installation, 1 500 mm lengths of 50-mm pipe are joined by pipe couplings to extend the column of pipes to the surface of the embankment.

2.2 Equipment for Observation

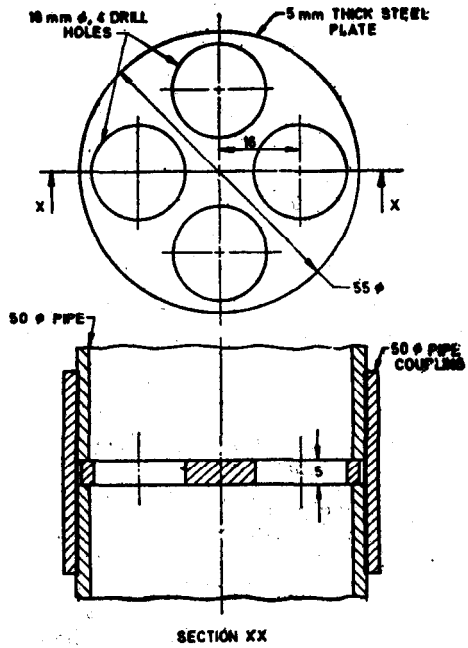
2.2.1 *Measuring Torpedo* (*see Fig. 3*) — Readings of baseplate are taken by lowering from the top of the system a torpedo attached to a steel measuring tape. The torpedo is machined to dimensions from a brass shaft and contains two wings or pawls which open or close at opening slots and closing slots due to spring action. The maximum dimension of torpedo is at the wings when fully opened and this dimension is less than 50 mm and greater than 40 mm.

2.2.2 *Reading Scale and Adapter* — The details of reading scale with adapter used for lowering the torpedo are given in Fig 4.



All dimensions in millimetres.

FIG. 1 BASEPLATE INSTALLATION



All dimensions in millimetres.

FIG. 2 LATCHING PLATE

2.2.3 *Water Level Indicator* — Any suitable device to measure water levels if desired.

NOTE — *Cleaning of the measuring equipment* — The measuring devices shall be kept clean and free of grit. It is suggested that each type of instrument be disassembled, insofar as practicable, and cleaned following completion of readings. The tape should be carefully inspected for kinks and breaks.

3. INSTALLATION

3.1 Prior to installation of the test equipment, permanent instrument benchmarks and targets shall be established beyond the area of influence of reservoir and/or embankment load. These targets shall be visible and accessible throughout construction of the entire embankment. These targets and benchmarks are utilized to locate the centre of the installation at all stages of construction.

3.2 Base Extension (*see* **Fig. 5A and 6A**) — The base extension for the device consists of two pieces of pipe which form the extension into the

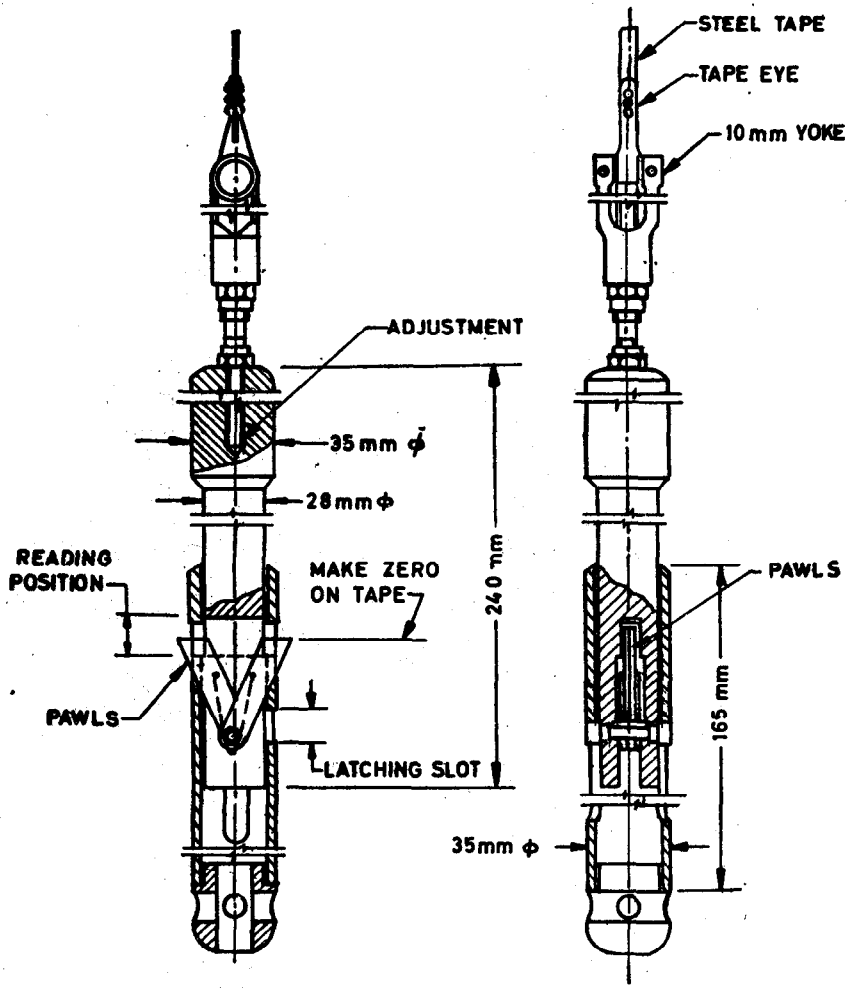


FIG. 3 MEASURING TORPEDO

foundation. This extension should be assembled and set into a 100 mm minimum diameter hole which has been drilled to the required depth into the foundation. The hole may be drilled by an earth auger. After setting the pipe extension, the backfill around the 50 mm pipe should be done with cement grout to within 250 mm of its top. If the foundation baseplate is not installed immediately, a temporary pipe cover should be placed over the extending 50 mm pipe and covered with 450 mm minimum of compacted embankment material.

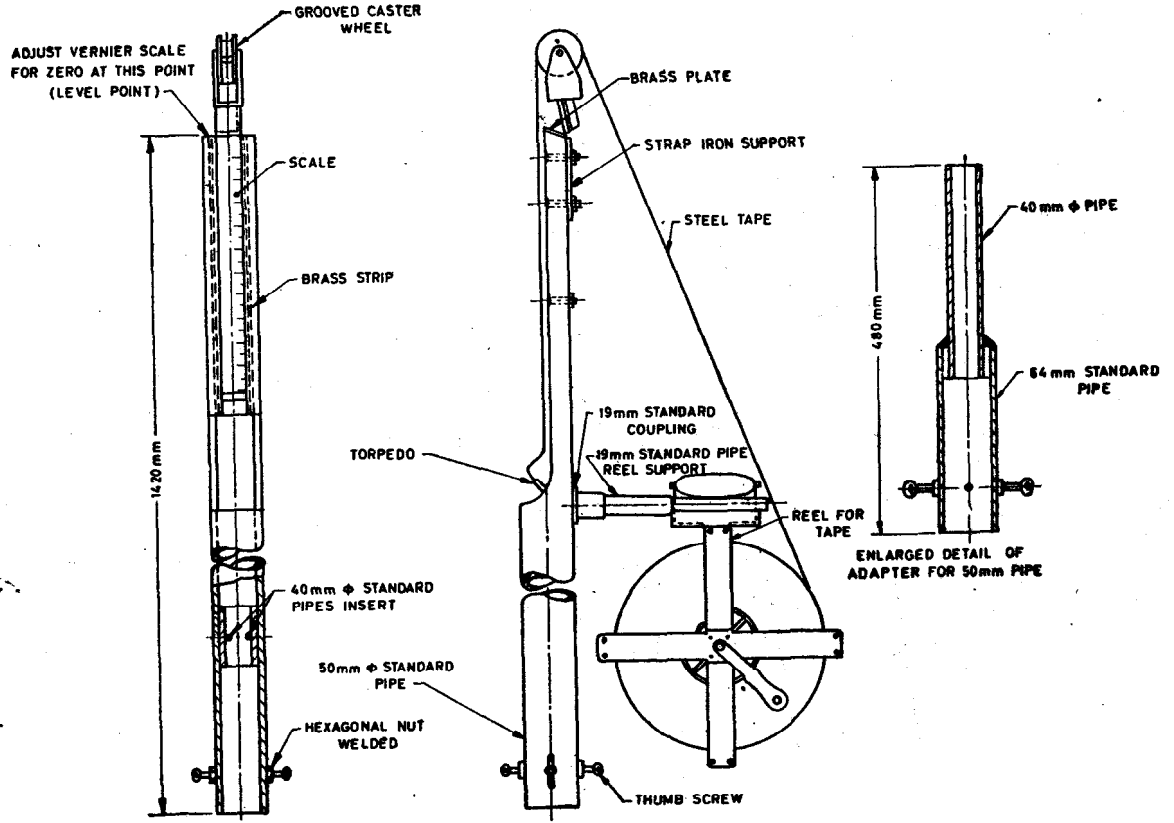


FIG. 4 READING SCALE WITH ADAPTER

3.3 The foundation settlement apparatus shall be installed as embankment placement operations progress. Each pipe section shall be placed in a vertical position. The operation of all heavy equipment should be prohibited in the immediate vicinity of the installation when sections of the apparatus are being placed. If, for some reason, the upper surface of the embankment in the vicinity of the installation is to be reworked before an additional extension pipe is placed, the installation shall be flaged or marked so that it will not be damaged or displaced by earth moving equipment.

3.4 Installation in Rock-free Soils

3.4.1 *Baseplate* (*Fig. 5B*) — The centre of installation should be located and a trench excavated up to foundation excavation line. The baseplate unit should be placed and aligned over the base extension. A pipe cover should be placed on top of the 40-mm pipe and the joints of the 40-mm pipe with the base extension pipe at bottom and with the pipe cover at top should be fitted with oakum and wrapped with burlap. The trench and the hole should be backfilled with embankment material to the level of the oakum joint at top. The original elevation of the baseplate should be noted by lowering the torpedo in the pipe by removing the temporary pipe cover as described in **4.1** and the pipe cover replaced. The backfilling should then be continued up to 1 000 mm above the level of the baseplate. Embankment placement should then be continued.

3.4.2 *Extension Pipe and Anchor Crossarm* (*Fig. 5C*) — The centre of the installation should be located and a trench excavated up to the level of the anchor crossarm. A hole should be bored from the bottom of the trench so as to locate the pipe cover placed in operation described in **3.4.1**. The pipe cover should be removed and the 50-mm pipe with anchor crossarm placed and aligned. The hole should then be backfilled to 400 mm below bottom of trench.

3.4.3 *Extension of Pipe to Top of Embankment* — The operations are similar to those described in **3.4.2** except that no trench is required to be excavated as no crossarms are installed at higher levels. However crossarms may be installed at higher elevations so that it becomes a combined foundation settlement and vertical movement device. At the surface of the embankment, rocky material should be placed around the pipe extension and concrete placed above so as to afford fixity to the installation (*see* Fig. 5D). At the top of the last 50 mm pipe a plug should be fitted to a 50-mm coupling.

3.5 Installation in Rocky Materials

3.5.1 It is difficult to bore a hole in rocky material. The operations involved in the installation as described in **3.4.1** to **3.4.3** are therefore modified. The pipe cover over the base extension if placed should be removed and the baseplate unit should be placed and aligned over the base

extension. A pipe cover should be placed on top of the 40-mm pipe of the baseplate unit and the joints of the 40-mm pipe with the base extension pipe at the bottom and with the pipe cover at the top should be fitted with oakum and covered with burlap. Backfilling should be done to 250 mm above the centre line of baseplate. At this stage, the pipe cover should be removed and the original elevation of baseplate measuring point should be obtained. Then the extension pipe with anchor crossarm should be placed, aligned and a pipe cover seated at the top of this extension pipe. A mound of rocky material should be placed around the pipe about 75 mm below the pipe cover at the top to support the pipe. The embankment placement around the pipe should be continued till it reaches a level 150 mm above the pipe cover, leaving a depression around the pipe cover (*see* Fig. 6B). After the anchor crossarm unit is thus installed, the protective pipe cover should be removed and the vertical alignment of the system should be checked by lowering a plumb bob. If a deviation from vertical alignment is found, an attempt should be made immediately to correct the error. If it is impracticable to correct the error, succeeding pipe sections should be placed vertically and the offset from the true vertical alignment recorded. Succeeding extension pipes should be placed similarly by using 50-mm pipe couplings (*see* Fig. 6C) till the surface of the embankment is reached. At the surface of the embankment, rocky soil should be placed around the pipe extension and concrete should be placed above so as to afford fixity to the installation (*see* Fig. 6D). At the top of the last 50-mm pipe a plug should be fitted to a 50-mm coupling.

4. OBSERVATION

4.1 Settlement readings shall be taken on the baseplate measuring point which is the bottom of the 40 mm pipe by means of the measuring torpedo shown in Fig. 3. The elevation of the measuring point of the baseplate is determined by lowering the torpedo through the reading scale and into the pipe system by means of the steel tape. Pawls on the torpedo engage the lower end of the 40 mm pipe (the measuring point), and upon reaching the bottom of the installation and striking the latching plate, they latch in a closed position to enable the torpedo to be withdrawn from the system. When readings are made, the reading scale is attached to the top section of the pipe projecting from the existing installation. The elevation of the leveling plate on top of the reading scale shall be established from a permanent benchmark off the embankment.

4.2 During construction, readings for elevations of the baseplate measuring points and of the top of the embankment should be determined and noted in the form shown in Appendix A. Throughout construction, including shutdowns, readings shall be taken at intervals of 30 days. When the installation is completed the elevation of the top of the final pipe coupling should be established to the nearest 5 mm (*see* Note) and the date of completion

should be noted on the form shown in Appendix A. The first set of periodic readings should be made immediately after installation; thereafter readings should be taken every 3 months for the first 3 years and every 6 months thereafter. The observations should be recorded in the form given in Appendix A.

NOTE — The elevation of the final pipe coupling shall be verified at least once in 6 months with a permanent benchmark.

4.3 The position of water level in the pipe system may be noted by means of the water level indicator.

5. RECORD TESTS

5.1 Record tests of foundation materials at the instrument installation are necessary. Representative undisturbed samples of the foundation soils should be obtained and tested for grain size analysis, consistency limits, specific gravity, natural water content, natural dry density and consolidation.

APPENDIX A

(*Clause* 4.1)

PRO FORMA FOR RECORD OF OBSERVATION OF BASEPLATE INSTALLATION (FOUNDATION SETTLEMENT READINGS)

Project..... Dam.....

Location..... Top of dam.....

Reference drawing..... Reservoir water level R.L.....

Date of observation.....

Observed by.....

Base-plate No.	Location		Elevation of Baseplate†		Settlement of Base-plate	Present Elevation of Embank-ment‡	Height of Embank-ment		Change in Depth ¶	Elevation of Water in System
	Station	Offset*	Original	Present			Original§	Present‖		

*Record upstream or downstream from centre line of crest of dam.

†Report data to 5 mm.

‡On completion of installations, use elevation of top of pipe (at system) in lieu of current elevation of embankment.

§Determined when the installation is complete; subtract existing elevation of baseplate from elevation of top of pipe.

‖Indicate increase in depth by minus (—).

¶Subtract current elevation of baseplate from current elevation of top of pipe.

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