



भारतीय मानक ब्यूरो

(उपभोक्ता मामले, खाद्य एवं सार्वजनिक वितरण मंत्रालय, भारत सरकार)

BUREAU OF INDIAN STANDARDS

(Ministry of Consumer Affairs, Food & Public Distribution, Govt. of India)

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व्यापक परिचालन मसौदा

हमारा संदर्भ : डब्ल्यूआरडी 14/ T-1

13 सितम्बर 2024

तकनीकी समिति : पानी संवाहक प्रणाली अनुभागीय समिति, डब्ल्यूआरडी 14

प्राप्तकर्ता :

- जल संसाधन विभाग परिषद, डब्ल्यूआरडीसी के सभी सदस्य
- पानी संवाहक प्रणाली, डब्ल्यूआरडी 14 के सभी सदस्य
- रुचि रखने वाले अन्य निकाय।

महोदय /महोदया,

निम्नलिखित मानक का मसौदा संलग्न है:

प्रालेख संख्या	शीर्षक
डब्ल्यूआरडी14 (26562)WC	पानी पहुंचाने वाली सुरंगों का डिजाइन करना भाग 1 सामान्य डिजाइन - रीति संहिता (4880 Part 1 का दूसरा पुनरीक्षण)- भारतीय मानक मसौदा (आई सी एस 93.160)

कृपया इस मसौदे का अवलोकन करें और अपनी सम्मतियाँ यह बताते हुए भेजे कि यह मसौदा प्रकाशित हो तो इन पर अमल करने में आपको व्यवसाय अथवा कारोबार में क्या कठिनाइयां आ सकती हैं।

सम्मतियाँ भेजने की अंतिम तिथि : 13 नवंबर 2024

सम्मति यदि कोई हो तो कृपया अधोहस्ताक्षरी को ई-मेल द्वारा wrd@bis.gov.in पर या उपरलिखित पते पर, संलग्न फॉर्मेट में भेजें। सम्मतियाँ बीआईएस ईगवर्नेस पोर्टल-, www.manakonline.in के माध्यम से ऑनलाइन भी भेजी जा सकती हैं।

यदि कोई सम्मति प्राप्त नहीं होती है अथवा सम्मति में केवल भाषा संबंधी त्रुटि हुई तो उपरोक्त प्रालेख को यथावत अंतिम रूप दे दिया जाएगा। यदि सम्मति तकनीकी प्रकृति की हुई तो विषय समिति के अध्यक्ष के परामर्श से अथवा उनकी इच्छा पर आगे की कार्यवाही के लिए विषय समिति को भेजे जाने के बाद प्रालेख को अंतिम रूप दे दिया जाएगा।

यह प्रालेख भारतीय मानक ब्यूरो की वेबसाइट www.bis.gov.in पर भी उपलब्ध है।

धन्यवाद।

भवदीय

ह-/

श्री दुष्यन्त प्रजापति

वैज्ञानिक 'ई' (निदेशक) एवं प्रमुख

जल संसाधन विभाग

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संलग्न: उपरलिखित



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WIDE CIRCULATION DRAFT

: :Our ReferenceWRD14/T - 1

13 September 2024

: :TECHNICAL COMMITTEE WATER CONDUCTOR SYSTEMS, WRD 10

ADDRESSED TO:

1. All Members of Water Resources Department Council, WRD
2. All Members of Water Conductor Systems Sectional Committee, WRD 14
3. All others interested.

Dear Sir/ Madam,

Please find enclosed the following draft:

Doc No.	Title
WRD 10(25190) WC	DESIGN OF TUNNELS CONVEYING WATER PART 1 GENERAL DESIGN - CODE OF PRACTICE (Second Revision of IS 4880 Part 1) (ICS: 93.160)

Kindly examine the attached draft and forward your views stating any difficulties which you are likely to experience in your business or profession, if this is finally adopted as National Standard.

Last Date for Comments: 13 November 2024

Comments if any, may please be made in the enclosed format and emailed at wrd@bis.gov.in or sent at the above address. Additionally, comments may be sent online through the BIS e-governance portal, www.manakonline.in.

In case no comments are received or comments received are of editorial nature, kindly permit us to presume your approval for the above document as finalized. However, in case comments, technical in nature are received, then it may be finalized either in consultation with the Chairman, Sectional Committee or referred to the Sectional Committee for further necessary action if so desired by the Chairman, Sectional Committee.

The document is also hosted on BIS website www.bis.gov.in.

Thanking you,

Yours faithfully,

Sd/-

(DUSHYANT PRAJAPATI)

Head (Water Resources Department)

Email: wrd@bis.gov.in

Phone: +91-11 23231906

Encl: As above

BUREAU OF INDIAN STANDARD

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भारतीय मानक मसौदा

**पानी पहुंचाने वाली सुरंगों का डिजाइन करना भाग 1 सामान्य
डिजाइन — रीति संहिता**

(4880 Part 1 का दूसरा पुनरीक्षण)

Draft Indian Standard

**DESIGN OF TUNNELS CONVEYING WATER PART 1 GENERAL
DESIGN — CODE OF PRACTICE**

(Second Revision of IS 4880 Part 1)

ICS 93.160

Water Conductor Systems,
Sectional Committee, WRD 14

Last date for Comments:
13/11/2024

FOREWORD

(Formal Clause of the foreword will be added later)

For the alignment of tunnels and designs of tunnel supports and lining, the nature of soft or hard strata and its formation plays a vital role. It is necessary to know the general topography, the geology of the area, state of stress and other mechanical properties of the strata. For this certain topographical and geological investigations, in-situ and laboratory test, and observations are necessary. For certain locations where difficult working conditions are anticipated, more detailed investigations may be undertaken. This standard has been published in various parts. Other parts of this standard are as follows:

- Part 2 Geometric design;
- Part 3 Hydraulic design;
- Part 4 Structural design of concrete lining in rock;
- Part 5 Structural design of concrete lining in soft strata and soils;
- Part 6 Tunnels supports; and
- Part 7 Structural design of steel lining.

This standard was first published in 1975 and subsequently revised in 1987 in light of experience gained during the past in the use of this standard. In the first revision, the clauses on 'in-situ rock and tests' and 'instrumentation' were modified to introduce the

modern rock mass classification. This revision (second revision) has been brought out to bring the standard in the latest style and format of the Indian Standards. In addition, the following major changes have been incorporated:

- a) The scale and contour interval in the Survey of India Topo Sheets under clause 2.2.1 have been modified to allow for more detailed mapping, which improves the accuracy of the tunnel alignment process.
- b) Clause 2.3 has been modified to incorporate geological investigations to be carried with modern investigation methods in accordance with the provisions contained in IS 17883: 2022 'Geological Exploration for Tunnels Guidelines'.
- c) Clause 2.3.2 has been modified to mandate geophysical investigations before exploratory drilling and drifting activities.

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 : 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded-off value should be the same as that of the specified value in this standard.

Draft Indian Standard**DESIGN OF TUNNELS CONVEYING WATER PART 1 GENERAL
DESIGN — CODE OF PRACTICE***(Second Revision of IS 4880 Part 1)*Water Conductor Systems,
Sectional Committee, WRD 14Last date for Comments:
13/11/2024**1 SCOPE**

This standard (Part 1) covers the general requirements, like various types of investigations, tests and instrumentation of tunnel generally required for planning and designing of pressure tunnel section and supports.

2 REFERENCES

The Indian Standards listed below contain provisions which through reference in this text constitute provisions 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 these standards are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

<i>IS No.</i>	<i>Title</i>
IS 5878 (Part 1) : 1971	Code of practice for construction of tunnels conveying water Part 1 Precision survey and setting out
IS 17883 : 2022	Geological Exploration for Tunnels Guidelines
IS 11315 (Part 11) : 2023	Methods for quantitative description of discontinuities in rock masses Part 11 Core recovery and rock quality designation (<i>first revision</i>)

3 INVESTIGATIONS

3.1 General — Records of any existing tunnels and other excavations in the vicinity including any information regarding old mine workings or old wells, should be sought and studied. Information should also be sought in historic records concerning flooding, avalanches, landslips, earthquakes, etc.

3.2 Topographical Surveys — Surveys for preparation of plans and aligning the tunnel should be carried out covering the area of tunnel alignment, after establishing adequate number of temporary bench mark with reference to the G. T. S. bench mark available in the vicinity. The survey shall be carried out in accordance with the provisions contained in IS 5878 (Part 1). Where movements along faults are suspected, local network of survey

monuments shall be laid and observations made during construction period as also later during operation.

3.2.1 Preliminary investigations for aligning the tunnel should be carried out on available scale of 1 : 50000/ 1 : 25000. Once the general feasibility of the tunnel is established, detailed strip topographic maps along the tunnel alignment should be prepared to a scale 1:10000/ 1:5000 with 5m to 2m contour interval. The width of the strip may be fixed on the basis of investigations, which shall be carried out more intensely at locations where certain local geologically adverse features like major shears, thrusts, faults synclines, etc, exist or where exposed rock is encountered and where the rock cover is less than the internal water pressure at that location. The strip width shall be commensurate with the internal water pressure on either side of alignment and also up to contours corresponding to tunnel grade indicating location of adits where necessary. At portal faces, the contour interval should be reduced to 2m.

3.2.2 Wherever possible, aerial (photographic) survey should be carried out and the stereoptic coverage should extend for at least 3 km on either side of the possible foreseen limits of the tunnel alignment. This would facilitate to pinpoint those areas that require surface and subsurface investigations for a detailed assessment. If infra-red aerial photography is used, it would facilitate to delineate hot water bearing zones in bed rock.

3.3 Geological Investigations — Geological investigations should be carried out with investigation methods in accordance with the provisions contained in IS 17883. If the area has been aerially photographed, such data should also be studied.

3.3.1 The geological investigations should be carried out to determine the following

- a) Origin and type of rock along the alignment and study of regional geological maps of the area, if available;
- b) Geological section along the tunnel alignment giving rock types and their disposition; location and attitude of all structural features of rock such as faults, thrusts, joints, dips, strikes and other geological features including pattern, extent and contents of fissures; presence of water in small or large quantities and their probable pressure at tunnel grade, etc;
- c) Any geological feature which may affect the magnitude of rock pressure to be anticipated along the proposed alignment;
- d) Cover on the tunnel, position of subsurface rock and overburden contacts;
- e) Physical, mechanical and strength properties of rock to determine supporting arrangements and also resistance to driving tunnel through rock (if tunnelling with a mole is proposed); and
- f) Hydrological data and information regarding location, type and volume of water and injurious or troublesome gases contained in subsurface strata around tunnel grade.

3.3.2 The geological data should be developed through a comprehensive geological investigation which includes:

- a) Detailed geological mapping — Detailed geological mapping to know the rock formations, locations and altitude of structural features such as folds, faults, joint pattern, etc, to plan drill holes;
- b) Subsurface exploration — Few cored bore holes should be taken at suitable locations along the alignment of tunnel as suggested by geologist. The number of bore holes depends upon the length of tunnel, rock cover over tunnel grade, number of adits available and geological features likely to be met with. However, the minimum number of bore holes as adjudged to be necessary by an experienced engineering geologist in consultation with design engineers should be provided. For proper determination of rock quality designation (RQD) (see **4.2.3**), the bore holes should be drilled with NX size and larger size only and not that BX or smaller sizes. The core samples of each bore hole shall be preserved and logged by an engineering geologist. Bore holes shall avoid, as far as possible, intercepting tunnel bore, particularly in water bearing strata, and shall be properly backfilled preferably with concrete;
- c) Geophysical investigations — This type of investigation is helpful in establishing the rock-soil boundary, in delineating fault and shear zones, other geological structures and similar phenomenon. Geophysical investigations should generally precede exploratory drilling and drifting activities. This investigation is also used in evaluating rock mass quality by determining in-situ modulus of elasticity;
- d) Television investigation of boreholes — If possible, the walls of boreholes may be examined by television borehole cameras. This method facilitates in studying the depth of altered rock, location and determination of the altitude and character of shear zones, joints fractures, foliations and bedding planes, assessment of rock condition above and below the water table, identification of rock types and other visually detectable geological characteristics of in-place rock prior to excavation; and
- e) Exploration drifts — Drifts should be provided at portals or at adit points. These are most accurate means of determining the geological conditions in tunnelling and for conducting in-situ rock tests.

3.3.3 Geological investigations should be continued during construction not only in the interest of checking design data but also for ascertaining the tunnelling methods and predicting tunnel conditions ahead of tunnel face to minimize surprises.

4 TESTS

4.1 Laboratory Tests — The core samples collected from the boreholes shall be classified and specimens from each group shall be tested to determine the following properties:

- a) Specific gravity;
- b) Modulus of elasticity (static and/or dynamic);
- c) Poisson's ratio;

- d) Tensile strength;
- e) Compressive strength (dry and wet);
- f) Triaxial shear strength;
- g) Hardness of rock;
- h) Swelling index (in case of soft argillaceous rocks);
- j) Porosity, grain size and cementing material for sand stones and similar rocks;
- k) Brittleness Index;
- m) Siever's 'J' value;
- n) Abrasivity Index; and
- p) Slake Durability Index.

4.2 In-situ Rock Tests

4.2.1 The data obtained from field and laboratory tests shall be substantiated by in-situ rock tests. When a cavity is formed in the rock mass, the in-situ rock stresses are altered for some distance around the opening. In-situ rock tests are carried out to evaluate:

- a) In-situ rock characteristics like shear strength parameters (C and φ), compressive strength and deformation modulus preferably by Goodman Jack;
- b) Deformation of rock around opening;
- c) Rock load on supports — temporary and permanent; and
- d) The tests shall be carried out in two directions at right angles to each other in case of laminated rock structures — one parallel to and the other at right angles to the dip and strike of rock. Plastic fields shall be determined by repeated loading and unloading tests.

4.2.2 The information obtained above is required for providing supporting system in tunnel and design lining. These are to be obtained by installing instruments described in **5.1**.

4.2.3 From the borehole logs, rock quality designation (RQD) should be determined. Geotechnical and geological data should be collected with a view to enable modern rock mass classification [see IS 11315 (Part 11)].

5 INSTRUMENTATION

5.1 Systematic instrumentation is to be done in all major tunnels under construction to monitor the behaviour of supports and the rock. Such a study may be started from the very start of the tunnel. The instruments should be installed at the time of installation of the supports. The following may be done. The instrumented section should be so dispersed as to cover statistically differing rock conditions:

- a) Closure/Convergence Observations — Tunnel closure (walls and roof) should be observed at random intervals throughout the length of the tunnel;
- b) Bore-Hole Extensometer — Multipoint bore-hole extensometer should be used to know the deformation in the rock around the tunnel opening. The observations will help in ascertaining the shape and size of the plastic (broken) zone. A minimum of three, that is, one horizontal, one vertical and one at 45° to the horizontal per section should be used;

- c) Load Observations — Rock load coming on the steel supports should be monitored by installing load cells on ribs. A minimum of three per section should be used;
- d) Contact Pressure Observations — Pressure cells should be placed at the intervals of the supports and the rock surface to measure rock pressure and internal water pressure. The pressure cells should not be placed at preferably less than 60°;
- e) Strain Observations — Should be done by embedding strain meters in concrete lining for the measurement of stress in the lining; and
- f) Pore Pressure Observations — Pore pressure meter for monitoring the pore water pressure around the tunnels.

5.2 The instruments mentioned above may be provided at more than three sections or at the typical representative reaches met with while excavating. The range of instruments to be installed depends upon rock cover, internal pressure and geological features and properties of rock mass and should be fixed after due analysis. Instrumentation may be done in the drifts which are made during investigation so that the data can be made available for design of supports and lining during execution of the work.

5.3 Suitable instruments may be used for construction and post-construction stages.

5.4 The observations shall be taken in accordance with the format and frequency suggested by the experts.

5.5 Numerical tools should be used to carry out stress analysis using the laboratory and in-situ test results to predict the likely stress pattern and deformation around tunnels after excavation. The same shall be compared with the instrumentation observations on the tunnels and thereby analysis should be refined as construction progresses.

6 SPECIFIC DESIGN

6.1 Investigations as detailed in **3**, **4** and **5** can be used in general designing of the tunnel which can be proceeded for specific design of tunnels as laid down in other parts of this standard.