

*Indian Standard*

RECOMMENDATIONS FOR  
CEMENT-MORTAR LINING FOR CAST-IRON  
MILD STEEL AND DUCTILE-IRON PIPES AND  
FITTINGS FOR TRANSPORTATION OF WATER

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**BUREAU OF INDIAN STANDARDS**  
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG  
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# Indian Standard

## RECOMMENDATIONS FOR CEMENT-MORTAR LINING FOR CAST-IRON MILD STEEL AND DUCTILE-IRON PIPES AND FITTINGS FOR TRANSPORTATION OF WATER

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# *Indian Standard*

## RECOMMENDATIONS FOR CEMENT-MORTAR LINING FOR CAST-IRON MILD STEEL AND DUCTILE-IRON PIPES AND FITTINGS FOR TRANSPORTATION OF WATER

### 0. FOREWORD

**0.1** This Indian Standard was adopted by the Indian Standards Institution on 28 November 1986, after the draft finalized by the Water Supply and Sanitation Sectional Committee had been approved by the Civil Engineering Division Council.

**0.2** For the majority of water supply systems; tuberculation presents no problem; however, in certain cases, uncoated or unlined cast iron water mains had lost an appreciable part of their original carrying capacity after many years of service. In these relatively limited areas, reduced carrying capacity was generally caused by tuberculation, a nodulose growth on the inside of the pipe caused by tuberculating water. It is now known, and has been conclusively demonstrated, that the use of cement linings prevents tuberculation by keeping the "active" water from coming into contact with the iron.

**0.3** The principal advantage of cement linings is increased carrying capacity when the pipe is new and maintained carrying capacity as the pipe grows older since experience has shown that less friction results when cement linings are used even where non-tuberculating waters are transported.

**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.

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

## 1. SCOPE

**1.1** This standard covers recommendation for cement mortar linings for cast-iron and ductile-iron pipe and fittings for water and is intended for use as a supplement to those standard.

NOTE — This type of lining is used in particular in the transport and distribution of water for domestic and industrial use. The temperature of the water transported shall not exceed 80°C.

## 2. MATERIALS

**2.1 Cement** — The cement used shall be any of the following, with the prior approval of engineer-in-charge:

- a) Ordinary or low heat portland cement conforming to IS : 269-1976\*.
- b) Rapid hardening portland cement conforming to IS : 8041-1978†.
- c) Portland pozzolana cement conforming to IS : 1489-1976‡.
- d) High strength ordinary portland cement conforming to IS : 8112-1976§.

### 2.2 Sand

**2.2.1 Type of Sand** — The sand shall be well graded, from fine to coarse, and consist of inert granular material having hard, strong, durable, uncoated grains and meet the requirements given in **2.2.1.1**.

**2.2.1.1. Grading of sand** — The sand used for lining shall be tested with, standard sieves, as defined in IS : 460 ( Part 1 )-1985|| and shall meet the requirements listed in Table 1.

**2.2.2 Deleterious Material and Organic Impurities** — Sand shall be free from injurious amount of dust, clay, lumps, shale, soft or slaky particles, mica, loam oil, alkali or other deleterious substances. Total weight of such substances shall not exceed 3 percent of the combined weight of the substances and the sand that contains them. In addition, limitation shall apply to specific substance as follows:

- |               |                                |
|---------------|--------------------------------|
| a) Shale      | 1% maximum allowable by weight |
| b) Clay lumps | 1% maximum allowable by weight |

\*Specification for ordinary and low heat portland cement ( *third revision* ).

†Specification for rapid hardening portland cement ( *first revision* ).

‡Specification for portland-pozzolana cement ( *second revision* ).

§Specification for high strength ordinary portland cement

||Specification for test sieves: Part 1 Wire cloth test sieves ( *third revision* ).

- c) Mica and deleterious substances other than shale and clay lumps impurities shall be determined in accordance with IS : 2386 ( Part 2 )-1963\* 2% maximum allowable by weight

**2.2.2.1** Organic impurities when tested as per IS : 2386 ( Part 2 )-1963\*, the sand shall not produce a colour darker than required in the standard. The sand shall be acceptable, however, if it is shown by adequate test that the impurities causing the colour are not harmful to the strength or other specified properties of the finished lining.

**TABLE 1 REQUIREMENTS FOR SAND TESTED WITH STANDARD SIEVES**  
( Clause 2.2.1.1 )

SIEVE SIZE	PERCENT BY WEIGHT PASSING
2.00 mm	100
850 $\mu\text{m}$	95-100
600 $\mu\text{m}$	85-95
425 $\mu\text{m}$	45-60
250 $\mu\text{m}$	5-25
150 $\mu\text{m}$	2-5

**2.3 Water** — Water used for mixing the mortar shall meet the requirements of IS : 456-1978†.

**2.4 Mortar** — Mortar for the lining shall be composed of cement, sand, and water. The mortar shall be well mixed and of proper consistency to produce a dense homogeneous lining that will adhere firmly to the pipe or fitting surface. Admixtures may be used provided they do not prejudice the quality of the coating and that of transported water nor the conformance of the lining requirement of this standard. The cement mortar shall contain not less than one part of cement to two parts of sand, by volume. The works strength of the mortar tested in accordance with IS : 516-1959‡ should not be less than 30 N/mm<sup>2</sup> after 28 days of curing.

### 3. PREPARATION OF PIPE AND FITTINGS FOR LINING

**3.1** The inner surface to be lined shall be free from foreign material, loose scale or any other material which would adversely affect the

\*Methods of test for aggregates for concrete: Part 2 Estimation of deleterious materials and organic impurities.

†Code of practice for plain and reinforced concrete ( *third revision* ).

‡Methods of test for strength of concrete.

lining adhesion or cause inclusions, blisters, or voids in the lining. The inner surface shall be free from metal projections which may protrude beyond the thickness of lining.

#### **4. METHOD OF LINING**

**4.1 Lining of Pipe and Fittings** — The cement mortar of the lining is cast centrifugally inside the pipe. Fittings shall be lined by a process that will produce lining conforming to the requirements of this standard; such lining may be carried out by one of the following methods:

- a) Centrifugally spraying and subsequent rotated to achieve smoothing.
- b) Centrifugally spraying and simultaneously smoothing by trowelling.

The waterway surfaces of pipe and fittings shall be completely covered with the specified mortar. The mortar lining shall be entirely free from cavities or visible air bubbles and shall be thoroughly compacted throughout. The consistency of the mortar and the time and speed of centrifuging of the pipe shall be adjusted so that segregation of the sand from the cement is reduced to minimum. Vibration may be applied to shorten further the duration of rotation.

**4.2 Repair of Defective or Damaged Areas of Linings** — Defective or damaged areas of linings may be patched by cutting out the defective or damaged lining to the metal so that the edges of the lining not removed are perpendicular or slightly undercut. A stiff mortar shall be prepared in accordance with 2.4. The cut-out area and the adjoining lining shall be thoroughly wetted, and the mortar applied and trowled smooth with the adjoining lining. After any surface water has evaporated, but while the patch is still moist, it shall be cured as specified in 9.

#### **5. SOCKET**

**5.1** The socket shall be free of mortar.

#### **6. PROTECTION OF WORK**

**6.1** The lined pipe and fittings shall be protected from extreme heat due to direct rays of the sun, from impact of rainfall, and from freezing temperatures until the linings have cured sufficiently to withstand these conditions.

#### **7. THICKNESS OF LINING**

**7.1 Standard Thickness** — The normal thickness of linings for pipe and fittings, as determined in 8 are given in Table 2.

**TABLE 2 THICKNESS OF THE CEMENT MORTAR LINING***( Clause 7.1 )*

PIPE MATERIAL	NOMINAL DIAMETER OF PIPE	MINIMUM MEAN LAYER THICKNESS	MINIMUM THICKNESS AT ONE POINT
(1)	(2)	(3)	(4)
	mm	mm	mm
Cast iron or ductile iron	100-250	3	1.5
	300-900	5	2.5
	Over 900	6	3.0
Steel	100-300	5	3.0
	350-900	8	6.0
	1 000-1 500	10	8.0
	Over 1 500	15	12.0

NOTE — If desired by the purchaser, layer thickness more than specified may be provided.

At the pipe ends, the lining thickness may be reduced to values below the minimum thickness. The length of the chamfer shall be less than 50 mm.

**7.2 Permitted Tolerances** — A thickness tolerance of + 20% shall be permitted on pipe and + 40% on fittings.

## 8. DETERMINATION OF THICKNESS

**8.1** Lining thickness shall be determined on the freshly centrifuges mortar at intervals frequent enough to assure compliance. Thickness of lining may be determined by means of a steel pin not larger than 1.5 mm in diameter or on a hardened mortar by means of a non-destructive measurement process. The lining shall be measured at four equidistant points on two cross sections of the barrel at each end of the pipe or fittings. The first set shall be at least 200 mm from the respective ends of the pipe or fitting. The second set shall be made as far into the interior of the pipe or fitting as can be readily reached without injuring the lining.

## 9. CURING

**9.1** The lining shall be cured in such a manner as to produce a properly hydrated mortar lining that is hard and durable and will otherwise meet the requirements of 10. After final setting of lining mortar, curing water may be applied by laying sprinkler hose at the invert. The curing may also be effected by covering with a layer of sacking, canvas, hessian or similar materials and kept constantly wet for at least 7 days



from the date of application of mortar. Overground pipes shall be protected from direct sun light by putting moist hessian or similar material.

NOTE — Membrane curing may also be used with approved curing components in lieu of the moist curing with the permission of the Engineer-in-Charge. Such compounds shall be applied as soon as the mortar has set.

## **10. LINING QUALITY**

**10.1** The surface of cement mortar lining shall be uniformly smooth and shall be free from voids. The lining shall not have any flaky areas. It shall not be crumbly and have not any waves or grooves.

**10.2** Unbonded areas of cement lining in a pipe or fitting are acceptable if the dimension of any single area does not exceed the nominal diameter in the circumferential direction and in longitudinal direction does not exceed the nominal diameter or 300 mm, whichever is greater.

Longitudinal cracks developed due to shrinkage, less than 225 mm in length or less than the nominal diameter, whichever is greater, are permitted. Circumferential cracks of any length are permitted. Surface crazing is permitted.

Repair of any unacceptable condition is permitted in the field, in accordance with 4.2.

Pipe shall not be despatched until 21 days have elapsed since the date of lining.

## **11. LINING OF SPECIALS**

**11.1** Whenever practicable, special shall be made from cut lengths of matured lined straight pipes. The lining shall be cut back from the end to ends to be bevelled and welded, for a sufficient distance to ensure that any of the mortar which is intended to remain as part of lining shall not suffer damage by the cutting or welding process. The lining shall be made good by rendering by hand.

**11.1.1** Hand rendering of specials shall consist of freshly mixed mortar of a mixture equivalent to that of the lining being repaired, and shall be thoroughly compacted and finished to a smooth surface of the correct form.

## **12. SEAL COAT**

**12.1** The seal coat as pore sealer may be applied to the surface of lining with the prior approval of engineer-in-charge. The seal coat shall be continuous and shall adhere to the mortar lining at all points. The seal coat after drying for at least 48 hours, shall have no harmful effect to the quality of the water or on the lining.