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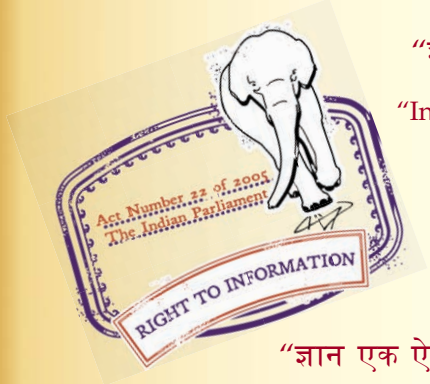
"जानने का अधिकार, जीने का अधिकार"
Mazdoor Kisan Shakti Sangathan
"The Right to Information, The Right to Live"

"पुराने को छोड नये के तरफ"
Jawaharlal Nehru
"Step Out From the Old to the New"

IS 4515 (2002): Stone Pitched Lining for Canals - Code of Practice [WRD 13: Canals and Cross Drainage Works]



"ज्ञान से एक नये भारत का निर्माण"
Satyanarayan Gangaram Pitroda
"Invent a New India Using Knowledge"

"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

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IS 4515 : 2002
(Reaffirmed-2012)

भारतीय मानक

नहरों के लिए पत्थर के पिच वाले अस्तर — रीति संहिता

(दूसरा पुनरीक्षण)

Indian Standard

STONE PITCHED LINING FOR CANALS — CODE OF PRACTICE

(Second Revision)

ICS 93.160

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

October 2002

Price Group 2

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Canals and Cross Drainage Works Sectional Committee had been approved by the Water Resources Division Council.

Stone pitched lining of canals will be found useful in the following circumstances, provided it is economically feasible:

a) Prevention of erosion, and
b) Where the ground water level is above the bed of the canal and there is possibility of occurrence of damaging back pressures since this type of lining allows water pressure to be released through the interstices.

This standard is intended to help engineers in the field in selecting suitable type of stones to be used in lining and their maximum and minimum sizes depending on the canal capacity. It also covers the method of laying stone pitched lining and lays down recommendations for filters to be used in the lining.

This standard was originally published in 1967 and its first revision was done in 1993. This second revision has been taken up in the light of the experience gained during the last decade in the use of this standard. In this revision for the design of granular filters reference has been taken from 'Design of roadside drainage channels' Hydraulic Design Series No. 4, U. S. Department of Commerce, Bureau of Public Roads, Washington : 1965.p.34'. For the selection of synthetic filter reference has been taken from Malcolm P. Keown, Elba A Dardeau Jr., 'Utilization of Filter Fabric for Streambank Protection Application, Hydraulic Laboratory U.S. Army Engineer, Waterway Experiment Station, July 1980.'

There is no ISO Standard on the subject. This standard has been prepared based on indigenous manufacturers' data/practices prevalent in the field in India.

The composition of the Committee responsible for the formulation of this standard is given in Annex A.

Indian Standard

STONE PITCHED LINING FOR CANALS — CODE OF PRACTICE

(Second Revision)

1 SCOPE

This standard covers the design and laying of stone pitched lining for canals.

2 REFERENCES

The following Indian Standards contain provisions, which through reference in this text, constitute provisions of the standard. At the time of publication, this editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
456 : 2000	Plain and reinforced concrete — Code of practice
1126 : 1974	Method of test for determination of durability of natural building stones (*first revision*)
3873 : 1993	Laying cement concrete/stone slab lining on canals — Code of practice
10430 : 2000	Criteria for design of lined canals and guidelines for selection of type of lining (*first revision*)

3 TERMINOLOGY

3.1 Lip-Cutting — It is the extra width provided at the inner face of the bank under compaction to allow for any lapses in compaction due to the inability of compacting rollers to cover the edge of the bank.

3.2 Made-up Ground — Excavated soil or rock deposited for the purpose of filling a depression or raising a site above the natural level of the ground.

3.3 Sub-Grade — The specially prepared surface over which stone pitch lining should be carried out.

3.4 Expansive Soils — They are inorganic or organic clays having high compressibility and liquid limits more than 50 and are characterized by shrinkage and swelling properties.

3.5 Cohesive Non Swelling (CNS) Soils — They are soils, possessing the property of cohesion of varying degrees and having non expanding type clay minerals such as illite and kaolinite and their combinations, with low plasticity and liquid limit not exceeding 55.

4 NECESSARY INFORMATION

For necessary information to be procured before commencing the work reference may be made to IS 10430.

5 SPECIFICATION FOR STONES FOR LINING

5.1 Stones used for lining should be rounded or sub-angular river cobbles or blasted rock pieces with sufficient base area to be stable.

5.2 All the stones should have a reasonably uniform size with dimensions as given in Table 1, depending upon the canal capacity.

Table 1 Dimensions of Stones and Thickness of Lining

Sl No.	Canal Capacity m^3/s	Thickness of Lining mm	Average Dimension Along the Largest Axis mm
(1)	(2)	(3)	(4)
i)	0 to less than 10	150	150
ii)	10 to less than 100	225	225
iii)	100 and above	300	300

NOTES

1 Maximum tolerance of 10 percent is permissible in the thickness of lining and the dimensions of stones.

2 Limiting safe velocity may be adopted as 1.5 m/s.

5.3 Individual stones should be sound, hard and durable and should be such that they will be able to sustain weathering and water action. They should be free from laminations, soft spots, cracks, seams and other defects.

NOTE — The help of tests and requirements given in Table 2 for stones may be taken in making a judgement of the suitability of stones for canal lining.

Table 2 Requirements for Stones

Sl No.	Test	Requirements
(1)	(2)	(3)
i)	Specific (apparent) gravity when tested according to the method given in IS 1126	Greater than 2.5
ii)	Soundness (sodium sulphate method) when tested according to IS 1126	Less than 10 percent, loss of weight after 5 cycles

6 PREPARATION OF SUB-GRADE

The sub-grade should be prepared according to IS 3873.

7 LAYING

7.1 Sub-grade (both bed and slope) of the canal should be divided into compartments by stone masonry or concrete ribs. The compartments should have dimensions of not more than 15 m along the length of the canal. The spacing of ribs cross in the section of the canal should be so chosen as to divide the canal bed and slope symmetrically about the centre line and in such a manner that ribs are provided at the junction of the slope and bed and at the upper extremity of the slope. The ribs along the slope of the bank should be continuous (*see* Fig.1).

7.1.1 If stone masonry ribs are used, the stones should meet the requirements specified in **5.3**.

7.1.2 If concrete ribs are used they should be made of Grade M15 concrete in accordance with IS 456.

7.1.3 Ribs should be rectangular in cross-section with width equal to the dimension of stone along its longer axis as specified in **5.2** and depth equal to the thickness of lining plus thickness of filter.

7.2 A 15 cm thick layer of filter material is required and should be laid in compartments formed by ribs. Filter material should be in accordance with requirements specified in **8**.

7.3 Stones should be carefully hand packed in the compartments. The placing method should be such as to ensure a reasonably smooth surface and uniform thickness.

7.3.1 Spaces between the stones should be minimized. Such spaces should be wedged with spalls of suitable size to avoid filter material being washed out. Such filling should immediately follow the placing of stones.

8 FILTER

8.1 Filter material where required, should be free from flakes, soft particles, shale, organic matter or other deleterious substances.

8.2 Filter should satisfy the criteria:

i) $\dfrac{D_{15}\ (\text{Filter})}{D_{15}\ (\text{Base})} > 4 < 40$

ii) $\dfrac{D_{15}\ (\text{Filter})}{D_{85}\ (\text{Base})} < 5$

8.2.1 Where a large difference exists between the grading of the free draining material and of the soil to be retained, it may be necessary to use more than one

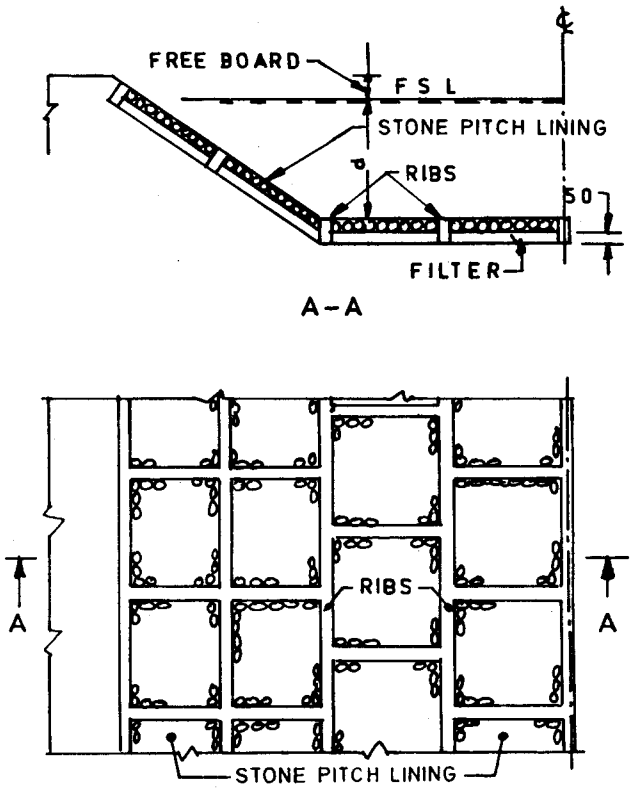

FIG. 1 ILLUSTRATORY LAYOUT OF STONE PITCHED LINING FOR CANALS

layer of filter material, each progressively larger in grain size but satisfying the filter criteria given in **8.2**, with respect to the adjacent lower layer.

8.3 Design of Granular Filter

A filter blanket is often needed beneath the stone lining to prevent the bank material from passing through the voids in the stone blanket and escaping. The loss of bank material leaves cavities behind the stone blanket and a failure of the blanket might result. Whether a filter blanket is needed, will depend upon the gradation of the bank material and the openings or voids in the riprap cover. In general, a filter ratio of 5 or less between successive layers will result in a stable condition. The filter ratio is defined as the ratio of the 15 percent particle size (D_{15}) of the coarser layer to the 85 percent particle size (D_{85}) of the finer layer. An additional requirement for stability is that the ratio of the 15 percent particle size of the coarse material to the 15 percent particle size of the fine material should exceed 5 and be less than 40. These requirements can be stated as follows:

$$\frac{D_{15}\text{ (of coarser layer)}}{D_{85}\text{ (of finer layer)}} < 5 < \frac{D_{15}\text{ (of coarser layer)}}{D_{15}\text{ (of finer layer)}} < 4$$

If a single layer of filter of material does not satisfy the filter requirement, additional layers of filter may be required. Same criteria applies for additional layer of filter between adjacent layers of material. In addition to the filter requirement, the grain size curves for the various layers should be approximately parallel to minimize the infiltration of the fine material into the coarse material. The filter material should contain not more than 5 percent of material passing the IS Sieve 200.

The thickness of the filter blanket ranges from 15 to 37.50 cm for a single layer or from 10 to 20 cm for individual layers of a multiple layer blanket. The thicker layer is used where the gradation curves of adjacent layers are not approximately parallel.

NOTE — In case of any difficulty in finding conventional granular filter, synthetic filter may be considered as given in **8.4**.

8.4 Selection of Synthetic Filter

The criteria for selection of synthetic filter differ from those for granular filter. The criteria for selection of the filter fabric are given below:

a) For base material containing 50 percent or less particles smaller than 0.074 mm IS Sieve 200 by weight, the equivalent opening size of filter should not be smaller than 0.149 mm IS Sieve 100 and should not be larger than D_{85}.

b) For base material containing at least 50 percent but not more than 85 percent of particles smaller than 0.074 mm IS Sieve 200 by weight, the equivalent opening size of filter should not be smaller than 0.149 mm IS Sieve 100 and also should not be larger than 0.211 mm IS Sieve 70.

c) For base material containing 85 percent or more of particles smaller than 0.074 mm IS Sieve 200 filter should not be placed.

It is preferable to use a fabric with an opening as large as allowed by criteria mentioned above.

8.5 Construction of Filter

8.5.1 The sub-grade, before placing the filter, should be firm and compacted suitably, wherever necessary, according to IS 3873.

8.5.2 Clean filter material should have sufficient water content (3 to 10 percent) during placement and placement should be such that segregation is prevented.

ANNEX A

(Foreword)

COMMITTEE COMPOSITION

Canals and Cross Drainage Works Sectional Committee, WRD 13

Organization	*Representative(s)*
Sardar Sarovar Narmada Nigam Ltd, Gandhi Nagar	SHRI G. L. JAVA (***Chairman***)
Bhakra Beas Management Board, Nangal Township, Punjab	DIRECTOR (WR) EXECUTIVE ENGINEER (*Alternate*)
Central Board of Irrigation & Power, New Delhi	SHRI T. S. MURTHY
Central Water & Power Research Station, Pune	SHRIMATI V. K. APPUKUTTAN SHRI M. S. SHITOLE (*Alternate*)
Central Water Commission, New Delhi	DIRECTOR (BCD N&W&NWS) DIRECTOR (SSD&C) (*Alternate*)
Consulting Engineering Services (India) Ltd, New Delhi	SHRI S. P. SOBTI DEPUTY PROJECT MANAGER (*Alternate*)
Continental Construction Ltd, New Delhi	SHRI P. A. KAPUR SHRI T. B. S. RAO (*Alternate*)
Indira Gandhi Nahar Board, Phalodi	SHRI R. K. GUPTA
Irrigation Department, Government of Andhra Pradesh, Hyderabad	CHIEF ENGINEER SUPERINTENDING ENGINEER (*Alternate*)
Irrigation Department, Government of Haryana, Chandigarh	CHIEF ENGINEER (PROJECTS) DIRECTOR (ENGINEERING) (*Alternate*)
Irrigation Department, Government of Karnataka, Bangalore	CHIEF ENGINEER (DESIGNS)
Irrigation Department, Government of Maharashtra, Nasik	SUPERINTENDING ENGINEER (GATES) EXECUTIVE ENGINEER (CSI) (*Alternate*)
Irrigation Department, Government of Punjab, Chandigarh	CHIEF ENGINEER (LINING & PLANNING) DIRECTOR (*Alternate*)
Irrigation Department, Government of Rajasthan, Jaipur	DIRECTOR (D&R) DIRECTOR (I&S) (*Alternate*)
Irrigation Department, Government of Uttar Pradesh, Lucknow	CHIEF ENGINEER DIRECTOR (*Alternate*)
Narmada & Water Resources Department, Government of Gujarat, Gandhi Nagar	SUPERINTENDING ENGINEER (CDO) EXECUTIVE ENGINEER (UNIT G) (*Alternate*)
Public Works Department, Government of Tamil Nadu, Chennai	ENGINEER-IN-CHIEF
Reliance Industries Ltd, New Delhi	DR V. K. SAROOP SHRI AVINESH DUBEY (*Alternate*)
Sardar Sarovar Narmada Nigam Ltd, Gujarat	DIRECTOR (CANALS) CHIEF ENGINEER (CD/W) (*Alternate*)
University of Roorkee, Roorkee	SHRI NAYAN SHARMA
Water and Land Management Institute, Lucknow	PROF P. K. SINHA
Water Resources Department, Government of Orissa, Bhubaneshwar	CHIEF ENGINEER (D&R)
BIS Directorate General	SHRI S. S. SETHI, Director & Head (WRD) [Representing Director General (*Ex-officio*)]

Member Secretary
SHRI R. S. JUNEJA
Joint Director (WRD), BIS

Bureau of Indian Standards

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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

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