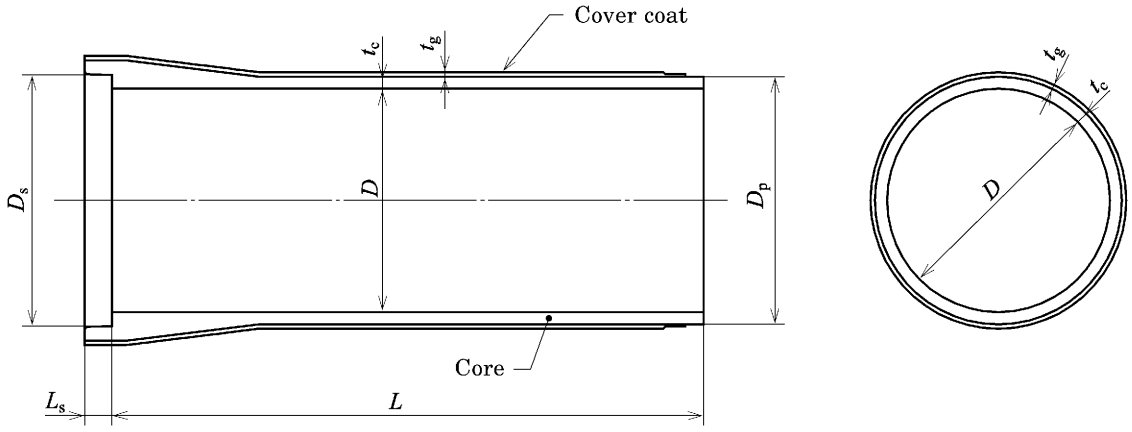
If the reference dimension is changed within the range specified in D.4, the manufacturer shall submit the data indicating that PC tubes conform to Table D.3 in the design document or the performance test result when requested by the purchaser.

**Recommended specification D-1 Table 5**
**Shape and dimensions of PC tube, Type S**



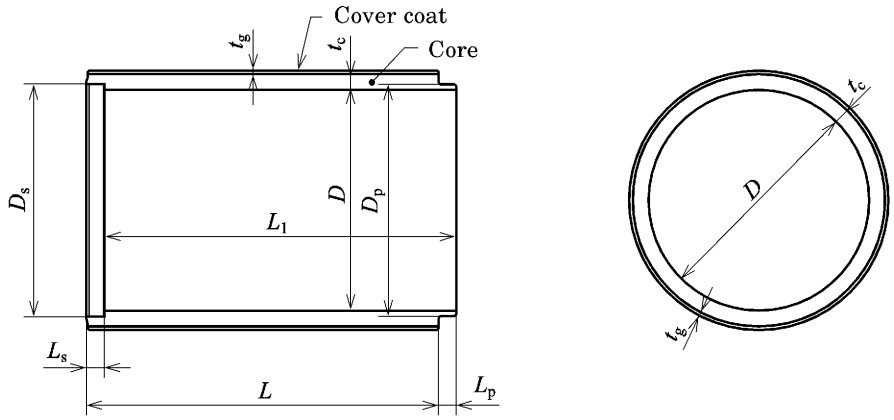

Unit: mm

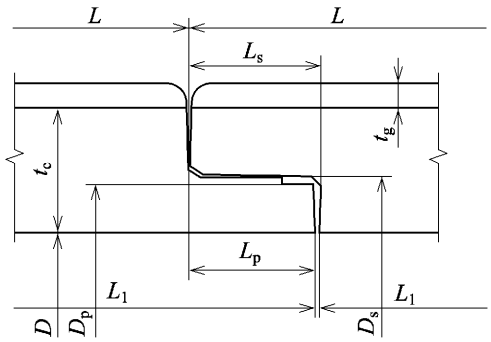
| Nominal designation | Internal diameter $D$ | Thickness of core $t_c$ | External diameter of spigot $D_p$ | Internal diameter of socket $D_s$ | Depth of socket $L_s$ | Thickness of cover coat $t_g$ | Effective length [a] $L$ | Mass (informative) (kg/m) |
|---|---|---|---|---|---|---|---|---|
| 600 | 612 | 44 | 684 | 708 | 140 | 25 min. | 4 000 | 410 |
| 700 | 724 | 46 | 800 | 824 | | | | 480 |
| 800 | 828 | 52 | 916 | 940 | | | | 610 |
| 900 | 932 | 59 | 1 034 | 1 058 | | | | 740 |
| 1 000 | 1 034 | 65 | 1 144 | 1 172 | 165 | | | 870 |
| 1 100 | 1 134 | 71 | 1 258 | 1 286 | | | | 970 |
| 1 200 | 1 234 | 78 | 1 372 | 1 400 | | | | 1 210 |
| 1 350 | 1 382 | 87 | 1 538 | 1 566 | | | | 1 460 |
| 1 500 | 1 532 | 96 | 1 702 | 1 734 | 190 | | | 1 770 |
| 1 650 | 1 680 | 105 | 1 868 | 1 900 | | | | 2 080 |
| 1 800 | 1 824 | 115 | 2 032 | 2 064 | | | | 2 480 |
| 2 000 | 2 040 | 125 | 2 268 | 2 300 | | | | 2 940 |

Work such as chamfering, notching, unevenness to the degree not detrimental to practical use may be applied, unless it affects the shape of PC tube or compromises its strength. The inside and outside circumferences of the cross-section of a tube shall be practically a concentric circle, and its end shall be practically vertical to the tube axis. The internal surface of PC tube shall be smooth against the water-flow surface.

Note [a] The effective length $L$ may be 2 000 or 3 000.

## Recommended specification D-1 Table 6
## Shape and dimensions of PC tube, Type NC




**Details of joint**

Unit: mm

| Nominal designation | Internal diameter $D$ | Thickness of core $t_c$ | External diameter of spigot $D_p$ | Internal diameter of socket $D_s$ | Length of spigot $L_p$ | Depth of socket $L_s$ | Thickness of cover coat $t_g$ | Effective length $L$ | Inner face length $L_1$ | Mass (informative) (kg/m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 500 | 1 500 | 140 | 1 598 | 1 632 | 115 | 120 | 25 min. | 2 300 | 2 295 | 2 110 |
| 1 650 | 1 650 | 150 | 1 758 | 1 792 | | | | | | 2 450 |
| 1 800 | 1 800 | 160 | 1 916 | 1 950 | | | | | | 2 820 |
| 2 000 | 2 000 | 175 | 2 130 | 2 164 | | | | | | 3 380 |
| 2 200 | 2 200 | 190 | 2 344 | 2 378 | | | | | | 3 990 |
| 2 400 | 2 400 | 205 | 2 550 | 2 594 | 130 | 135 | | | | 4 640 |
| 2 600 | 2 600 | 220 | 2 764 | 2 808 | | | | | | 5 330 |
| 2 800 | 2 800 | 235 | 2 978 | 3 022 | | | | | | 6 120 |
| 3 000 | 3 000 | 250 | 3 192 | 3 236 | | | | | | 6 900 |

**Recommended specification D-1 Table 7 Dimensional tolerances**

Unit: mm

| Range of nominal designation | Internal diameter | Thickness of core [a)] | External diameter of spigot | Internal diameter of socket | Depth of spigot/ socket | Effective length | Inner face length |
|---|---|---|---|---|---|---|---|
| | | | | | | Type S, Type NC | Type NC |
| | $D$ | $t_c$ | $D_p$ | $D_s$ | $L_p$, $L_s$ | $L$ | $L_1$ |
| 600 to 900 | ±4 | +4<br>−2 | +2<br>−1 | +1<br>−2 | ±5 | +10<br>− 5 | |
| 1 000 to 1 350 | ±6 | +6<br>−3 | ±2 | ±2 | | | |
| 1 500 to 2 000 | ±8 | +8<br>−4 | | | | | |
| 2 200 to 2 400 | ±10 | +10<br>− 5 | | ±3 | | | |
| 2 600 to 3 000 | ±12 | +12<br>− 6 | +3<br>−2 | ±4 | | | |

Note [a)] The thickness $t_c$ of core shall be measured before giving the prestress in the periphery direction of core.

### D-1.5 Bar arrangement

The bar arrangement of PC tubes that satisfies the performances of **D-1.3** shall be specified by the manufacturer.

### D-1.6 Quality of concrete

The quality of concrete shall be as specified in **D.6.2**. To verify the quality of cover coat mortar, a substitute characteristic (e.g. density) may be used, provided that it is sufficiently correlated with the strength.

### D-1.7 Test methods

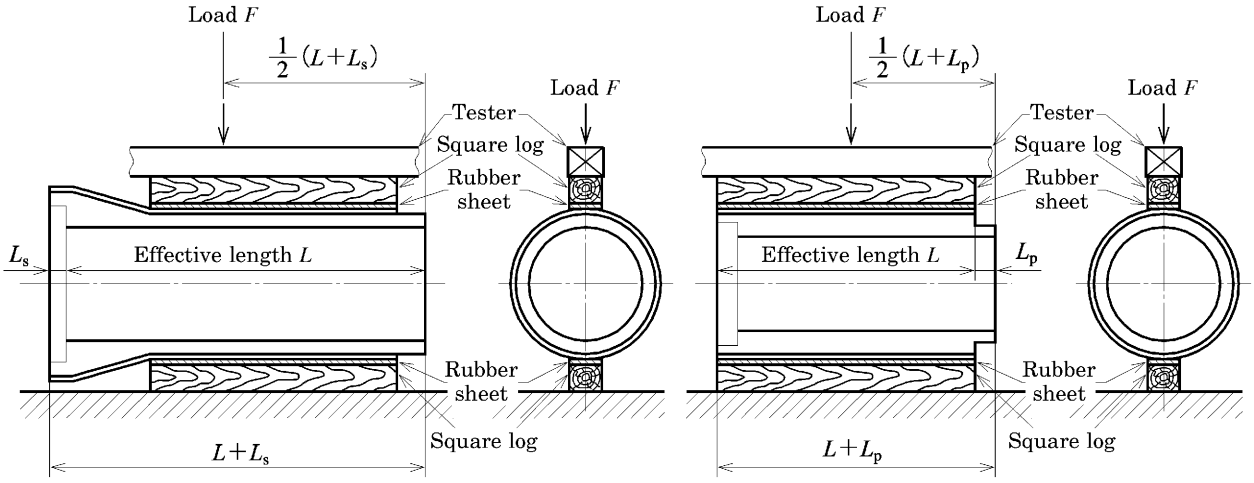
#### D-1.7.1 Compressive strength test of concrete

The compressive strength test of concrete shall be as specified in **D.7.1**.

#### D-1.7.2 Flexural strength test of product

In the flexural strength test, the PC tubes shall be installed as shown in Recommended specification D-1 Figure 1. The load equivalent to the cracking strength specified in Recommended specification D-1 Table 8 multiplied by the effective length $L$ shall be applied, and the tubes shall be examined for the cracking. Also, they shall be checked that the breakage does not occur when the load is applied up to the ultimate load specified in Recommended specification D-1 Table 8. When the flexural strength test of the product is conducted, the load shall be uniformly distributed by applying the rubber sheet [1)] of about 20 mm in thickness and the square log of about 150 mm × 150 mm to the pressure surface and the support surface.

Note [1)] The rubber sheet should have such hardness and width that the influence of the unevenness of the supporting position and the loading position can be absorbed.




**Type S** **Type NC**

**Recommended specification D-1 Figure 1**
**Flexural strength test method of PC tube**

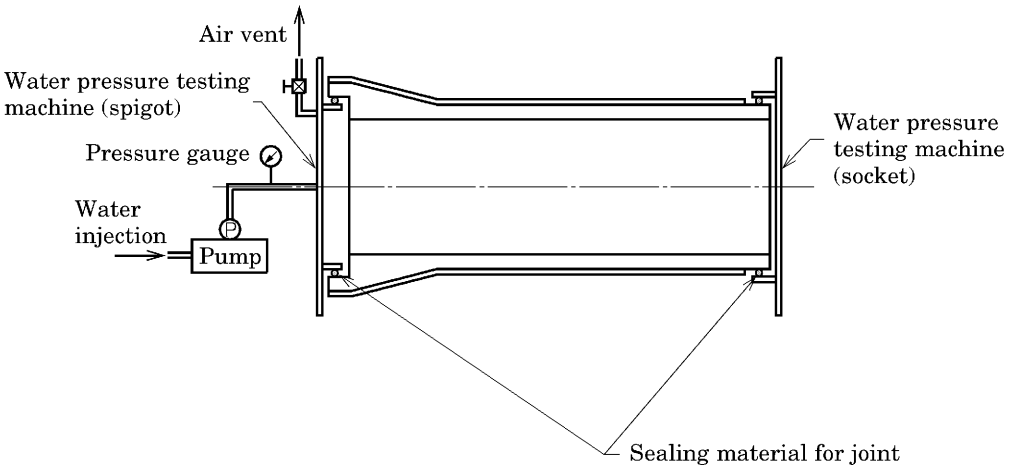
**Recommended specification D-1 Table 8**
**Load corresponding to cracking strength and ultimate load of PC tube**

Unit: kN/m

| Nominal designation | Internal pressure tube/external pressure tube | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cracking load | | | | | | | | Ultimate load | | | | | | | |
| | High pressure Class 1 | High pressure Class 2 | High pressure Class 3 | Class 1 | Class 2 | Class 3 | Class 4 | Class 5 | High pressure Class 1 | High pressure Class 2 | High pressure Class 3 | Class 1 | Class 2 | Class 3 | Class 4 | Class 5 |
| 600 | | | | 110 | 95 | 78 | 61 | 52 | | | | 220 | 190 | 156 | 122 | 104 |
| 700 | | | | 113 | 96 | 79 | 61 | 52 | | | | 226 | 192 | 158 | 122 | 104 |
| 800 | | | | 120 | 102 | 84 | 64 | 55 | | | | 240 | 204 | 168 | 128 | 110 |
| 900 | | | | 130 | 110 | 88 | 67 | 56 | | | | 260 | 220 | 176 | 134 | 112 |
| 1 000 | | — | | 138 | 117 | 94 | 73 | 61 | | — | | 276 | 234 | 188 | 146 | 122 |
| 1 100 | | | | 144 | 121 | 100 | 76 | 61 | | | | 288 | 242 | 200 | 152 | 122 |
| 1 200 | | | | 151 | 128 | 105 | 81 | 69 | | | | 302 | 256 | 210 | 162 | 138 |
| 1 350 | | | | 157 | 133 | 108 | 82 | 69 | | | | 314 | 266 | 216 | 164 | 138 |
| 1 500 | | | | 169 | 143 | 118 | 90 | 75 | | | | 338 | 286 | 236 | 180 | 150 |
| 1 650 | | 240 | 200 | 180 | 155 | 127 | 97 | 80 | | 480 | 400 | 360 | 310 | 254 | 194 | 160 |
| 1 800 | 300 | | | 190 | 161 | 129 | 98 | 82 | 600 | | | 380 | 322 | 258 | 196 | 164 |
| 2 000 | | 250 | 230 | 200 | 165 | 137 | 103 | 85 | | 500 | 460 | 400 | 330 | 274 | 206 | 170 |
| 2 200 | | | | 210 | 177 | 143 | 108 | 89 | | | | 420 | 354 | 286 | 216 | 178 |
| 2 400 | | 300 | 250 | 220 | 185 | 149 | 112 | 93 | | 600 | 500 | 440 | 370 | 298 | 224 | 186 |
| 2 600 | — | | | 230 | 193 | 155 | 118 | 97 | — | | | 460 | 386 | 310 | 236 | 194 |
| 2 800 | | — | 300 | 240 | 201 | 161 | 123 | 101 | | — | 600 | 480 | 402 | 322 | 246 | 202 |
| 3 000 | | | | 250 | 209 | 167 | 128 | 105 | | | | 500 | 418 | 334 | 256 | 210 |

### D-1.7.3 Internal pressure strength test of product

In the internal pressure strength test of the product, the PC tube shall be installed as shown in Recommended specification D-1 Figure 2. After the hollow part of product is filled with water, the internal pressure strength for testing specified in Recommended specification D-1 Table 4 shall be applied for 3 min, and the product shall be examined for the leakage of water. Spots or water drops oozed on the surface of product are not deemed as the leakage of water. For the cracking internal pressure, when the pressure reaches the value specified in recommended specification D-1 Table 4, it shall be examined for crack.




**Recommended specification D-1 Figure 2**
**Internal pressure strength test of PC tube**

## D-1.8 Inspections

### D-1.8.1 Inspection items

The inspection items of PC tubes shall be as follows.

a) **Final inspection** The final inspection items shall be as follows.

1) Appearance

2) Performance

3) Shape and dimensions

b) **Delivery inspection** The delivery inspection items shall be as follows. The delivery inspection may be omitted as agreed between the parties concerned with delivery.

1) Appearance

2) Shape and dimensions

### D-1.8.2 Inspection lot

The size of inspection lot of PC tubes shall be decided by the manufacturer for the final inspection, and by the purchaser for the delivery inspection as agreed between the

parties concerned with delivery in consideration of the characteristics of product, production method, production quantity, production period, quantity of ordered poles, etc. One inspection lot may consist of 50 units or fractions thereof.

### D-1.8.3 Inspection method

The inspection method of PC tubes shall be as follows.

a) **Final inspection** The final inspection method shall be as follows.

1) **Appearance** As the inspection of the appearance, a 100 % inspection shall be conducted by visual observation, and those conforming to the provisions of **5.1** shall be accepted.

2) **Performance** As the inspection of the performance, one arbitrary PC tube per lot shall be taken and inspected as specified in **D-1.7.1** for the external pressure tube, and **D-1.7.1** and **D-1.7.2** for the internal pressure tube. If it conforms to **D-1.3**, the lot shall be accepted. If it does not conform, the remainder of the lot shall be subjected to a 100 % inspection, and those conforming to the provisions shall be accepted.

3) **Shape and dimensions** As the inspection of shape and dimensions, one arbitrary PC tube per lot shall be taken, and if it conforms to the provisions of **D-1.4**, the lot shall be accepted. If it does not conform, the remainder of the lot shall be subjected to a 100 % inspection, and those conforming to the provisions shall be accepted.

b) **Delivery inspection** The delivery inspection method shall be as follows.

1) **Appearance** The appearance shall be inspected in the same way as **a**) **1**).

2) **Shape and dimensions** The shape and dimensions shall be inspected in the same way as **a**) **3**).

### D-1.9 Marking

The PC tubes which conform to all the requirements of this Standard shall be marked as specified in **D.9**.

# Recommended specification D-2
# Prestressed concrete box culverts

## D-2.1 Outline

This recommended specification describes the prestressed concrete box culverts in Group I of covered conduits (hereafter referred to as PC box culverts) in Annex D.

## D-2.2 Classification

The PC box culverts shall be divided according to the nominal dimension and applicable earth covering as shown in recommended specification D-2 Table 1.

**Recommended specification D-2 Table 1**
**Classification of PC box culverts**

| Type | Division by nominal dimension<br>mm | Division by applicable earth covering [a)]<br>m |
|---|---|---|
| Type 150<br>Type 300<br>Type 600 | 600 × 600<br>to<br>5 000 × 2 500 | 0.50 to 1.50<br>1.51 to 3.00<br>3.01 to 6.00 |
| Note [a)] Regardless of the division of applicable earth covering indicated above, the minimum earth covering is 0.2 m. | | |

## D-2.3 Performance

The performance of PC box culverts shall be as follows.

### D-2.3.1 Flexural cracking strength

The flexural cracking strength of PC box culvert shall be the value specified in Recommended specification D-2 Table 2 or more.

### D-2.3.2 Ultimate flexural strength

In the case where the ultimate flexural strength is verified as agreed between the parties concerned with delivery, it shall be as specified in **D.3**.

**Recommended specification D-2 Table 2**
**Flexural cracking strength of PC box culverts**

| Nominal dimension $B \times H$ (mm) | Flexural cracking strength (kN・m/m) | | |
|---|---|---|---|
| | Type 150 | Type 300 | Type 600 |
| 600 × 600 | 3.53 | 2.50 | 4.00 |
| 700 × 700 | 4.55 | 3.22 | 5.17 |
| 800 × 800 | 5.71 | 4.04 | 6.48 |
| 900 × 600 | 6.61 | 5.23 | 9.77 |
| 900 × 900 | 7.00 | 4.95 | 8.53 |
| 1 000 × 800 | 8.19 | 6.24 | 10.78 |
| 1 000 × 1 000 | 8.41 | 5.94 | 10.05 |
| 1 000 × 1 500 | 8.22 | 4.02 | 5.96 |
| 1 100 × 1 100 | 9.92 | 7.01 | 11.85 |
| 1 200 × 800 | 10.84 | 8.71 | 15.11 |
| 1 200 × 1 000 | 11.22 | 8.59 | 14.71 |
| 1 200 × 1 200 | 11.43 | 8.17 | 13.79 |
| 1 200 × 1 500 | 11.40 | 6.99 | 11.41 |
| 1 300 × 1 300 | 12.96 | 9.42 | 15.87 |
| 1 400 × 1 400 | 15.07 | 11.23 | 18.10 |
| 1 500 × 1 000 | 16.00 | 13.60 | 22.54 |
| 1 500 × 1 200 | 16.41 | 13.46 | 22.11 |
| 1 500 × 1 500 | 16.68 | 12.68 | 20.46 |
| 1 800 × 1 200 | 20.95 | 18.94 | 32.64 |
| 1 800 × 1 500 | 21.49 | 18.59 | 31.70 |
| 1 800 × 1 800 | 21.59 | 17.52 | 29.51 |
| 2 000 × 1 500 | 24.71 | 22.86 | 40.05 |
| 2 000 × 1 800 | 24.98 | 22.08 | 38.34 |
| 2 000 × 2 000 | 24.92 | 21.13 | 36.48 |
| 2 200 × 1 800 | 29.30 | 27.94 | 48.36 |
| 2 200 × 2 200 | 29.16 | 26.08 | 44.70 |
| 2 300 × 1 500 | 30.55 | 30.86 | 53.83 |
| 2 300 × 1 800 | 31.05 | 30.51 | 52.87 |
| 2 300 × 2 000 | 31.13 | 29.86 | 51.50 |
| 2 300 × 2 300 | 30.87 | 28.21 | 48.34 |
| 2 400 × 2 000 | 32.94 | 32.60 | 57.43 |
| 2 400 × 2 400 | 32.58 | 30.42 | 53.23 |
| 2 500 × 1 500 | 33.90 | 35.89 | 65.78 |
| 2 500 × 1 800 | 34.56 | 35.86 | 65.13 |
| 2 500 × 2 000 | 34.74 | 35.40 | 63.93 |
| 2 500 × 2 500 | 34.97 | 33.51 | 58.21 |
| 2 800 × 1 500 | 39.79 | 44.91 | 80.24 |
| 2 800 × 2 000 | 41.00 | 45.20 | 80.07 |
| 2 800 × 2 500 | 40.90 | 43.24 | 76.13 |
| 2 800 × 2 800 | 40.16 | 40.94 | 71.91 |
| 3 000 × 1 500 | 51.20 | 60.78 | 104.09 |
| 3 000 × 2 000 | 52.26 | 60.47 | 103.30 |

**Recommended specification D-2 Table 2 (concluded)**

| Nominal dimension $B \times H$ (mm) | Flexural cracking strength (kN・m/m) | | |
|---|---|---|---|
| | Type 150 | Type 300 | Type 600 |
| 3 000 × 2 500 | 51.60 | 57.28 | 97.97 |
| 3 000 × 3 000 | 45.68 | 48.84 | 88.18 |
| 3 500 × 2 000 | 68.23 | 82.97 | 138.15 |
| 3 500 × 2 500 | 67.81 | 81.52 | 142.21 |
| 4 000 × 2 000 | 84.97 | 105.74 | 166.93 |
| 4 000 × 2 500 | 85.68 | 105.88 | 168.39 |
| 4 500 × 2 000 | 112.79 | 142.70 | 225.61 |
| 4 500 × 2 500 | 114.30 | 143.99 | 228.41 |
| 5 000 × 2 000 | 125.35 | 161.70 | 292.95 |
| 5 000 × 2 500 | 128.58 | 165.56 | 296.71 |

NOTE : The values in this table are the flexural cracking strength of PC box culverts designed under the following applicable earth covering conditions: for Type 150, 0.50 m to 1.50 m; for Type 300, 1.51 m to 3.00 m; and for Type 600, 3.01 m to 6.00 m on the assumption that the vehicle load of 245 kN in total weight is taken as the design live load.

### D-2.4 Shape, dimensions and dimensional tolerances

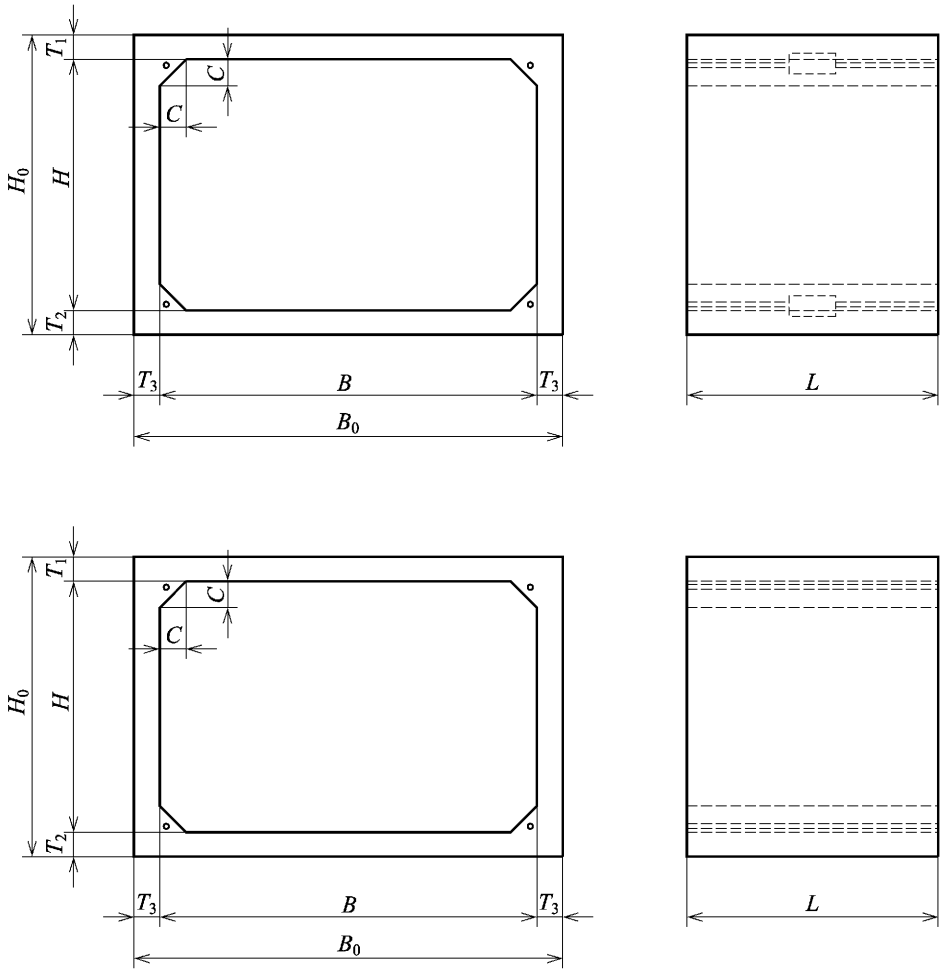
The shape, dimensions and dimensional tolerances of PC box culverts shall be as specified in Recommended specification D-2 Figure 1, Recommended specification D-2 Table 3 and Recommended specification D-2 Table 4.

If the reference dimension is changed within the range specified in **D.4**, the manufacturer shall submit the data indicating that PC box culverts conform to Table D.3 in the design document or performance test result when requested by the purchaser.

NOTE 1 The shape of a product is a standard type or an inverted type. The shape of joint is a butting type, a fitting type or a socket/spigot type.

NOTE 2 Products may have chamfer, packing window, sling hole or others unless such additions affect the shape or compromise the strength of PC box culverts.

NOTE 3 Products can be installed in several ways. Product may be simply laid down, joined with prestressing tendon, or joined with bolts. The products jointed by using prestressing tendon are shown in Recommended specification D-2 Figure 1.




**Recommended specification D-2 Figure 1　Shape of PC box culverts**