ISO #####-#:####(X)

ISO TC 296

Date:

Bamboo winding composite pipe

WD stage

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Published in Switzerland

Contents.

Foreword

This standard is drafted in accordance with the rules given in the GB/T 1.1-2009. SAC/TC 263 is in charge of this English translation. In case of any doubt about the contents of English translation, the Chinese original shall be considered authoritative.

This standard was proposed by the National Forestry and Grassland Administration.

This standard was prepared by SAC/TC 263 (National Bamboo and Rattan Standardization Technical Committee).

Introduction

Bamboo is distributed in tropical, subtropical and warm temperate regions between 46° N and 47° S latitude, and is known as "the world's second largest forest product". The development and utilization of bamboo resources in the bamboo industry is the world's recognized green and low-carbon industry, which provides economic income, food and housing for 2.5 billion people around the world every year, and the annual trade volume of global bamboo products is more than 8.5 billion US dollars.

Bamboo winding composite pipe is a new kind of bio-based pressure pipe, which is processed by winding process with bamboo as the base material. It has the characteristics of renewable raw materials, energy saving and emission reduction, carbon fixation and carbon storage, light weight and high strength, good thermal insulation performance, seawater corrosion resistance, good sound insulation performance, and good fire resistance. So that it can completely replace most of the spiral welded pipe on the market, prestressed steel tube concrete pipe, plastic and metal and other traditional pipes, and the cost is lower than traditional materials. Therefore, bamboo winding composite pipe has significant economic and environmental benefits.

The formulation of the international standard for bamboo wound composite pipe will play an important role in promoting the bamboo wound composite pipe industry in the global layout, the healthy development of the industry, and international trade, while improving the international competitiveness of bamboo wound composite pipe, and also in line with the global green and low-carbon development tre

Bamboo winding composite pipe

1 Scope

This standard specifies the terms and definitions, classification and marking, raw materials, technical requirements, test methods, inspection rules, manufacturer's certification, packaging, transport and storage of bamboo winding composite pipes (hereinafter referred to as BWCP).

This standard applies to BWCPs with a nominal inner diameter of 150 mm ～ 3 000 mm, a pressure level no greater than 1.6 MPa, a ring stiffness grade of 5 000 N/m2 ～ 20 000 N/m2, an application ambient temperature of -40 ℃ ～ 80 ℃, and a maximum temperature not exceeding 90 ℃ for the transmission medium, for hydraulic, municipal, industrial water supply and drainage projects.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 531.1 Rubber, vulcanized or thermoplastic - Determination of indentation hardness - Part 1: Duromerer method (Shore hardness)

GB/T 1034 Plastics - Determination of water absorption

GB/T 1446-2005 Fiber-reinforced plastics composites - The generals for determination of properties

GB/T 1447-2005 Fiber-reinforced plastics composites - Determination of tensile properties

GB/T 1449 Fibre-reinforced plastic composites - Determination of flexural properties

GB/T 1458 Test method for mechanical properties of ring of filament-winding reinforced plastics

GB/T 1725-2007 Paints, varnishes and plastics - Determination of non-volatile-matter content

GB/T 2567-2008 Test methods for properties of resin casting boby

GB/T 2576 Test method for insoluble matter content of resin used in fiber reinforced plastics

GB/T 2794-2013 Determination for viscosity of adhesives - Single cylinder rotational viscometer method

GB/T 2895-2008 Plastics - Polyester resin - Determination of partial acid value and total acid value

GB/T 3139 Fiber-reinforced plastics composites - Determination of thermal conductivity

GB/T 4380 Assessment of departure from roundness-Two-and three-point methods

GB/T 5351 Fiber-reinforced thermosetting plastic composites pipe - Determination of short-time hydraulic failure pressure

GB/T 5352 Fiber-reinforced thermosetting plastic composites pipe - Determination for external loading properties by parallel-plate loading

GB/T 7689.2-2013 Reinforcements - Test method for woven fabrics - Part 2: Determination of number of yarns per unit length of warp and weft

GB 8624-2012 Classification for burning behavior of building materials and products

GB/T 8626 Test method of flammability for building materials

GB/T 9914.1-2013 Test method for reinforcement products - Part 1: Determination of moisture content

GB/T 9914.3-2013 The method for reinforcement products - Part 3: Determination of mass per unit area

GB/T 14074-2017 Testing methods for wood adhesives and their resins

GB/T 17219 Standard for safety evaluation of equipment and protective materials in drinking water system

GB/T 20284 Single burning item test for building materials and products

GB/T 24148.7-2014 Plastics - Unsaturated polyester resins - Part 7: Measurement of gel time at ambient temperature

GB/T 24218.2-2009 Textiles - Test methods for nonwovens - Part 2: Determination of thickness

GB/T 24218.3-2010 Textiles - Test methods for nonwovens - Part 3: Determination of tensile strength and elongation (strip method)

GB/T 24218.18-2014 Textiles - Test methods for nonwovens - Part 18: Determination of breaking strength and elongation (grab method)

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
bamboo winding composite pipe (BWCP)
a pipe that is made using a winding process, with bamboo as the base material, and thermosetting resin as the adhesive. It is composed of an inner protection liner, a structural layer and an external protection layer

3.2
ring stiffness
the amount of load that a pipe ring of a unit length receives under a certain amount of radial deformation caused by external pressure

3.3
inner protection liner
a resin-rich layer made of bamboo-fiber nonwoven fabrics and resin on the inner surface of the pipe

3.4
structural layer
the pipe's force bearing layer made of bamboo and thermosetting resin

3.5
external protection layer
a coating outside the structural layer of the pipe

3.6
bamboo sliver
a long and thin piece element with a certain specification processed from bamboo culms

3.7
bamboo curtain
a curtain with a certain specification woven with bamboo slivers arranged in parallel

3.8
bamboo curtain roll
the roll formed by winding the bamboo curtain around the inner barrel

3.9
bamboo material
bamboo slivers, bamboo curtains or bamboo curtain rolls

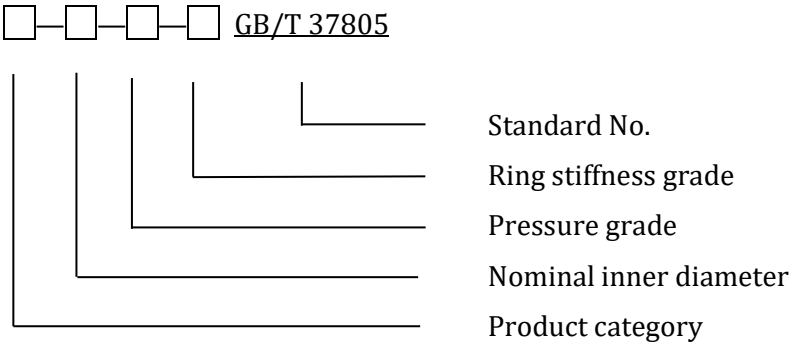
4 Classification and marking

4.1 Classification

Based on usage, BWCPs can be divided into non-drinking water category (BWCP1) and drinking water category (BWCP2).

4.2 Marking

A BWCP is marked in the following way:



Example:

BWCP1s, with a nominal inner diameter of 500 mm, a pressure grade of 0.6 MPa, and a ring stiffness grade of 5 000 N/m2. BWCPs produced according to this standard are marked as: BWCP1-500-0.6-5 000 GB/T 37805.

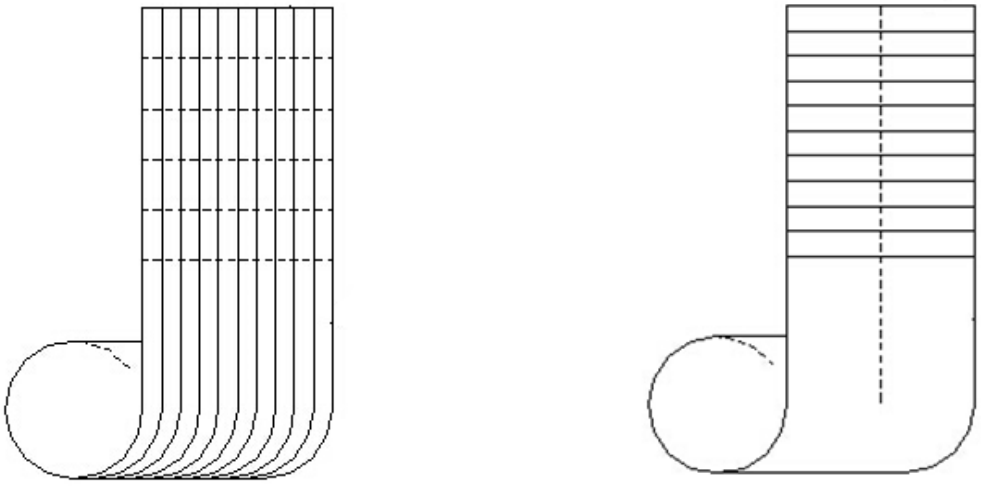
5 Raw materials

5.1Bamboo materials

5.1.1 There shall be no defects such as insect damage, mildew on the surface of bamboo materials.

5.1.2 The moisture content of bamboo slivers shall be kept within the range from 7% to 13%.

5.1.3 There are two kinds of structures of bamboo curtain rolls. One is hoop, as shown in Figure 1a), and the other one is axial, as shown in Figure 1b).



a) b)

Figure 1 Directions of bamboo curtain roll

5.1.4 The tensile strength of bamboo slivers shall be no less than 60 MPa.

5.2 Resin

5.2.1 The technical requirements of the thermosetting resin used in the structural layer shall comply with the requirements in Table 1.

Table 1 The technical requirements of the thermosetting resin used in the structural layer

Item	Technical requirement	Test method
Appearance	Free from impurities or precipitation	GB/T 14074-2017

Viscosity (25 ℃)/(mPa・s)	30～100	
Solid content/%	≥50	
pH value	8.0～9.0	

Table 1 (continued)

Item	Technical requirement	Test method
Free formaldehyde content/%	≤0.8	GB/T 14074-2017
Storage stability test/days	≥30	
Tensile strength/MPa	≥5	GB/T 2567-2008

5.2.2 Out of m-benzene type unsaturated polyester resin, vinyl ester resin, and bisphenol A type resin, etc., one shall be used as the resin for the inner protection liner, and the technical requirements shall comply with the requirements in Table 2.

Table 2 The technical requirements of the inner protection liner resin

Item	Technical requirement	Test method
Viscosity (25 ℃)/(mPa・s)	400～800	GB/T 2794-2013
Solid content/%	≥55	GB/T 1725-2007
Gelation time (25 ℃)/minutes	10～60	GB/T 24148.7-2014
Acid value (in KOH)/(mg/g)	16～24	GB/T 2895-2008
Tensile strength/MPa	≥60	GB/T 2567-2008
Elongation at break/%	≥3.0	

5.3 Bamboo fiber nonwoven fabric

The technical requirements of bamboo fiber nonwoven fabric shall comply with the requirements in Table 3.

Table 3 The technical requirements of the bamboo fiber nonwoven fabric

Item	Technical requirement	Test method
Thickness/mm	0.3～0.36	GB/T 24218.2-2009
Moisture content/%	6～17	GB/T 9914.1-2013
Tensile breaking strength longitudinal/(N/5cm)	≥15	GB/T 24218.3-2010
Tensile breaking strength	≥7	

latitudinal/(N/5cm)		
Vertical elongation/%	<30	
Horizontal elongation/%	<200	

5.4 Mesh fabric

5.4.1 The technical requirements of mesh fabric shall comply with the requirements in Table 4.

Table 4 The technical requirements of the mesh fabric

Item	Technical requirement	Test method
Warp and weft densities/ (line/10 mm)	2.5～6.0	GB/T 7689.2-2013
Mass per unit area/(g/m2)	≤40	GB/T 9914.3-2013
Elongation at break (warp, weft)/%	≤5	GB/T 24218.18-2014
Warp breaking strength/N	≥1500	

6 Technical requirements

6.1 Appearance

The inner surface of BWCPs shall be smooth and flat, without any defects such as delamination, starvation, crack, or bubbles, etc. The end face of pipes shall be flush with no burrs on the edges, and there shall be no obvious unevenness or defects on the outer surface.

6.2 Dimensions

6.2.1 Nominal inner diameter

The actual inner diameters of BWCPs and the allowable deviation at both ends shall comply with the requirements in Table 5.

Table 5 Nominal inner diameter and allowable deviation

in mm

Nominal inner diameter	Inner diameter		Allowable deviation for inner diameters at both ends
	Small end	Large end	
150	147	153	±1.0
200	197	206	±1.0

Nominal inner diameter	Inner diameter		Allowable deviation for inner diameters at both ends
	Small end	Large end	
250	247	256	±1.0
300	297	307	±1.0
350	347	357	±1.0
400	397	407	±1.2
450	447	457	±1.2
500	497	507	±1.5
600	596	606	±1.5
700	696	707	±1.5

Table 5 (continued)

in mm

Nominal inner diameter	Inner diameter		Allowable deviation for inner diameters at both ends
	Small end	Large end	
800	796	807	±1.8
900	896	907	±1.8
1 000	996	1 007	±2.0
1 200	1 196	1 207	±2.0
1 400	1 397	1 409	±2.5
1 500	1 497	1 510	±2.5
1 600	1 597	1 610	±2.5
1 800	1 797	1 811	±2.5
2 000	1 997	2 012	±2.5
2 200	2 197	2 213	±3.0
2 400	2 397	2 413	±3.0
2 600	2 597	2 613	±4.0
2 800	2 796	2 815	±4.0

3 000	2 996	3 015	±4.0

6.2.2 Length

The length and allowable length deviation of BWCPs shall comply with the requirements in Table 6.

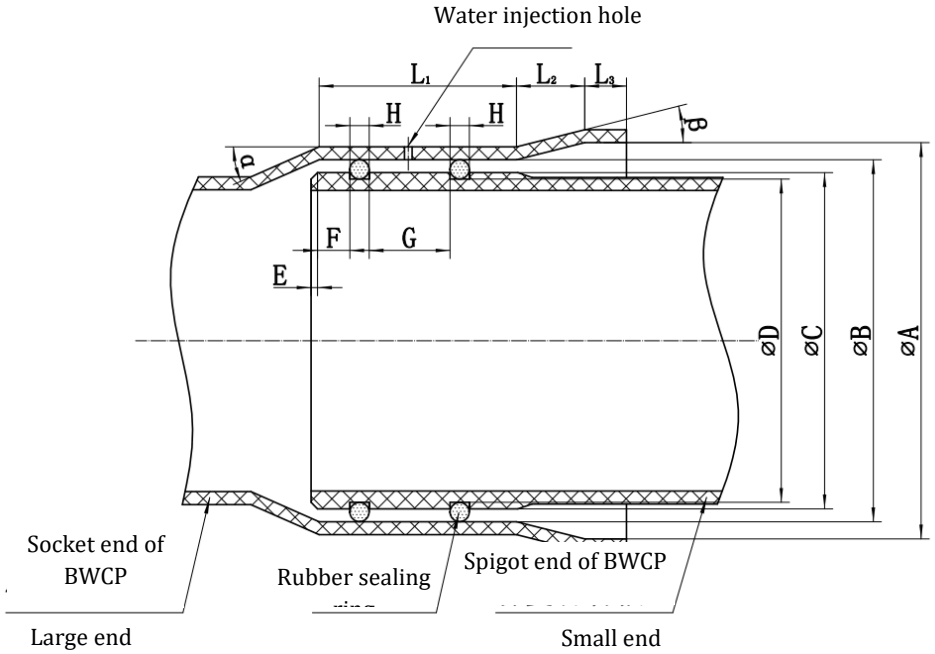
Table 6 The length and allowable deviation

in mm

Length	3 000	4 000	5 000	6 000	9 000	10 000	12 000
Allowable length deviation	+7.5	+10	+12.5	+15	+22.5	+25	+30

6.2.3 Dimensions of socket end and spigot end

Figure 2 is a schematic diagram for socket end and spigot end of a BWCP, α is 12 °, and β is 15 °; the socket end and spigot end dimensions of a BWCP shall comply with the requirements in Table 7.



Explanation:

α - transition angle between the socket's working face and the pipe's inner diameter;
β - transition angle between the lead-in segment and the working face;
L2 - length of the slope of the lead-in segment;
L3 - length of the lead-in segment;

ΦA - inner diameter of the lead-in segment;
ΦB - inner diameter of the working face;
ΦC - outer diameter of the spigot end;
ΦD - diameter of the seal groove;
L1 - length of the working face;
E - chamfering of the spigot end;
F - width of the lead-in entrance;
G - groove spacing;
H - width of the seal groove.

Figure 2 BWCP socket and spigot ends

Table 7 Dimensions and allowable deviations of socket and spigot ends

in mm

DN	L1	L2	L3	ΦA	ΦB	ΦC	ΦD	E	F	G	H
150	140	21	20	194±0.3	179±0.2	177±0.1	164.5±0.1	5	20	30	17±0.1
200	165	21	20	254±0.3	239±0.2	237±0.1	224.5±0.1	5	25	30	17±0.1
250	165	21	20	304±0.3	289±0.2	287±0.1	274.5±0.1	5	25	30	17±0.1
300	175	36	20	366±0.3	347±0.3	344±0.1	326±0.1	10	32	30	24±0.1
350	175	36	20	416±0.3	397±0.3	394±0.1	376±0.1	10	32	30	24±0.1

Table 7 (continued)

in mm

DN	L1	L2	L3	ΦA	ΦB	ΦC	ΦD	E	F	G	H
400	175	36	20	466±0.3	447±0.3	444±0.1	426±0.1	10	32	30	24±0.1
450	190	41	25	524±0.3	502±0.3	499±0.1	478±0.1	10	35	40	30±0.1
500	190	41	25	574±0.3	552±0.3	549±0.1	528±0.1	10	35	40	30±0.1
600	190	41	25	674±0.3	652±0.3	649±0.1	628±0.1	10	35	40	30±0.1
700	190	41	25	774±0.3	752±0.3	749±0.1	728±0.1	10	35	40	30±0.1
800	190	41	25	874±0.3	852±0.3	849±0.1	828±0.1	10	35	40	30±0.1
900	190	41	25	988±0.3	966±0.3	963±0.1	942±0.1	10	35	40	30±0.1

1 000	190	41	25	1 088±0.3	1 066±0.3	1 063±0.1	1 042±0.1	10	35	40	30±0.1
1 200	190	41	25	1 288±0.35	1 266±0.3	1 263±0.1	1 242±0.1	10	35	40	30±0.1
1 400	190	41	25	1 500±0.35	1 478±0.3	1 475±0.1	1 454±0.1	10	35	40	30±0.1
1 500	220	45	30	1 602±0.35	1 578±0.3	1 574±0.1	1 536±0.2	20	45	40	40±0.2
1 600	220	45	30	1 715±0.35	1 691±0.4	1 687±0.1	1 649±0.2	20	45	40	40±0.2
1 800	220	45	30	1 915±0.35	1 891±0.4	1 887±0.1	1 849±0.2	20	45	40	40±0.2
2 000	220	45	30	2 135±0.35	2 111±0.4	2 107±0.1	2 069±0.2	20	45	40	40±0.2
2 400	220	45	40	2 536±0.4	2 511±0.4	2 507±0.1	2 469±0.2	20	45	40	40±0.2
2 600	220	45	40	2 736±0.4	2 712±0.4	2 707±0.1	2 669±0.2	20	45	40	40±0.2
2 800	220	45	45	2 936±0.4	2 912±0.5	2 907±0.1	2 869±0.2	20	45	40	40±0.2
3 000	200	45	45	3 186±0.4	3 161±0.5	3 156±0.1	3 112±0.2	20	45	40	40±0.2
Note: The allowable deviation of L1, L2, L3, F and G is ±0.5 mm.											

6.2.4 Pipe end face perpendicularity

The perpendicularity of the pipe end face shall comply with the requirements in Table 8.

Table 8 Allowable deviations of pipe end face verticality

in mm

Nominal inner diameter	Allowable deviation of pipe end face perpendicularity
DN<600	4
600≤DN<1 000	6
DN≥1 000	8

6.2.5 Roundness of pipe ends

The allowable deviation of the roundness of the pipe ends shall be no greater than 5‰ of the inner diameter and be no greater than 15 mm.

6.3 Insoluble matter content of inner protection liner resin

The insoluble matter content of the inner protection liner resin shall be no less than 92%.

6.4 Mechanical properties

6.4.1 Resistance to external pressure

6.4.1.1 Ring stiffness

The ring stiffness grades of BWCPs are 5 000 N/m2, 10 000 N/m2, 15 000 N/m2, and 20 000 N/m2. Pipes of non-standard ring stiffness grades can be designed according to the ring stiffness equation.

6.4.1.2 Resistance to external pressure deformation

The resistance to external pressure deformation shall meet the following requirements at the same time:

a) When the deformation reaches 25% of the calculated diameter, the sample does not yield;

b) After completing the process in a), the sample is rotated by 90 ° in the axial direction and reloaded. When the deformation reaches 25% of the calculated diameter, the load drop does not exceed 10% of the load at the same deformation in the a) process.

6.4.2 Hoop tensile strength

The hoop tensile strength, Fth, shall be determined according to the engineering design, but shall be no less than the value calculated by equation (1).

$F_{th} = C \times PN \times DN/2$ ……(1)

Where:

Fth - hoop tensile strength of the pipe, in kilonewtons per meter (kN/m);

C - coefficient (C=3);

PN - pressure grade, in megapascals (MPa);

DN - nominal inner diameter, in millimeters (mm).

Fth shall be no less than the specified value in Table 9.

Table 9 Minimum value of hoop tensile strength

in kN/m

Nominal	Pressure grade/MPa

inner diameter/mm	0.4	0.6	0.8	1.0	1.2	1.4	1.6
150	120	180	240	300	360	420	480
200	160	240	320	404	480	560	640
250	200	300	410	500	600	700	800
300	240	360	480	600	720	840	960
350	280	420	560	700	840	980	1 120
400	320	480	640	800	960	1 120	1 312
450	360	540	720	900	1 080	1 260	1 440
500	400	600	800	1 000	1 200	1 400	1 600
600	480	720	960	1 200	1 440	1 680	1 920
700	560	840	1 120	1 400	1 680	1 960	2 240
800	640	960	1 280	1 600	1 960	2 240	2 560
900	720	1 080	1 440	1 800	2 160	2 520	2 880
1 000	800	1 200	1 600	2 000	2 400	2 800	3 200
1 200	960	1 440	1 920	2 400	2 880	3 360	3 840
1 400	1 120	1 680	2 240	2 800	3 360	—	—
1 600	1 280	1 920	2 440	3 200	3 840	—	—
1 800	1 440	2 160	2 880	3 600	—	—	—
2 000	1 600	2 400	3 200	4 000	—	—	—
2 200	1 760	2 640	3 520	4 400	—	—	—
2 400	1 920	2 880	3 840	—	—	—	—
2 600	2 080	3 120	4 160	—	—	—	—
2 800	2 240	3 360	—	—	—	—	—
3 000	2 400	3 600	—	—	—	—	—

6.4.3 Axial tensile strength

The axial tensile strength of the pipe wall, FtL, shall be no less than the specified value in Table 10.

Table 10 Minimum axial tensile strength

in kN/m

Nominal inner diameter/mm	Pressure grade/MPa						
	0.4	0.6	0.8	1.0	1.2	1.4	1.6
150	80	86	94	100	104	108	110
200	86	96	104	110	114	118	120
250	90	106	116	126	128	132	136
300	96	116	128	140	144	148	150
350	100	124	138	150	156	162	168
400	106	130	146	160	168	178	186
45O	110	140	158	176	184	194	204
500	116	150	170	190	200	210	220
600	126	166	194	220	232	244	256
700	136	180	216	250	264	278	290
800	150	200	240	280	296	310	326
900	166	216	264	310	326	340	356
1 000	186	230	286	340	358	374	390
1 200	206	260	320	380	408	434	460
1 400	226	290	356	420	456	—	—
1 600	250	320	390	460	508	—	—
1 800	276	350	426	500	—	—	—
2 000	300	380	460	540	—	—	—
2 200	326	410	496	580	—	—	—
2 400	350	440	530	—	—	—	—
2 600	376	470	566	—	—	—	—
2 800	400	506	—	—	—	—	—
3 000	430	540	—	—	—	—	—

6.4.4 Water pressure leakage

When a water pressure which is 1.5 times the pressure grade of a pipe is applied to the pipe or the pipe with joints for 2 minutes, there shall be no leakage on the pipe or the joint.

6.4.5 Deflection

The deflection level A and deflection level B of each sample shall meet the requirements of Table 11. The specifications of Table 11 are based on the maximum deflection of 3% after installation and long-term field service.

Table 11 Radial deformation ratio and requirements for deflection

Deflection level	Ring stiffness grade/(N/m2)				Requirements
	5 000	10 000	15 000	20 000	
A	15%	13%	11%	9%	No cracks on the inner pipe wall
B	25%	22%	19%	16%	No delamination, fracture or buckling on the pipe wall structure
For pipes with other ring stiffness, the radial deformation ratio of deflection shall be in accordance with the following requirements: a) For pipes with ring stiffness S between standard grades, their radial deformation ratios corresponding to deflection levels A and B are respectively determined by linear interpolation method; b) For pipes with ring stiffness S ≤ 5 000 N/m2 or ≥ 20 000 N/m2, the deflection levels A and B are determined with the equations below: Radial deformation ratio corresponding to deflection level A = 15 × (5 000/S) 1/3. Radial deformation ratio corresponding to deflection level B = 25 × (5 000/S) 1/3.					

6.4.6 Hoop bending strength

The hoop bending strength, Ftm, of the pipe wall shall be calculated according to the engineering design, but shall be no less than the value calculated by equation (2).

$$F_{tm} = \frac{4.28 \times E_p \times t \times \Delta}{(D+\frac{\Delta}{2})^2} \quad \text{.....(2)}$$

Where:

F_{tm} - the hoop bending strength of the pipe wall, in megapascals (MPa);

t - the actual measured thickness of the pipe wall, in millimeters (mm);

D - the calculated diameter of the pipe, in millimeters (mm); $D = D_n + t$;

Among them, D_n - the inner diameter of the pipe, in millimeters (mm);

Δ - the radial compression deformation of the pipe when the initial deflection test reaches deflection level B, in millimeters (mm);

Ep - the hoop bending elasticity modulus of the pipe wall, in megapascals (MPa), determined by equation (3).

$$E_p = 12 \times 10^{-6} S \cdot D^3 / t^3 \quad \text{.....(3)}$$

Where:

S - the measured ring stiffness, in newtons per square meter (N/m2);

6.5 Surface water absorption

The surface water absorption shall be no greater than 3%.

6.6 Combustion performance

The combustion performance shall reach the B1 (B) grade from the combustion performance grading of construction materials and products of GB 8624-2012.

6.7 Thermal conductivity

The thermal conductivity shall be no greater than 0.2 W/(m•K).

6.8 Hygiene target

The hygienic performance of BWCP2s shall meet the requirements of GB/T 17219, and they shall be regularly inspected according to the relevant requirements of national health authorities.

6.9 Shore hardness

The Shore hardness of the outer surface of BWCPs shall be no less than 60 HA.

6.10 Alternation of heat and cold

When 10 cycles are done, there shall be no separation on the interface.

7 Test methods

7.1 Appearance

In accordance with the appearance requirements in 6.1, measurements shall be conducted using visual inspection in natural light, with magnifying glasses, steel rulers and vernier calipers.

7.2 Dimensions

7.2.1 Measuring instruments

7.2.1.1 Inner diameter micrometer (150 mm ～ 4 000 mm), with a division value of 0.02 mm.

7.2.1.2 Steel tape, with a division value of 1 mm.

7.2.1.3 Steel ruler, with a division value of 0.5 mm and 1 mm.

7.2.1.4 Square, with an accuracy grade of 1.

7.2.2 Inner diameter

The inner diameter shall be measured with an inner diameter micrometer. For BWCPs with a nominal inner diameter no greater than 500 mm, the inner diameters of the same section in two directions perpendicular to each other are measured, and the arithmetic average of three measurements is taken. For BWCPs with a nominal inner diameter greater than 500 mm, the inner diameters of the same section in vertical and horizontal directions are measured, and the arithmetic average of three measurements is taken.

7.2.3 Length

The BWCP shall be placed on a flat surface, and its length shall be measured along its generatrix using a steel tape. The arithmetic average of two measurements of generatrixes is taken.

7.2.4 Pipe end face perpendicularity

For BWCPs with a nominal inner diameter of less than 1 000 mm, a square and a steel ruler with a division value of 0.5 mm shall be used. For BWCPs with a nominal inner diameter of not less than 1 000 mm, a steel ruler with a division value of 1 mm shall be used.

7.2.5 Roundness of pipe ends

The roundness of BWCP ends shall be measured as specified in GB/T 4380.

7.3 Insoluble matter content of inner protection liner resin

Test shall be conducted according to GB/T 2576, but blank test of bamboo fiber nonwoven fabric and mesh fabric shall be additionally conducted, specifically with the following method:

Place the n1 layers of bamboo fiber nonwoven fabrics and n2 layers of mesh fabrics required for liners corresponding to different types of BWCPs into a forced air oven at 80 ℃ ± 2 ℃ for 2 h. Take them out and place them in a desiccator to cool down to room temperature. Combine the samples and take 1 g ± 0.2 g of it with an analytical balance.

Record the weight to the accuracy of 0.1 mg, and ensure that the area of each layer is the same.

The mass loss ratio of blank bamboo fiber nonwoven fabric and mesh fabric is calculated by equation (4):

$$C_1 = (m_1 - m_2)/m_1 \times 100 \quad \text{.....(4)}$$

Where:

C1 - the mass loss ratio of blank bamboo fiber nonwoven fabric and mesh fabric, %;

m1 - the mass of blank bamboo fiber nonwoven fabric and mesh fabric before extraction, in milligrams (mg);

m2 - the mass of blank bamboo fiber nonwoven fabric and mesh fabric after extraction, in milligrams (mg);

The mass of the sample after extraction is calculated by equation (5):

$$m_3 = m_4 - m(1 - C_0) \quad \text{.....(5)}$$

where:

m_3 - the mass of the sample after extraction, in milligrams (mg);

m_4 - the total mass of the filter paper cylinder or filter paper bag and residuals after extraction, in milligrams (mg);

m - the mass of the filter paper cylinder (including absorbent cotton) or filter paper bag containing the sample, in milligrams (mg);

C_0 - mass loss ratio of blank filter paper, %.

The mass loss of bamboo fiber nonwoven fabric and mesh fabric is calculated by equation (6). Inner protection liner resin content is calculated by equation (A.3) in Annex A:

$$m_5 = m_6(1 - M_r) \times C_1 \quad \text{.....(6)}$$

Where:

m_5 - the mass loss of bamboo fiber nonwoven fabric and mesh fabric, in milligrams (mg);

m_6 - the mass of the sample before extraction, in milligrams (mg);

M_r - the resin content of the inner protection liner, %;

The insoluble matter content of the inner protection liner resin is calculated by equation (7):

$$C_r = [1 - \frac{m_6 - (m_3 + m_5)}{m_6 \times M_r}] \times 100 \quad \text{.....(7)}$$

where:

C_r - the insoluble matter content of the inner protection liner resin, %;

7.4 Mechanical properties

7.4.1 Resistance to external pressure

7.4.1.1 Ring stiffness

The test equipment, test environment and samples shall comply with the requirements of GB/T 5352. The loading speed shall be calculated by equation (8). The initial ring stiffness shall be calculated by equation (9). The arithmetic average of the initial ring stiffness of three samples shall be taken as the test result.

$$\mathrm{V} = 3.5 \times 10^{-4} D^2 / t \quad \text{.....(8)}$$

where:

V - the loading speed, which shall be an integer. If the pipe diameter is greater than 500 mm, it can be rounded to 0 or 5 at the units digit. In millimeters per minute (mm/min);

$$\mathrm{S_0} = 0.01935 \times \mathrm{F} / \triangle \mathrm{y} \quad \text{.....(9)}$$

where:

S_0 - the initial ring stiffness, in newtons per square meter (N/m^2);

Δy - the change of the diameter of the pipe. 3% of the calculated diameter of the sample is taken. In meters (m);

F - the linear load corresponding to Δy, in newtons per meter (N/m).

7.4.1.2 Resistance to external pressure deformation

The test method for initial ring stiffness shall apply. Record the load value F_1 when the pipe diameter deformation is 25% of the calculated diameter. Unload and rotate the sample by 90 ° in the axial direction, and then reload. Record the load value F_2 when the pipe diameter deformation is 25% of the calculated diameter. Calculate by equation (10) and take the arithmetic average of the load ratio of three samples as the test result.

$$A = (F_1 - F_2)/F_1 \times 100 \quad \text{.....(10)}$$

where:

A - the load ratio of the sample, %;

F_1 - the load on the sample in the first test, in newtons (N);

F_2 - the load on the sample after rotating by 90 °, in newtons (N).

7.4.2 Hoop tensile strength

The test shall be conducted in accordance with GB/T 1458, and calculation is done with equation (B.1) in Annex B. When the nominal inner diameter is no greater than 1 000 mm, a vertical separator disk is used for the test. When the nominal inner diameter is greater than 1 000 mm, a horizontal separator disk is used for the test.

7.4.3 Axial tensile strength

The test shall be conducted as specified in Annex C.

7.4.4 Water pressure leakage

The test shall be conducted in accordance with GB/T 5351. The sample shall be a complete pipe sealed with rubber rings. The test pressure shall be 1.5 times the pressure grade and it shall be maintained for 2 minutes.

7.4.5 Deflection

The test equipment, environment and samples shall comply with the requirements of GB/T 5352. After loading to deflection level A, the load shall be maintained for 2 minutes, and the conditions of the samples shall be observed. If they pass, the load shall be increased to deflection level B and maintained for 2 minutes, and the conditions of the samples shall be observed.

7.4.6 Hoop bending strength

The test shall be conducted as specified in GB/T 1449.

7.5 Surface water absorption

The test shall be conducted as specified in GB/T 1034 and calculations shall be done with equation (11). The arithmetic average of the test results of three effective samples shall be taken as the test result.

$$W = (W_i - W_h)/W_h \times 100 \quad \text{.....(11)}$$

where:

W - the water absorption of the sample, %;

W_i - the mass of the sample after soaking, in grams (g);

W_h - the mass of the sample before soaking, in grams (g);

7.6 Flammability

The test shall be conducted as specified in GB/T 8626. The calorific value of single burning items shall be tested as specified in GB/T 20284.

7.7 Thermal conductivity

The test shall be conducted as specified in GB/T 3139.

7.8 Hygienic indicators

The hygienic performance of $BWCP_2$s shall be tested as specified in GB/T 17219.

7.9 Shore hardness

The test shall be conducted as specified in GB/T 531.1.

7.10 Alternation of heat and cold

The samples shall be placed for at least 24 h in the standard laboratory environment with the temperature of (23 ± 2) ℃ and the relative humidity of (50 ± 10) %. After that, the sample shall be placed in a refrigerator at -40 ℃ for 2 h, and then placed in an oven at 90 ℃ for 2 h. Do this for a total of 10 cycles, and observe whether there is any crack on the interface.

8 Inspection rules

8.1 Types of inspections

There are delivery inspections and type inspections.

8.2 Delivery inspection

8.2.1 Inspection items

Appearance, dimension, water pressure leakage, and shore hardness.

8.2.2 Inspection plan

Each pipe shall be inspected on appearance, dimensions, water pressure leakage, and shore hardness.

8.2.3 Evaluation criteria

The appearance, dimensions, water pressure leakage, and shore hardness shall meet the corresponding requirements, otherwise the pipe becomes a fail.

8.3 Type inspection

8.3.1 Inspection conditions

In normal production, at least one inspection shall be conducted each year, and type inspections shall be conducted in any of the following situations:

a) Model evaluation for a new product or an old converted product in trial production;

b) For a product in massive production, when its material, structure, or process has changed significantly, and the performance of the product may be affected;

c) When the production of a product is resumed after being suspended for a long time (more than 3 months);

d) When there is a big difference between the delivery inspection result and the latest type inspection result;

e) When a national quality supervision authority calls for an inspection.

8.3.2 Inspection items

All the items required in Chapter 6 shall be inspected.

8.3.3 Inspection plan

100 pipes of the same specifications go into a batch (all remaining pipes go into one batch if there are less than 100), out of which a random sample shall be taken for all the inspection items.

8.3.4 Evaluation criteria

If all the inspection items are passed, the inspection objects pass the inspection; if the sample fails in any test item, a second sampling and inspection shall be conducted for that inspection item. The number of samples shall be 5; if there is still a failure in the second inspection, the test objects fail the type inspection.

9 Manufacturer's certification, packaging, transport and storage

9.1 Manufacturer's certification

Each batch of BWCPs shall be accompanied with a factory certificate and mark when delivered.

9.1.1 Factory certificate

The factory certificate shall include the manufacturer's name (or trademark), batch number and product number, product standard number and date of manufacture, product specifications, and a routine test certificate.

9.1.2 Marks

Each BWCP shall bear at least one permanent mark. The mark shall not damage the pipe wall, and shall remain legible during normal handling and installation. The mark shall include the manufacturer's name (or trademark), batch number and product number, and date of manufacture.

9.2 Packaging

Before the BWCPs are shipped, flexible packaging materials such as foamed plastic films shall be used to pack the pipe end faces and the outer connecting surfaces, and the width of the packaging shall be 100 mm larger than the width of the outer connecting surfaces.

9.3 Transport

The following requirements shall be followed for transport and lifting:

a) Flexible ropes shall be used for lifting. If iron chains or steel ropes are used, rubber or other flexible objects shall be filled between the contact surfaces of the chains/ropes and the pipes;

b) Two-point lifting shall be used;

c) Lifting, loading and unloading shall be carried out gently;

d) The pipes shall be firmly fixed during transport and they shall be horizontally stacked;

e) Severe impact shall be avoided during transport and handling.

9.4 Storage

BWCPs shall be stacked based on types, specifications, and grades. Different layers shall be separated from each other by skids. The stacking area shall be flat and away from heat sources. When BWCPs are stored outdoors, sun protection measures like covering up shall be taken. The stacking of the pipes shall be in accordance with Table 12.

Table 12 Maximum stacking layers of pipes

in mm

Nominal inner diameter	≤300	400	500	600≤DN≤700	800≤DN≤1 600	＞1 600
Maximum layer	6	5	4	3	2	1

10 Pipe fittings

See Appendix D.

Annex A
(Normative)

Test method for inner protection liner resin content

A.1 Samples for inner protection liner resin content test

The samples shall meet the following requirements:

a) Cut a 50 mm long ring from the pipe and cut samples with an arc length of 50 mm on three different locations of the ring.

b) Carefully remove the inner protection liner with a knife on a 50 mm x 50 mm sample.

c) Cut a piece of bamboo fiber nonwoven fabric and a piece of mesh fabric for inner protection liner. The length × width (L × B) shall be no less than 200 mm × 150 mm. Measure the bamboo fiber nonwoven fabric for length L_1 and width B_1, and measure the mesh fabric for length L_2 and width B_2.

A.2 Procedures for inner protection liner resin content test

Place the inner protection liner, bamboo fiber nonwoven fabric and mesh fabric in a forced air oven at 80 ℃ ± 2 ℃ for 2 h. Take them out, place them in a desiccator to cool down to room temperature, and leave them for 48 h before weighing them using an analytical balance. Record the mass W1 of the inner protection liner, the mass W2 of the bamboo fiber nonwoven fabric, and the mass W3 of the mesh fabric to the accuracy of 0.1 mg.

A.3 Results for inner protection liner resin content test

Calculate the mass M_1 of the bamboo fiber nonwoven fabric per unit area by equation (A.1) (g/m^2):

$$M_1 = W_2/(L_1 \times B_1) \quad \text{.....(A.1)}$$

where:

M_1 — the mass of the bamboo fiber nonwoven fabric per unit area, in grams per square meter (g/m^2);

W_2 — the mass of the bamboo fiber nonwoven fabric, in grams (g);

L_1 — the length of the bamboo fiber nonwoven fabric, in meters (m);

B_1 — the width of the bamboo fiber nonwoven fabric, in meters (m).

Calculate the mass M_2 of the mesh fabric per unit area by equation (A.2) (g/m²):

$$M_2 = W_3/(L_2 \times B_2) \quad \text{.....(A.2)}$$

where:

M_2 — the mass of the mesh fabric per unit area, in grams per square meter (g/m²);

W_3 — the mass of the mesh fabric, in grams (g);

L_2 — the length of the mesh fabric, in meters (m);

B_2 — the width of the mesh fabric, in meters (m).

Calculate the inner protection liner resin content M_r by equation (A.3):

$$M_r = \frac{W_1 - 0.0025 \times (N_1 \times M_1 + N_2 \times M_2)}{W_1} \times 100 \quad \text{.....(A.3)}$$

where:

M_r — the resin content of the inner protection liner, %;

W_1 — the mass of the inner protection liner, in grams (g);

N_1 — the number of layers of bamboo fiber nonwoven fabric in the inner protection liner;

N_2 — the number of layers of mesh fabric in the inner protection liner.

Annex B

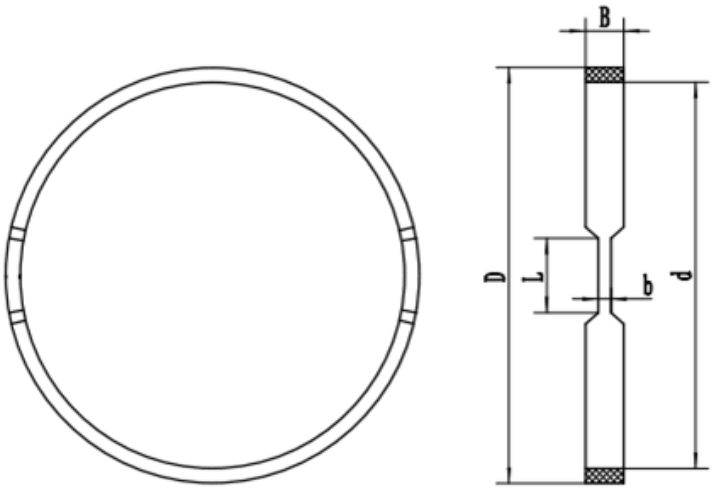
(Normative)

Hoop tensile strength test

B.1 Samples for hoop tensile strength test

B.1.1 Sample dimensions

See Figure B.1 for the shape of samples, and the dimensions shall comply with the requirements in Table B.1.



Explanation:

D — the outer diameter of the pipe;

L — the length of the middle parallel segment;

b — the width of the middle parallel segment;

B — sample width;

d — the inner diameter of the pipe.

Figure B.1 hoop tensile strength test sample

Table B.1 Dimensions of hoop tensile strength test sample

in mm

Nominal inner diameter DN	Middle parallel segment length L	Sample width B	Middle parallel segment width b
150≤DN≤600	40～50	30	10
600＜DN≤1 000	50～60	40	12
DN＞1 000	60～70	45	12

B.1.2 Number of samples

As specified in 4.3 of GB/T 1446-2005.

B.2 Test conditions

The test conditions shall meet the following requirements:

a) The test environment conditions shall be as specified in Chapter 3 of GB/T 1446-2005.

b) Standard laboratory environmental conditions: temperature: (23 ± 2) ℃; relative humidity: (50 ± 10) %;

c) Non-standard laboratory environmental conditions: If standard laboratory environmental conditions are not available, laboratory environmental conditions that are close to the standard ones shall be chosen;

d) See Figure B.2 for the test equipment;

e) The loading speed is 5 mm/min.

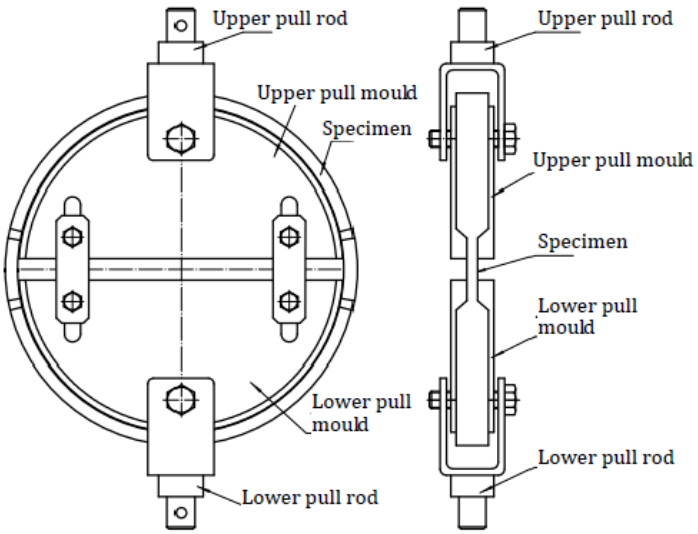


Figure B.2 Schematic of a sample for hoop tensile strength test and the fixture

B.3 Test result

The hoop tensile strength is calculated by equation (B.1), and the arithmetic average of the values for five effective samples is taken as the test result.

$$F_{th} = \mathrm{F/b} \quad \text{.....(B.1)}$$

where:

F_{th} — the tensile strength of the sample, in kilonewtons per meter (kN/m);

F — the breaking load, in kilonewtons (kN);

b — the width of the middle gap of the sample, in meters (m).

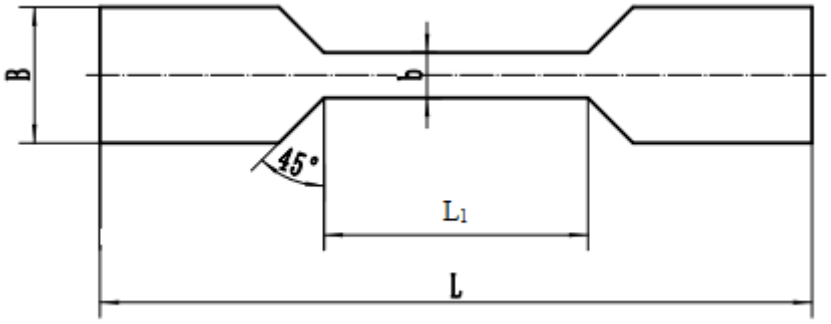
Annex C

(Normative)

Axial tensile strength test

C.1 Samples for axial tensile strength

A sample shall be taken along the axial direction of the BWCP, and the shape and dimensions of the sample are shown in Figure C.1 and Table C.1.



Explanation:

B — sample width;

b — the width of the middle parallel segment;

L — sample length;

L_1 — the length of the middle parallel segment.

Figure C.1 Shape of tensile strength test sample

Table C.1 Dimensions of tensile strength test sample

in mm

Nominal inner diameter DN	Sample length L	Middle parallel segment length L_1	Sample width B	Middle parallel segment width b
150≤DN≤600	140～160	50	30	6
600＜DN≤1 200	160～180	60	40	8

DN＞1 200	180～200	70	40	10

C.2 Number of samples, test equipment, and test procedures

The number of samples shall be as specified in 4.3 of GB/T 1446-2005. The test procedures shall be as specified in Chapter 8 of GB/T 1447-2005. The test equipment is shown in Figure C.2.

C.3 Test results

The axial tensile strength is calculated by equation (C.1), and the arithmetic average of the values for five effective samples is taken as the test result.

$$F_{tl} = \mathrm{F/b} \quad \text{.....(C.1)}$$

where:

F_{tl} — the tensile strength of the sample, in kilonewtons per meter (kN/m);

F — the breaking load, in kilonewtons (kN);

b — the width of the middle gap of the sample, in meters (m).

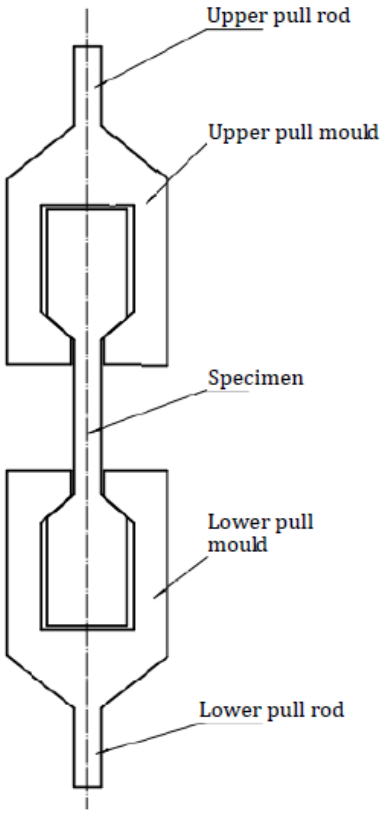


Figure C.2 Schematic of a sample for axial tensile strength test and the fixture

Annex D

(Informative)

Technical details of BWCP fittings

D.1 Scope

This annex specifies the dimension standards and connection methods for BWCP fittings (including flanges, elbows, reducers, and tee joints, etc.). This annex applies to BWCPs and other ancillary products.

D.2 Normative references

GB/T 9119 Slip-on-welding plate steel pipe flanges

D.3 Technical requirements

D.3.1 Flange

D.3.1.1 When the BWCP is connected using loose flanges, the flange profile is shown in Figure D.1, and the flange is made of Q235C steel. The flange connection dimensions shall be as specified in GB/T 9119, and the flange pressure grade shall be no less than the pressure grade of the corresponding pipe.

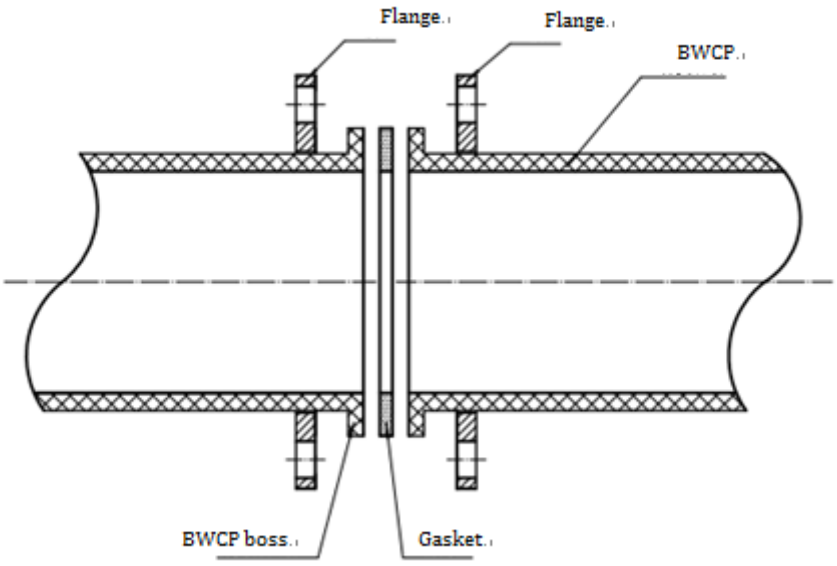


Figure D.1 Flange connection assembly diagram

D.3.1.2 The thickness of bosses for BWCPs of different pressure grades shall comply with the requirements in Table D.1.

Table D.1 Minimum thickness of BWCP bosses

in mm

Nominal inner diameter/mm	Pressure grade/MPa			
	≤0.4	0.6	1.0	1.6
150	5	11	18	28
200	5	13	21	34
250	6	15	25	40
300	7	17	28	44
350	8	20	33	52
400	9	22	36	58
450	10	24	40	64
500	11	26	44	70
600	13	31	51	82
700	15	36	60	96
800	17	40	66	106
900	18	44	74	118
1 000	20	49	84	132

D.3.1.3 The outer diameter of the BWCP boss shall be equal to the diameter of the sealing surface of the connecting flange.

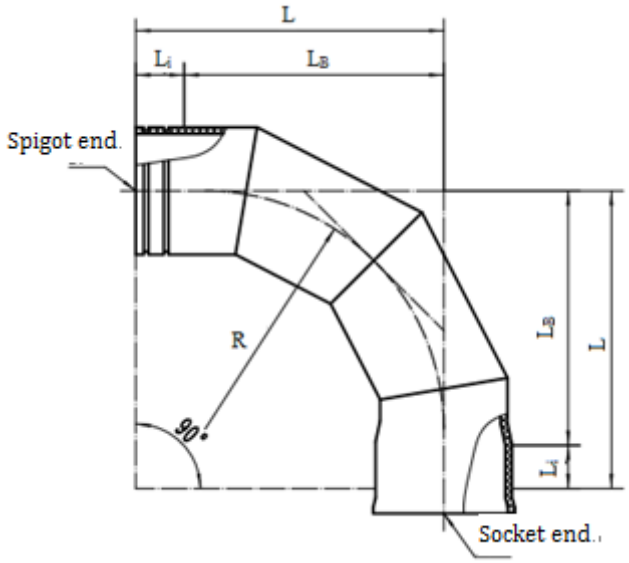
D.3.1.4 The allowable perpendicularity deviation between the flange sealing surface and the centerline of the BWCP shall be less than 1/2. The allowable flatness deviation of the flange sealing surface, shall be 1.0 mm when the pipe diameter is no greater than 450 mm, and 2.0 mm when the pipe diameter is greater than 450 mm.

D.3.1.5 The flange sealing surface shall have a corrosion resistant layer of the same material as the inner protection liner of the BWCP.

D.3.2 Elbow

D.3.2.1 The elbow shall be designed considering the nominal inner diameter, pressure grade, stiffness grade, joint type, elbow angle, forming process, and pipe type.

D.3.2.2 The elbow of the BWCP is as shown in Figure D.2, the angle of which can be 90 °, 60 ° and 45 °; the allowable deviation of the elbow direction angle is ±0.5 °.



Explanation:

R - the radius of curvature;

L - the laying length;

L_B - the body length;

L_i - the insertion length.

Figure D.2 Typical joint elbow

D.3.2.3 The radius of curvature R of the elbow is 1.5 times the nominal inner diameter of the pipe. The number of 90 ° elbows is 4, and the number of elbow joints is 3. The number of 60 ° and 45 ° elbows is 3, and the number of elbow joints is 2.

D.3.2.4 The nominal inner diameter of the elbow is the same as the nominal inner diameter of the corresponding BWCP.

D.3.2.5 Each part of the elbow shall have a length reserved for connection to each other.

D.3.2.6 The minimum value of the body length shall comply with the requirements in Table D.2, or the value agreed on by the purchaser and the manufacturer shall apply.

Table D.2 Minimum body length of elbow, LB

Nominal inner diameter DN/mm	Minimum body length of elbow LB/mm		
	90 °	60 °	45 °
150	230	135	95
200	305	180	130
250	380	225	160

Table D.2 (continued)

Nominal inner diameter DN/mm	Minimum body length of elbow LB/mm		
	90 °	60 °	45 °
300	455	265	190
350	530	310	225
400	605	350	255
450	680	395	285
500	755	440	315
600	905	525	380
700	1 055	615	440
800	1 205	700	505
900	1 355	785	565
1 000	1 505	875	670
1 200	1 805	1 050	750
1 400	2 105	1 250	905
1 600	2 455	1 400	1 025
1 800	2 785	1 590	1 185
2 000	3 050	1 750	1 305
2 400	3 695	2 100	1 575
2 600	3 955	2 280	1 625
2 800	4 295	2 445	1 750
3 000	4 595	2 625	1 925

D.3.2.7 The laying length of the elbow, L, starts from an end face centroid of the elbow. If there is a socket end, the starting point does not include the insertion length; if there is a spigot end at the other end of the elbow, the laying length L equals the body length L_B plus the insertion length L_i.

D.3.2.8 The body length of the elbow, L_B, starts from the intersection of the axes of the two end faces of the elbow, and terminates at the axis length of the starting point (i.e., the center of one end face of the elbow) of one of the axes, and its length equals the laying length L minus the connecting length L_i.

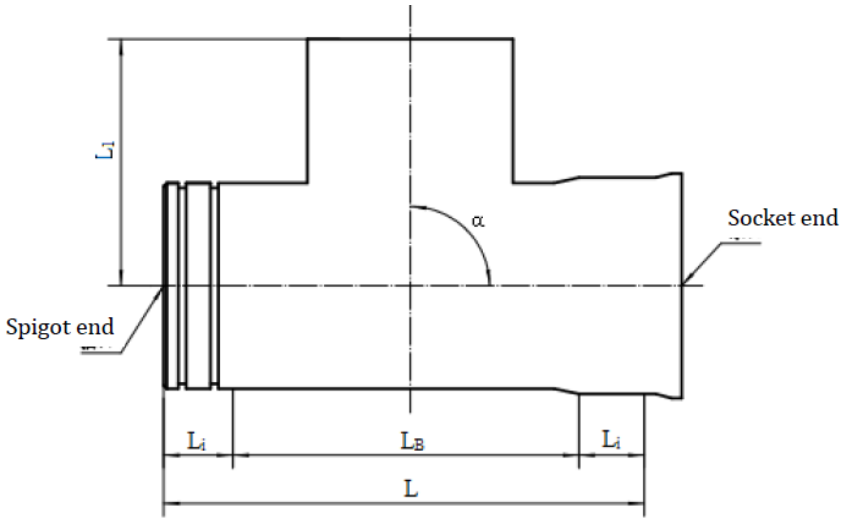
D.3.2.9 The allowable deviation of the elbow laying length is ±15 mm × the number of joints in the elbow.

D.3.3 Tee joint

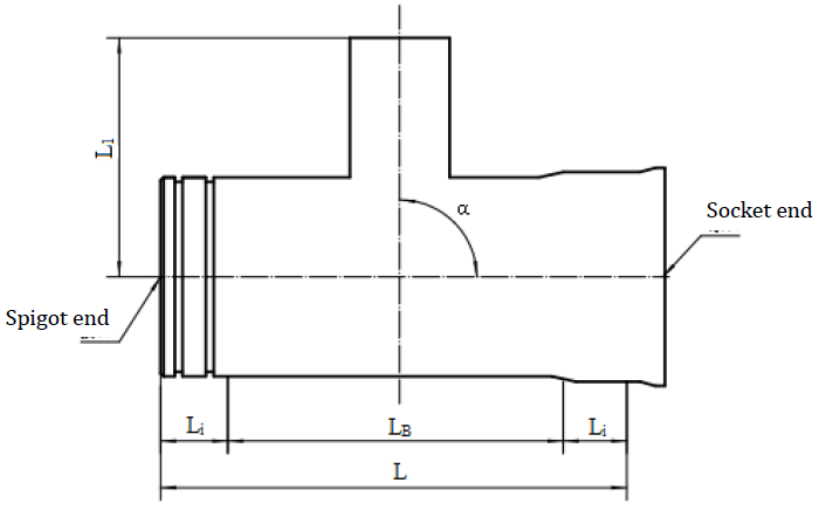
D.3.3.1 Tee joints shall be designed considering the nominal inner diameter, pressure grade, joint type, tee joint type and pipe type.

D.3.3.2 The nominal inner diameter of the tee joint is the same as the corresponding inner diameter of the BWCP.

D.3.3.3 The tee joint is shown in Figure D.3. The allowable angular deviation of the tee joint is ±0.5 °, and the branch pipe length of the tee joint shall be consistent with the nominal inner diameter of the main pipe.



a) Equal tee joint



b) Reducing tee joint

Explanation:

L - the laying length of the main body of the tee joint;

L_1 - the laying length of the tee joint branch;

L_B - the length of the main body of the tee joint;

L_i - the connection length of the tee joint;

α - the tee joint angle.

Figure D.3 Tee joint

D.3.3.4 The body length of the tee joint shall be no less than the minimum value given in Table D.3. For other types of three-way joints, the length shall be as agreed by the purchaser and the manufacturer.

Table D.3 Minimum body length of tee joint LB

in mm

Nominal inner diameter DN	Minimum body length of tee joint LB	Nominal inner diameter DN	Minimum body length of tee joint LB
150	290	1 000	1 220
200	360	1 200	1 420
250	430	1 400	1 620
300	510	1 600	1 620

350	540	1 800	2 020
400	550	2 000	2 220
450	650	2 200	2 420
500	700	2 400	2 620
600	800	2 600	2 820
700	900	2 800	3 020
800	1 000	3 000	3 220
900	1 120	—	—

D.3.3.5 For a tee joint with a spigot end and a socket end, the laying length of the main pipe, L, is equal to the body length L_B plus the insertion length at the spigot end.

D.3.3.6 For a tee joint with two spigot ends, the laying length of the main pipe, L, is equal to the body length L_B plus twice the insertion depth L_i.

D.3.3.7 The allowable deviation of the body length and branch pipe length shall comply with the requirements in Table D.4.

Table D.4 Allowable deviation of body and branch pipe length of tee joint

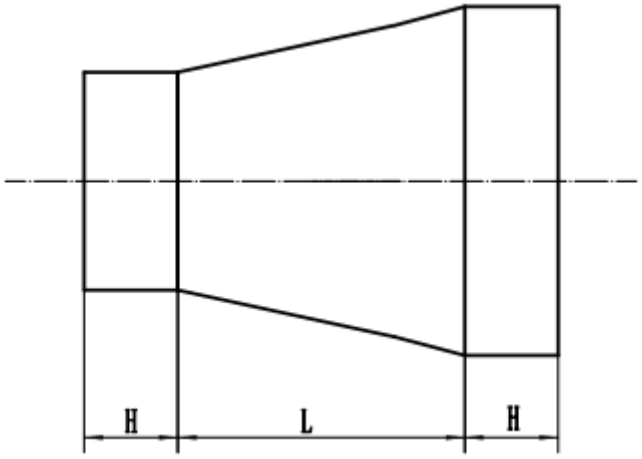
in mm

Nominal inner diameter	Allowable deviation of body and branch pipe length of tee joint
150≤DN≤800	+5
800＜DN≤1 400	+8
1 400＜DN≤2 400	+10
2 400＜DN≤3 000	+12

D.3.4 Reducer

D.3.4.1 The reducers shall be designed considering the nominal inner diameter, pressure grade, stiffness grade, joint type, reducer type and pipe type.

D.3.4.2 Concentric reducer is as shown in Figure D.4. The nominal inner diameters D_1 and D_2 of the reducer are consistent with those of the corresponding BWCPs.



Explanation:

H - the straight pipe segment length;

L - the length from large end face to small end face.

Figure D.4 Concentric reducer

D.3.4.3 The dimensions of the reducer shall comply with the requirements in Table D.5.

Table D.5 Dimensions of BWCP reducer

in mm

Nominal inner diameter D2×D1	The length from large end face to small end face, L	The straight pipe segment length, H	Nominal inner diameter D2×D1	The length from large end face to small end face, L	The straight pipe segment length, H
350×300	400	300	1 200×1 000	850	370
400×300	450	300	1 400×1 200	950	370
400×350	450	300	1 600×1 200	950	450
450×350	500	300	1 600×1 400	1 000	450
450×400	500	300	1 800×1 400	1 000	450
500×400	550	300	1 800×1 600	1 100	450
500×450	550	300	2 000×1 600	1 100	450

600×450	600	300	2 000×1 800	1 200	450

Table D.5 (continued)

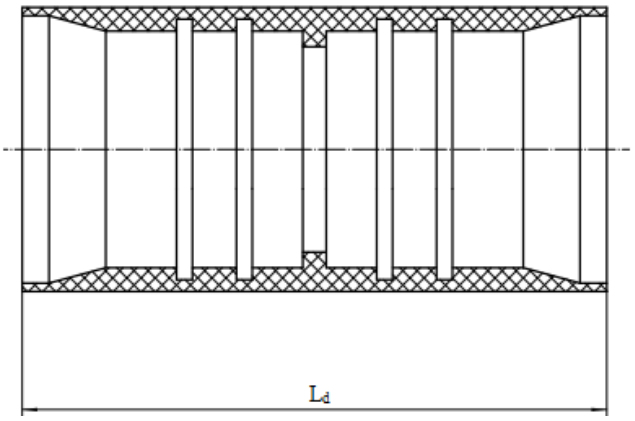
in mm

Nominal inner diameter D2×D1	The length from large end face to small end face, L	The straight pipe segment length, H	Nominal inner diameter D2×D1	The length from large end face to small end face, L	The straight pipe segment length, H
600×500	600	300	2 200×1 800	1 200	450
700×500	650	370	2 200×2 000	1 300	450
700×600	650	370	2 400×2 200	1 300	450
800×600	700	370	2 600×2 200	1 400	450
800×700	700	370	2 600×2 400	1 400	540
900×700	750	370	2 800×2 400	1 500	540
900×800	750	370	2 800×2 600	1 500	540
1 000×800	800	370	3 000×2 600	1 600	540
1 000×900	800	370	3 000×2 800	1 600	540
1 200×900	850	370	—	—	—
Note: When the nominal inner diameter $D_2 \times D_1$ <1 000×800, the allowable deviation of the straight pipe segment length H is ±5 mm; when the nominal inner diameter $D_2 \times D_1$ ≥1 000×800, the allowable deviation of the straight pipe segment length H is ±10 mm.					

D.3.4.4 The elbow or tee joint thickness corresponding to the large end can be referred to the wall thickness of the reducer.

D.3.5 Straight joint

D.3.5.1 Figure D.5 is a section of a straight joint.



Explanation:

L_d - Minimum length of the straight joint.

Figure D.5 Straight joint section

D.3.5.2 The length of the straight joint shall comply with the requirements in Table D.6.

Table D.6 Minimum length of the straight joint under internal pressure

in mm

Nominal inner diameter DN	Minimum length of the straight joint Ld	Nominal inner diameter DN	Minimum length of the straight joint Ld
150	442	1 000	662
200	502	1 200	662
250	562	1 400	662
300	576	1 600	780
350	586	1 800	790
400	586	2 000	790
450	642	2 200	790
500	642	2 400	790
600	652	2 600	800
700	652	2 800	830
800	652	3 000	830
900	652	—	—