

Hume Pipe

(Precast Circular Cement Concrete Pipes: with and without Reinforcement) — Specification

Draft NS

PRECAST Circular Cement CONCRETE PIPES (WITH AND WITHOUT REINFORCEMENT) — SPECIFICATION

1 SCOPE

This standard covers the requirements for reinforced and unreinforced ()precast cement concrete pipes, of both pressure and non-pressure varieties used for water mains, sewers, culverts and irrigation. The requirements for collars are also covered by this standard.

This standard covers the requirements for pressure,non-pressure pipes and collars manufactured by spinning process and vibration casting process.

Pre stressed concrete pipes are not covered by this standard.

2 REFERENCES

The standards given in Annex A contain provisions which through reference in this text constitute provisions of this standard. . 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 in Annex A.

3 TERMINOLOGIES

For the purpose of this standard, the following definitions shall apply

3.1 Working Pressure: The maximum sustained internal pressure excluding surge, to which each portion of the pipeline may be subjected when installed.

3.2 Site Test Pressure: 1.5 times working pressure pertaining to the section or 1.1 times static pressure, whichever is more (surge pressure is to be controlled within 25 percent of pump head in case of pumping mains).

3.3 Hydrostatic Test Pressure: It is the maximum pressure which the pipe can withstand without any leakage when tested for hydrostatic pressure in accordance with this standard and Annex B.

3.4 Surge (Water Hammer) Pressure: It is a pressure which is produced by a change of velocity of the moving stream and becomes maximum when there is a sudden stoppage which may be caused by the closing of a valve or by shutting down a pump station. Surge pressure is to be controlled within 25 percent of pump head.

4 CLASSIFICATIONS

4.1 For the purpose of this standard, concrete pipes shall be classified as under:

a) Unreinforced Concrete Pipes:

Class	Description	Conditions where Normally Used
NP1 - UR	Unreinforced concrete non-pressure spun pipes	For drainage and irrigation use, above ground or in shallow trenches
NP3 - UR	Unreinforced spun/vibrated cast concrete non-pressure pipes	For drainage and irrigation use for cross drains/culverts carrying light traffic
NP4 - UR	Unreinforced spun/ vibrated cast concrete non-pressure pipes	For drainage and irrigation use, for cross drains/culverts carrying medium traffic

b) Reinforced Concrete Pipes:

Class	Description	Conditions where Normally Used
NP2 - R	Reinforced concrete light duty, non-pressure spun/vibrated pipes	For drainage and irrigation use, for cross drains/ culverts carrying light traffic
NP3 - R	Reinforced concrete Medium duty, non-pressure spun/vibrated pipes	For drainage and irrigation use, for cross drains/ culverts carrying medium traffic
NP4 - R	Reinforced concrete Heavy duty, non-pressure spun/vibrated pipes	For drainage and irrigation use, for cross drains/ culverts carrying heavy traffic
P-1	Reinforced concrete pressure pipes tested to a hydrostatic pressure of 0.2 MPa (20 m head)	For use of gravity mains, the site test pressure not exceeding two-thirds of the hydrostatic test pressure
P-2	Reinforced concrete pressure pipes tested to a hydrostatic pressure of 0.4 MPa (40 m head)	For use on pumping mains, the site test pressure not exceeding half of the hydrostatic test pressure.
P-3	Reinforced concrete pressure pipes tested to a hydrostatic pressure of 0.6 MPa (60 m head)	For use on pumping mains, the site test pressure not exceeding half of the hydrostatic test pressure.

NOTE: The uses are only by way of recommendations as a general guidance and the exact usage shall be decided by the engineer-in-charge.

4.2 Unreinforced and reinforced concrete non-pressure pipes shall be capable of withstanding a test pressure of 0.07 MPa (7 m head).

5 MATERIALS

5.1 For precast concrete pipes, materials complying with the requirements given in 5.2 to 5.8 shall be used.

5.2 Cement

Cement used for the manufacture of unreinforced and reinforced concrete pipes shall conform to the following Nepal standards:

- a) Ordinary Portland cement conforming to NS 49/NS572,
- b) Portland slag cement conforming to NS 384,
- c) Portland pozzolana cement, fly ash based conforming to NS 385
- d) Portland pozzolana cement, calcined clay based conforming to NS 385,
- e) .

5.3 Aggregates

Aggregates used for the manufacture of unreinforced and reinforced concrete pipes shall conform to NS 297 . The maximum nominal size of aggregate should not exceed one third thickness of the pipe or 20 mm, whichever is smaller for pipes above 250 mm internal diameter. But for pipes of internal diameter 80 to 250 mm the maximum size of aggregate should be 10 mm.

5.4 Reinforcement

Reinforcement used for the manufacture of the reinforced concrete pipes shall conform to mild steel Grade I or medium tensile steel bars conforming to NS 191

5.5 Concrete or Mortar

5.5.1 The concrete used for manufacturing of pipes and collar shall conform to NS - 511 for at least very severe environment exposure condition. The concrete shall have a minimum compressive strength of 35 N/mm² or as specified in respective Tables given in this standard, whichever is higher. Higher cement content, more fines aggregates and higher water-cement ratio may be required for manufacturing of pipes by spinning process, as per process requirement.

For non-pressure pipes, if mortar is used, it shall have minimum cement content of 450 kg/m³ and compressive strength not less than 35 N/mm² at 28 days. For pressure pipes, if mortar is used, it shall have minimum cement content of 600 kg/m³ and compressive strength not less than 35 N/mm² at 28 days.

5.5.2 For pipes manufactured by the manufacturing process where compressive strength of cubes and compressive strength of concrete in pipes/collars differs, the manufacturer shall declare relation between these two compressive strengths. For spun pipes, conversion factor of 1.25 may be taken for conversion of compressive strength of concrete in cubes to compressive strength of concrete in pipes, in the absence of data provided by the manufacturer. This value shall be used to check the conformity against the compressive strength requirement in case of spun pipes, given in **5.5.1**.

5.5.3 For pressure pipes, splitting tensile strength of concrete cylinders at 28 days, when tested in accordance with Annex B, shall not be less than 2.5 N/mm².

5.5.4 Compressive strength tests shall be conducted on 150 mm cubes in accordance with the relevant requirements of NS - 511 .

5.5.5 The manufacturer shall give a certificate indicating the quantity of cement in the concrete mix

5.6 Rubber Ring

Rubber ring chords and profile gaskets used in pipe joints shall conform to Type 2 of Annex D.

5.7 Water

Water used for mixing of concrete and curing of pipes shall conform to NS 511 .

5.8 Chemical Admixtures

The admixtures, where used, shall conform to Annex E

6 DESIGN

6.1 General

Reinforced concrete pipes either spun or vibrated cast shall be designed such that the maximum tensile stress in the circumferential steel due to specified hydrostatic test pressure does not exceed the limit of 125 N/mm² in the case of mild steel rods, 140 N/mm² in the case of hard-drawn steel wires and high strength deformed steel bars and wires.

6.1.1 The barrel thickness shall be such that under the specified hydrostatic test pressure, the maximum tensile stress in concrete, when considered as effective to take stress along with the tensile reinforcement, shall not exceed 2 N/mm² for pressure pipes and 1.5 N/mm² for non-pressure pipes. But the barrel wall thickness shall be not less than those given in Tables 1, 2, 3, 6, 9, 10 and 11 subject to **8.2** (iii) for pipes

manufactured by spun process. For pipes manufactured by vibrated casting process, the barrel wall thickness shall be as given in Tables 2A, 4, 5, 7, 8, 9A, 10 A and 11A.

6.1.2 Pipes of length above 3 m and up to 4 m may be supplied by agreement between the user and the supplier and for such pipes, the quantity of reinforcement shall be modified as per **6.1.2.1**.

6.1.2.1 Longitudinal reinforcement

Reinforced cement concrete pipes of lengths up to 4 m may be accepted, if the longitudinal reinforcement is increased in proportion to the square of length compared with what is used for 3 m length as specified in Tables 2 to 11A, except for Table 4 and Table 7.

For length ' L ' (in metre) of pipe, longitudinal reinforcement shall be $L^2/32$ times the longitudinal reinforcement used for 3 m long pipes.

6.1.3 Longitudinal reinforcement shall be provided to ensure rigidity and correct location of cages (grids) longitudinally and to limit the effects of transverse cracking. Minimum longitudinal reinforcement shall be as given in Tables 2, 3, 6, 9, 10 and 11 for pipes manufactured by spinning process. For reinforced pipes manufactured by vibrated casting process, the minimum longitudinal reinforcement shall be as given in Tables 2A, 5, 8, 9A, 10A and 11A.

6.2 Reinforcement

The reinforcement in the reinforced concrete pipe shall extend throughout the length of the pipe and shall be so designed that it may be readily placed and maintained to designed shape and in the proper position within the pipe mould during the manufacturing process. The circumferential and longitudinal reinforcement shall be adequate to satisfy the requirements specified under **6.1**.

For non-welded cages spiral reinforcement of the same diameter shall be closely spaced at the end of the pipe for a length of 150 mm to minimize damage during handling. The spacing of such end spirals shall not exceed 50 mm or half the pitch whichever is less. Such spiral reinforcement at ends shall be part of the total spiral reinforcement specified in different tables.

6.2.1 The pitch of circumferential reinforcement shall not be more than following:

- a) 200 mm for pipes of nominal internal diameter 80 to 150 mm,
- b) 150 mm for pipes of nominal internal diameter 200 to 350 mm, and
- c) 100 mm for pipes of nominal internal diameter 400 mm and above.

The pitch shall also be not less than maximum size of aggregate plus diameter of the reinforcement bar used.

6.2.2 The quantity and disposition of steel in pipes may be decided by mutual agreement between the purchaser and the supplier. However, it shall be proved by calculations and tests that the quantity of the reinforcement conforms to all the requirements specified in the standard. In the absence of calculations and tests, the reinforcement given in Tables 2, 3, 6, 9, 10 and 11 for pipes manufactured by spinning process and in Tables 2A, 5, 8, 9A, 10A and 11A for pipes manufactured by vibrated casting process shall be used as minimum reinforcement subject to the requirements of **6.2.2.1**.

6.2.2.1 Tolerances given in NS-191 shall be applied to the minimum mass of longitudinal reinforcement specified in different tables. Total mass of longitudinal reinforcement shall be calculated taking into account the clear cover provided at each end of the pipe.

NOTE; for longitudinal reinforcement conforming to NS - 191 tolerance on mass shall be calculated from the diameter tolerance.

6.2.3 If so required by the purchaser, the manufacturer shall give a certificate indicating the details relating to quality, quantity and dispersion of steel in the pipes as well as the clear cover to the steel provided in the pipe.

6.3 Ends of Pipes

Spigot and socket ended pipes shall be used for water mains, sewer, irrigation and culverts/cross drains. Flush jointed (NP3 and NP4) and collar jointed (NP2) pipes shall be used for culverts/cross drains only (*see* Fig. 1 and Fig. 2). However, as agreed to between manufacturer and purchaser, collar jointed (NP3 and NP4) pipes may also be used for culverts/cross drains.

The ends of concrete pipes used for water mains, sewer, and irrigation shall be suitable for spigot and socket, roll on or confined gasket joints. Dimensions of spigot and socket for various classes of spun pipes shall be as given in Tables 12, 13, 14, 16, 17, 18 and 19. However, dimensions of spigot and socket shall be as given in Tables 13A, 15A, 15B, 15C, 16, 18A and 19A in case of pipes manufactured by vibration casting process. Reinforcement in socket of rubber ring jointed pipes may be as given in Table 20.

In case of flush joints, for pipes of internal diameters up to 700 mm, external flush joint (*see* Fig. 1B) and for pipe of internal diameter above 700 mm, internal flush joint (*see* Fig. 1A) is recommended. Dimension of collars for NP1 and NP2 class spun pipes shall be according to details given in Table 1 and Table 21, respectively. Dimensions of collars for NP3 and NP4 class pipes, when used shall be in according to details given in Table 22. Reinforcement in collars shall be as given in Table 21 (NP2 class) and Table 22 (NP3 and NP4 class). The end of collar reinforcement shall have a full ring at both ends.

NOTES

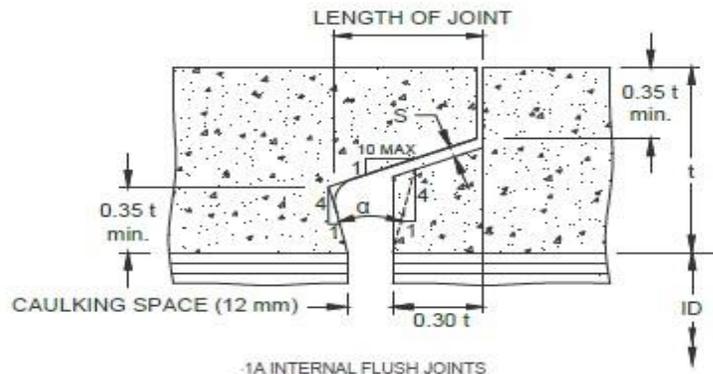
- 1** Bends, junctions and specials for concrete pipes covered under this standard shall conform..
- 2** Some typical arrangement of reinforcement in socket are illustrated in Fig. 3 and Fig. 4.
- 2** Table 20 for reinforcement in socket of rubber ring jointed pipes is for guidance only

6.3.1 Only flexible rubber ring joints shall be used for the joints in,

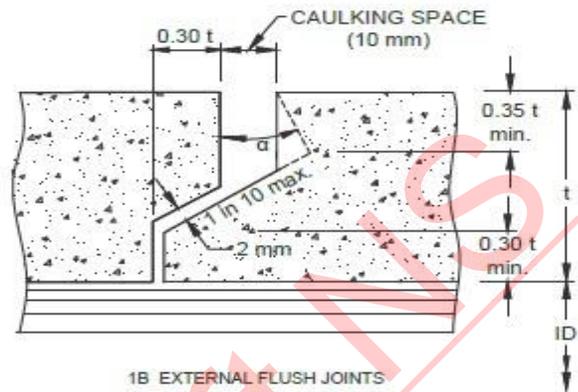
- a) all pressure pipes; and
- b) all non-pressure pipes except when used for road culverts/cross drains.

The pipe joints shall be capable of withstanding the same pressures as the pipe.

NOTE — the requirements of **6.3.1** does not imply that the collar shall also be tested for the test pressure for pipes specified in **4.1**, **4.2** and **10.2**.



1A INTERNAL FLUSH JOINTS



1B EXTERNAL FLUSH JOINTS

KEY

- t - WALL THICKNESS
- s - 0.002 OF INTERNAL DIA. OR 2 mm min.
- ID - INTERNAL DIAMETER
- α - INCLUDED ANGLE NOT MORE THAN 25° (ONLY FOR DESIGN PURPOSE NOT TO BE MEASURED)

FIG. 1 DETAILS OF FLUSH JOINTS

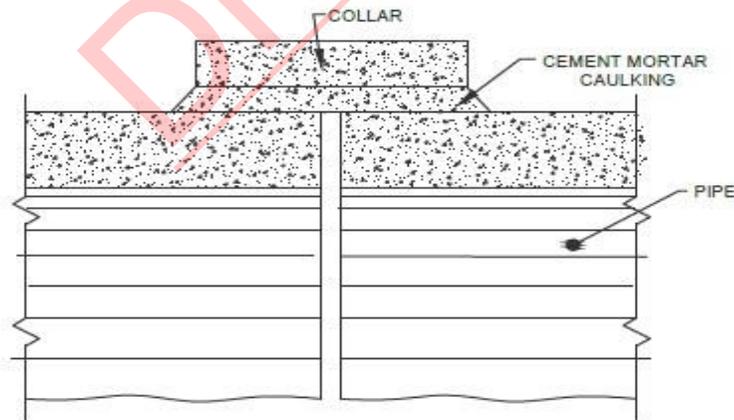


FIG. 2 COLLAR JOINTS (RIGID)

6.4 Cover

The minimum clear covers for reinforcement in pipes and collars shall be as given below:

S.No	Precast Concrete Pipe/collar	Minimum clear cover, mm
i	Barrel wall thickness	
	a) Up to and including 30 mm	8
	b) Over 30 mm and upto 40 mm	10
	c) Over 40 mm and upto 60 mm	15
	d) Over 60 mm	18
ii	At spigot steps	5
iii	At end of longitudinal	5

NOTE — An effective means shall be provided for maintaining the reinforcement in position and for ensuring correct cover during manufacture of the unit. Spacers for this purpose shall be of rust proof material or of steel protected against corrosion.

7 MANUFACTURES

7.1 General

The method of manufacture shall be such that the forms and dimensions of the finished pipe are accurate within the limits specified in this standard. The surfaces and edges of the pipes shall be well defined and true, and their ends shall be square with the longitudinal axis.

7.2 Concrete Mixing and Placing

7.2.1 Concrete shall be mixed in a mechanical mixer. Mixing shall be continued until there is a uniform distribution of the materials and the mass is uniform in color and consistency, but in no case shall the mixing be done for less than 2 min.

7.2.2 Concrete shall be placed before setting has commenced. It should be ensured that the concrete is not dropped freely so as to cause segregation. The concrete shall be consolidated by spinning, vibrating, spinning combined with vibrations, or other appropriate mechanical means.

7.3 Reinforcement Cages

Reinforcement cages for pipes shall extend throughout the pipes barrel. The cages shall consist of spirals or circular rings and straights of hard drawn steel wire or mild steel rod. Reinforcement cages shall be placed symmetrically with respect to thickness of the pipe wall. The spirals shall end in a complete ring at both the ends of a pipe.

7.3.1 Pipes having barrel wall thickness 100 mm and above shall have double reinforcement cage and the amount of spirals steel in the outer cage shall be 75 percent of the mass of spiral steel in the inner cage, whilst the total shall conform to the requirements specified in the relevant tables of this standard. The mass of longitudinal in the outer cage and inner cage should be the same that is equal to half the total

mass of longitudinal specified in the relevant tables. The total longitudinal steel per pipe shall be as given in the relevant tables.

NOTE: It is preferable that single reinforcement cage should be located near the inner surface of the pipe with adequate clear cover.



NOTE - NO OF Z BARS: MINIMUM HALF THE NUMBER OF LONGITUDINALS
MAXIMUM EQUAL TO NUMBER OF LONGITUDINALS

3A SOCKET CAGE CONNECTED TO BARREL CAGE BY MEANS OF Z BARS

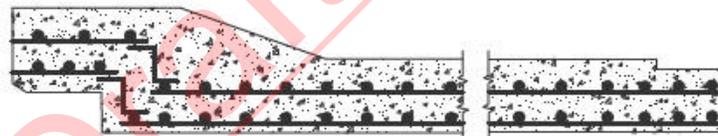


3B SOCKET CAGE LONGITUDINALS SUITABLY BENT
FOR CONNECTED TO BARREL CAGE



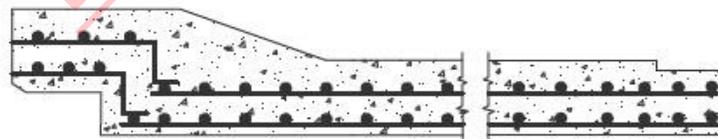
3C CAGE MADE OF CONTINUOUS LONGITUDINALS

FIG. 3 TYPICAL ARRANGEMENT OF REINFORCEMENT IN SOCKET FOR SINGLE CAGE



NOTE - NO OF Z BARS: MINIMUM HALF THE NUMBER OF LONGITUDINALS
MAXIMUM EQUAL TO NUMBER OF LONGITUDINALS

4A SOCKET CAGE CONNECTED TO BARREL CAGE BY MEANS OF Z BARS



4B SOCKET CAGE LONGITUDINALS SUITABLY BENT
FOR CONNECTING TO BARREL CAGE



4C CAGE MADE OF CONTINUOUS LONGITUDINALS

FIG. 4 TYPICAL ARRANGEMENT OF REINFORCEMENT IN SOCKET FOR DOUBLE CAGE

7.3.2 Diagonal reinforcement may be provided in pipes, the cages for which are not welded so as to help in binding the cage securely. It shall, however, be ensured that the clear cover for any reinforcement is not below the limits specified in **6.4**. Diagonal reinforcement is a process requirement and shall not be counted against longitudinal and spiral reinforcement.

7.4 Curing

Curing shall be either by steam or by water or by a combination of steam and water or by use of approved curing compounds. If water curing is used, the pipes shall be cured for a minimum period of 7 days in case of non-pressure pipes, and 14 days in case of pressure pipes. In case of pipes where cement with fly ash or slag is used, the minimum period of water curing shall be 14 days. If steam curing is used, after that it shall be water cured for 3 days with application of moist jute cover. Impermeable membrane may be used for curing as per NS 511

8 DIMENSIONS

8.1 Pipes and Collars

The internal diameter, barrel wall thickness, length, the minimum reinforcement and strength test requirements for different classes of pipes (*see 4.1*) shall be as specified in Table 1 to Table 11A. Dimensions of collar for class NP1 shall be as per Table 1. Dimensions and reinforcement of collar for class NP2 shall be as per Table 21 and for classes NP3 and NP4 shall be as per Table 22. However, in case of pipes manufactured by vibration casting process, the internal diameter, wall thickness, the minimum reinforcement (in case of reinforced pipes) and strength test requirements for different classes of pipes shall be as given in Tables 2A, 4, 5, 7, 8, 9A, 10A and 11A. The manufacturer shall inform the purchaser of the effective length of spigot and socket and flush jointed pipes that he is able to supply. For collar jointed pipes, effective length shall be 2 m or 2.5 m up to 250 mm nominal diameter pipes and 2.5 m, 3.0 m, 3.5 m or 4.0 m for pipes above 250 mm nominal diameter. Class NP3 and NP4 pipes of nominal internal diameter 900 mm and above, the effective length may also be 1.25 m.

NOTE — Pipes of internal diameter, barrel wall thickness and length of barrel and collar other than those specified in **8.1** may be supplied by mutual agreement between the purchaser and the supplier. In such case, the design of pipes submitted to the purchaser shall include all standard details as covered in Tables 1 to Table 11A.

8.2 Tolerances

The following tolerances shall be permitted:

S.no	Dimensions	Tolerances (mm)
i.	Overall Length	± 1 percent of standard Length
ii.	Internal Diameter of Pipes a) Upto and Including 300 mm b) Over 300 mm and upto 600mm c) Over 600 mm	±3 ±5 ±10
iii	Barrel Wall Thickness a) Up to and including 30 mm b) Over 30 mm up to and including 50 mm	+2 -1 +3 -1.5

	c) Over 50 mm up to and including 65 mm	+4 -2
	d) Over 65 mm up to and including 80 mm	+5 -2.5
	e) Over 80 mm up to and including 95 mm	+6 -3
	f) Over 95 mm	+7 -3.5

NOTE: In case of pipes with flexible rubber ring joints, the tolerance on thickness near the ends will have to be reduced. Near the rubber ring joints, the tolerance on thickness shall be as given in respective tables

9 WORKMANSHIP AND FINISH

9.1 Finish

Pipes shall be straight and free from cracks except that craze cracks may be permitted. The ends of the pipes shall be square with their longitudinal axis so that when placed in a straight line in the trench, no opening between ends in contact shall exceed 3 mm in pipes up to 600 mm diameter (inclusive), and 6 mm in pipes larger than 600 mm diameter.

9.1.1 The outside and inside surfaces of the pipes shall be dense and hard and shall not be coated with cement wash or other preparation unless otherwise agreed to between the purchaser and the manufacturer or the supplier. The inside surface of the pipe should be smooth as far as possible. For better bond, inner surface of the collar may be finished rough.

9.1.2 The pipes shall be free from defects resulting from imperfect grading of the aggregate, mixing or molding.

9.1.3 Pipes shall be free from local dents or bulges greater than 3.0 mm in depth and extending over a length in any direction greater than twice the barrel wall thickness.

9.1.4 Pipes may be repaired, if necessary, because of accidental injury during manufacture or handling and shall be accepted if in the opinion of the purchaser, the repairs are sound and appropriately finished and cured, and the repaired pipe conforms to the requirements of this specification.

9.2 Deviation from Straight

The deviation from straight in any pipe throughout its effective length, tested by means of a rigid straight edge as shall not exceed, for all diameters, 3 mm for every meter run.

10 TESTS

10.1 Test Specimens

All pipes for testing purposes shall be selected at random from the stock of the manufacturer and shall be such as would not otherwise be rejected under this standard.

10.1.1 During manufacture, tests on compressive strength of concrete cubes shall be done as described in NS - 511 For pressure pipes, splitting tensile strength tests of concrete cylinders shall be carried out as described in Annex C .. The manufacturer shall supply, when required to do so by the purchaser or his representative, the results of compressive tests of concrete cubes (*see 5.5.1*) and split tensile tests of

concrete cylinder (*see* 5.5.2) made from the concrete used for the pipes. The manufacturer shall supply cylinders or cubes for test purposes required by the purchaser, and such cylinders or cubes shall withstand the tests prescribed in 5.5.1 and 5.5.2. Every pressure pipe shall be tested by the manufacturer for the hydrostatic test pressure (*see* 4.1). For non-pressure pipes, 2 percent of the pipes shall be tested for hydrostatic test pressure.

10.2 The specimens of pipes selected in accordance with 10.1 shall be subjected to the following tests in accordance with Annex C...

General Test

Appearance, color, straightness, cracks

Physical Test

Length, Diameter, Barrel Thickness, Line

Characteristics Test

- a) Hydrostatic test,
- b) Three-edge bearing test, and
- c) Absorption Test.

10.2.1 Hydrostatic test (Refer as per annex B)

10.2.1.1 The specimens for determination of leakage under internal hydrostatic pressure shall be sound and full-size pipe. If the pipes are tested after storing in adverse weather condition presoaking shall be permitted. For presoaking pipes shall be submerged in water or sprayed with water for a period not less than 6 hours prior to testing and excess water removed.

10.2.1.2 Procedure

The pipe shall be supported in such a way so that the longitudinal axis is approximately horizontal and the exterior surface excepting the supports can be examined readily.

The equipment for making the test shall be such that the specimen under test can be filled with water to the exclusion of air and subjected to the required hydrostatic pressure. Apply hydrostatic pressure to the whole pipe including the portion of socket and rebated joints. that is, subjected to pressure in the 'as laid' condition.

The specimen shall be filled with water and the air expelled. Pressure shall be applied at a gradual rate until the specified test pressure is reached, or beads of water on the pipe surface is seen, whichever occurs first.

Pressure shall be maintained for 1min + 30 s for each 10 mm of wall thickness, or for twice that entire period if the application of pressure resulted in the formation of beads of water on the pipe surface.

At the end of the holding period, the pressure shall be released immediately if the test pressure has been maintained. If the beads of the water have not grown or run the pressure shall be increased slowly until the test pressure is reached or the beads of water grow or run (whichever occurs first).

If the test pressure has been reached without the beads of water growing or running the test pressure shall be maintained constant for 1 min + 30 s for each 10 mm of wall thickness. At the end of the holding period the pressure shall be released immediately.

After releasing the pressure, the test pipe shall be drained completely.

10.2.2 Three Edge Bearing Test

10.2.2.1 Three-edge bearing test shall be performed by the method given below. The pipe shall be surface dry when tested. The test specimen shall be tested in a machine so designed that a crushing force may be

exerted in a true vertical plane through one diameter and extending -the full length of the barrel of the pipe but excluding the sockets, if any

a) Testing machine

Any mechanical or hand-powered device may be used in which the head that applies the load moves at such a speed as to increase the load at a uniform rate of approximately 20 percent of the expected crushing load per linear meter per minute. The loading device shall be calibrated within an accuracy of ± 2 percent. The testing machine used for the load tests should produce an uniform deflection throughout the full length of the pipe and shall be so substantial and rigid throughout, that the distribution of the test load along the length of the barrel of the pipe will not be appreciably affected by the deformation or yielding of any part of the machine during the application of the load.

b) Lower Bearing Block

The lower bearing block (see Fig. 5) shall consist of two hardwood or hard rubber strips fastened to a wooden or steel beam or direct to a concrete base, which shall provide sufficient rigidity to permit application of maximum load without appreciable deflection . Wooden or rubber strips shall be straight , have a cross-section of not less than 50 mm in width and not less than 25 mm nor more than 40 mm in height and shall have the top inside corners rounded, to a radius of approximately 15 mm . The interior vertical sides of the strips shall be parallel and spaced apart a distance of not more than 1 /12th of the specimen diameter but i n no case less than 25 mm . The bearing faces of the bottom strips shall not vary from a straight line vertically or horizontally by more than 1 mm in 375 mm of the length under load.

About 6 mm thick hard rubber or felt should be placed / fixed at the lower face of the upper wooden block which shall come in contact with the surface of the pipe.

c) Upper Bearing Block

The upper bearing shall be a rigid hardwood block or a block with hard rubber facing at least 150 mm x 150 mm in cross-section. The wood block shall be free of knots and shall be straight and true from end to end. It shall be fastened to steel or wood faced steel beam of such dimensions that deflections under maximum load will not be appreciable. The bearing face of the upper bearing block shall not deviate from a straight line by more than 1 mm in 375 mm of length under load.

The equipment shall be so designed that the load will be distributed about the center of the overall length of the pipe (see Fig. 5). The load may be applied either at a single point or at multiple points dependent on the length of the pipe being tested and the rigidity of the test frame

NOTE -Multiple points of load applicable to the top bearing will permit use of lighter beams without appreciable deflection

d) Crack measuring gauge

The crack measuring gauge shall be made from 0.25 mm thick strip and shall be of a shape as shown in Fig. 6.

10.2.2.2 Procedure

The specimen shall be placed on the two bottom bearing strips in such a manner that the pipe tests firmly and with the most uniform possible bearing on each strip for the full length of the pipes less the socket portion, if any .

If mutually agreed upon by the manufacturer and the purchaser prior to the test, a fillet of plaster of Paris not exceeding 25 mm in thickness may be cast on the surface of the upper and lower bearing before the pipe is placed. The width of the fillet cap, top or bottom, shall be not more than 25 mm per 300 mm diameter, but in no case less than 25 mm.

Each end of the pipe at a point mid-way between the lower bearing strips shall be marked and then diametrically opposite points thereof shall be established. The top bearing block shall be so placed that it contacts the two ends of the pipe at these marks. After placing the specimen in the machine on the bottom strips, the top bearing shall be symmetrically aligned in the testing machine. Load shall be applied at the rate indicated in 10.2.2.1 a) until either the formation of a 0.25 mm wide crack or ultimate strength load, as may be specified, has been reached . If both the 0.25 mm crack and ultimate load are required, the specified rate of loading need not be maintained after the load at 0.25 mm crack has been determined.

The 0.25 mm crack load is the maximum load applied to the pipe before a crack having a width of 0.25 mm measured at close intervals occurs throughout a length of 300 mm or more. The crack shall be considered 0.25 mm in width when the point of the measuring gauge described in 10.2.2.1 d) penetrates 1.5 mm at close intervals throughout the specified distance of 300 mm. The ultimate load will be reached when the pipe will sustain no greater load.

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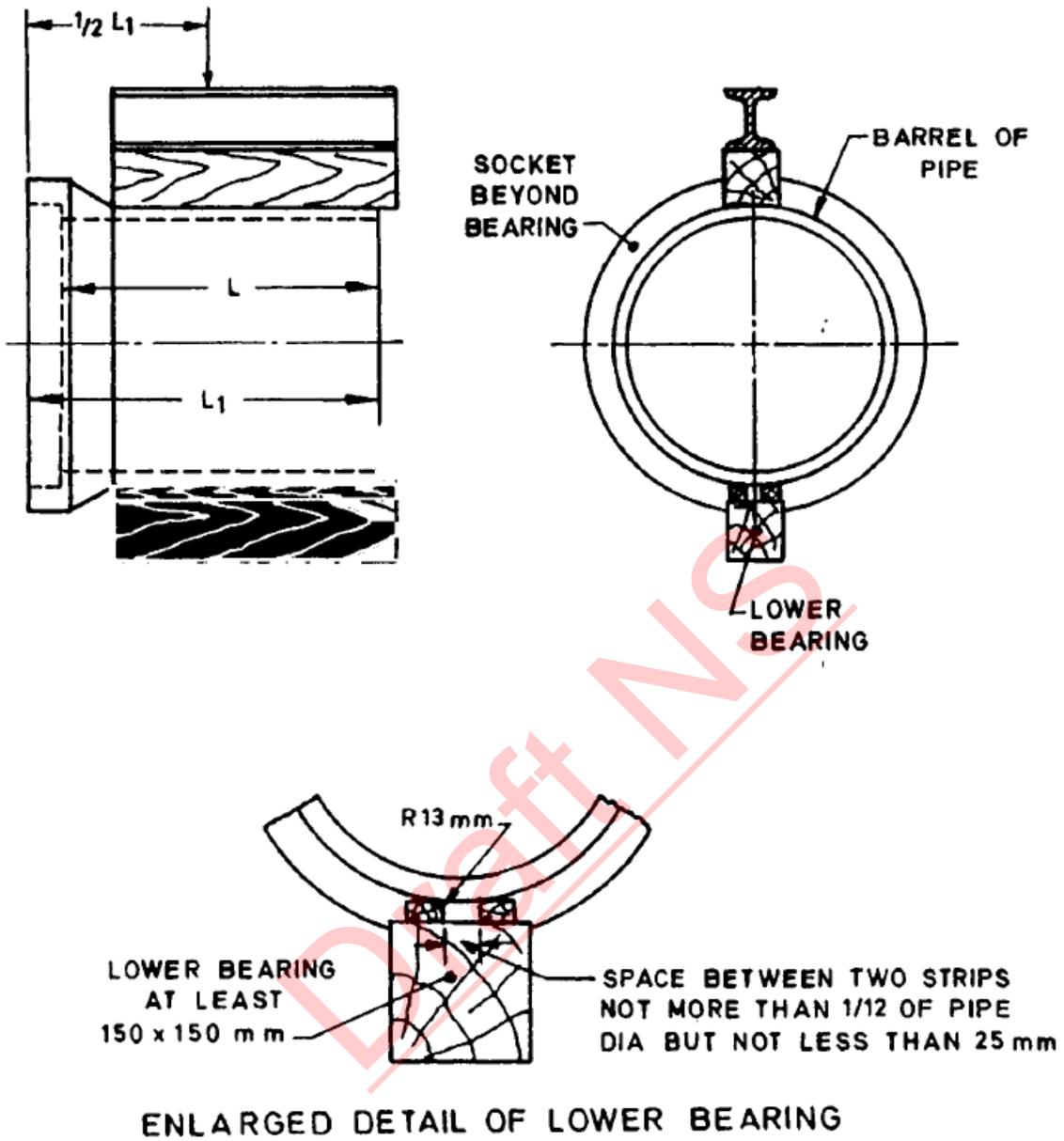


Figure 5 Three Edge Bearing Test Method

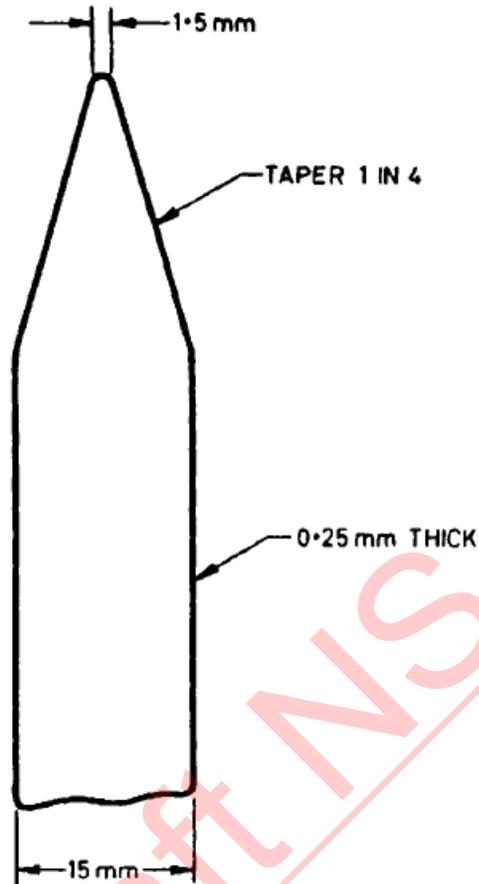


Figure 6 Gauge Leaf for Measuring cracks..

Calculation

The crushing strength in Newton per linear metre of pipe shall be calculated by dividing the total load on the specimen by the nominal laying length. Effective length of the pipe shall be taken as the nominal laying length of the specimen. In case of spigot and socket ended pipes, the effective length shall be equal to the overall length minus the depth of socket (see Fig.7) and in case of collar and flush jointed pipes. The effective length shall be equal to the overall length .

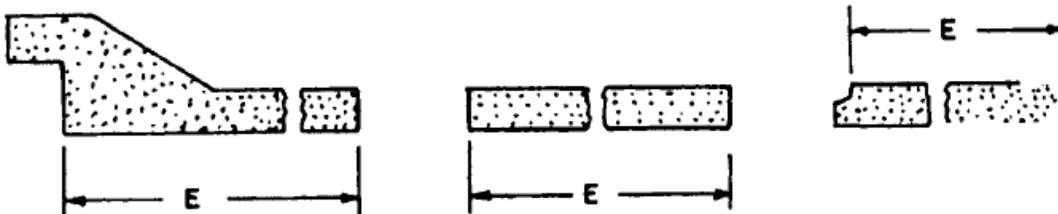


Figure 7 Illustrating Effective Length 'E' of Pipes.

10.2.3 Absorption Test

10.2.3.1 Each specimen selected at random shall have a square area of $100 \text{ cm}^2 \pm 10$ percent of the length of the pipe as measured on surface of the pipe, and a thickness equal to the full depth of the pipe thickness and shall be free from visible cracks.

10.2.3.2 Procedure Drying Specimen

Specimens shall be dried in a mechanical convection oven at a temperature of 105°C to 115°C until two successive weighing at interval of not less than 8 h show an increment of loss not greater than 0.1 percent of the mass of the specimen. The drying time shall be not less than 36 h. The dry mass of the specimen shall be the mass after the final drying determined at ambient temperature.

After drying and weighing as specified, the specimens shall be immersed in clean water at room temperature for the specified period. The specimens shall then be removed from the water and allowed to drain for not more than one minute. The superficial water shall then be removed by absorbent cloth or paper and the specimens weighed immediately.

The least count/accuracy of the weighing balance shall be 0.1 g which the test specimen shall be weighed.

Calculation and Report

The increase in mass of the specimen over its dry mass shall be taken as the absorption of the specimen and shall be expressed as a percentage of the dry mass. The results shall be reported separately for each specimen.

11 SAMPLING AND INSPECTION

11.1 Scale of Sampling

11.1.1 Lot

In any consignment, all the pipes of same class, same size and belonging to the same mix of concrete shall be grouped together to constitute a lot.

11.1.2 For ascertaining the conformity of the material to the requirements of this specification, samples shall be tested from each lot separately.

11.1.3 The number of pipes to be selected from the lot shall depend on the size of the lot and shall be according to Table 23.

11.2 Number of Tests and Criteria for Conformity

11.2.1 All the pipes selected according to 11.1.3 shall be inspected for dimensional requirements (*see 8*), finish (*see 9.1*) and deviation from straight (*see 9.2*). A pipe failing to satisfy one or more of these requirements shall be considered as defective.

11.2.1.1 The lot shall be declared as conforming to these requirements if the number of defectives found in the sample does not exceed the number of defectives given in col 3 of Table 23.

11.2.2 The lot having found satisfactory shall be further subjected to the tests given under 10.2 except ultimate load test. For this purpose, the number of pipe given in col 4 of Table 23 shall be selected from the lot. These pipes shall be selected from those that have satisfied the requirements given in 11.2.1. For

ultimate load test, the number of pipes to be checked shall be according to mutual agreement between the purchaser and the manufacturer. However, ultimate load test shall not be done for a lot size of 20 pipes or less.

11.2.2.1 The lot shall be declared as conforming to the requirements of this specification if there is no failure under **11.2.2**.

12 MARKING

12.1 The following information shall be indelibly and clearly marked on each pipe:

- a) Indication of the source of manufacture,
- b) Size of pipe (internal diameter),
- c) Class of pipe,
- d) The word R for reinforced' and UR for 'unreinforced' shall be marked,
- e) The word SP for 'spun pipe' and VCP for 'vibrated cast pipe' shall be marked Quarter and Year of manufacture.
- f) Logo of Nepal standard (If certified by NBSM)

The above information shall be clearly marked on outside only for pipes up to and including 350 mm internal diameter, and both outside and inside for pipes above 350 mm internal diameter.

12.2 NS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the Nepal Standard and the Rules and Regulations framed thereunder, and the product(s) may be marked with the Standard Mark.

Table 1 Design and Strength Test Requirements of Concrete Pipes of Class NP1 - UR —Unreinforced, Non-pressure Pipes
(Clauses 6.1.1, 6.3 and 8.1)

Internal Diameter of Pipe mm (1)	Barrel Wall Thickness mm (2)	Collar Dimensions		Minimum Length of Collar mm (5)	Strength Test Requirements for Three Edge Bearing Test Ultimate Load Test KN/linear meter (6)
		Minimum Caulking Space mm (3)	Minimum Thickness mm (4)		
80	25	13	25	150	15.3
100	25	13	25	150	15.3
150	25	13	25	150	15.3
200	25	13	25	150	16.4
225	25	13	25	150	16.4
250	25	13	25	150	16.4
300	30	16	30	150	17.6
350	32	16	32	150	18.4
400	32	16	32	150	18.8
450	35	19	35	200	21.9

NOTE — Concrete for pipes shall have a minimum compressive strength of 35 N/mm² at 28 days.

Table 2 Design and Strength Test Requirements of Concrete Pipes of Class NP2 -R Reinforced Concrete, Light Duty, Non-pressure Pipes Made by Spinning Process

(Clauses 6.1.1, 6.1.2.1, 6.1.3, 6.2.2, 7.3.2, 8.1 and Table 20)

Internal Diameter of Pipes mm (1)	Barrel Wall Thickness mm (2)	Reinforcements			Strength Test Requirements for Three Edge Bearing Test	
		Longitudinal, Mild Steel or Hard Drawn Steel		Spirals, Hard Drawn Steel	Load to Produce 0.25 mm Crack kN/linear metre (6)	Ultimate load kN/linear metre (7)
		Minimum Number (3)	kg/linear metre (4)	kg/linear metre (5)		
80	25	6	0.59	0.16	10.05	15.08
100	25	6	0.59	0.18	10.05	15.08
150	25	6	0.59	0.24	10.79	16.19
200	25	6	0.59	0.38	11.77	17.66
225	25	6	0.59	0.46	12.26	18.39
250	25	6	0.59	0.58	12.55	18.83
300	30	8	0.78	0.79	13.48	20.22
350	32	8	0.78	1.14	14.46	21.69
400	32	8	0.78	1.55	15.45	23.18
450	35	8	0.78	1.97	16.18	24.27
500	35	8	0.78	2.46	17.16	25.74
600	45	8	0.78	3.47	18.88	28.32
700	50	8	1.22	4.60	20.35	30.53
800	50	8	1.22	6.71	21.57	32.36
900	55	8	1.22	9.25	22.80	34.20
1000	60	8	1.76	10.69	24.27	36.41
1100	65	8	1.76	12.74	25.50	38.25
1200	70	8	1.76	15.47	26.97	40.46
1400	75	12	2.64	20.57	29.42	44.13
1600	80	12 or 8 + 8	3.52	25.40	32.12	48.18
1800	90	12 or 8 + 8	3.52	32.74	35.06	52.59
2000	100	12+12	5.28	45.14	37.76	56.64
2200	110	12+12	5.28	56.37	40.21	60.32

NOTES

- 1 Concrete for pipes shall have a minimum compressive strength of 35 N/mm² at 28 days.
- 2 If mild steel is used for spiral reinforcement, the mass specified under col 5 shall be increased to 140/125.
- 3 soft grade mild steel wires for spirals may be used for pipes of internal diameters 80 mm, 100 mm and 150 mm only, by increasing mass to 140/84.
- 4 The longitudinal reinforcement given in this table is valid for pipes up to 2.5 m effective length for internal diameter of pipe up to 250 mm and up to 3 m effective length for higher diameter pipes.
- 5 Total mass of longitudinal reinforcement shall be calculated by multiplying the values given in col 4 by the length of the pipe and then deducting for the cover length provided at the two ends.

Table 2A Design and Strength Test Requirements of Concrete Pipes of Class NP2 -R —Reinforced Concrete, Light Duty, Non-pressure Pipes Made by Vibration Casting Process

(Clauses 6.1.1, 6.1.2.1, 6.1.3, 6.2.2, 7.3.2, 8.1 and Table 20)

Internal Diameter of Pipes mm (1)	Barrel Wall Thickness mm (2)	Reinforcements			Strength Test Requirements for Three Edge Bearing Test	
		Longitudinal, Mild Steel or Hard Drawn Steel		Spirals, Hard Drawn Steel kg/linear metre (5)	Load to Produce 0.25 mm Crack kN/linear metre (6)	Ultimate load kN/linear metre (7)
		Minimum Number (3)	kg/linear metre (4)			
700	50	8	1.22	4.60	20.35	30.53
800	50	8	1.22	6.71	21.57	32.36
900	55	8	1.22	9.25	22.80	34.20
1000	60	8	1.76	10.69	24.27	36.41
1100	65	8	1.76	12.74	25.50	38.25
1200	70	8	1.76	15.47	26.97	40.46
1400	75	12	2.64	20.57	29.42	44.13
1600	80	12 or 8 + 8	3.52	25.40	32.12	48.18
1800	90	12 or 8 + 8	3.52	32.74	35.06	52.59
2000	100	12 + 12	5.28	45.14	37.76	56.64
2200	110	12 + 12	5.28	56.37	40.21	60.32

NOTES

- 1** Concrete for pipes shall have a minimum compressive strength of 35 N/mm² at 28 days.
- 2** If mild steel is used for spiral reinforcement, the mass specified under col 5 shall be increased to 140/125.
- 3** The longitudinal reinforcement given in this table is valid for pipes up to 3 m effective length.
- 4** Total mass of longitudinal reinforcement shall be calculated by multiplying the values given in col 4 by the length of the pipe and then deducting for the cover length provided at the two ends.

Table 3 Design and Strength Test Requirements of Concrete Pipes of Class NP3-R –Reinforced Concrete, Medium Duty, Non-pressure Pipes Made by Spinning Process

(Clauses 6.1.1, 6.1.2.1, 6.1.3, 6.2.2, 7.3.2, 8.1 and Table 20)

Internal Diameter of Pipes mm (1)	Barrel Wall Thickness mm (2)	Reinforcements			Strength Test Requirements for Three Edge Bearing Test	
		Longitudinal, Mild Steel or Hard Drawn Steel		Spirals, Hard Drawn Steel kg/linear metre (5)	Load to Produce 0.25 mm Crack kN/linear metre (6)	Ultimate Load kN/linear metre (7)
		Minimum Number (3)	kg/linear metre (4)			
80	25	6	0.59	0.17	13.00	19.50
100	25	6	0.59	0.24	13.00	19.50
150	25	6	0.59	0.49	13.70	20.55
200	30	6	0.59	0.68	14.50	21.75
225	30	6	0.59	0.86	14.80	22.20
250	30	6	0.59	1.05	15.00	22.50
300	40	8	0.78	1.53	15.50	23.25
350	75	8	0.78	1.58	16.77	25.16
400	75	8	0.78	1.60	19.16	28.74
450	75	8	0.78	1.90	21.56	32.34
500	75	8	0.78	1.97	23.95	35.93
600	85	8 or 6 + 6	1.18	2.82	28.74	43.11
700	85	8 or 6 + 6	1.18	4.87	33.53	50.30
800	95	8 or 6 + 6	2.66	6.87	38.32	57.48
900	100	6+ 6	2.66	11.55	43.11	64.67
1000	115	6+ 6	2.66	15.70	47.90	71.85
1100	115	6+ 6	2.66	20.42	52.69	79.00
1200	120	8+ 8	3.55	24.74	57.48	86.22
1400	135	8+ 8	3.55	46.21	67.06	100.60
1600	140	8+ 8	3.55	65.40	76.64	114.96
1800	150	12+ 12	9.36	87.10	86.22	129.33
2000	170	12+ 12	9.36	97.90	95.80	143.70
2200	185	12+ 12	9.36	133.30	105.38	158.07
2400	200	12+ 12	14.88	146.61	114.96	172.44
2600	215	12+ 12	14.88	175.76	124.54	186.81

Notes

- 1 Concrete for pipes shall have a minimum compressive strength of 35 N/mm² at 28 days.
- 2 If mild steel is used for spiral reinforcement, the mass specified under col 5 shall be increased to 140/125.
- 3 The longitudinal reinforcement given in this table is valid for pipes up to 2.5 m effective length for Internal diameter of pipe up to 250 mm and up to 3 m effective length for higher diameter pipes.
- 4 Total mass of longitudinal reinforcement shall be calculated by multiplying the values given in col 4 by the length of the pipe and then deducting for the cover length provided at the two ends.

Table 4 Design and Strength Test Requirements of Concrete Pipes of Class NP3-UR — Unreinforced Concrete, Medium-Duty, Non-pressure Pipes Made by Spinning/Vibration Casting Process

(Clauses 5.5.1, 6.1.1, 6.3, 8.1 and Table 20)

Internal Diameter of Pipes mm (1)	Barrel Wall Thickness mm (2)	Strength Test Requirement for Three Edge Bearing Test, Ultimate Load kN/linear metre (3)
100	24	13.00
150	28	13.70
200	32	14.50
250	37	15.00
300	50	15.50
350	55	16.77
400	60	19.16
450	65	21.56
500	70	23.95
600	75	28.74
700	85	33.53
800	95	38.32
900	100	43.11
1 000	115	47.90
1 100	120	52.69
1 200	125	57.48
1 400	140	67.06
1 600	165	76.64
1 800	180	86.22

NOTES

- 1** Concrete for pipes shall have a minimum compressive strength of 45 N/mm² at 28 days.
- 2** The pipes up to 250 mm dia shall be manufactured in standard length of 1.25 m.

Table 5 Design and Strength Test Requirements of Concrete Pipes of Class NP3-R — Reinforced Concrete, Medium-Duty, Non-pressure Pipes Made by Vibration Casting Process

(Clauses 5.5.1, 6.1.1, 6.1.2.1, 6.1.3, 6.2.2, 7.3.2, 8.1 and Table 20)

Internal Diameter of Pipes mm (1)	Barrel Wall Thickness mm (2)	Reinforcements			Strength Test Requirements for Three Edge Bearing Test	
		Longitudinal, Mild Steel or Hard Drawn Steel		Spirals, Hard Drawn Steel	Load to Produce 0.25 mm Crack kN/linear metre (6)	Ultimate Load kN/linear metre (7)
		Minimum Number (3)	kg/linear metre (4)	kg/linear metre (5)		
300	50	8	0.78	1.53	15.50	23.25
350	55	8	0.78	1.58	16.77	25.16
400	60	8	0.78	1.60	19.16	28.74
450	65	8	0.78	1.90	21.56	32.34
500	70	8	0.78	2.0	23.95	35.93
600	75	8 or 6 + 6	1.18	2.20	28.74	43.11
700	85	8 or 6 + 6	1.18	4.87	33.53	50.30
800	95	8 or 6 + 6	2.66	6.87	38.32	57.48
900	100	6 + 6	2.66	11.55	43.11	64.67
1000	115	6 + 6	2.66	15.70	47.90	71.85
1100	120	6 + 6	2.66	19.61	52.69	79.00
200	125	8 + 8	3.55	21.25	57.48	86.22
1400	140	8 + 8	3.55	30.00	67.06	100.60
1600	165	8 + 8	3.55	50.63	76.64	114.96
1800	180	12 + 12	9.36	64.19	86.22	129.33
2000	190	12 + 12	9.36	83.12	95.80	143.70
2200	210	12 + 12	9.36	105.53	105.38	158.07
2400	225	12 + 12	14.88	133.30	114.96	172.44

NOTE — Concrete for pipes shall have a minimum compressive strength of 35 N/mm² at 28 days.

Table 6 Design and Strength Test Requirements of Concrete Pipes of Class NP4-R Reinforced Concrete, Heavy Duty, Non-pressure Pipes Made by Spinning Process

(Clauses 6.1.1, 6.1.2.1, 6.1.3, 6.2.2, 7.3.2, 8.1 and Table 20)

Internal Diameter of Pipes mm (1)	Barrel Wall Thickness mm (2)	Reinforcements			Strength Test Requirements for Three Edge Bearing Test	
		Longitudinal, Mild Steel or Hard Drawn Steel		Spirals, Hard Drawn Steel	Load to Produce 0.25 mm Crack kN/linear metre (6)	Ultimate Load kN/linear metre (7)
		Minimum Number (3)	kg/linear metre (4)	kg/linear metre (5)		
80	25	6	0.59	0.26	22.10	33.15
100	25	6	0.59	0.37	22.10	33.15
150	25	6	0.59	0.76	23.30	34.95
200	30	6	0.59	0.88	24.60	36.90
225	30	6	0.59	1.11	25.20	37.80
250	30	6	0.59	1.35	25.50	38.25
300	40	8	0.78	1.53	26.40	39.60
350	75	8	0.78	1.61	29.80	44.70
400	75	8	0.78	1.97	33.90	50.90
450	75	8	0.78	3.36	36.90	55.30
500	75	8	0.78	5.56	40.00	61.20
600	85	8 or 6 + 6	2.34	8.50	46.30	69.40
700	85	8 or 6 + 6	3.44	12.78	52.20	78.30
800	95	8 or 6 + 6	3.44	16.72	59.30	89.10
900	100	6 + 6	3.44	20.92	66.30	99.40
1000	115	8 + 8	6.04	26.70	72.60	108.90
1100	115	8 + 8	6.04	38.02	80.40	120.60
1200	120	8 + 8	6.04	46.25	88.30	132.40
1400	135	8 + 8	9.36	59.20	99.10	148.65
1600	140	12 + 12	9.36	86.60	109.90	164.85
1800	150	12 + 12	14.88	103.30	120.70	181.05
2000	170	12 + 12	14.88	125.28	131.50	197.25
2200	185	12 + 12	14.88	154.94	142.20	213.30
2400	200	12 + 12	14.88	181.25	155.00	232.50
2600	215	12 + 12	14.88	208.25	166.70	250.00

NOTES

- 1 Concrete for pipes shall have a minimum compressive strength of 35 N/mm² at 28 days.
- 2 If mild steel is used for spiral reinforcement, the mass specified under col 5 shall be increased to 140/125.
- 3 The longitudinal reinforcement given in this table is valid for pipes up to 2.5 m effective length for internal diameter of pipe up to 250 mm and 3 m effective length for higher diameter pipes.
- 4 Total mass of longitudinal reinforcement shall be calculated by multiplying the values given in col 4 by the length of the pipe and then deducting for the cover length provided at the two ends.

**Table 7 Design and Strength Test Requirements of Concrete Pipes of Class NP4-UR —
Unreinforced Concrete, Heavy Duty, Non-pressure Pipes Made by Spinning/Vibration Casting
process**

(Clauses 5.5.1, 6.1.1, 6.3, 8.1 and Table 20)

Internal Diameter of Pipes mm (1)	Barrel Wall Thickness mm (2)	Strength Test Requirements for Three Edge Bearing Test, Ultimate Load kN/linear metre (3)
100	24	22.1
150	28	23.8
200	32	24.6
250	37	25.5
300	50	26.4
350	55	29.8
400	60	33.9
450	65	36.9
500	70	40.0
600	75	46.3
700	85	52.2
800	95	59.3
900	100	66.3
1 000	115	72.6
1 100	125	80.4
1 200	135	88.3
1 400	155	104.2
1 600	180	119.6
1 800	205	135.3

NOTES

1 Concrete for pipes shall have a minimum compressive strength of 50 N/mm² at 28 days.

2 The pipes up to 250 mm dia shall be manufactured in standard length of 1.25 m.

Table 8 Design and Strength Test Requirements of Concrete Pipes of Class NP4 -R—Reinforced Concrete, Heavy Duty, Non-pressure Pipes Made by Vibration Casting Process

(Clauses 5.5.1, 6.1.1, 6.1.2.1, 6.1.3, 6.2.2, 7.3.2, 8.1 and Table 20)

Internal Diameter of Pipes mm (1)	Barrel Wall Thickness mm (2)	Reinforcements			Strength Test Requirements for Three Edge Bearing Test	
		Longitudinal, Mild Steel or Hard Drawn Steel		Spirals, Hard Drawn Steel	Load to Produce 0.25 mm Crack kN/linear metre (6)	Ultimate load kN/linear metre (7)
		Minimum Number (3)	kg/linear metre (4)	kg/linear metre (5)		
300	50	8	0.78	1.53	26.4	38.6
350	55	8	0.78	1.61	29.8	44.7
400	60	8	0.78	1.97	33.9	50.9
450	65	8	0.78	3.36	36.9	55.3
500	70	8	0.78	5.56	40.0	61.2
600	75	8 or 6 + 6	2.34	8.50	46.3	69.4
700	85	8 or 6 + 6	3.44	12.78	52.2	78.3
800	95	8 or 6 + 6	3.44	16.72	59.3	89.1
900	100	6 + 6	3.44	20.92	66.3	99.4
1 000	115	8 + 8	6.04	26.70	72.6	108.9
1 100	120	8 + 8	6.04	35.60	80.4	120.6
1 200	125	8 + 8	6.04	42.42	88.3	132.4
1 400	140	8 + 8	9.36	51.39	99.10	148.65
1 600	165	12 + 12	9.36	61.81	109.90	164.85
1 800	180	12 + 12	14.88	78.03	120.70	181.05
2 000	190	12 + 12	14.88	103.50	131.50	197.25

NOTE — Concrete for pipes shall have a minimum compressive strength of 35 N/mm² at 28 days.

Table 9 Design and Strength Test Requirements of Concrete Pipes of Class P1 — Reinforced Concrete, Pressure Pipes Safe for 0.2 MPa Pressure Test Made by Spinning Process

(Clauses 6.1.1, 6.1.2.1, 6.1.3, 6.2.2, 7.3.2, 8.1 and Table 20)

Internal Diameter of Pipes mm (1)	Barrel Wall Thickness mm (2)	Reinforcements		
		Longitudinal, Mild Steel or Hard Drawn Steel		Spirals, Hard Drawn Steel kg/linear metre (5)
		Minimum Number (3)	kg/linear metre (4)	
80	25	6	0.59	0.16
100	25	6	0.59	0.22
150	25	6	0.59	0.46
200	25	6	0.59	0.79
225	25	6	0.59	1.00
250	25	6	0.59	1.22
300	30	8	0.78	1.75
350	32	8	0.78	2.37
400	32	8	0.78	3.05
450	35	8	0.78	3.86
500	35	8	0.78	4.72
600	45	8	0.78	6.79
700	50	8	1.22	9.15
800	50	8	1.22	11.94
900	55	8	1.22	15.12
1000	60	8	1.76	18.64
1100	65	8	1.76	22.88
1200	70	8	1.76	26.82

NOTES

- 1 Concrete for pipes shall have a minimum compressive strength of 35 N/mm² at 28 days.
- 2 Strength requirements for pressure pipes shall be the same as for NP-2 class pipes.
- 3 If mild steel is used for spiral reinforcement, the mass specified under col 5 shall be increased to 140/125.
- 4 Soft grade mild steel wire for spirals may be used for pipes of internal diameters 80 mm, 100 mm and 150 mm only, by increasing mass to 140/84.
- 5 The longitudinal reinforcement given in this table is valid for pipes up to 2.5 m effective length for internal diameter of pipe up to 250 and up to 3 m effective length for higher diameter pipes
- 6 Total mass of longitudinal reinforcement shall be calculated by multiplying the values given in col 4 by the length of the pipe and then deducting for the cover length provided at the two ends.

Table 9A Design and Strength Test Requirements of Concrete Pipes of Class P1 — Reinforced Concrete, Pressure Pipes Safe for 0.2 MPa Pressure Test Made by Vibration Casting Process

(Clauses 6.1.1, 6.1.2.1, 6.1.3, 6.2.2, 7.3.2, 8.1 and Table 20)

Internal Diameter of Pipes mm (1)	Barrel Wall Thickness mm (2)	Reinforcements		
		Longitudinal, Mild Steel or Hard Drawn Steel		Spirals, Hard Drawn Steel kg/linear metre (5)
		Minimum Number (3)	kg/linear metre (4)	
700	50	8	1.22	9.15
800	50	8	1.22	11.94
900	55	8	1.22	15.12
1 000	60	8	1.76	18.64
1 100	65	8	1.76	22.88
1 200	70	8	1.76	26.82

1 Concrete for pipes shall have a minimum compressive strength of 35 N/mm² at 28 days.

2 Strength requirements for pressure pipes shall be the same as for NP-2 class pipes.

3 If mild steel is used for spiral reinforcement, the mass specified under col 5 shall be increased to 140/125.

4 The longitudinal reinforcement given in this table is valid for pipes up to 3 m effective length.

5 Total mass of longitudinal reinforcement shall be calculated by multiplying the values given in col 4 by the length of the pipe and then deducting for the cover length provided at the two ends.

Table 10 Design and Strength Test Requirements of Concrete Pipes of Class P2 — Reinforced Concrete Pressure Pipes Safe for 0.4 MPa Pressure Test Made by Spinning Process

(Clauses 6.1.1, 6.1.2.1, 6.1.3, 6.2.2, 7.3.2, 8.1 and Table 20)

Internal Diameter of Pipes mm (1)	Barrel Wall Thickness mm (2)	Reinforcements		
		Longitudinal, Mild Steel or Hard Drawn Steel		Spirals, Hard Drawn Steel kg/linear metre (5)
		Minimum Number (3)	kg/linear metre (4)	
80	25	6	0.59	0.29
100	25	6	0.59	0.45
150	25	6	0.59	0.93
200	30	6	0.59	1.63
225	30	6	0.59	2.03
250	30	6	0.59	2.47
300	40	8	0.78	3.61
350	45	8	0.78	4.88
400	50	8	0.78	6.36
450	50	8	0.78	7.96
500	55	8	0.78	9.80
600	65	8	1.76	14.10
700	70	8	1.76	21.90
800	80	8 or 6 + 6	2.66	28.54
900	90	8 or 6 + 6	2.66	35.92
1000	100	6 + 6	2.66	43.48

NOTES

1 Strength requirements for pressure pipes shall be the same as for NP-2 class pipes.

2 If mild steel is used for spiral reinforcement, the mass specified under col 5 shall be increased to 140/125.

3 Soft grade mild steel wire for spirals may be used for pipes of internal diameters 80 mm, 100 mm and 150 mm only, by increasing mass to 140/84,

4 The longitudinal reinforcement given in this table is valid for pipes up to 2.5 m effective length for internal diameter of pipe up to 250 mm and up to 3 m effective length for higher diameter pipes.

5 Total mass of longitudinal reinforcement shall be calculated by multiplying the values given in col 4 by the length of the pipe and then deducting for the cover length provided at the two ends.

Table 10A Design and Strength Test Requirements of Concrete Pipes of Class P2 — Reinforced Concrete Pressure Pipes Safe for 0.4 MPa Pressure Test Made by Vibration Casting Process
(Clauses 6.1.1, 6.1.2.1, 6.1.3, 6.2.2, 7.3.2, 8.1 and Table 20)

Internal Diameter of Pipes mm (1)	Barrel Wall Thickness mm (2)	Reinforcements		
		Longitudinal, Mild Steel or Hard Drawn Steel		Spirals, Hard Drawn Steel
		Minimum Number (3)	kg/linear metre (4)	kg/linear metre (5)
400	50	8	0.78	6.36
450	50	8	0.78	7.96
500	55	8	0.78	9.80
600	65	8	1.76	14.10
700	70	8	1.76	21.90
800	80	8 or 6 + 6	2.66	28.54
900	90	8 or 6 + 6	2.66	35.92
1000	100	6 + 6	2.66	43.48

NOTES

- 1 Strength requirements for pressure pipes shall be the same as for NP-2 class pipes.
- 2 If mild steel is used for spiral reinforcement, the mass specified under col 5 shall be increased to 140/125.
- 3 The longitudinal reinforcement given in this table is valid for pipes up to 3 m effective length.
- 4 Total mass of longitudinal reinforcement shall be calculated by multiplying the values given in col 4 by the length of the pipe and then deducting for the cover length provided at the two ends.

Table 11 Design and Strength Test Requirements of Concrete Pipes of Class P3 — Reinforced

Internal Diameter of Pipes mm (1)	Barrel Wall Thickness mm (2)	Reinforcements		
		Longitudinal, Mild Steel or Hard Drawn Steel		Spirals, Hard Drawn Steel
		Minimum Number (3)	kg/linear metre (4)	kg/linear metre (5)
80	25	6	0.59	0.45
100	25	6	0.59	0.66
150	25	6	0.59	1.39
200	35	6	0.59	2.49
225	35	6	0.59	3.10
250	35	6	0.59	3.78
300	45	8	0.78	5.49
350	55	8	0.78	7.52
400	60	8	0.78	9.78
450	70	8	0.78	13.06
500	75	8	0.78	15.96
600	90	8 or 6 + 6	2.66	22.63
700	105	6 + 6	2.66	30.82
800	120	6 + 6	2.66	39.46

NOTES

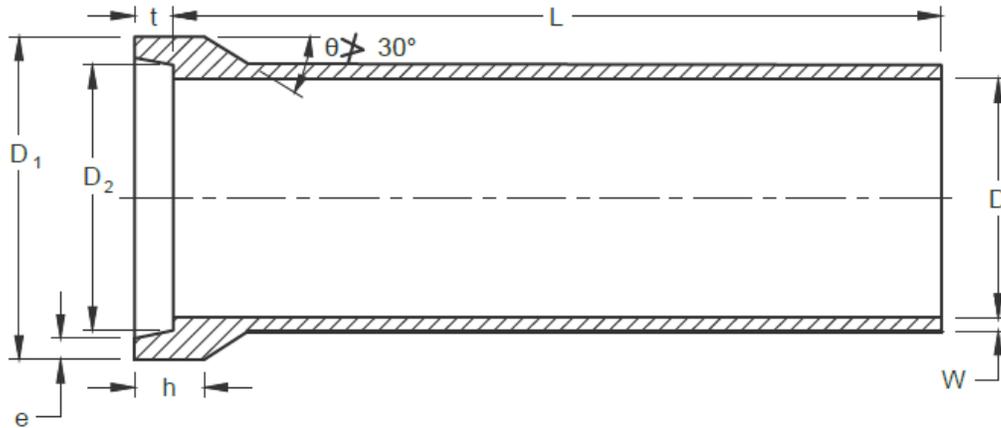
- 1 Strength requirements for pressure pipes shall be the same as for NP-2 class pipes.
- 2 If mild steel is used for spiral reinforcement, the mass specified under col 5 shall be increased to 140/125.
- 3 Soft grade mild steel wire for spirals may be used for pipes of internal diameters 80 mm, 100 mm and 150 mm only, by increasing mass to 140/84,
- 4 The longitudinal reinforcement given in this table is valid for pipes up to 2.5 m effective length for internal diameter of pipe up to 250 mm and up to 3 m effective length for higher diameter pipes.
- 5 Total mass of longitudinal reinforcement shall be calculated by multiplying the values given in col 4 by the length of the pipe and then deducting for the cover length provided at the two ends.

Table 11A Design and Strength Test Requirements of Concrete Pipes of Class P3 — Reinforced Concrete Pressure Pipes Safe for 0.6 MPa Pressure Test Made by Vibration Casting Process
(Clauses 6.1.1, 6.1.2.1, 6.1.3, 6.2.2, 7.3.2, 8.1 and Table 20)

Internal Diameter of Pipes mm (1)	Barrel Wall Thickness mm (2)	Reinforcements		
		Longitudinal, Mild Steel or Hard Drawn Steel		Spirals, Hard Drawn Steel
		Minimum Number (3)	kg/linear metre (4)	kg/linear metre (5)
350	55	8	0.78	7.52
400	60	8	0.78	9.78
450	70	8	0.78	13.06
500	75	8	0.78	15.96
600	90	8 or 6 + 6	2.66	22.63
700	105	6 + 6	2.66	30.82
800	120	6 + 6	2.66	39.46

NOTES

- 1 Strength requirements for pressure pipes shall be the same as for NP-2 class pipes.
- 2 If mild steel is used for spiral reinforcement, the mass specified under col 5 shall be increased to 140/125.
- 3 The longitudinal reinforcement given in this table is valid for pipes up to 3 m effective length.
- 4 Total mass of longitudinal reinforcement shall be calculated by multiplying the values given in col 4 by the length of the pipe and then deducting for the cover length provided at the two ends.



All dimensions in millimetres.

D	W	D1	D2	E	h	T
(1)	(2)	(3)	(4)	(5)	(6)	(7)
80	25	206	156	22	60	45
100	25	226	176	22	60	45
150	25	276	226	22	65	50
250	25	376	326	22	70	55
300	30	452	392	26	75	60
350	32	510	446	28	80	65
400	32	560	496	28	80	65
450	35	628	558	31	85	70

NOTE — The dimensions D_2 , h and e shall conform to the values given in this table as these are critical dimensions. The following tolerances shall apply on the critical dimensions:

$D_2 = \pm 3$ mm for pipes up to and including 300 mm diameter

+ 4 mm for pipes over 300 mm

internal diameter $h = \pm 3$ mm for

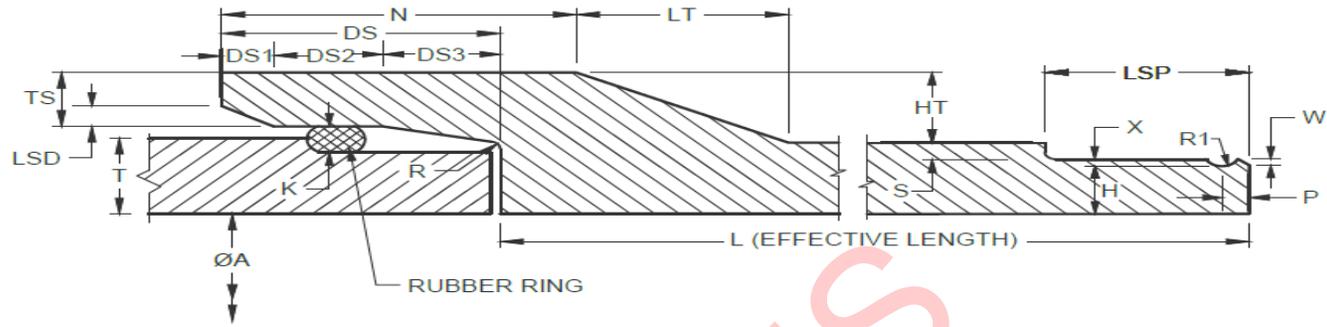
dimensions up to 60 mm

+ 5 mm for dimensions above 60 mm

$e = \pm 2$ mm for dimensions up to 30 mm

+ 3 mm for dimensions above 30 mm

Table 13 Spigot and Socket Dimensions of NP-2 and P-1 Class Pipes (Rubber Ring Roll on Joint) pipes made by Spinning Process
(Clauses 6.3 and 8.2)



All dimensions in millimetres

Pipe Diameter ϕA	Rubber Ring Chord Diameter	Rubber Ring Internal Diameter	T	TS	DS	DS1	DS2	DS3	R	LSD	K	N	LT	HT	LSP	P	S	H	X	W	R1
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
80	11	102	25	32.5	70	8	28	34	3	5.5	6.5	95	84	34	50	7	5.5	19.5	1	1	5.5
100	11	120	25	32.5	70	8	28	34	3	5.5	6.5	95	84	34	50	7	5.5	19.5	1	1	5.5
150	11	170	25	32.5	70	8	28	34	3	5.5	6.5	95	84	34	50	7	5.5	19.5	1	1	5.5
200	11	215	25	32.5	70	8	28	34	3	5.5	6.5	95	84	34	50	7	5.5	19.5	1	1	5.5
225	11	225	25	32.5	70	8	28	34	3	5.5	6.5	95	84	34	50	7	5.5	19.5	1	1	5.5
250	11	250	25	32.5	70	8	28	34	3	5.5	6.5	95	84	34	50	7	5.5	19.5	1	1	5.5
300	12	315	30	35	77	9	31	37	3	6	7	107	92	37	55	7.5	6	24	1	1	6
350	12	360	32	37	77	9	31	37	3	6	7	109	96	39	55	7.5	6	26	1	1	6
400	12	400	32	37	77	9	31	37	3	6	7	109	96	39	55	7.5	6	26	1	1	6
450	12	450	35	40	77	9	31	37	3	6	7	112	104	42	55	7.5	6	29	1	1	6
500	12	500	35	40	77	9	31	37	3	6	7	112	104	42	55	7.5	6	29	1	1	6
600	16	590	45	49	102	12	42	48	6	9	9.5	132	106	47	72	10	7.5	37.5	2	2	8

Table 13 (Concluded)

700	16	680	50	56	102	12	42	48	6	9	9.5	132	106	47	72	10	9.5	40.5	2	2	8
800	20	785	50	56	128	15	52	61	6	11	11.5	162	117	52	90	12.5	9.5	40.5	2	2	10
900	20	875	55	60	128	15	52	61	6	11	11.5	165	133	59	90	12.5	10.5	44.5	2	2	10
1 000	22	980	60	65	141	17	57	67	8	12	13.5	169	137	64	99	14	10.5	49.5	2	2	11
1 100	22	1070	65	71	141	17	57	67	8	12	13.5	171	148	69	99	14	10.5	54.5	2	2	11
1 200	22	1170	70	76	141	17	57	67	8	12	13.5	173	161	75	99	14	10.5	59.5	2	2	11
1 400	22	1370	75	82	141	17	57	67	8	12	13.5	179	184	86	99	14	10.5	64.5	2	2	11
1 600	25	1560	80	87	165	20	67	78	8	15	15	205	195	91	100	15	12	68	2.5	2.5	12
1 800	25	1780	90	99	165	20	67	78	8	15	15	210	221	103	100	15	12	78	2.5	2.5	12
2 000	25	1935	100	109	165	20	67	78	8	15	15	215	242	113	100	15	12	88	2.5	2.5	12
2 200	25	2130	110	119	165	20	67	78	8	15	15	220	264	123	100	15	12	98	2.5	2.5	12

NOTES

1 Important dimensions of socket and spigot to be checked in socket and spigot pipes.

- a. Socket inside diameter each pipe
- b. Spigot outside diameter each pipe

The procedure for the inspection is given in **10** of IS 3597.

2 For the dimensional checks, dimensions of few Pipes have to be checked from each mould to ensure that mould is accurate. Later on it is not necessary to check these dimensions.

3 Corners to be rounded off.

4 Tolerances:

Dimensions	Tolerances
T and HT	Same as that of barrel wall thickness given in 8.2
TS and H	Half the tolerance on barrel wall thickness given in 8.2
DS2, DS3, LSP, K & S	The tolerance, in mm, shall be given as below:

Chord Diameter	DS2	DS3	LSP	K	S
11	± 2.0	± 3.0	± 4.00	± 1.25	± 0.75
12	± 2.0	± 3.0	± 4.00	± 1.25	± 0.75
16	± 2.5	± 3.5	± 5.00	± 2.00	± 1.25
20	± 3.0	± 4.0	± 5.50	± 2.25	± 1.50
22	± 3.5	± 4.5	± 6.25	± 2.75	± 1.75
25	± 4.0	± 5.0	± 7.00	± 3.25	± 2.00

5 In order to ascertain the correctness of mould, 5 percent of the pipes be randomly selected from each control unit and checked for all critical dimensions.

Table 13A (Concluded)

NOTES

1 Important dimension of socket and spigot to be checked in socket and spigot pipes.

- a. Socket inside diameter each pipe
- b. Spigot outside diameter each pipe

2 The procedure for the inspection is given in **10** of IS 3597.

3 Corners to be rounded off.

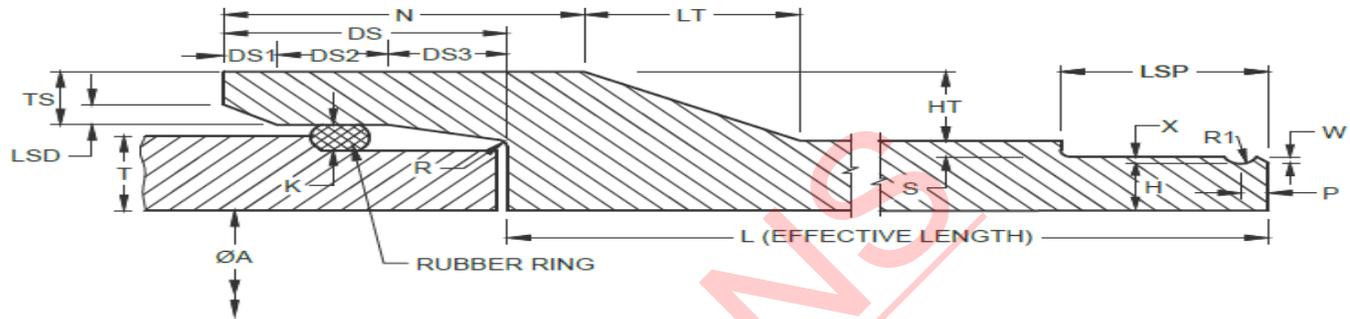
4 Tolerances:

Dimensions	Tolerances
T and HT	Same as that of barrel wall thickness given in 8.2
TS and H	Half the tolerance on barrel wall thickness given in 8.2
DS2, DS3, LSP, K and S	The tolerance, in mm, shall be given as below:

Chord Diameter	DS2	DS3	LSP	K	S
16	± 2.5	± 3.5	± 5.00	± 2.00	± 1.25
20	± 3.0	± 4.0	± 5.50	± 2.25	± 1.50
22	± 3.5	± 4.5	± 6.25	± 2.75	± 1.75
25	± 4.0	± 5.0	± 7.00	± 3.25	± 2.00

5 In order to ascertain the correctness of mould, 5 percent of the pipes be randomly selected from each control unit and checked for all critical dimensions.

Table 14 Spigot and socket Dimensions of NP3 and NP4 Class pipes (Rubber Ring Roll on Joint) from 80 to 900 mm



All dimensions in millimetres

Pipe Diameter ϕA	Rubber Ring Chord Diameter	Rubber Ring Internal Diameter	T	TS	DS	DS1	DS2	DS3	R	LSD	K	N	LT	HT	LSP	P	S	H	X	W	R1
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
80	11	102	25	32.5	70	8	28	34	3	5.5	6.5	95	84	34	50	7	5.5	19.5	1	1	5.5
100	11	120	25	32.5	70	8	28	34	3	5.5	6.5	95	84	34	50	7	5.5	19.5	1	1	5.5
150	11	170	25	32.5	70	8	28	34	3	5.5	6.5	95	84	34	50	7	5.5	19.5	1	1	5.5
200	11	230	30	38	83	11	38	34	5	6.5	6.5	113	97	39.5	50	7	5.5	24.5	1	1	5.5
225	11	255	30	38	83	11	38	34	5	6.5	6.5	113	97	39.5	50	7	5.5	24.5	1	1	5.5
250	11	275	30	38	83	11	38	34	5	6.5	6.5	113	97	39.5	50	7	5.5	24.5	1	1	5.5
300	12	340	40	51	90	12	42	36	6	7	7	130	130	53	55	7.5	6	34	1	1	6
350	16	435	75	75	120	16	56	48	8	10	10	158	135	78	72	10	8	67	2	2	8
400	16	480	75	75	120	16	56	48	8	10	10	158	135	78	72	10	8	67	2	2	8
450	16	525	75	75	120	16	56	48	8	10	10	158	135	78	72	10	8	67	2	2	8
500	16	570	75	75	120	16	56	48	8	10	10	158	135	78	72	10	8	67	2	2	8
600	20	675	85	85	150	20	70	60	10	12	12	193	153	88.5	90	12	10	75	2	2	10
700	20	765	85	85	150	20	70	60	10	12	12	193	153	88.5	90	12	10	75	2	2	10
800	20	875	95	95	150	20	70	60	10	12	12	197	171	98.5	90	12	10	85	2	2	10
900	20	970	100	100	150	20	70	60	10	12	12	200	180	103.5	90	12	10	90	2	2	10

Table 14 (Concluded)

NOTES

1 Important dimensions of socket and spigot to be checked in socket and spigot pipes.

- a. Socket inside diameter each pipe
- b. Spigot outside diameter each pipe

The procedure for the inspection is given in 10 of IS 3597.

2 Corners to be rounded off.

3 Tolerances

Dimensions

Tolerances

T and HT

Same as that of barrel wall thickness given in 8.2

TS and H

Half the tolerance on barrel wall thickness given in 8.2

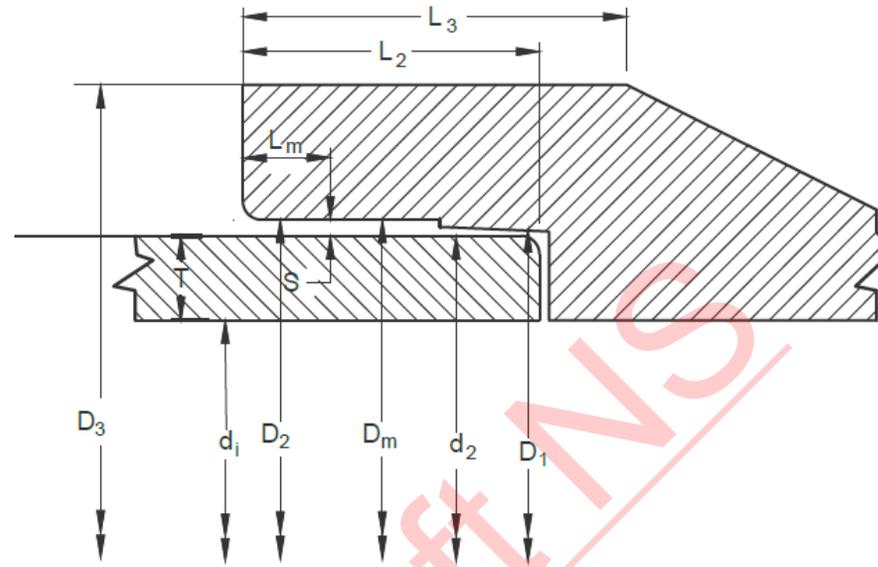
DS2, DS3, LSP, K and S

The tolerance, in mm, shall be given as below:

Chord Diameter	DS2	DS3	LSP	K	S
11	±2.0	±3.0	±4.00	±1.25	±0.75
12	±2.0	±3.0	±4.00	±1.25	±0.75
16	±2.5	±3.5	±5.00	±2.00	±1.25
20	±3.0	±4.0	±5.50	±2.25	±1.50

4 In order to ascertain the correctness of mould, 5 percent of the pipes be randomly selected from each control unit and checked for all critical dimension.

Table 15A Spigot and Socket Dimensions for NP3 and NP4 Unreinforced Pipes Made by Vibration Casting Process from 100 to 250 mm Diameter



All dimensions in millimetres

d_1	G	R	T	d_2	D_1	D_2	D_3	L_2	D_m	L_m	L_3	S
100	11	119	24	148	152	163	213	61.5	162	20.5	65	6.9 ± 1.1
150	13	172	28	206	210	224	282	68.5	222	23.5	70	8.1 ± 1.3
200	13	220	32	264	268	282	348	68.5	280	23.5	70	8.1 ± 1.3
250	13	268	37	324	328	342	418	68.5	340	23.5	70	8.1 ± 1.3

NOTES

1 G is the diameter of the un-stretched rubber chord, hardness 40 ± 5 IRHD, stretching 15 percent.

2 R is the inner diameter of the un-stretched rubber ring.

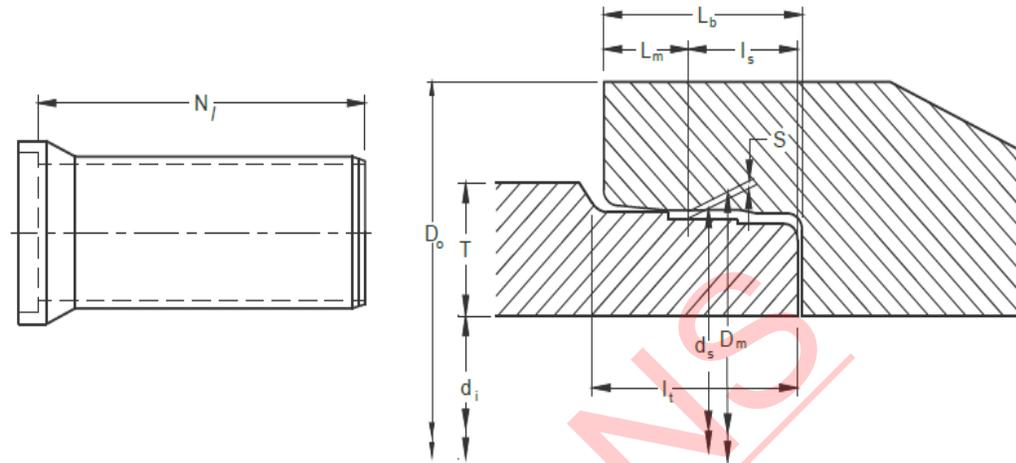
3 T is the nominal barrel wall thickness.

4 D_3 , D_m , L_m and L_3 are nominal dimensions.

5 Tolerance on $D_3 \pm 4$, $L_3 \pm 2$, $S \pm 1.3$.

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Table 15B Spigot and Socket Dimensions for NP-3 Reinforced and Unreinforced +NP-4 Reinforced Pipes Made by Vibration Casting/Spun Process from 300 to 1 800 mm Diameter



All dimensions in millimetres

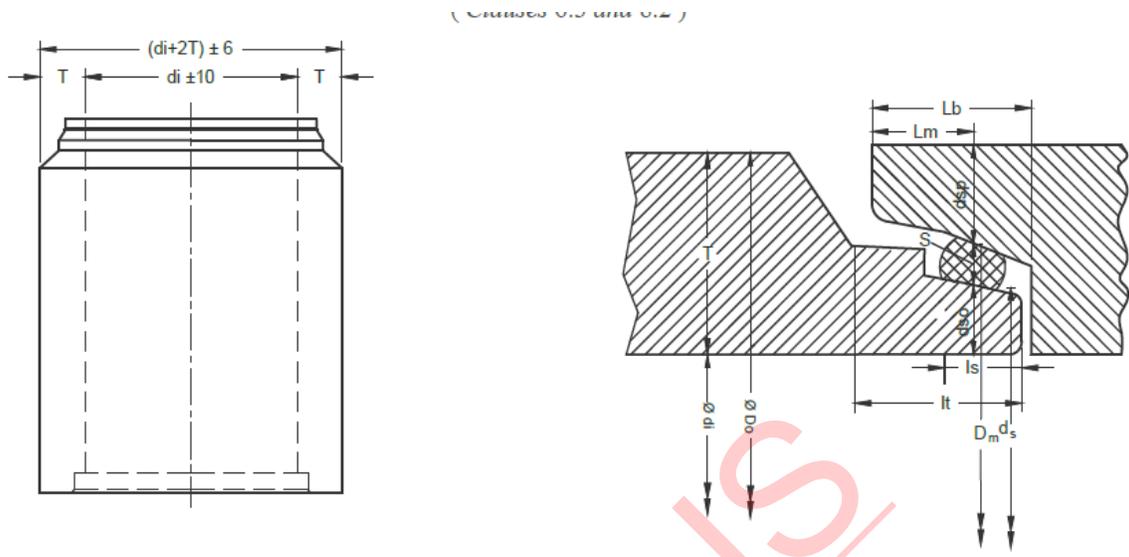
d_i	G	R	T	D_o	I_t	L_b	d_m	D_m	L_m	I_s	S
300 ± 4	13	322	50	487 ± 4	112 ± 4	105 ± 2	370.07	386.07	49	50	8.00 ± 1.0
350 ± 5	13	370	55	555 ± 4	112 ± 4	105 ± 2	425.07	441.07	49	50	8.00 ± 1.0
400 ± 5	13	417	60	615 ± 4	112 ± 4	105 ± 2	480.07	496.07	49	50	8.00 ± 1.0
450 ± 5	13	465	65	680 ± 4	112 ± 4	105 ± 2	536.07	552.07	49	50	8.00 ± 1.0
500 ± 5	13	513	70	735 ± 4	112 ± 4	105 ± 2	590.07	606.07	49	50	8.00 ± 1.0
600 ± 5	13	609	75	850 ± 4	112 ± 4	105 ± 2	700.07	716.07	49	50	8.00 ± 1.0
700 ± 7	18	706	85	980 ± 5	141 ± 5	132 ± 3	808.00	830.00	61	65	11.00 ± 1.2
800 ± 7	18	803	95	1100 ± 5	141 ± 5	132 ± 3	924.00	946.00	61	65	11.00 ± 1.2
900 ± 7	18	901	100	1215 ± 5	141 ± 5	132 ± 3	1036.00	1058.00	61	65	11.00 ± 1.2
1000 ± 7	18	998	115	1330 ± 5	141 ± 5	132 ± 3	1148.00	1170.00	61	65	11.00 ± 1.2
1100 ± 7	24	1097	120	1520 ± 6	155 ± 6	145 ± 3	1262.00	1291.30	72	63	14.65 ± 1.5
1200 ± 7	24	1195	125	1640 ± 6	155 ± 6	145 ± 3	1372.48	1401.78	72	63	14.65 ± 1.5
1400 ± 10	24	1383	140	1870 ± 6	155 ± 6	145 ± 3	1590.91	1620.21	72	63	14.65 ± 1.5

Table 15B (Concluded)

d_i	G	R	T	D_o	I_t	L_b	d_m	D_m	L_m	I_s	S
1600 ± 10	24	1578	165	2100 ± 6	155 ± 6	145 ± 3	1814.91	1844.21	72	63	14.65 ± 1.5
1800 ± 10	24	1774	180	2340 ± 6	155 ± 6	145 ± 3	2040.00	2069.30	72	63	14.65 ± 1.5
<p>NOTES</p> <p>1 G is the diameter of the un-stretched rubber chord hardness 40 ± 5 IRHD stretching 15 percent.</p> <p>2 R is the inner diameter of the un-stretched rubber ring.</p> <p>3 T is the nominal barrel wall thickness.</p> <p>4 d_s, D_m, L_m, and I_s are nominal dimensions.</p> <p>5. Tolerance on $D_o \pm 4$, $I_b \pm 2$, $S \pm 1.3$.</p>											

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Table 15C Spigot and Socket Dimensions of single offset joint (in wall joint) for NP3 and NP4 Reinforced Pipes Made by Vertical Vibrated Casting Process from 1400 to 2400 mm Diameter



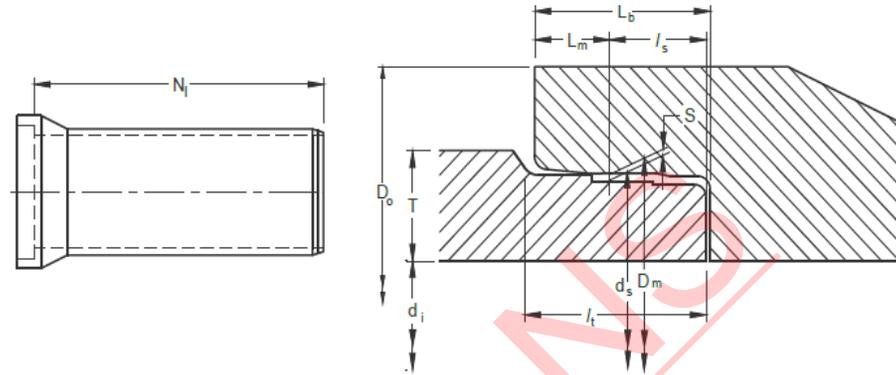
All dimensions in millimetres

d_i	G	R	T	I_t	L_b	d_i	D_m	L_m	I_s	S	Do	d_{so}	d_{sp}
1 400 ± 10	24	1320	140	130	130	1516	1545	70	52	15	1680	67	58
1 600 ± 10	24	1520	165	130	130	1745	1774	70	52	15	1930	78	72
1 800 ± 10	24	1705	180	130	130	1959	1988	70	52	15	2160	86	79
2 000 ± 12	28	1890	190	130	130	2169	2204	70	52	17	2380	88	85
2 200 ± 12	28	2080	210	130	130	2389	2423	70	52	17	2620	98	95
2 400 ± 12	28	2258	225	130	130	2597	2632	70	52	17	2850	109	99

NOTES

- 1 G is the diameter of the unstretched rubber chord, hardness 40 ± 5 IRHD, stretching 15 percent.
- 2 R is the inner diameter of the unstretched rubber ring.
- 3 T is the nominal barrel wall thickness.
- 4 l_t , L_b , d_s , D_m , L_m and I_s are nominal dimensions.

Table 16 Spigot and Socket Dimensions for NP-4 Unreinforced Pipes Made by Vibration Casting/spun Process from 300 to 1800 mm Diameter



All dimensions in millimetres

d_i	G	R	T	D_o	l_t	L_b	d_s	D_m	L_m	l_s	S
300 ± 4	13	322	50	487 ± 4	112 ± 4	105 ± 2	370.07	386.07	49	50	8.00 ± 1.0
350 ± 5	13	370	55	555 ± 4	112 ± 4	105 ± 2	425.07	441.07	49	50	8.00 ± 1.0
400 ± 5	13	417	60	615 ± 4	112 ± 4	105 ± 2	480.07	496.07	49	50	8.00 ± 1.0
450 ± 5	13	465	65	680 ± 4	112 ± 4	105 ± 2	536.07	552.07	49	50	8.00 ± 1.0
500 ± 5	13	513	70	735 ± 4	112 ± 4	105 ± 2	590.07	606.07	49	50	8.00 ± 1.0
600 ± 5	13	609	75	850 ± 4	112 ± 4	105 ± 2	700.07	716.07	49	50	8.00 ± 1.0
700 ± 7	18	706	85	980 ± 5	141 ± 5	132 ± 3	808.00	830.00	61	65	11.00 ± 1.2
800 ± 7	18	803	95	1100 ± 5	141 ± 5	132 ± 3	924.00	946.00	61	65	11.00 ± 1.2
900 ± 7	18	901	100	1215 ± 5	141 ± 5	132 ± 3	1036.00	1058.00	61	65	11.00 ± 1.2
1000 ± 7	18	998	115	1330 ± 5	141 ± 5	132 ± 3	1148.00	1170.00	61	65	11.00 ± 1.2
1100 ± 7	24	1097	120	1520 ± 6	155 ± 6	145 ± 3	1262.00	1291.30	72	63	14.65 ± 1.5
1200 ± 7	24	1195	125	1640 ± 6	155 ± 6	145 ± 3	1372.48	1401.78	72	63	14.65 ± 1.5
1400 ± 10	24	1383	140	1870 ± 6	155 ± 6	145 ± 3	1590.91	1620.21	72	63	14.65 ± 1.5

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Table 16 (Concluded)

d_i	G	R	T	D_o	l_t	L_b	d_s	D_m	L_m	l_s	S
1600 ± 10	24	1578	165	2100 ± 6	155 ± 6	145 ± 3	1814.91	1844.21	72	63	14.65 ± 1.5
1800 ± 10	24	1774	180	2340 ± 6	155 ± 6	145 ± 3	2040.00	2069.30	72	63	14.65 ± 1.5

NOTES

1 G is the diameter of the un-stretched rubber chord. Hardness 40 ± 5 IRHD stretching 15 percent.

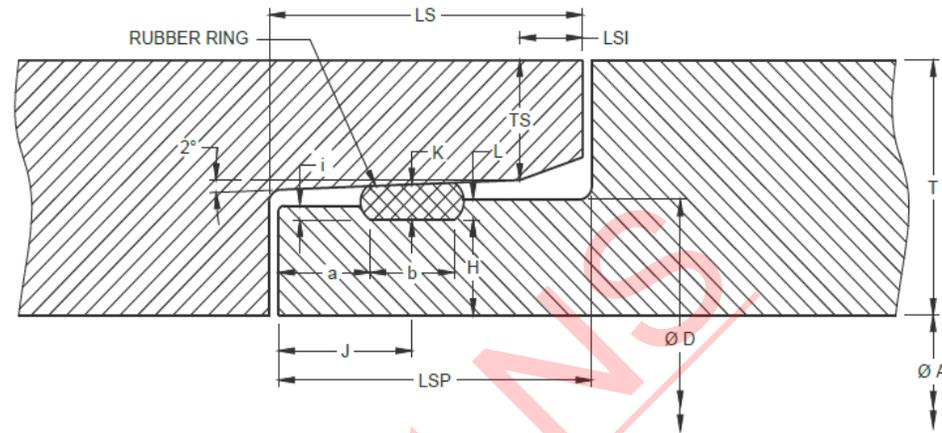
2 R is the inner diameter of the un-stretched rubber ring.

3 T is the nominal barrel wall thickness.

4 d_s , D_m , L_m and l_s are nominal dimensions.

Draft NS

Table 17 Spigot and Socket Dimensions of NP-3 and NP-4 Glass from 1000 to 2600 mm Diameter (Rubber Ring Confined Joint)



All dimensions in millimetres

Pipe Diameter ϕA	Rubber Ring Chord Diameter	Rubber Ring Internal Dia.	T	TS	LS	LSI	K	LSP	a	b	J	H	i	L	ϕD
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1000	20	920	115	58.0	114	20	13	114	25	28	39	42	4	9	1102
1100	20	1003	115	58.0	114	20	13	114	25	28	39	42	4	9	1202
1200	20	1095	120	60.5	114	20	13	114	25	28	39	44.5	4	9	1307
1400	25	1275	135	67.5	114	20	16	114	25	35	42.5	50	4	10	1520
1600	25	1445	140	72.5	114	25	16	114	25	35	42.5	50	4	10	1720
1800	25	1620	150	77.5	114	25	16	114	25	35	42.5	55	4	10	1930
2000	25	1810	170	87.5	114	25	16	114	25	35	42.5	65	4	10	2150
2200	25	1995	185	95.0	114	25	16	114	25	35	42.5	72.5	4	10	2365
2400	25	2180	200	102.5	114	25	16	114	25	35	42.5	80	4	10	2580
2600	25	2360	215	110.0	114	25	16	114	25	35	42.5	87.5	4	10	2795

Draft NS

Table 17 (Concluded)

NOTES

1 Important dimensions of socket and spigot to be checked in socket and spigot pipes.

- a. Socket inside diameter — each pipe
- b. Spigot outside diameter — each pipe

The procedure for the inspection is given in 10 of IS 3597.

2 Corners to be rounded off.

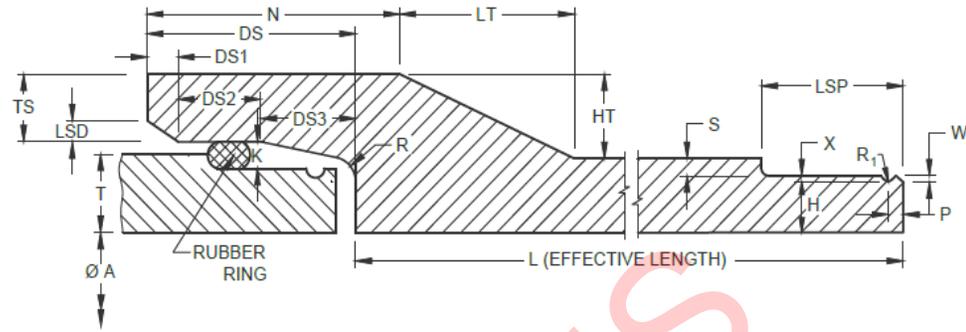
3 Tolerances on spigot and socket

Dimensions	Tolerances
<i>Ls</i> and <i>LSP</i>	± 7 mm
<i>T</i>	Same as that of barrel wall thickness given in 8.2
<i>H</i> and <i>TS</i>	Half the tolerance on barrel wall thickness given in 8.2
<i>L</i>	± 0.5 mm
<i>b</i>	± 1 mm for 28 mm and ± 1.5 mm for 35 mm
<i>k</i>	± 2.5 mm for 25 mm rubber ring chord diameter

4 In order to ascertain the correctness of mould, 5 percent of the pipes be randomly selected from each control unit and checked for all critical dimensions

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Table 18 Spigot and Socket Dimensions of P2 Class Pipes (Rubber Ring Roll on Joint)



All dimensions in millimetres

Pipe Diameter ϕA	Rubber Ring Chord Diameter	Rubber Ring Internal Diameter	T	TS	DS	$DS1$	$DS2$	$DS3$	R	LSD	K	N	LT	HT	LSP	P	S	H	X	W	R_1
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
80	11	102	25	32.5	70	8	28	34	3	5.5	6.5	95	84	34	50	7	5.5	19.5	1	1	5.5
100	11	120	25	32.5	70	8	28	34	3	5.5	6.5	95	84	34	50	7	5.5	19.5	1	1	5.5
150	11	170	25	32.5	70	8	28	34	3	5.5	6.5	95	84	34	50	7	5.5	19.5	1	1	5.5
200	11	230	30	38	83	11	38	34	5	6.5	6.5	113	97	39.5	50	7	5.5	24.5	1	1	5.5
225	11	255	30	38	83	11	38	34	5	6.5	6.5	113	97	39.5	50	7	5.5	24.5	1	1	5.5
250	11	275	30	38	83	11	38	34	5	6.5	6.5	113	97	39.5	50	7	5.5	24.5	1	1	5.5
300	12	340	40	51	90	12	42	36	6	7	7	130	130	53	55	7.5	6	34	1	1	6
350	12	400	45	57	90	12	42	36	6	7	7	135	145	59	55	7.5	6	39	1	1	6
400	12	450	50	61	90	12	42	36	6	7	7	140	155	63	55	7.5	6	44	1	1	6
450	12	500	50	61	90	12	42	36	6	7	7	140	155	63	55	7.5	6	44	1	1	6
500	12	525	55	67	90	12	42	36	6	7	7	145	170	69	55	7.5	6	49	1	1	6
600	16	640	65	79	120	16	56	48	8	10	9.5	185	185	82	72	10	7.5	57.5	2	2	8
700	16	740	70	84	120	16	56	48	8	10	9.5	190	195	87	72	10	7.5	62.5	2	2	8
800	20	845	80	96	150	20	70	60	10	12	12	230	225	100	90	12.5	9.5	70.5	2	2	10
900	20	970	90	108	150	20	70	60	10	12	12	240	250	112	90	12.5	9.5	80.5	2	2	10
1000	22	1060	100	120	165	22	77	66	11	13	13	265	265	124	99	14	10.5	89.5	2	2	11

Table 18 (Concluded)

NOTES

1 Important dimensions of socket and spigot to be checked in socket and spigot pipes.

- a. Socket inside diameter — each pipe
- b. Spigot outside diameter — each pipe

The procedure for the inspection of Spigot and Socket dimensions is given in 10 of IS 3597.

2 Corners to be rounded off.

3 Tolerances

Dimensions

T and HT

TS and H

DS2, DS3, LSP, K and S

Tolerances

Same as that of barrel wall thickness given in 8.2

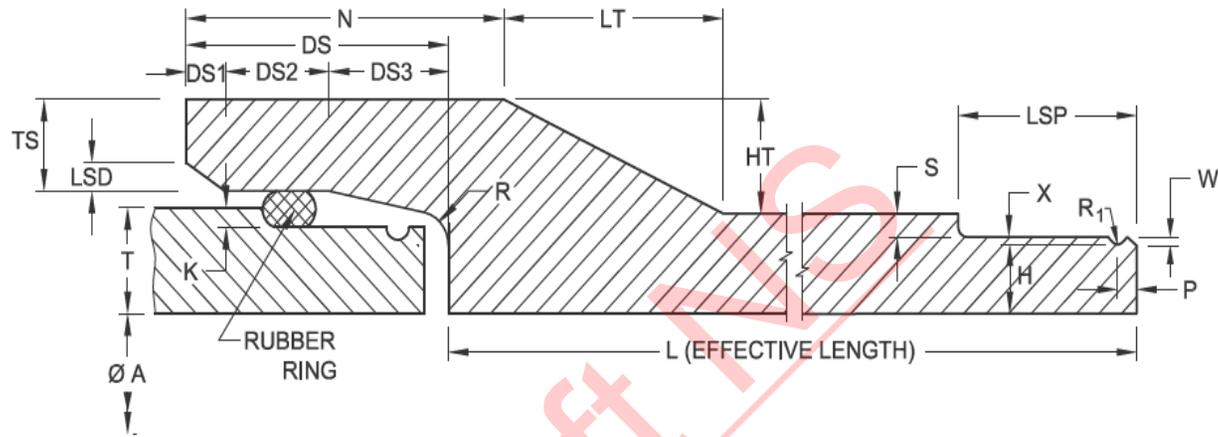
Half the tolerance on barrel wall thickness given in 8.2

The tolerance, in mm, shall be given as below:

Chord Diameter	DS2	DS3	LSP	K	S
11	±2.0	±3.0	±4.00	±1.25	±0.75
12	±2.0	±3.0	±4.00	±1.25	±0.75
16	±2.5	±3.5	±5.00	±2.00	±1.25
20	±3.0	±4.0	±5.5	±2.25	±1.50
22	±3.5	±4.5	±6.00	±2.75	±1.50

4 In order to ascertain the correctness of mould, 5 percent of the pipes be randomly selected from each control unit and checked for all critical dimensions

Table 18A Spigot and Socket Dimensions of P2 Class Pipes (Rubber Ring Confined Joint) Pipes Made by Vibrated Casting Process



All dimensions in millimetres

Pipe Diameter ϕA	Rubber Ring Chord Diameter	Rubber Ring Internal Diameter	T	TS	DS	DS1	DS2	DS3	R	LSD	K	N	LT	HT	LSP	P	S	H	X	W	R ₁
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
400	12	450	50	61	90	12	42	36	6	7	7	140	155	63	55	7.5	6	44	1	1	6
450	12	500	50	61	90	12	42	36	6	7	7	140	155	63	55	7.5	6	44	1	1	6
500	12	525	55	67	90	12	42	36	6	7	7	145	170	69	55	7.5	6	49	1	1	6
600	16	640	65	79	120	16	56	48	8	10	9.5	185	185	82	72	10	7.5	57.5	2	2	8
700	16	740	70	84	120	16	56	48	8	10	9.5	190	195	87	72	10	7.5	62.5	2	2	8
800	20	845	80	96	150	20	70	60	10	12	12	230	225	100	90	12.5	9.5	70.5	2	2	10
900	20	970	90	108	150	20	70	60	10	12	12	240	250	112	90	12.5	9.5	80.5	2	2	10
1 000	22	1060	100	120	165	22	77	66	11	13	13	265	265	124	99	14	10.5	89.5	2	2	11

Draft NS

Table 18A (Concluded)

NOTES

1 Important dimensions of socket and spigot to be checked in socket and spigot pipes.

- a. Socket inside diameter — each pipe
- b. Spigot outside diameter — each pipe

The procedure for the inspection of spigot and socket dimensions is given in 10 of IS 3597.

2 Corners to be rounded off.

3 Tolerances

Dimensions

T and *HT*

TS and *H*

DS2, *DS3*, *LSP*, *K* and *S*

Tolerances

Same as that of barrel wall thickness given in 8.2

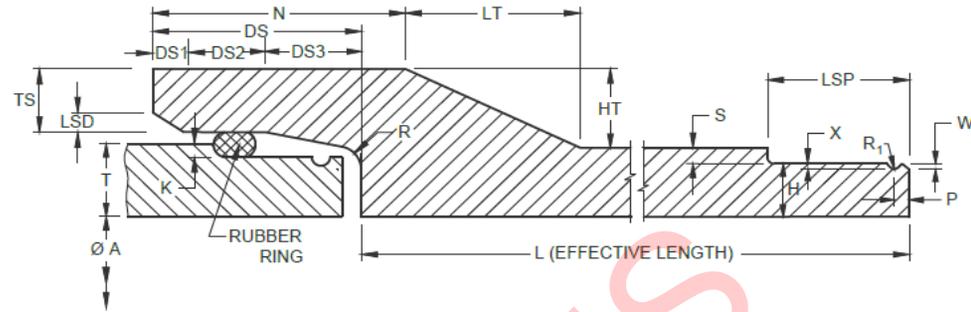
Half the tolerance on barrel wall thickness given in 8.2

The tolerance, in mm, shall be given as below:

Chord Diameter	<i>DS2</i>	<i>DS3</i>	<i>LSP</i>	<i>K</i>	<i>S</i>
12	±2.0	±3.0	±4.0	±1.25	±0.75
16	±2.5	±3.5	±5.0	±2.00	±1.25
20	±3.0	±4.0	±5.5	±2.25	±1.50
22	±3.5	±4.5	±6.0	±2.75	±1.50
22	±3.5	±4.5	±6.0	±2.75	±1.50

4 In order to ascertain the correctness of mould, 5 percent of the pipes be randomly selected from each control unit and checked for all critical dimensions.

Table 19 Spigot and Socket Dimensions of P3 Class Pipes (Rubber Ring Roll on Joint)



All dimensions in millimetres

Pipe Diameter ϕA	Rubber Ring Chord Diameter	Rubber Ring Internal Diameter	T	TS	DS	DS1	DS2	DS3	R	LSD	K	N	LT	HT	LSP	P	S	H	X	W	R ₁
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
80	11	102	25	32.5	70	8	28	34	3	5.5	6.5	95	84	34	50	7	5.5	19.5	1	1	5.5
100	11	120	25	32.5	70	8	28	34	3	5.5	6.5	95	84	34	50	7	5.5	19.5	1	1	5.5
150	11	170	25	32.5	70	8	28	34	3	5.5	6.5	95	84	34	50	7	5.5	19.5	1	1	5.5
200	11	230	35	45	83	11	38	34	5	5.5	6.5	120	115	46.5	50	7	5.5	29.5	1	1	5.5
225	11	255	35	45	83	11	38	34	5	5.5	6.5	120	115	46.5	50	7	5.5	29.5	1	1	5.5
250	11	275	35	45	83	11	38	34	5	5.5	6.5	120	115	46.5	50	7	5.5	29.5	1	1	5.5
300	12	340	45	60	90	12	42	36	6	7	7	135	150	62	55	7.5	6	39	1	1	6
350	12	400	55	75	90	12	42	36	6	7	7	145	190	77	55	7.5	6	49	1	1	6
400	12	450	60	80	90	12	42	36	6	7	7	150	200	82	55	7.5	6	54	1	1	6
450	12	525	70	95	90	12	42	36	6	7	7	160	240	97	55	7.5	6	64	1	1	6
500	12	570	75	100	90	12	42	36	6	7	7	165	250	102	55	7.5	6	69	1	1	6
600	16	680	90	120	120	16	56	48	8	10	9.5	190	275	123	72	10	7.5	82.5	2	2	8
700	16	805	105	140	120	16	56	48	8	10	9.5	200	320	143	72	10	7.5	97.5	2	2	8
800	20	915	120	160	150	20	70	60	10	12	11.5	240	365	164	90	12.5	9.5	110.5	2	2	10

Table 19 (Concluded)

NOTES

Important dimensions of socket and spigot to be checked in socket and spigot pipes.

- 1 a. Socket inside diameter — each pipe
- b. Spigot outside diameter — each pipe

The procedure for the inspection of spigot and socket dimensions is given in 10 of IS 3597.

2 Corners to be rounded off.

3 Tolerances

Dimensions

T and *HT*

TS and *H*

DS2, *DS3*, *LSP*, *K* and *S*

Tolerances

Same as that of barrel wall thickness given in 8.2

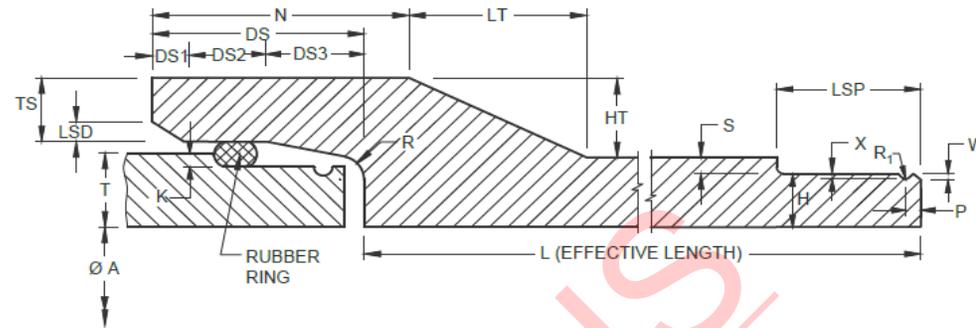
Half the tolerance on barrel wall thickness given in 8.2

The tolerance, in mm, shall be given as below:

Chord Diameter	<i>DS2</i>	<i>DS3</i>	<i>LSP</i>	<i>K</i>	<i>S</i>
11	±2.0	±3.0	±4.0	±1.25	±0.75
12	±2.0	±3.0	±4.0	±1.25	±0.75
16	±2.5	±3.5	±5.0	±2.00	±1.25
20	±3.0	±4.0	±5.5	±2.25	±1.50

4 In order to ascertain the correctness of mould, 5 % of the pipes be randomly selected from each control unit and checked for all critical dimensions.

Table 19A Spigot and Socket Dimensions of P3 Class Pipes (Rubber Ring Roll on Joint) Pipes Made by Vibration Casting Process



All dimensions in millimetres

Pipe Diameter ϕA	Rubber Ring Chord Diameter	Rubber Ring Internal Diameter	T	TS	DS	DS1	DS2	DS3	R	LSD	K	N	LT	HT	LSP	P	S	H	X	W	R ₁
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
350	12	400	55	75	90	12	42	36	6	7	7	145	190	77	55	7.5	6	49	1	1	6
400	12	450	60	80	90	12	42	36	6	7	7	150	200	82	55	7.5	6	54	1	1	6
450	12	525	70	95	90	12	42	36	6	7	7	160	240	97	55	7.5	6	64	1	1	6
500	12	570	75	100	90	12	42	36	6	7	7	165	250	102	55	7.5	6	69	1	1	6
600	16	680	90	120	120	16	56	48	8	10	9.5	190	275	123	72	10	7.5	82.5	2	2	8
700	16	805	105	140	120	16	56	48	8	10	9.5	200	320	143	72	10	7.5	97.5	2	2	8
800	20	915	120	160	150	20	70	60	10	12	11.5	240	365	164	90	12.5	9.5	110.5	2	2	10

NOTES

1 Important dimensions of socket and spigot to be checked in socket and spigot pipes.

a. Socket inside diameter — each pipe

b. Spigot outside diameter — each pipe

The procedure for the inspection of spigot and socket dimensions is given in 10 of IS 3597.

2 Corners to be rounded off.

Table 19A (Concluded)

3 Tolerances

Dimensions

Tolerances

T and *HT*

Same as that of barrel wall thickness given in 8.2

TS and *H*

Half the tolerance on barrel wall thickness given in 8.2

DS2, *DS3*, *LSP*, *K* and *S*

The tolerance, in mm, shall be given as below:

Chord Diameter	<i>DS2</i>	<i>DS3</i>	<i>LSP</i>	<i>K</i>	<i>S</i>
12	±2.0	±3.0	±4.0	±1.25	±0.75
16	±2.5	±3.5	±5.0	±2.00	±1.25
20	±3.0	±4.0	±5.5	±2.25	±1.50

4 In order to ascertain the correctness of mould, 5 percent of the pipes be randomly selected from each control unit and checked for all critical dimensions.

Table 20 Mass of Spirals (Hard Drawn Steel) in Socket of Rubber Ring Jointed RCC Pipes of Different Classes (kg/Number)

Internal Diameter of Pipe mm (1)	NP2-R Class (2)	NP3-R Class (3)	NP4-R Class (4)	P1 Class (5)	P2 Class (6)	P3 Class (7)
80	0.08	0.08	0.08	0.08	0.08	0.08
100	0.09	0.09	0.09	0.09	0.09	0.09
150	0.12	0.12	0.12	0.12	0.12	0.15
200	0.14	0.14	0.21	0.14	0.21	0.35
225	0.15	0.15	0.26	0.15	0.26	0.43
250	0.16	0.16	0.31	0.16	0.31	0.51
300	0.45	0.45	0.53	0.45	0.53	0.84
350	0.51	0.64	0.64	0.51	0.74	1.24
400	0.56	0.71	0.71	0.56	0.99	1.66
450	0.63	0.76	0.76	0.63	1.23	2.26
500	0.68	0.87	1.08	0.68	1.57	2.85
600	0.81	1.00	2.12	1.52	2.88	4.74
700	0.92	2.16	3.02	1.79	3.96	6.79
800	1.14	2.87	4.67	2.04	6.28	9.99
900	1.50	4.06	6.03	2.63	8.29	—
1000	1.91	—	—	3.33	11.29	—
1100	2.34	—	—	4.08	—	—
1200	2.80	—	—	4.90	—	—
1400	3.82	—	—	—	—	—
1600	5.64	—	—	—	—	—
1800	7.25	—	—	—	—	—
2000	11.78	—	—	—	—	—
2200	12.88	—	—	—	—	—

NOTES

- 1 Longitudinal reinforcement shall be proportional to the length of socket cage as given in Tables 2 to 11A. (Except Table 4 and Table 7).
- 2 If mild steel is used for spiral reinforcement, the mass specified above shall be increased by a factor 140/125.
- 3 The above table is provided for guidance only.

Table 21 Design Requirements of Reinforced Concrete Collar for Pipes of Class NP2
(Clauses 6.3 and 8.1)

Nominal Internal Diameter of Pipe mm (1)	Collar Dimensions			Reinforcements		
	Minimum	Minimum	Minimum	Longitudinal, Mild Steel or Hard Drawn Steel		Spirals Hard Drawn Steel
	Caulking Space Mm (2)	Thickness mm (3)	Length mm (4)	Minimum Number (5)	Mass kg/collar (6)	kg/collar (7)
80	13	25	150	6	0.08	0.07
100	13	25	150	6	0.08	0.08
150	13	25	150	6	0.08	0.10
200	13	25	150	6	0.08	0.12
225	13	25	150	6	0.08	0.14
250	13	25	150	6	0.08	0.16
300	16	30	150	8	0.11	0.22
350	16	32	150	8	0.11	0.25
400	16	32	150	8	0.11	0.27
450	19	35	200	8	0.15	0.40
500	19	35	200	8	0.15	0.60
600	19	40	200	8	0.15	0.70
700	19	40	200	8	0.23	1.05
800	19	45	200	8	0.23	1.85
900	19	50	200	8	0.23	2.05
1 000	19	55	200	8	0.33	2.25
1 100	19	60	200	8	0.33	3.09
1 200	19	65	200	8	0.33	4.11
1 400	19	75	200	12	0.50	5.08
1 600	19	80	200	12 or 8 + 8	0.67	6.55
1 800	19	90	200	12 or 8 + 8	0.67	9.00
2 000	19	100	200	12+12	1.00	12.15
2 200	19	110	200	12+12	1.00	13.30

NOTES

1 If mild steel is used for spiral reinforcement, the mass specified under col 7 shall be increased by a factor 140/125.

2 Soft grade mild steel wires may be used for reinforcement for collars of pipes of nominal internal diameter up to 250 mm only, by increasing the mass by a factor 140/84. Where only soft grade mild steel wire is used for making collar cages, the mass of reinforcement shall be total mass of col 6 and col 7 multiplied by 140/84. This is allowed as a process requirement.

3 Internal diameter of collar to suit the actual diameter of pipes with minimum caulking space as given in col 2.

Table 22 Design Requirements of Reinforced Concrete Collars of Class NP3 - R and NP4-R Suitable for Plain Ended Non-pressure Pipes

(Clauses 6.3 and 8.1)

Nominal Internal Diameter of Pipe mm (1)	Collar Dimensions			Reinforcements		
	Minimum	Minimum	Minimum	Longitudinal, Mild Steel or Hard Drawn Steel		Spirals Hard Drawn Steel
	Caulking Space mm (2)	Thickness mm (3)	Length mm (4)	Minimum Number (5)	Mass kg/collar (6)	kg/collar (7)
80	13	25	150	6	0.08	0.07
100	13	25	150	6	0.08	0.08
150	13	25	150	6	0.08	0.10
200	13	25	150	6	0.08	0.12
225	13	25	150	6	0.08	0.14
250	13	25	150	6	0.08	0.16
300	16	30	150	8	0.11	0.22
350	16	32	200	8	0.15	0.40
400	16	32	200	8	0.15	0.50
450	19	35	200	8	0.15	0.60
500	19	35	200	8	0.15	0.70
600	19	40	200	8	0.23	1.05
700	19	40	200	8	0.23	1.85
800	19	50	200	8	0.23	2.05
900	19	50	200	8	0.33	2.25
1 000	19	55	200	8	0.33	3.09
1 100	19	65	200	8	0.33	4.11
1 200	19	75	200	12	0.50	5.08
1 400	19	80	200	12 or 8 + 8	0.67	6.55
1 600	19	90	200	12 or 8 + 8	0.67	9.00
1 800	19	100	200	12+12	1.00	12.15
2000	19	110	200	12+12	1.00	13.30

NOTES

- Collars for sizes 2200 mm and above shall be made out of mild steel plate of 6 mm thickness confirming to **table No** 24 & 25.
- If mild steel is used for spiral reinforcement, the mass specified under col 7 shall be increased by a factor 140/125.
- Soft grade mild steel wire may be used for reinforcement for collars of pipes of nominal internal diameter up to 250 mm only, by increasing the mass by a factor 140/84.

Table 23 Scale of Sampling and Permissible Number of Defectives
 (Clauses 11.1.3, 11.2.1.1 and 11.2.2)

No of Pipes in the Lot (1)	For Requirement under <i>Clauses 8 and 9</i>		Samples Size for Test Under <i>Clause 10.2</i>
	Sample Size (2)	Permissible Number of Defectives (3)	(Excluding Ultimate Load Test) (4)
Up to 50	8	0	2
51 to 100	13	1	3
101 to 300	20	2	5
301 to 500	32	3	7
501 and above	50	5	10

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Table 24 Chemical Composition

Grade Designation (1)	Quality (2)	Ladle Analysis, Percent, Max					Carbon Equivalent (CE), Max (8)	Mode of Deoxidation (9)
		C (3)	Mn (4)	S (5)	P (6)	Si (7)		
E 250	A	0.23	1.50	0.045	0.045	0.40	0.42	Semi-killed/killed
	BR B 0	0.22	1.50	0.045	0.045	0.40	0.41	Semi-killed/killed
	C	0.20	1.50	0.040	0.040	0.40	0.39	Killed
E 275	A	0.23	1.50	0.045	0.045	0.40	0.43	Semi-killed/killed
	BR B 0	0.22	1.50	0.045	0.045	0.40	0.42	Semi-killed/killed
	C	0.20	1.50	0.040	0.040	0.40	0.41	Killed
E 300	A BR B 0	0.20	1.50	0.045	0.045	0.45	0.44	Semi-killed/killed
	C	0.20	1.50	0.040	0.040	0.45	0.44	Killed
E 350	A BR B 0	0.20	1.55	0.045	0.045	0.45	0.47	Semi-killed/killed
	C	0.20	1.55	0.040	0.040	0.45	0.45	Killed
E 410	A BR B 0	0.20	1.60	0.045	0.045	0.45	0.50	Semi-killed/killed
	C	0.20	1.60	0.040	0.040	0.45	0.50	Killed
E 450	A	0.22	1.65	0.045	0.045	0.45	0.52	Semi-killed/killed
	BR							
E 550	A	0.22	1.65	0.020	0.025	0.50	0.54	Semi-killed/killed
	BR							
E 600	A	0.22	1.70	0.020	0.025	0.50	0.54	Semi-killed/killed
	BR							
E 650	A	0.22	1.70	0.015	0.025	0.50	0.55	Semi-killed/killed
	BR							

NOTES

1 New grade designation system based on minimum yield stress has been adopted.

2 For semi-killed steel, silicon shall be less than 0.10 percent. For killed steel, when the steel is killed by aluminium alone, the total aluminium content shall not be less than 0.02 percent. When the steel is killed by silicon alone, the silicon content shall not be less than 0.10 percent. When the steel is silicon-aluminium killed, the silicon content shall not be less than 0.03 percent and total aluminium content shall not be less than 0.01 percent.

3 Steels of qualities A, BR, B0 and C are generally suitable for welding processes. The weldability increases from quality A to C for grade designation E 250 and E 275.

4 Carbon equivalent (CE) would be calculated based on ladle analysis, only.
$$CE = C + \frac{Mn}{6} + \frac{(Cr + Mo + V)}{5} + \frac{(Ni + Cu)}{15}$$

5 Micro-alloying elements like Nb, V and Ti may be added singly or in combination. Total micro-alloying elements shall not be more than 0.25 percent.

6 Alloying elements such as Cr, Ni, Mo and B may be added under agreement between the purchaser and the manufacturer. In case of E 600 and E 650 the limit of Cr and Ni, either singly or in combination, shall not exceed 0.50 percent and 0.60 percent respectively.

7 Copper may be present between 0.20 to 0.35 percent as mutually agreed to between the purchaser and the manufacturer. The copper bearing quality shall be designated with a suffix Cu, for example E 250 Cu. In case of product analysis the copper content shall be between 0.17 and 0.38 percent.

8 *Incidental element* — Elements not quoted in Table 1 shall not be intentionally added to steel without the agreement of the purchaser, other than for the purpose of finishing the heat. All reasonable precautions shall be taken to prevent the addition from scrap or other materials used in manufacture of such elements which affect the hardenability, mechanical properties and applicability.

9 Nitrogen content of steel shall not exceed 0.012 percent which shall be ensured by the manufacturer by occasional check analysis.

10 The steel, if required, may be treated with calcium based compound or rare earth element for better formability.

11 Lower limits for carbon equivalent and closer limits for other elements may be mutually agreed to between the purchaser and the manufacturer.

Table 25 Mechanical Properties

Grade Designation	Quality	Tensile Strength Rm, Min MPa1) (See Note 1)	Yield Stress ReH, Min MPa1)			Percentage Elongation A, Min at Gauge Length, Lo=5.65	Internal Bend Diameter Min (See Note 2)		Charpy Impact Test (See Note 3)	
			<20	20-40	>40		≤ 25	>25	Temp oC	Min J
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
E 250	A	410	250	240	230	2 3	2t	3t	—	—
	BR								RT	2 7
	B 0								0	2 7
	C								(-) 20	2 7
E 275	A	430	275	265	255	2 2	2t	3t	—	—
	BR								RT	2 7
	B 0								0	2 7
	C								(-) 20	2 7
E 300	A	440	300	290	280	2 2	2t	—	—	—
	BR								RT	2 7
	B 0								0	2 7
	C								(-) 20	2 7
E 350	A	490	350	330	320	2 2	2t	—	—	—
	BR								RT	2 7
	B 0								0	2 7
	C								(-) 20	2 7
E 410	A	540	410	390	380	2 0	2t	—	—	—
	BR								RT	2 5
	B 0								0	2 5
	C								(-) 20	2 5
E 450	A	570	450	430	420	2 0	2.5t	—	—	—
	BR								RT	2 0
E 550	A	650	550	530	520	1 2	3t	—	—	—
	BR								RT	1 5
E 600	A	730	600	580	570	1 2	3.5t	—	—	—
	BR								RT	1 5
E 650	A	780	650	630	620	1 2	4t	—	—	—
	BR								RT	1 5

NOTES

1 In case of product thickness/diameter more than 100 mm, lower minimum limit of tensile strength may be mutually agreed to between the purchaser and the manufacturer/supplier.

2 Bend test not required for thickness > 25 mm for grades E 300 to E 650. 'r' is the thickness of the test piece.

3 For sub-quality BR, impact test is optional; if required, at room temperature (25 ± 2°C).

1MPa = 1N/mm² = 1MN/m² = 0.102 kgf/mm² = 144.4 psi.

Annex A

IS: 458:2023 PRECAST CONCRETE PIPES (WITH AND WITHOUT REINFORCEMENT SPECIFICATION

IS: 5382 – 1985 (Reaffirmed 2003) SPECIFICATION FOR RUBBER SEALING RINDS FOR GAS MAINS, WATER MAINS, AND SEWERS

IS: 9103:1999 CONCRETE ADMIXTURES – SPECIFICATION (FIRST REVISION)

IS: 432(part1)-1982 SPECIFICATION FOR MILD STEEL AND MEDIUM TENSILE STEEL BARS AND HARD-DRAWN STEEL WIRE FOR CONCRETE REINFORCEMENT

IS.432 (Part II)-1982 (REAFFIRMED II) -1982 (REAFFIRMED 2004)

IS: 516.1959 (REAFFIRMED 2004) METHODS OF TEST FOR STRENGTH OF CONCRETE

IS 2062:2011 HOT ROLLED MEDIUM AND HIGH TENSILE STRUCTURAL STEEL – SPECIFICATION

IS 3597.1998 CONCRETE PIPES – METHODS OF TEST

IS 4905 -1968 (REAFFIRMED 2001) METHODS FOR RANDOM SAMPLING

IS 5816: 1999 (REAFFIRMED 2004) SPLITTING TENSILE STRENGTH OF CONCRETE – METHOD OF TEST

IS 456: 2000 (REAFFIRMED 2000) PLAIN AND REINFORCED CONCRETE - CODE OF PRACTICE

Annex B

HYDROSTATIC TEST

1. Test Specimen

The specimens for determination of leakage under internal hydrostatic pressure shall be sound and full-size pipe. If the pipes are tested after storing in adverse weather condition presoaking shall be permitted. For presoaking pipes shall be submerged in water or sprayed with water for a period not less than 6 hours prior to testing and excess water removed.

2. Procedure

The pipe shall be supported in such a way so that the longitudinal axis is approximately horizontal and the exterior surface excepting the supports can be examined readily.

The equipment for making the test shall be such that the specimen under test can be filled with water to the exclusion of air and subjected to the required hydrostatic pressure. Apply hydrostatic pressure to the whole pipe including the portion of socket and rebated joints. that is, subjected to pressure in the 'as laid' condition.

The specimen shall be filled with water and the air expelled. Pressure shall be applied at a gradual rate until the specified test pressure is reached, or beads of water on the pipe surface is seen, whichever occurs first.

Pressure shall be maintained for 1 min + 30 s for each 10 mm of wall thickness. or for twice that entire period if the application of pressure resulted in the formation of beads of water on the pipe surface.

At the end of the holding period, the pressure shall be released immediately if the test pressure has been maintained. If the beads of the water have not grown or run the pressure shall be increased slowly until the test pressure is reached or the beads of water grow or run (whichever occurs first).

If the test pressure has been reached without the beads of water growing or running. The test pressure shall be maintained constant for 1 min + 30 s for each 10 mm of wall thickness. At the end of the holding period the pressure shall be released immediately.

After releasing the pressure, the test pipe shall be drained completely.

Annex C

SPLITTING TENSILE STRENGTH OF CONCRETE - METHOD OF TEST

TEST SPECIMENS

1. Cube

Cube specimen shall be of size not less than four times the maximum size of the coarse aggregate and not less than 150 mm.

2. Cylinder

The cylindrical specimen shall have diameter not less than four times the maximum size of the coarse aggregate and not less than 150 mm. The length of the specimens shall not be less than the diameter and not more than twice the diameter. For routine testing and comparison of results, unless otherwise specified the specimens shall be cylinder 150 mm in diameter and 300 mm long.

3. Making and Curing Test Specimen

The procedure of making and curing tension test specimen in respect of sampling of materials, preparation of materials, proportioning, weighing, mixing, workability, moulds, compacting and curing shall comply in all respects with the requirements given in NS 511 Nepal Standard for Plain and Reinforced Concrete.

4 APPARATUS

4.1 Testing Machine

Any compression machine of reliable type, of sufficient capacity for the tests and capable of applying the load at the rate specified in 7.5 shall be used. Provide a minimum loading area of 12 mm x the length of the cylinder or cube, as the case may be so that the load is applied over the entire length of the specimen. If necessary, a supplementary bearing bar or plate of machined steel may be used.

4.2 Jigs

Either jig shown in Fig. I for splitting cylindrical and cubic specimen or alternatively jig shown in Fig. 2 for cubic specimen shall be used

4.2.1 Components of Jigs shown in Fig. I

4.2.1.1 Two packing strips of tempered hardboard of nominal thickness 4 mm having following dimensions of the test specimen shall be used only once:

Width	15 ± 2 mm
Nominal thickness	4 mm
Length	Greater than the length of the line of contact of the test specimen

4.2.1.2 Steel loading strips

A steel loading plate having minimum hardness value, when tested shall be used between the platen of the machine and the hardboard packing strips. The piece shall not be shorter than the specimen. For cylindrical specimens it shall be of rectangular cross section. For cubic specimens, it shall be a section of a cylinder, with a radius of 75 mm, so that the load is applied along a line on the surface of the specimen (see Fig. 1A and 1B). This loading piece can be incorporated with in the jig.

4.2.2 Components of Jigs shown in Fig. 2

4.2.2.1 Steel loading pieces

Steel loading pieces having a minimum hardness of 550, shall be auxiliary platens incorporating steel strips with the following dimensions:

Width	6 ± 1 mm for 150 mm size
Thickness	4 ± 1 mm
Length	Not less than the length of the line of contact with the test specimen

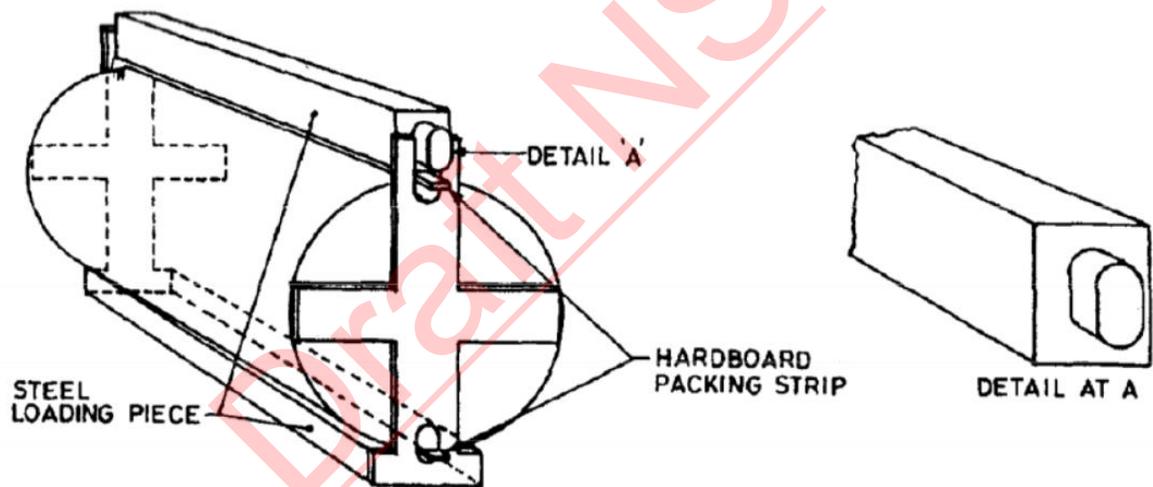


FIG. 1A APPARATUS FOR SPLITTING CYLINDERS

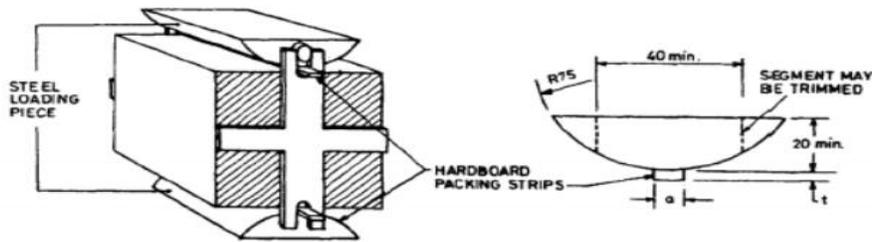


FIG. 1B APPARATUS FOR SPLITTING CYLINDER AND CUBE

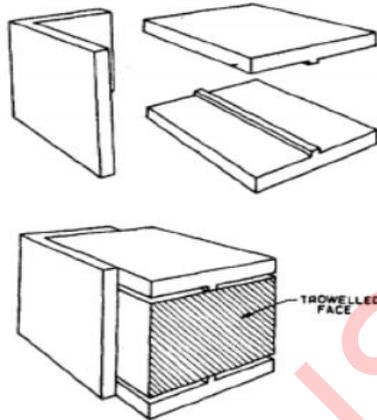


FIG. 2 ALTERNATE APPARATUS FOR SPLITTING CUBES

4.3 Tolerances

The steel loading pieces specified in 4.2.1.2 and 4.2.2.2 shall have flatness, square ness parallelism and surface requirements along the length of the strips within the tolerances given below:

- Flatness -0.03 mm for each contact face.
- Square ness-for each edge of the piece with respect to the adjacent edge as datum shall be 0.06 mm.
- Parallelism -one contact face with respect to the other face as datum shall be 0.06 mm.
- Ra value for the surface texture of the contact faces -0.04 m and 3.2 m.

The steel load ing pieces shall be replaced when the dimensions are out of tolerance or they are seriously damaged or pitted along the content face.

5 AGE AT TEST

Tests shall be made at the recognized ages of the test specimens, the most usual being 7 and 28 days. Tests at any other age at which the tensile strength is desired may be made, if so required. The ages shall be calculated from the time of the addition of water to the dry ingredients. The age at test shall be reported along with the results.

6 NU MBER OF SPECIMENS

At least three specimens shall be tested for each age of tests.

7. PROCEDURE

7.1 Specimens when received dry shall be kept in water for 24 h before they are taken for testing. Unless other conditions are required for specific laboratory investigation specimen shall be tested immediately on removal from the water whilst they are still wet. Surface water and grit shall be wiped off the specimens and any projecting fins removed from the surfaces which are to be in contact with

the packing strips.

7.2 Marking

Central lines shall be drawn on the two opposite faces of the cube using any suitable procedure and device that will ensure that they are in the same axial plane.

7.3 Measurement

The mass and dimensions of the specimen shall be noted before testing. The sides of the specimen, lying in the plane of the pre-marked lines, shall be measured near the ends and the middle of the specimen and the average taken to the nearest 0.2 mm. The length of the specimen shall be taken to the nearest 0.2 mm by averaging the two lengths measured in the plane containing the pre-marked lines.

7.4 Placing of the Specimen in the Testing Machine

The bearing surfaces of the testing machine and of the loading strips shall be wiped clean.

7.4.1 Positioning

The test specimen shall be placed in the centering jig with packing strip and/or loading pieces carefully positioning along the top and bottom of the plane of loading of the specimen. The jig shall then be placed in the machine so that the specimen is located centrally. In the case of cubic specimens, the load shall be applied on the molded faces in such a way that the fracture plane will cross the trowelled surface.

For cylindrical specimen it shall be ensured that the upper platen is parallel with the lower platen.

7.5 Rate of Loading

The load shall be applied without shock and increased continuously at a nominal rate within the range 1.2 N/ (mm²/min) to 2.4 N/ (mm²/min). Maintain the rate, once adjusted, until failure. On manually controlled machines as failure is approached the loading rate will decrease; at this stage the controls shall be operated to maintain as far as possible the specified loading rate. The maximum load applied shall then be recorded. The appearance of concrete and any unusual features in the type of failure shall also be noted.

The rate of increase of load may be calculated from the formula:

$$(1.2 \text{ to } 2.4) \times \pi/2 \times l \times d \text{ N/min}$$

8 CALCULATION

8.1 The measured splitting tensile strength f_{ct} of the specimen shall be calculated to the nearest 0.05 N/mm² using the following formula:

$$f_{ct} = 2P / \pi ld$$

where

- P = maximum load in Newton's applied to the specimen,
- l = length of the specimen as shown in Fig. 3 (in mm), and
- d = cross sectional dimension of the specimen as shown in Fig. 3 (in mm).

9 REPORT

9.1 The following information shall be included in the report on each specimen:

- a) Date of test,

- b) Identification mark, shape and size of the specimen in mm,
- c) Age of specimen at date of test when known,
- d) Curing history,
- e) Weight of specimen in Newtons,
- f) Type of fracture and the appearance of concrete on the fractured face if these are unusual,
- g) Splitting tensile strength to the nearest 0.05 N/mm² on the lower side, and
- h) Estimate of the proportion of coarse aggregate fractured during test.

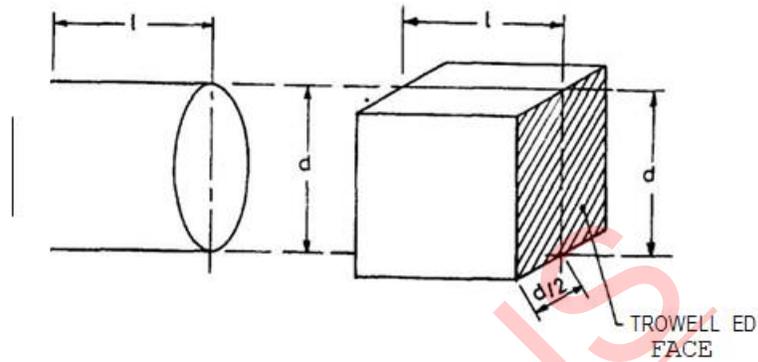


FIG 3 PLANE OF LOADING

Annex D

RUBBER RING CHORDS AND PROFILE GASKET

TABLE 1 GENERAL REQUIREMENTS

(Clauses 3.7.1, 3.7.3 to 3.7.7)

Sl No	CHARACTERISTICS	REQUIREMENTS						METHOD OF TEST, REF TO
		Type 1 (3)	Type 2 (4)	Type 3 (5)	Type 4 (6)	Type 5 (7)	Type 6 (8)	
(1)	(2)							
i)	Hardness in IRHD	40 ± 5	50 + 5 - 4	60 + 5 - 4	70 + 5 - 4	80 ± 4	88 ± 3	NS**
ii)	Compression set, percent, <i>Max</i>							
	for 24 $\frac{+0}{-2}$ h at 70 ± 1°C	25	25	25	25	25	25	
	for 72 $\frac{+0}{-2}$ h at 27 ± 2°C	12	12	12	12	15	15	
iii)	Ageing, maximum change for unaged values after 7 days in air at 70°C							
a)	Hardness in IRHD	- 5 to + 8						
b)	Tensile strength, percent	± 20	± 20	± 20	± 20	± 20	± 20	
c)	Elongation at break, percent	- 30 to + 10						

*Methods of test for vulcanized rubber: Part 2 Hardness (first revision).

†Methods of test for vulcanized rubber: Part 10 Compression set at constant strain (first revision).

‡Methods of test for vulcanized rubber: Part 1 Tensile stress strain properties (first revision).

(Continued)

TABLE 1 GENERAL REQUIREMENTS—Contd

Sl. No.	CHARACTERISTICS	REQUIREMENTS						METHOD OF TEST, REF TO
		Type 1	Type 2	Type 3	Type 4	Type 5	Type 6	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	NS**
iv)	Water immersion change in volume after immersion in neutral water for 7 days at 70°C	- 0 to + 8	- 0 to + 8	- 0 to + 8	- 0 to + 8	- 0 to + 8	- 0 to + 8	
v)	Cold resistance, increase in hardness after 7 days at -10°C, <i>Max</i>	+10	+10	+10	+10	+10	+10	}
vi)	Stress relaxation in compression:							
	— after 7 days at 27°C, percent by mass, <i>Max</i>	18	18	18	18	—	—	
	— after 90 days at 27°C, percent by mass, <i>Max</i>	25	25	25	25	—	—	
vii)	Splice strength, elongation imposed, percent, <i>Max</i>	100	100	100	100	50	30	

*Methods of test for vulcanized rubber: Part 6 Resistance to liquid.

TABLE 2 TENSILE STRENGTH AND ELONGATION FOR DIFFERENT TYPES
(Clause 3.7.2)

Sl. No.	POLYMER USED	REQUIREMENTS					
		Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	Natural rubber (NR) and Isoprene rubber (IR)						
a)	Tensile strength, MPa, percent, <i>Min</i>	18	18	17	15	11	6
b)	Elongation at break, percent, <i>Min</i>	450	450	375	250	175	100
ii)	Butadiene-styrene rubber (SBR)						
a)	Tensile strength, MPa, <i>Min</i>	12	13	14	13	11	8
b)	Elongation at break, percent, <i>Min</i>	450	425	400	300	250	150
iii)	Ethylene propylene rubber (EPM and EPDM)						
a)	Tensile strength, MPa, <i>Min</i>	11	11	11	11	9	8
b)	Elongation at break, percent, <i>Min</i>	450	400	325	200	125	100

Annex E

CHEMICAL ADMIXTURES

Sl No.	Requirements	Accele- rating Admixture	Retarding Admixture	Water Reducing Admixture	Air-Entrain- ing Admixture	Superplasticizing Admixture (for Water- Reduced Concrete Mix)		Test Ref
						Normal	Retarding Type	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	Water content, percent of control sample, <i>Max</i>	—	—	95	—	80	80	NS**
ii)	Slump	—	—	—	—	Not more than 15 mm below that of the control mix concrete		
iii)	Time of setting, allowable deviation from control sample hours:							
	Initial							
	<i>Max</i>	-3	+3	±1	—	—	+4	
	<i>Min</i>	-1	+1	—	—	+1.5	+1	
	Final							
	<i>Max</i>	-2	+3	±1	—	+1.5	±3	
	<i>Min</i>	-1	+1	—	—	—	—	
iv)	Compressive strength, percent of control sample, <i>Min</i>							
	1 day	—	—	—	—	140	—	
	3 days	125	90	110	90	125	125	
	7 days	100	90	110	90	125	125	
	28 days	100	90	110	90	115	115	
	6 months	90	90	100	90	100	100	
	1 year	90	90	100	90	100	100	
v)	Flexural strength, percent of control sample, <i>Min</i>							
	3 days	110	90	100	90	110	110	
	7 days	100	90	100	90	100	100	
	28 days	90	90	100	90	100	100	
vi)	Length change, percent increase over control sample, <i>Max</i>							
	28 days	0.010	0.010	0.010	0.010	0.010	0.010	
	6 months	0.010	0.010	0.010	0.010	0.010	0.010	
	1 year	0.010	0.010	0.010	0.010	0.010	0.010	
vii)	Bleeding, percent increase over control sample, <i>Max</i>	5	5	5	5	5	5	
viii)	Loss of workability	—	—	—	—	At 45 min the slump shall be not less than that of control mix concrete at 15 min	At 2 h, the slump shall be not less than that of control mix concrete at 15 min	
ix)	Air content (%) <i>Max, over control</i>	—	—	—	—	1.5	1.5	

Table 1B Requirements for High Workability Test Mix*(Clause 4)*

Sl No.	Requirements	Type of Superplasticizing Admixture		Test Reference
		Normal (3)	Retarding Type (4)	
(1)	(2)			(5)
i)	Flow	510 mm - 620 mm	510 mm - 620 mm	NS**
ii)	Loss of workability on standing	At 45 min the slump shall be not less than that of control mix concrete at 15 min	At 2 h the slump shall be not less than that of control mix concrete at 15 min	
iii)	Minimum compressive strength, percent of control mix concrete			
	7 days	90	90	
	28 days	90	90	
	6 months	90	90	
	1 year	90	90	