SIST

SLOVENSKI STANDARD
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Armiranobetonske tlačne cevi in betonske tlačne cevi s porazdeljeno armaturo (brez kovinskega plašča), skupaj s spoji in fazonskimi kosi

Reinforced concrete pressure pipes and distributed reinforcement concrete pressure pipes (non-cylinder type), including joints and fittings

Stahlbetondruckrohre und Betondruckrohre mit verteilter Bewehrung (ohne Blechmantel) einschließlich Rohrverbindungen und Formstücken

Tuyaux pression en béton armé et tuyaux pression a armature diffuse (sans âme en tôle), y compris joints et pieces spéciales

Ta slovenski standard je istoveten z: EN 640:1994

ICS:

23.040.50	Cevi in fitingi iz drugih materialov	Pipes and fittings of other materials

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English version

Reinforced concrete pressure pipes and distributed reinforcement concrete pressure pipes (non-cylinder type), including joints and fittings

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CEN

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FOREWORD

This European Standard for concrete pipes is a standard which was prepared by WG 5 "Concrete pipes" of the Technical Committee CEN/TC 164 "Water Supply", Secretariat of which is held by AFNOR.

During preparation of this standard the provisional results already available of CEN/TC 164/WG 1 "General requirements for external systems and components" and of CEN/TC 164/165/JWG 1 "Structural design" were considered.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 1995, and conflicting national standards shall be withdrawn at the latest by April 1995.

In accordance with the CEN/CENELEC Internal Regulations, following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

0 INTRODUCTION

The product* which is in permanent or temporary contact with water, intended for human consumption, does not adversly affect the quality of the drinking water and does not contravene the CE Directives and EFTA Regulations on the quality of drinking water.

This standard is to be used together with EN 639 (Common Requirements).

When the relevant EN dealing with general requirements, such as "General requirements for external systems and components" (CEN/TC 164/WG 1), "Materials in contact with water" (CEN/TC 164/WG 3) and "Structural design" (CEN/TC 164/165/JWG 1) are adopted, the current standard shall be revised, where appropriate, in order to ensure that these requirements comply with the relevant EN's.

To the present standard, is attached :

- Annex A (informative) : Typical design procedure.

1 SCOPE

This standard covers the requirements and manufacture of circumferentially reinforced concrete pressure pipe, without steel cylinder and not circumferentially prestressed, with steel reinforcement (RCP) or a homogeneously distributed reinforcement composed of multiple layers of small diameter wires (DRP).

Pipes shall have diameter ranging DN/ID 300 to DN/ID 4000.

Larger size could be manufactured based on the concepts of this standard.

This type of pipe is designed for the internal pressure, external loads, and bedding conditions designated by the purchaser.

Maximum design pressure shall not exceed 500 kPa. The above limit shall be increased to 2000 kPa in case of distributed reinforcement pipes (DRP).

2 MATERIALS

Materials are as specified in clause 5 of EN 639 (Common Requirements).

Additional requirements are specified as follows.

2.1 Aggregates

The maximum size of the aggregate shall not exceed one third of the pipe wall thickness, but in no case shall it exceed 32 mm.

For distributed reinforcement pipes, the aggregate size shall not exceed the spacing between reinforcement steel wires and in no case shall exceed 4 mm.

2.2 Steel wire for distributed reinforcement pipes

The wire to be used for distributed reinforcement shall conform to subclause 5.7 of EN 639 (Common Requirements) and shall have a characteristic tensile strength of not less than 800 MPa and a tolerance on the diameter of ± 0,04 mm.

3 DESIGN AND FABRICATION OF PIPE

3.1 General requirements

Pipes shall have the following principal features : a reinforcing cage or cages of steel rods, bars, wire, or fabric encased in a dense concrete wall (RCP), or multiple layers of continous thin steel wire helically wrapped and encased in a dense mortar wall (DRP).

Where beam strength is required by design, the longitudinal reinforcement shall consist of steel bars or wires or layers of wire ribbon.

Prestressing wire may also be used.

Joints shall be provided with elastomeric sealing rings in accordance with 5.8 of EN 639.

3.1.1 *Wall thickness*

Table 1 shows the minimum design wall thickness for each type of pipe.

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* Should be considered as any product used for the conveyance and distribution of water intended for human consumption.

Table 1 : Minimum wall thickness

DN/ID	Minimum design wall thickness for RCP (mm)	Minimum design wall thickness for DRP (mm)
300	60	40
400	60	40
450	60	40
500	60	40
600	65	45
700	65	45
800	70	50
900	75	55
1000	85	60
1100	90	65
1200	100	65
1300	110	70
1400	115	70
1500	125	75
1600	135	80
1700	140	*
1800	150	*
1900	160	*
2000	165	*
2100	180	*
2200	185	*
2300	190	*
2400	200	*
2500 and larger	*	*

* to be supplied by manufacturer

3.2 Design of pipe

3.2.1 *General*

Steel reinforcement shall consist of one or more circular cages, or a single elliptical cage, or a combination of an elliptical cage and one or more circular cages or multiple layers of thin wire.

At least one of the cages shall be circular in pipe for a design pressure of more than 150 kPa or in RCP larger than DN/ID 1800. An inner circular cage and an outer circular cage shall be used and may be combined with an elliptical cage in pipe for design pressures of more than 300 kPa.

Circumferential and longitudinal reinforcement for DRP shall be placed in a minimum of six layers and two layers respectively.

The cross sectional area of the reinforcement shall be sufficient to meet the design requirements.

3.2.2 *Combined load design criteria*

The pipe shall be designed to resist the stresses due to internal pressure, external loads and, if required, beam loading resulting from each of the following conditions :

- a combination of maximum design pressure and dead loads ;
- a combination of design pressure, dead loads, and live loads.

For information, see informative annex.

Dead and live loads, coefficients for moment and thrust calculations and bedding angle shall be calculated in accordance with the appropriate national standards transposing EN as available or, in absence of such standards, with the appropriate regulations or recognized and accepted methods at the place where the pipeline is installed.

3.3 Reinforcement

3.3.1 *Circumferential reinforcement for reinforced concrete pipe*

The circumferential reinforcement shall consist of steel bars or wire in helical or hoop form, or welded wire fabric shaped and lap welded or butt welded into cages. The weld quality and welding procedures shall be assured by testing a representative sample of butt or lap welds at a stress equal to at least the original strength of the steel. The elements composing the circumferential reinforcement shall be connected by longitudinal bars.

The diameter and number of these bars shall be sufficient to prevent the cage deforming during fabrication and shall be suitable to give the pipe the designed strength.

For pipes having thickness less than 80 mm, the reinforcement shall normally be a single cage.

For multiple cage reinforcement, the internal cage shall have at least 50 % of the circumferential steel area required by the design while the external cage shall have at least 40 % of the required area.

The maximum distance between two adjacent bars of the circumferential reinforcement shall not exceed 1,5 times the wall thickness but in no case greater than 150 millimetres.

3.3.2 *Circumferential reinforcement for distributed reinforcement pipe*

For DRP the circumferential reinforcement shall consist of layers of wire with diameter not greater than 2 millimetres in helical or hoop form homogeneously distributed in the pipe wall. For the above pipe the specific volume of reinforcement (as ratio between volume of reinforcing wire and total volume of pipe wall) shall not be less than 1 %.

In each layer, the design spacing between adjacent wires shall not be less than 3 times the wire diameter and not more than twice the largest size of aggregate used ; deviation from design spacing shall be accepted if, in a longitudinal section of the central part of the barrel, the following condition is met :

- five adjacent squares, having sides equal to the wall thickness, contain a total of at least 90 % of design number of wires.

3.3.3 *Longitudinal reinforcement for reinforced concrete pipe*

The circumferential reinforcement in cages shall be accurately spaced and rigidly assembled by means of longitudinal bars securely attached so that it is maintained in proper shape and position during the casting of the pipe. Not less than four longitudinal bars shall be provided for each cage, and additional bars shall be provided as necessary so that the circumferential spacing between longitudinal bars shall not exceed 450 millimetres in any barrel cage.

3.3.4 *Longitudinal reinforcement for distributed reinforcement pipe*

For distributed reinforcement pipe, the longitudinal reinforcement shall be made of wire with diameter not exceeding 2 millimetres, and shall be placed in layers parallel to the pipe axis and in between layers of circumferential reinforcement. Contact between longitudinal and circumferential reinforcement is allowed. If longitudinal reinforcement is made of short lengths of straight wire the overlap shall be not less than 80 times the wire diameter. If the longitudinal reinforcement is made of ribbon composed by a zig zag continuous wire, the overlapping sides of the helically wrapped ribbon shall not be less than 40 times the wire diameter.

Specific volume (as described in 3.3.2) of longitudinal reinforcement shall be not less than 0,2 %.

3.3.5 *Longitudinal prestressing reinforcement*

At the choice of manufacturer, the pipe shall be longitudinally prestressed throughout its length, including the socket, by means of high tensile wires (see 5.7.2 of EN 639 - Common Requirements). The longitudinal prestress shall be sufficient to prevent excessive tensile stresses developing in the pipe due to beam loading. The longitudinal wires shall be stressed to design tension, taking into account all losses due to creep, shrinkage, relaxation and slip.

3.3.6 *Placement and cover to steel*

The minimum cover to steel for both internal and external surfaces shall be 20 millimetres for RCP and 4 millimetres for DRP respectively or one times the largest aggregate size, whichever is the greater.

Maximum cover for DRP shall not exceed 8 millimetres.

3.4 Concrete and mortar

3.4.1 *Mix design*

For RCP, a minimum of 300 kilogrammes of cement shall be used for each cubic metre of concrete. The water-cement ratio shall be such as to ensure that the concrete will meet the strength requirements, but in no case shall it exceed 0,45.

For DRP, cement shall be not less than 500 kilogrammes per cubic metre of mortar, and water-cement ratio shall not exceed 0,4.

3.4.2 *Concrete strength*

The minimum 28 day compressive strength of concrete and mortar shall be 35 MPa.

4 FACTORY TESTING

4.1 Concrete tests

A quantity of three cylinders or cubes per week, per mix type, or per 100 cubic metre of concrete, whichever is the greater shall be tested for 28 day compressive strength.

4.2 Pipe tests

4.2.1 *Hydrostatic pressure tests*

Hydrostatic pressure test shall be carried out on every pipe either individually or jointed. The test section shall have suitable bulkheads attached to each end and shall be filled with water and allowed to gradually reach the maximum design pressure within 3 minutes. Pipe shall be kept under such pressure for at least 15 min. without cracking. No measurable leakage shall develop during the test period. Damp spots or water drops developing on the surface of the pipe and which remain on the surface shall not be considered cause for rejection. Pipes that fail may be reworked and retested at the option of the manufacturer.

4.2.2 *Crushing test for reinforced concrete pipe*

The test shall be carried out on a test machine having :

- a load recording facility,
- a stiff loading beam the lower face of which is a bearer having an elastomeric bearing strip of thickness between 10 millimetres and 40 millimetres and hardness between 45 and 65 IRHD.

  The maximum width of the bearing strip shall be :

  - DN ≤ 400 : 50 mm ;
  - 400 < DN ≤ 1200 : 0,12 mm times DN ;
  - DN > 1200 : 150 mm.

- a lower bearer on which is located a V shaped support which is either covered with or has two bearing strips of elastomeric material having the same thickness and hardness as that on the loading beam. Where the angle (β) of opening of the V is 170° or more, the crushing strength shall be as recorded. Where the opening is less than 170°, a reduction factor shall be applied to the recorded strength as given in Table 2.

Table 2 : Reduction factors for V shaped support

Angle	150° ≤ β < 160°	160° ≤ β < 170°	β ≥ 170°
Reduction factor	0,98	0,99	1,00

The test consists of subjecting a complete pipe or pipe section not shorter than 1 metre to the action of a uniformly distributed load. For instance, to achieve uniform distribution, bearers may be divided into sections.

The test load shall be applied symmetrically over the entire bearer length. The position of the load may be adjusted to maintain horizontal stability.

During application of at least the final third of the specified load, the rate of increase of load shall be constant and this period of loading shall be at least 30 seconds.

Test pipe resistance q_r expressed in N/m is related to the effective length of the specimen by the formula :

$$q_r = \frac{\text{test load}}{\text{internal barrel length}} = \frac{Q_r}{L_{bi}}$$

The purpose of this test is to verify pipe behaviour at limit states of cracking and ultimate :

- crack load (q_c) : load at which the first 0,3 millimetres wide crack occurs over a length of 300 millimetres as measured in accordance with 6.4.11 of EN 639 (Common Requirements),
- ultimate load (q_u) : maximum load that the pipe can sustain without collapse.

Pipe taken only to crack load and satisfactorily tested shall not be excluded from delivery.

4.2.3 *Combined crushing and pressure test for distributed reinforcement pipe*

The testing apparatus (see Figure 2), similar to the one described in 4.2.2, is fitted with a device for collecting and measuring water leakage.

The test shall be carried out on one pipe for each new design with the pipe filled with water, having bulkheads as described in 4.2.1.

The top of the pipe shall be loaded by means of a longitudinal beam of adequate stiffness, having a minimum length equal to 0,5 times the internal barrel of the pipe.

The supporting edges, spaced as described in 4.2.2 shall have a minimum length equal to 0,6 times the internal barrel length of the pipe.

The test is carried out by raising the internal pressure to MDP, and then slowly increasing the load, until the maximum wall moment Mc is reached, as determined by the following :

$$Mc = k \cdot q_r \cdot r_m$$

where :