STANDARDISATION IN THE FIELD OF INSTRUMENTATION FOR HYDRAULIC STRUCTURES

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1. INTRODUCTION

Instruments are used for measuring various parameters like movements, pore pressures, etc in hydraulic structures. Most instrumentation is installed to monitor the behaviour of hydraulic structures during construction as well as during subsequent operations. The specific applications for measurements are three fold and may be described as follows:

1. To provide information for a continuing check of the design assumptions so that modifications during the construction period may be made, if required, in the design and/or construction procedures. For example, observations of pore water pressure in the embankment or foundation and of surface and internal movements of ten provide a guide to the permissible rate of fill placement.
2. To furnish data to determine if the completed structure will function as intended, and to provide a continuing survelliance of the structure to warn of any developments which may endanger its safety. A record of periodic instrument readings during the life of a project of ten indicates changes in internal conditions that warrant more detailed investigations. For example, a sudden increase in the rate of seepage may denote serious cracking within the core zone.
3. To obtain information for future design criteria for high dams. The solution to many important problems such as cracking within embankments, deformations, rock fill under gravity loading and reservoir pressures, prediction of pore pressures in compacted core materials, seismic effects on overall stability now seem to be capable of solution only through field observations on the dams themselves.

Careful attention must be given to planning an instrumentation system to ensure that required information will be obtained. Both during the construction period and the life of the structure. The requirements of

the system and the procedures to be used for analyzing the observations should be formulated in detail and selection of the measuring devices and their location chosen to meet these requirements.

Realising the importance of the subject the Bureau of Indian Standards took up the work of standardization in the field of instrumentation of hydraulic structures with the setting up of a full-fledged Sectional Committee. Hydraulic Structures Instrumention RVD 16.

2. STANDARDIZATION

Standardization has been defined as the process of formulating and applying rules and procedures for an orderly approach to a specific activity for the benefit and with the co-operation of all concerned and in particular for the promotion of overall economy. It is based on consolidated results and science, techniques and experience. It determines not only the basis for the present but also for future developments and keeps pace with progress in the particular field of activity.

This chapter presents a brief discussion on the standardization activities in the field of instrumentation at the national level in the Bureau of Indian Standards. In this activity the Bureau has been assisted considerably by researchers, academicians, designers, manufacturers and users connected with instrumentation and in fact standards have been formulated with the concurrence of all the different interests who are represented on the technical committee of BIS dealing with the formulation of standards in the field of instrumention for hydraulic structures.

2.1 Indian Standards

The work of formulation of Indian Standards in the field of instrumentation for hydraulic structures is carried out through the Hydraulic Structures Instrumentation Sectional Committee RVD 16.

The standards have been formulated on the basis of experience gained from usage in the field. Such experience has also helped in updating/ revising the standards. A list of published standards in this field is given in Table 1.

The extent of standardization in the field of instrumentation for river valley projects is covered in subsequent paragraphs.

One of the important standards formulated by BIS in the field of instrumentation in river valley projects is 6524:1972. This standard deals

with the installation and observation of instruments of temperature measurements inside dams by means of resistance type thermometers. Another very important standard prepared is 6532 which covers installation of instruments for observation of uplift pressure at places of contact of the hydraulic structure and the foundation soils. In hydraulic structures on permeable foundations the stored water percolates below the foundation of the structure thereby causing uplift pressure. The pressure gradient noting along the direction of flow is a critical design parameter at the exit end of the structure. Design of the structure involves calculations of these pressures and gradients on the basis of certain assumptions. In these cases, therefore, actual observations of systematic records of these observations, apart from their scientific value will be necessary for maintenance of the structures as a record of usual sub-surface soundings and probings.

Installation, maintenance and observations of instruments for pore pressure measurements in earth and rockfill dams are covered in IS 7356 (Part 1) and 7356 (Part 2). Part 1 covers porous tube piexometer with connected accessories, the installation procedure and maintenance, method of taking observations, record and presentation of data. The porous piexometer is a device for measuring pore water pressure primarily in the foundation though it can also be used to instal at locations. Porous tube piexometers can be installed at locations not dissoluble to conventional twin tube hydraulic piexometer, as they are independent installations. Because of its simplicity, and reliability, the porous tube piexometer can be used by taking advantage of the drainage tunnels and grouting culverts to provide permanent access to the top of the holes. Since porous tube piexometers can be installed after completion of construction, obstruction to construction equipment can also be avoided. IS 7356 (Part 2) covers details of procedures for installation, maintenance and observations of twin tube hydraulic piexometers installed in earth and backfill dams for measuring rare pressure. This standard has recently been revised to include information on electrical transducers and readout equipment.

With increase in the height of structures and varied topographical conditions, the use of instrumentation has greatly increased because of the need for additional design information. Hence there is a need to establish adequate instruments both in the structures as well as the foundations to evaluate and understand the influence of various parameters in structures. 7436 (Part 1): 1993 covering the various types of measurements needed for monitoring the behaviour of earth and rockfill dam and 7436 Part 2 is for concrete and masonry dams. Both these

standards also provide guidelines for choice of instruments and their locations.

IS 7500:1974 is another important standard which provides details of installation and observation of cross arms, of mechanical and electrical types, for measurements of internal vertical movements in earth dams. Vertical movement devices provide a measure for determining volume change within the embankments and settlement of foundations. The crossarm installations especially permit the measurements of consolidation within any desired lift, or lifts, of embankments both during and after construction. Another important standard for installation and observation of baseplate apertures for observing foundation settlements of dams embankments resting on soil state is B 226:1976. This type of apparatus is used where the height of the dam or embankment is relatively low and when the foundation is unconsolidated, sand, silt, or clay material.

Large dams are provided with a row or rows of internally formed drains. A record of the pore pressure development/and its variations would indicate the effectiveness and adequacy of these drains. Seeing the importance of the subject, IS8282 (Part 1). Electrical resistance type cell for concrete and masonry dams and IS 12949:1990. Electrical pore pressure cells, vibratory wire type for earth and rockfill dams, have been formulated.

Rubber insulated and rubber sheathed flexible cords are used for connoting highly accurate measuring instruments embedded in concrete and masonry dams to suitable terminal boards located in the galleries of the dams. IS 10334:1982 provides details of specifications, methods of splicing and installation, mode of delivery, inception and tests to be carried out on the material used in the manufacture of cables as also on the finished cable. Pre-embedment tests, cable and protection and fixing of conduits size are also detailed in the standard.

For integral behaviour of contraction joints, left in large straight gravity and arch gravity dams, are grouted with cement grout. Measurement of joints, movement during grouting operation will indicate how much grout should be pumped into the joints. Surface measurement and joint movements with the help of resistance type jointmeters in the interior of concrete and masonry dams are covered in IS10434 (Part 1);1982.

Measurement of relative horizontal displacements of points in the interior of dams provide the fastest, simplest and direct method of watching the structural behaviour of dams. Plumb line observations can be used for

ascertaining the elastic and inelastic physical properties of the concrete or masonry and foundation rocks. IS13073 (Part 1);1991 gives the details of installation, maintenance and observation of regular and racers plumb line for measurement of horizontal defections of points inside a concrete or masonry dam.

Ancther important standard formulated is IS13232:1992 which deals with electrical strain measuring devices suitable for embedment in concrete dams.

ANNEXURE - 1

HYDRAULIC STRUCTURES INSTRUMENTATION, RVD 16

Scope:- Recommendations For Instrumentation In River Valley Projects. Criteria For Selection And Location of Instruments.

Specifications For Various Instruments Used For The Measurement Of Stresses, Temperature, Permeability, Displacement, etc. With Their Testing

Sl.No.	IS.No./Doc.No. Standards Published	Title
1	IS 6524:1972	Code practice for installation and observation of instruments for temperature measurement inside dams; resistance type thermometers .
2	IS 6532:1972	Code of practice for design, installation, observation and maintenance of uplift pressure pipes for hydraulic structures on permeable foundations.
3	IS 7356 (PT 1) : 1992	Code for installation, maintenance and observation of instruments for pore pressure measurements in earth dams and rockfill dams: Part 1 Porous tube piezometers (first revision).
4	IS 7356 (PT 2) : 1993	Installation, observation and maintenance of instruments for pore pressure measurements in earth and rockfill dams. Code of practice Part 2 Twin tube hydraulic piezometers (first revision).
5	IS 7436 (PT 1) : 1993	Guide for type measurements for structures in river valley projects and criteria for choice and location for measuring instruments: Part 1 For earth and rockfill dams (first revision).
6	IS 7436 (PT 2) : 1976	Guide for types of measurements for structures in river valley projects and criteria for choice and location of measuring instruments: 2 Concrete and masonry dams.
7	IS 7500:1974	Code of practice for installation and observation

		of cross arms for measurements of internal vertical movement in earth dams.
8	IS 8226:1976	Code of practice for installation and observation of base plates for measurement of foundation settlement in embankments.
9	IS 8282 (PT 1) : 1976	Code of practice for installation, maintenance and observation of pore pressure measuring devices in concrete and masonry dams: Part 1 Electrical resistance type cell.
10	IS 10334:1982	Code of practice for selection, splicing installation and providing protection to the open ends of cables used for connecting resistance type measuring devices in concrete and masonry dams.
11	IS 10434 (PT 1) : 1982	Guidelines for installation, maintenance and observation of deformation measuring devices in concert and masonry dams: Part1 Resistance type jointmeters.
12	IS 12949:1990	Code of practice for installation, maintenance and observation of instruments for pore pressure measurement in earth dams rockfill dams: Electrical pore pressure cells - vibratory wire type.
13	IS 13073 (PT 1) : 1991	Code of practice for installation, maintenance and observation of displacement measuring devices in concrete and masonry dams: Part 1 Deflection measurement using plumb lines.
14.	IS 13232 : 1992	Code of practice for installation, maintenance and observation of electrical strain measuring devices in concrete dams.

3. FUTURE WORK

In the field of instrumentation for hydraulic structures work has been initiated in several new areas also, and some of the important areas are:

i) Instrumentation for barrages.

ii) Stress measuring devices for concrete and masonry dams .

iii) Instrumentation for vibration studies (other than earthquakes).

iv) Displacement measuring devices for concrete and masonry dams using geodetic observations- crest collimation.

v) Measurement of internal vertical movement of earth dams by electrical probe extensometer.

4. CONCLUSIONS

Standardisation is an ongoing and dynamic activity and is a reflection of the state of art as available in the country. It will be advantageous to technology as a whole if these standards are used by all concerned and feed-back is made available to BIS for upgradation or revision of a standard in order to make its usage more viable and truly reflective of the expertise available to us.