JIS

JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

JIS A 5373 : 2016

(JPCC/JSA)

Precast prestressed concrete products

ICS 91.100.30;93.080.30

Reference number : JIS A 5373 : 2016 (E)

Date of Establishment: 2000-07-20
Date of Revision: 2016-04-20
Date of Public Notice in Official Gazette: 2016-04-20
Investigated by: Japanese Industrial Standards Committee
Standards Board for ISO area
Technical Committee on Civil Engineering

JIS A 5373:2016, First English edition published in 2017-05

Translated and published by: Japanese Standards Association
Mita MT Building, 3-13-12, Mita, Minato-ku, Tokyo, 108-0073 JAPAN

In the event of any doubts arising as to the contents,
the original JIS is to be the final authority.

Printed in Japan

KK/AT

Contents

Precast prestressed concrete products

1 Scope

This Japanese Industrial Standard specifies the precast prestressed concrete products (hereafter referred to as PC products). However, this Standard is not applied to the concrete products for buildings separately specified in Japanese Industrial Standards.

This Standard is not applied to the products which use the prestressing tendon [1], etc. for the purpose of ensuring the safety in construction, and is not intended to have the prestressed concrete structure.

The comparison table between previous and current editions of this Standard on technically significant revisions is given in Annex F.

Note [1] The prestressing tendon means the materials specified in **JIS G 3109**, **JIS G 3137** and **JIS G 3502**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) listed below shall be applied.

JIS A 0203 *Concrete terminology*

JIS A 1108 *Method of test for compressive strength of concrete*

JIS A 1136 *Method of test for compressive strength of spun concrete*

JIS A 5361 *Precast concrete products—General rules for classification, designation and marking*

JIS A 5362 *Precast concrete products—Required performance and methods of verification*

JIS A 5363 *Precast concrete products—General rules for methods of performance test*

JIS A 5364 *Precast concrete products—General rules of materials and product methods*

JIS A 5365 *Precast concrete products—General rules for method of inspection*

3 Terms and definitions

For the purposes of this Standard, the terms and definitions given in **JIS A 0203**, and the following apply.

3.1 Group I

PC products which are manufactured based on specifications that have been confirmed by actual results to satisfy the required performances

The recommended specifications are shown in respective Annexes.

3.2 Group II

PC products manufactured based on the performance requirements and specification which are agreed previously between the parties concerned with delivery

4 Classification

PC products shall be classified as specified in Table 1 according to the applications.

They shall be classified into Group I and Group II according to the determination method of performance and specification.

Table 1 Classification of PC products

Type	Applicable clause in Annex
Poles	See **A.2.**
Bridges	See **B.2.**
Retaining walls	See **C.2.**
Covered conduits	See **D.2.**
Piles	See **E.2.**
Other products Example: Disaster prevention facilities	As agreed between the parties concerned with delivery.
NOTE: Each Annex contains specifications of Group I and Group II. Recommended specification is provided for Group I, but not for Group II.	

5 Quality

5.1 Appearance

PC products shall be free from any flaw, crack, chip, camber, torsion (board products), etc. detrimental to practical use.

5.2 Performance

The performance according to the type of PC products shall conform to the provisions of Table 2. The performance tests for the verification of performances shall be as specified in **9.2.**

Table 2 Performances of PC products

Type	Applicable clause in Annex
Poles	See **A.3.**
Bridges	See **B.3.**
Retaining walls	See **C.3.**
Covered conduits	See **D.3.**
Piles	See **E.3.**
Other products Example: Disaster prevention facilities	a) **Performance** Specific items of performance shall be selected and designated as agreed between the parties concerned with delivery according to **JIS A 5362.** When the correlativity between the performance and the product specifications (dimensions, materials, constructions, etc.) is proven by actual results, the product specification indicated in **b)** may be alternatively given. b) **Alternative specification for performance** As follows. 1) Dimensions 2) Compressive strength of concrete 3) Bar arrangement 4) Effective prestress

6 Shape, dimensions and dimensional tolerances

The shape, dimensions and dimensional tolerances shall be as specified in Table 3.

Table 3 Shape, dimensions and dimensional tolerances of PC products

Type	Applicable clause in Annex
Poles	See **A.4.**
Bridges	See **B.4.**
Retaining walls	See **C.4.**
Covered conduits	See **D.4.**
Piles	See **E.4.**
Other products Example: Disaster prevention facilities	As agreed between the parties concerned with delivery.

7 Bar arrangement and tolerances on bar arrangement

The bar arrangement (reinforcing bar and prestressing tendon) of PC products shall be measured as specified in **9.3**, and the arrangement and the tolerance shall conform to the provisions of the following **a)** and **b)**.

a) **Bar arrangement** The bar arrangement (including covering of reinforcing bar) shall be as specified in Table 4. However, as agreed between the parties concerned with delivery, other bar arrangement may be adopted unless it compromises the performance of PC products (including the provisions of **5.2**). The manufacturer

shall prepare the bar arrangement drawing for each product, and shall provide it to the purchaser, if requested.

Table 4 Bar arrangement of PC products

Type	Applicable clause in Annex
Poles	See **A.5.**
Bridges	See **B.5.**
Retaining walls	See **C.5.**
Covered conduits	See **D.5.**
Piles	See **E.5.**
Other products Example: Disaster prevention facilities	Determined by the manufacturer.
NOTE : General precautions for designing the bar arrangement should be as follows. — The minimum gap between the reinforcing bar and the prestressing tendon should be at least 5/4 of the maximum dimension of coarse aggregates. — The necessary cross-sectional area of reinforcing bar and prestressing tendon shall be determined from the structural calculation or the structural details; however, there are more than one combination of diameter and the number of reinforcing bars and prestressing tendons which satisfy the cross-sectional area. The diameter and the number of reinforcing bars and prestressing tendons shall be selected in consideration of the thickness of components, the maximum dimension of coarse aggregates, etc. The bar arrangement shall be selected to ensure the complete adhesion between the reinforcing bar, prestressing tendon and concrete, and to obtain the good crack dispersion of concrete components.	

b) **Tolerance on bar arrangement** The tolerance on bar arrangement [2)] shall be determined by the manufacturer according to the type of product within the range in which the required performance can be satisfied.

Note [2)] The tolerance on bar arrangement means the limit of deviation between the positions of reinforcing bar and prestressing tendon indicated on the bar arrangement drawing, and the positions of reinforcing bar and prestressing tendon of the product.

8 Materials and production methods

The materials used for PC products and the production methods shall be as specified in **JIS A 5364**.

9 Test methods

9.1 Appearance test

The appearance shall be tested visually, and the product shall be examined for flaw, crack, chip, camber, torsion (in the case of board products), etc. detrimental to practical use.

9.2 Performance test

The test method of performance shall be as specified in **JIS A 5363** and Table 5.

Table 5 Performance test method of PC products

Type	Applicable clause in Annex
Poles	See **A.7**.
Bridges	See **B.7**.
Retaining walls	See **C.7**.
Covered conduits	See **D.7**.
Piles	See **E.7**.
Other products Example: Disaster prevention facilities	As agreed between the parties concerned with delivery.

9.3 Measurement of bar arrangement

In the measurement of bar arrangement, the diameter, number and covering of reinforcing bars and prestressing tendons shall be checked. The method shall be any of the following.

a) **Method by non-destructive test** The measurement by the non-destructive test shall be conducted using the electromagnetic induction method, radar method, etc. According to each designated measurement method, the diameter, number, and covering of reinforcing bars and prestressing tendons shall be measured.

b) **Method using broken sample** The measurement using the broken sample shall be conducted after finishing the performance test such as outside pressure test. The concrete part of the sample shall be chipped; reinforcing bars shall be exposed; and the diameter of reinforcing bar and prestressing tendon, and the number and covering thereof shall be measured.

c) **Method using bar arrangement before placing concrete** If the positions of reinforcing bar and prestressing tendon before and after placing concrete are not affected by the assembly method of reinforcing bar and prestressing tendon, fixing method of reinforcing bar and prestressing tendon to a formwork, and securing method of covering, the positions of reinforcing bar and prestressing tendon can be regarded as the positions of reinforcing bar and prestressing tendon of finished product by measuring the diameter, number, and covering of reinforcing bar and prestressing tendon before placing concrete.

10 Inspections

10.1 Division and items of inspections

The inspections on PC products are divided into the final inspection and the delivery inspection and as follows.

a) **Final inspection** The final inspection shall be conducted by the manufacturer of product on the following items.

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

10.2 Inspection methods

The inspection methods of PC products shall be as specified in **JIS A 5365** and Table 6.

Table 6 Inspection methods of PC products

Type	Applicable clause in Annex
Poles	See **A.8**.
Bridges	See **B.8**.
Retaining walls	See **C.8**.
Covered conduits	See **D.8**.
Piles	See **E.8**.
Other products Example: Disaster prevention facilities	As agreed between the parties concerned with delivery.

10.3 Judgement on inspection

The judgement method of inspection shall be as specified in **JIS A 5365**.

11 Designation of products

The designation of products shall be as specified in **JIS A 5361**.

12 Marking

Items specified in **JIS A 5361** shall be marked on PC products. If the marking is particularly specified in Annex of this Standard, the provisions in Annex shall prevail. For the Group II products, the following items shall be marked on the product.

a) Characters "Group II" or its abbreviation

b) Type (designation determined by manufacturer) or its abbreviation

c) Other necessary item or its abbreviation

13 Report

The manufacturer shall submit the report about the appearance, performance, shape/dimensions, etc., when requested by the purchaser.

Annex A (normative)
Poles

A.1 Outline

This Annex specifies Group I and Group II of poles which are mainly used for the communication, traffic-light and utility poles.

A.2 Classification

The poles shall be classified as specified in Table A.1, and Group I shall be as specified in Table A.2.

Table A.1 Classification of poles

Major division	Minor division
Poles	Prestressed concrete poles
	Decorative light poles
	Others

Table A.2 Classification of Group I of poles

Type	Division by application	Division by verification	Detail
Class 1	Power transmission, power distribution, communication, traffic light, etc.	Cracking test load	See Recommended specification A-1.
Class 2	Line in railroad and track (including trolley coach), etc.	Critical cracking width strength	
NOTE : The critical cracking width strength means the strength that can keep the flexural crack width below the limit value.			

A.3 Performance

The performance and the performance verification method shall be as follows.

a) **Product of Group I** The performance of product shall conform to the provisions of Recommended specification A-1.

b) **Product of Group II** The performance of product shall conform to the provisions of clause **4** and clause **5** of **JIS A 5362**, and shall be determined as agreed between the parties concerned with delivery. Table A.3 may be applied for general specifications.

Table A.3 Performance and performance verification method of poles

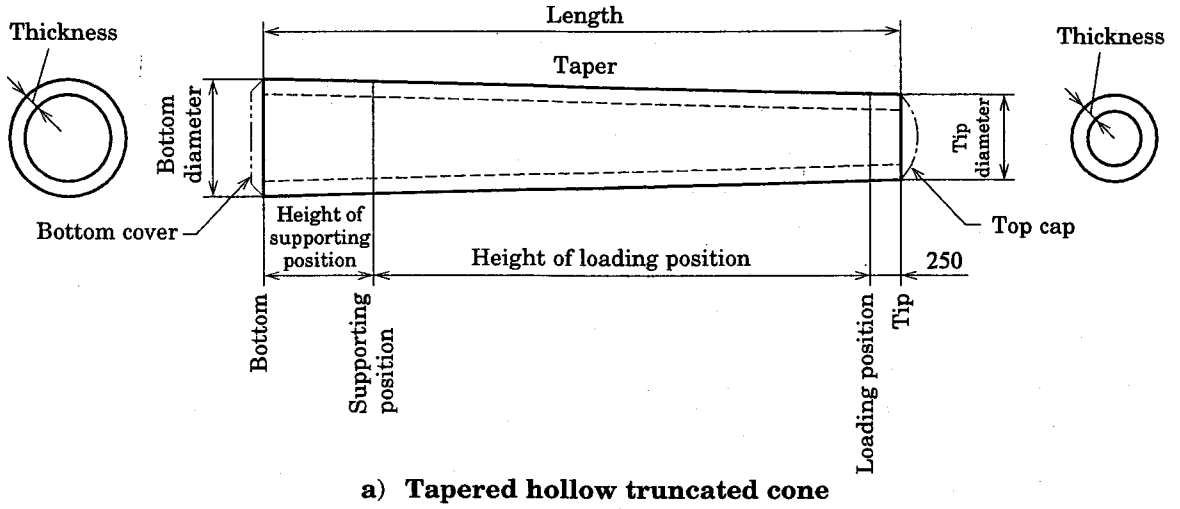
Performance item	Performance	Performance verification method
Service performance	It shall be able to be used smoothly under a load expected during service, fulfilling the required function.	See design document, **A.7** or actual results.
Safety [a)]	It shall not fracture under a load expected in design. The same applies to performance for joint.	See design document, **A.7** or actual results.
Durability [b)]	Cracking, ageing of material properties or the like due to the expected impact shall not deteriorate the required performance.	See design document or actual results.
Workability	It shall be transported, installed, assembled and joined safely and easily without abnormalities detrimental to use.	See design document or actual results.
The prestressing tendons whose durability against the stress corrosion cracking is confirmed shall be used for poles upon agreement between the parties concerned with delivery.		
Notes [a)] The verification of the safety shall be made when requested by the purchaser.		
[b)] Durability may be verified by the actual results of similar products equivalent in water-cement ratio and/or air content as well as the covering of reinforcing bar, etc. and production method.		

A.4 Shape, dimensions and dimensional tolerances

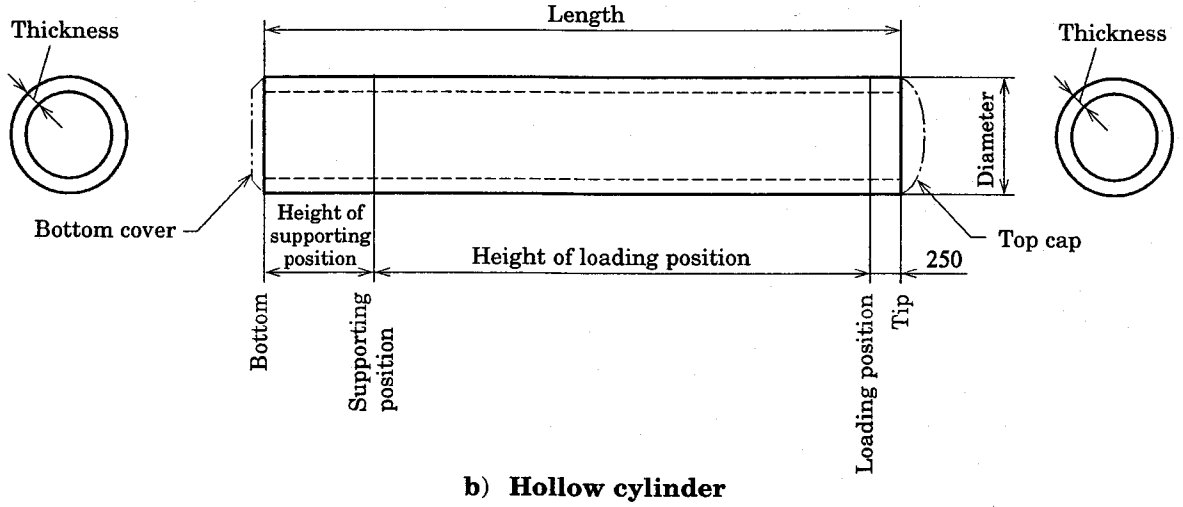
The shape, dimensions and dimensional tolerances of poles shall be as follows. As to Group I, if the design concept is equivalent and the performance and the performance verification method are the same, the reference dimension may be changed within ± 10 % in response to the purchaser's demand, provided that the necessary performance is satisfied.

a) **Shape** An example of shapes of poles is shown in Figure A.1. A joint may be provided, if necessary.

Unit: mm



a) Tapered hollow truncated cone



b) Hollow cylinder

Figure A.1 Example of shapes of poles

b) **Dimensions and dimensional tolerances** The dimensions and dimensional tolerances of the products classified into Group I shall be as specified in Table A.4. However, the lengths of a top cap and a bottom cover are not to be included in the length. The dimensions and dimensional tolerances of the products classified into Group II shall be as agreed between the parties concerned with delivery.

Table A.4 Dimensions and dimensional tolerances of poles

Unit: mm

Type		Length	Thickness	Tip diameter	Bottom diameter	Diameter
Prestressed concrete poles	Dimensions	7 m to 17 m	See a design document	120 to 220	230 to 450	300 to 400
	Tolerances	+50 −10	+Not specified. −0	+4 −2		

— The tip diameter, bottom diameter and diameter shall be the average of two values measured along each orthogonal axis at one cross-section of the end face, which is rounded to integer.

— The thickness shall be the average of four values measured along each orthogonal axis in one cross-section of the end face, which is rounded to integer.

A.5 Bar arrangement

The bar arrangement shall be as specified in clause **7**, **JIS A 5364** and a design document. However, as agreed between the parties concerned with delivery, the bar arrangement other than that of the recommended specification may be adopted unless it compromises the performance of PC products (including the provisions of **A.3**). The bar arrangement of poles that satisfy **A.3** shall be determined by the manufacturer for every product.

A.6 Quality of concrete

A.6.1 Material and production method

The materials for concrete and the production method shall be as specified in clause **8**.

A.6.2 Compressive strength

The compressive strength of concrete shall be 50 N/mm^2 or more after the predetermined material aging. The compressive strength at the time of prestress introduction shall be at least 1.7 times the prestress given at a supporting position, at least 1.3 times the prestress given at a loading position, and 25 N/mm^2 or more.

The compressive strength for Group II shall be as agreed between the parties concerned with delivery.

A.7 Test method

A.7.1 Compressive strength test of concrete

The compressive strength test of concrete shall be as specified in **JIS A 1108** or **JIS A 1136**.

The test piece shall be processed by the same curing as the product or be controlled properly.

A.7.2 Flexural strength test of product

The flexural strength test of product shall be as specified in **JIS A 5363**.

A.8 Inspection

Inspections shall be as specified in **JIS A 5365** and the following.

a) **Final inspection** The final inspection of poles shall be conducted on the appearance, performance, shape and dimensions, and shall be as follows.

1) **Appearance** As the inspection of the appearance, a 100 % inspection or a sampling inspection shall be conducted considering the characteristics of product, production method, production quantity, etc.

2) **Performance, shape and dimensions** As the inspections of performance, shape and dimensions, a sampling inspection shall be applied.

When substitute characteristics are inspected by using an alternative test piece in place of inspecting performances of a product, the correlation between the properties of the test piece and those of the product shall be confirmed in advance.

3) **Size of inspection lot** The size of inspection lot shall be determined by the manufacturer in consideration of the characteristics of product, production method, production quantity, production period, quantity of ordered poles, etc.

Any product in the inspection lot shall have the same characteristics, and shall be manufactured using the same materials, concrete mix proportion and manufacturing process, etc.

b) **Delivery inspection** The delivery inspection of poles shall be conducted on the appearance, shape and dimensions. The size of inspection lot and the sampling method shall be specified by the purchaser as agreed between the parties concerned with delivery. The delivery inspection may be omitted as agreed between the parties concerned with delivery.

A.9 Marking

The following items shall be marked on the poles as specified in **JIS A 5361**.

a) Type or its abbreviation

b) Designation of product

c) Manufacturer's name or its abbreviation

d) Date of manufacture or its abbreviation

A.10 Others (recommended specification)

The recommended specification of Group I of poles is shown in Table A.5.

Table A.5 Recommended specification

Structure-specific product group standard		Recommended specification
JIS A 5373	Annex A Poles	Recommended specification A-1 Prestressed concrete poles

Recommended specification A-1
Prestressed concrete poles

A-1.1 Outline

This recommended specification describes the prestressed concrete poles in Group I of poles (hereafter referred to as poles) specified in Annex A.

A-1.2 Classification

The poles shall be classified into Class 1 and Class 2.

a) Class 1 shall be divided according to the dimensions and the cracking test load as specified in Recommended specification A-1 Table 1.

b) Class 2 shall be divided according to the dimensions and the critical cracking width strength as specified in Recommended specification A-1 Table 2.

Recommended specification A-1 Table 1
Dimensions and cracking test load (Class 1)

Length L m	Height of loading position m	Height of supporting position l' m	Cracking test load kN			
			Tip diameter			
			120 mm	140 mm	190 mm	220 mm
7	5.55	1.2	—	1.5	—	—
8	6.35	1.4	—	1.5 2.0	4.3	—
9	7.25	1.5	2.0	2.5	3.5 4.3 5.0	—
10	8.05	1.7	2.0	2.5	3.5 5.0	—
11	8.85	1.9	2.0	—	3.5 5.0	—
12	9.75	2.0	—	—	3.5 5.0 7.0	—
13	10.55	2.2	—	—	3.5 5.0 7.0	—
14	11.35	2.4	—	—	3.5 5.0 7.0	—
15	12.25	2.5	—	—	5.0 7.0	—
	11.95	2.8	—	—	10	10
	11.75	3.0	—	—	—	15

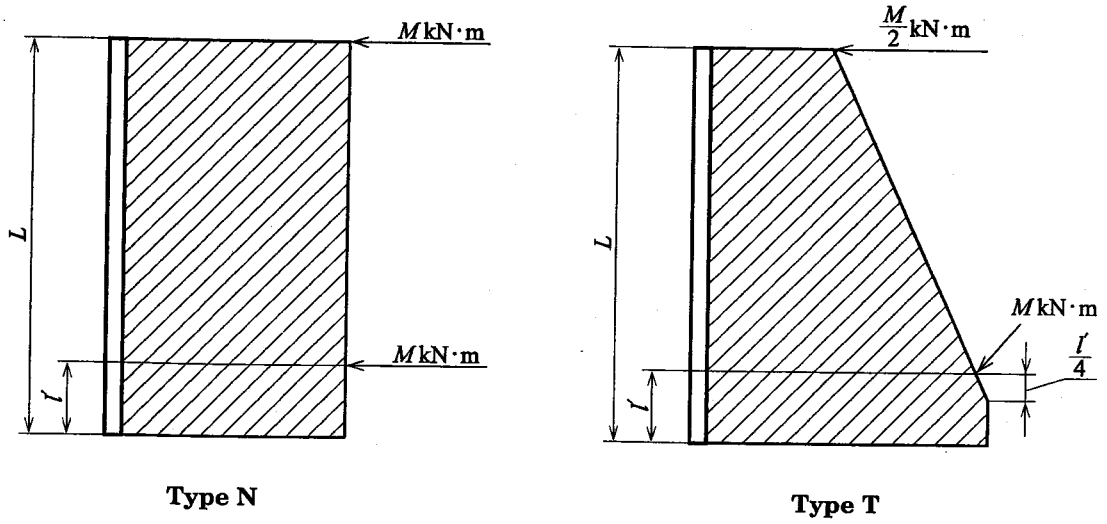
Recommended specification A-1 Table 1 (concluded)

Length L m	Height of loading position m	Height of supporting position l' m	Cracking test load kN			
			Tip diameter			
			120 mm	140 mm	190 mm	220 mm
16	13.25	2.5	—	—	5.0 7.0	—
	12.95	2.8	—	—	10	10
	12.75	3.0	—	—	—	15
17	13.95	2.8	—	—	5.0 7.0 10	 10
	13.75	3.0	—	—	—	15
A taper shall be 1/75.						

Recommended specification A-1 Table 2
Dimensions and critical cracking width strength (Class 2)

Length L m	Height of loading position m	Height of supporting position l' m	Critical cracking width strength kN·m			
			Type N			Type T
			Diameter			Diameter
			300 mm	350 mm	400 mm	350 mm
8	6.35	1.4	65	50 65	—	—
9	7.25	1.5	65	50 65	—	—
10	8.05	1.7	65	50 65 75	—	—
11	8.85	1.9	65	50 65 75	110	90 110
12	9.75	2.0	65	50 65 75	110	90 110
13	10.55	2.2	—	65 75	110	90 110
14	11.35	2.4	—	75	—	—
NOTE : Type N and Type T are the type symbols categorized by the distribution of critical cracking width strength. The magnitude and the distribution map of the critical cracking width strength according to the types are as specified in the following diagram.						

Recommended specification A-1 Table 2 (concluded)



Type N **Type T**

L : length of pole

l' : height of supporting position

M : critical cracking width strength shown in Recommended specification A-1 Table 2

A-1.3 Performance

A-1.3.1 Class 1 poles

The performance of Class 1 poles shall be as follows.

a) **Cracking test load** The cracking test load on Class 1 pole (0.25 mm or under in crack width) shall be not less than the value specified in Recommended specification A-1 Table 1. When this cracking test load is removed, the crack exceeding 0.05 mm in width shall not remain.

b) **Ultimate load** The ultimate load on Class 1 pole shall be at least twice the cracking test load specified in Recommended specification A-1 Table 1.

A-1.3.2 Class 2 poles

The performance of Class 2 poles shall be as follows.

a) **Critical cracking width strength** The critical cracking width strength of Class 2 poles (0.25 mm or under in crack width) shall be not less than the value specified in Recommended specification A-1 Table 2. When the load equivalent to the critical cracking width strength is removed, the cracking exceeding 0.05 mm in width shall not remain.

b) **Ultimate flexural strength** The ultimate flexural strength of Class 2 pole shall be at least twice the critical cracking width strength specified in Recommended specification A-1 Table 2.

c) **Deflection** The deflection of Class 2 pole shall be such that the deflection of a 8 m pole at 6 m from the supporting position and the deflection of at least 9 m pole at 7 m from the supporting position shall not exceed 75 mm when the pole is subjected to the load equivalent to 2/3 of critical cracking width strength specified in Recommended specification A-1 Table 2.

A-1.4 Shape, dimensions and dimensional tolerances

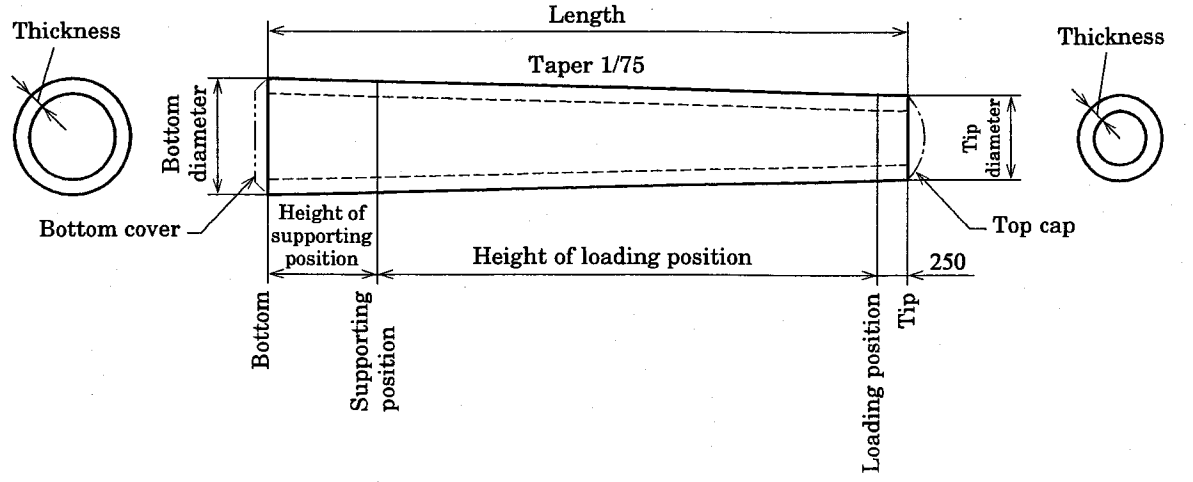
A-1.4.1 Shape

The shape of a pole shall be as follows.

a) The shape of Class 1 pole shall be a tapered truncated hollow cone as shown in Recommended specification A-1 Figure 1.

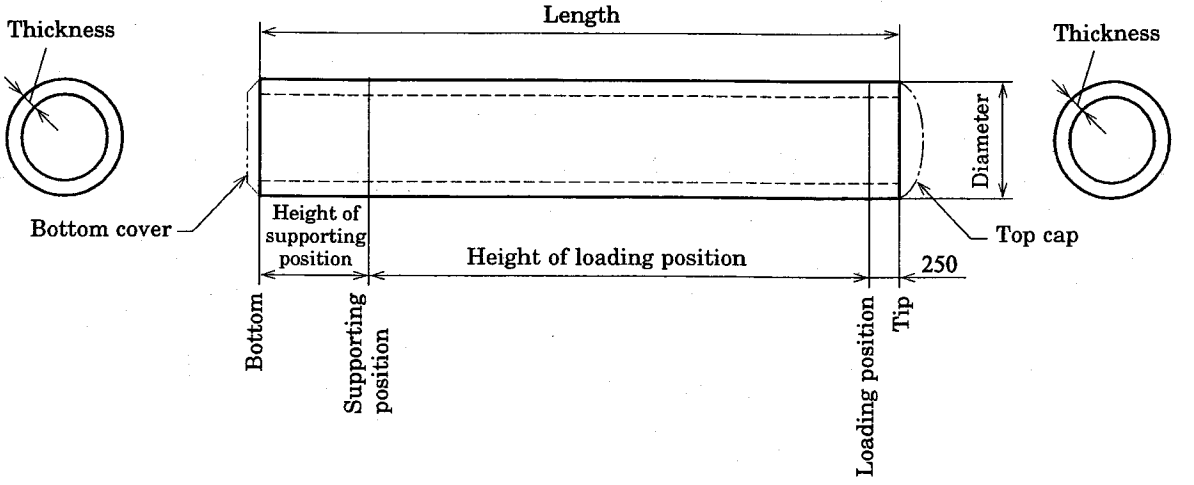
b) The shape of Class 2 pole shall be a hollow cylinder as shown in Recommended specification A-1 Figure 2.

Unit: mm



Recommended specification A-1 Figure 1 Shape of pole (Class 1)

Unit: mm



Recommended specification A-1 Figure 2 Shape of pole (Class 2)

A-1.4.2 Dimensions and dimensional tolerances

The dimensions of poles shall be as specified in Recommended specification A-1 Table 1 and Recommended specification A-1 Table 2, and dimensional tolerances shall be as specified in Recommended specification A-1 Table 3.

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

Recommended specification A-1 Table 3 Dimensional tolerances

Unit: mm

Type		Length	Thickness	Tip diameter	Bottom diameter	Diameter
Prestressed concrete poles	Dimensions	7 m to 17 m	See a design document	120 to 220	230 to 450	300 to 400
	Dimensional tolerances	+50 −10	+Not specified. −0	+4 −2		

— The tip diameter, bottom diameter and diameter shall be the average of two values measured along each orthogonal axis at one cross-section of the end face, which is rounded to integer.

— The thickness shall be the average of four values measured along each orthogonal axis in one cross-section of the end face, which is rounded to integer.

A-1.5 Bar arrangement

The bar arrangement of pole shall be as follows.

a) The prestressing tendon and the longitudinal reinforcing bar shall be arranged as uniformly as possible over the cross-section of pole.

b) The gap between the prestressing tendon and the longitudinal reinforcing bar shall be one or more times their diameters, and shall be 5/4 or more times the maximum dimension of coarse aggregates. If the gap between the prestressing tendon and the longitudinal reinforcing bar becomes not more than the specified value by attaching the accessory, etc., it shall be confirmed that concrete is compacted enough by the centrifugal compaction.

c) The prestressing tendon and the longitudinal reinforcing bar shall be assembled by execution bars. These execution bars shall be arranged so that the performance of body is not compromised.

d) When prestressing tendons or longitudinal reinforcing bars are joined with execution bars by welding, it shall be guaranteed that the mechanical characteristics of prestressing tendons or longitudinal reinforcing bars do not fall short of each specified value due to welding.

e) The covering shall be 9 mm or more and 1 or more times the diameter of prestressing tendon and longitudinal reinforcing bar.

A-1.6 Quality of concrete

The quality of concrete shall be as specified in **A.6.2**.

A-1.7 Test method

A-1.7.1 Compressive strength test

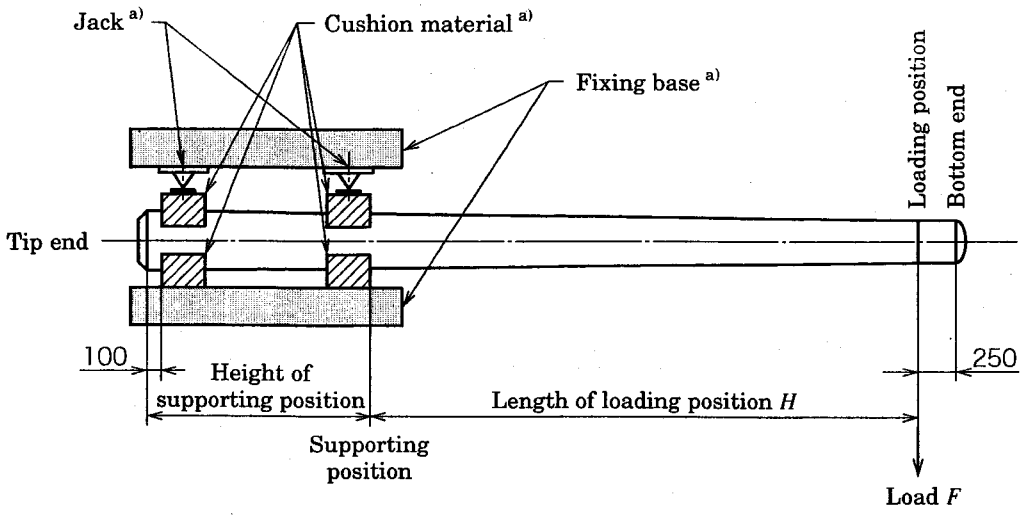
The compressive strength test of concrete shall be as specified in **A.7.1**.

A-1.7.2 Flexural strength test of product

For the flexural strength test on Class 1 pole, a pole shall be installed as shown in recommended specification A-1 Figure 3 and be fixed by applying cushion materials, etc. At a loading position, the load shall be applied in a direction as perpendicularly to the axis of the pole as possible. Loading shall be applied up to the crack test load at a slow rate, and the crack width and the deflection shall be measured. At this time the pole shall be examined for the crack exceeding 0.25 mm in width. After that, the load shall be removed, and the residual crack width shall be measured. Then, the pole shall be examined for the crack exceeding 0.05 mm in residual crack width. Further, the load shall be applied in the same way up to the ultimate load of the pole, if necessary. The crack test load and the ultimate load used for the test are shown in Recommended specification A-1 Table 4.

The flexural strength test of Class 2 pole shall be the same as that of Class 1 pole. However, the load equivalent to the critical cracking width strength and the ultimate load shown in Recommended specification A-1 Table 5 shall be used for loading.

Unit: mm



Note a) The fixing devices in the diagram (fixing bases, cushion materials and jacks) are examples.

Recommended specification A-1 Figure 3
Flexural strength test method of pole (example of Class 1)

Recommended specification A-1 Table 4
Cracking test load and ultimate load of pole (Class 1)

Unit: kN

Designation of product	Cracking test load	Ultimate load
7-14-1.5, 8-14-1.5	1.5	3.0
8-14-2.0, 9-12-2.0, 10-12-2.0, 11-12-2.0	2.0	4.0
9-14-2.5, 10-14-2.5	2.5	5.0
9-19-3.5, 10-19-3.5, 11-19-3.5, 12-19-3.5, 13-19-3.5, 14-19-3.5	3.5	7.0
8-19-4.3, 9-19-4.3	4.3	8.6
9-19-5.0, 10-19-5.0, 11-19-5.0, 12-19-5.0, 13-19-5.0, 14-19-5.0, 15-19-5.0, 16-19-5.0, 17-19.5.0	5.0	10.0
12-19-7.0, 13-19-7.0, 14-19-7.0, 15-19-7.0, 16-19-7.0, 17-19-7.0	7.0	14.0
15-19-10.0, 16-19-10.0, 17-19-10.0, 15-22-10.0, 16-22-10.0, 17-22-10.0	10.0	20.0
15-22-15.0, 16-22-15.0, 17-22-15.0	15.0	30.0
NOTE : The designation of product is shown by Length (m) – Tip diameter (cm) – Cracking test load (kN).		

Recommended specification A-1 Table 5
Load equivalent to critical cracking width strength and ultimate load of pole (Class 2)

Unit: kN

Designation of product	Height of loading position m	Load equivalent to critical cracking width strength	Ultimate load
8-35-N50	6.35	7.9	15.8
8-30-N65, 8-35-N65		10.3	20.6
9-35-N50	7.25	6.9	13.8
9-30-N65, 9-35-N65		9.0	18.0
10-35-N50	8.05	6.3	12.6
10-30-N65, 10-35-N65		8.1	16.2
10-35-N75		9.4	18.8
11-35-N50	8.85	5.7	11.4
11-30-N65, 11-35-N65		7.4	14.8
11-35-N75		8.5	17.0
11-35-T90		10.2	20.4
11-40-N110, 11-35-T110		12.5	25.0
12-35-N50	9.75	5.2	10.4
12-30-N65, 12-35-N65		6.7	13.4
12-35-N75		7.7	15.4
12-35-T90		9.3	18.6
12-40-N110, 12-35-T110		11.3	22.6
13-35-N65	10.55	6.2	12.4
13-35-N75		7.2	14.4
13-35-T90		8.6	17.2
13-40-N110, 13-35-T110		10.5	21.0
14-35-N75	11.35	6.7	13.4
NOTE : The designation of product is shown by Length (m) – Diameter (cm) – Type symbol and Critical cracking width strength (kN·m).			

A-1.8 Inspections

A-1.8.1 Inspection items

The inspection items of poles 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

A-1.8.2 Inspection lot

The size of inspection lot of poles 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 3 000 units or fractions thereof.

A-1.8.3 Inspection method

The inspection method of poles 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 poles conforming to the provisions of **5.1** shall be accepted.

2) **Performance** As the inspection of the cracking test load (Class 1) or the critical cracking width strength (Class 2), two arbitrary poles per lot shall be taken and inspected as specified in **A-1.7.2**. If both of the two conform to **A-1.3**, the lot shall be accepted. If neither of the two conforms, the lot shall be rejected. If only one of the two does not conform, the lot shall be re-inspected by taking four more poles from the lot. If all the four conform to the provisions, the lot shall be accepted after the first non-conforming product is eliminated. If one or more of them do not conform in the reinspection, the lot shall be rejected.

In the inspection of the ultimate load (Class 1) or the ultimate flexural strength (Class 2), one of the first two poles in the inspection of the cracking test load (Class 1) or the critical cracking width strength (Class 2) shall be inspected as specified in **A-1.7.2**. If it conforms to the provisions of **A-1.3**, the lot shall be accepted. If it does not conform, two more poles shall be taken from the lot and reinspected. If both of them conform to the provisions, the lot shall be accepted after the first non-conforming product is eliminated. If one or more of them do not conform in the reinspection, the lot shall be rejected.

3) **Shape and dimensions** For the inspection of shape and dimensions, two arbitrary poles per lot shall be taken. If they conform to **A-1.4**, the lot shall be accepted. If one or more do not conform, the remainder of the lot shall be subjected to a 100 % inspection. If the remainder conforms to the provisions, the lot 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)** or as follows.

When adopting the sampling inspection, two arbitrary poles are taken. If both of them conform to the provisions of **5.1**, the lot shall be accepted. If one or more do not conform, the remainder of the lot shall be subjected to a 100 % inspection. If the remainder conforms to the provisions, the lot shall be accepted.

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

A-1.9 Marking

The poles which conform to all the requirements of this Standard shall be marked as specified in **A.9**.

Annex B (normative)
Bridges

B.1 Outline

This Annex specifies Group I and Group II of bridges which are mainly used for highways.

B.2 Classification

The bridges shall be classified as specified in Table B.1, and Group I shall be as specified in Table B.2.

Table B.1 Classification of bridges

Major division	Minor division	
Bridges	Bridge beam	Bridge beam for highway bridge
		Segment of bridge beam for highway bridge
	Deck slab	Precast plate for composite deck slab
		Precast deck slab for highway bridge
	Others	

Table B.2 Classification of Group I of bridges

Division by application/shape				Detail
Standard span of bridge beam	Bridge beam for highway bridge	Ordinary bridge beam	Slab bridge beam	See Recommended specification B-1.
			T bridge beam	
		Light-load slab bridge beam		
	Segment of bridge beam for highway [a)]			See Recommended specification B-2.
Deck slab	Precast plate for composite deck slab			See Recommended specification B-3.
	Precast deck slab for highway bridge			See Recommended specification B-4.
Note [a)] PC product which becomes one bridge beam by assembling a set of several segments using prestressing tendon.				

B.3 Performance

The performance and the performance verification method of bridges shall be as follows.

a) **Product of Group I** The performance of product shall conform to the provisions of Recommended specification B-1, Recommended specification B-2, Recommended specification B-3 and Recommended specification B-4.

b) **Product of Group II** The performance of product shall conform to the provisions of clause **4** and clause **5** of **JIS A 5362**, and shall be determined as agreed between the parties concerned with delivery. Table B.3 may be applied for general specifications.

Table B.3 Performance and performance verification method of bridges

Performance item	Performance	Performance verification method
Service performance	It shall be able to be used smoothly under a load expected during service, fulfilling the required function.	See design document, **B.7** or actual results.
Safety [a)]	It shall not fracture under a load expected in design.	See design document, **B.7** or actual results.
Durability [b)]	Cracking or ageing of material properties due to the expected impact shall not deteriorate the required performance.	See design document or actual results.
Workability	It shall be transported, installed, assembled and joined safely and easily without abnormalities detrimental to use.	See design document or actual results.
Notes [a)] The verification of the safety shall be made when requested by the purchaser. [b)] Durability may be verified by the actual results of similar products equivalent in water-cement ratio and/or air content as well as the covering of reinforcing bar, etc. and production method.		

B.4 Shape, dimensions and dimensional tolerances

The shape, dimensions and dimensional tolerances of bridges shall be as follows. As to Group I, if the design concept is equivalent and the performance and the performance verification method are the same, the reference dimension may be changed within ± 10 % in response to the purchaser's demand, provided that the necessary performance is satisfied. A change in range of reference dimension for the bridge beam for highway and the precast deck slab for highway bridge shall be as specified in the recommended specification.

a) **Shape** Examples of shapes of bridges are shown in Figure B.1, Figure B.2, Figure B.3 and Figure B.4.

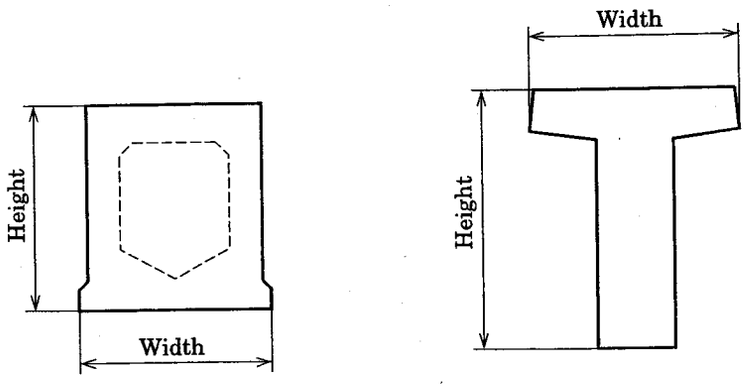


Figure B.1 Example of shape of bridge beams for highway bridge

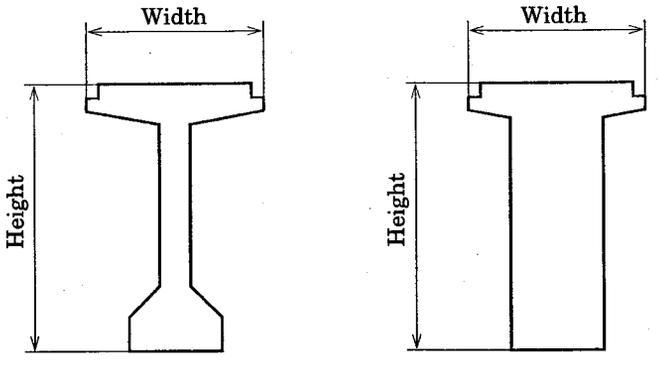


Figure B.2 Example of shape of segment of bridge beams for highway bridge

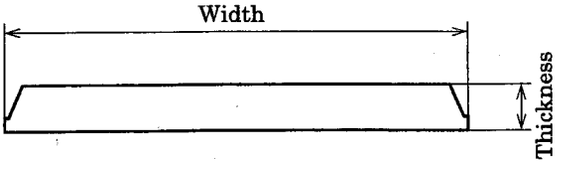
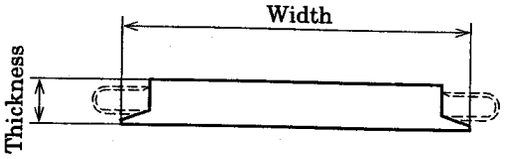
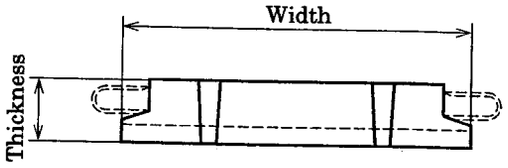


Figure B.3 Example of shape of precast plates for composite deck slab



Bridge axis direction cross section of middle part



Bridge axis direction cross section of supporting point

Figure B.4 Example of shape of precast deck slabs for highway bridge

b) **Dimensions and dimensional tolerances** The dimensions and dimensional tolerances of the products classified into Group I shall be as follows.

The dimensions and dimensional tolerances of the products classified into Group II shall be as agreed between the parties concerned with delivery.

1) **Bridge beam** The dimensions and dimensional tolerances of bridge beams shall be as specified in Table B.4.

2) **Deck slab** The dimensions and dimensional tolerances of deck slabs shall be as specified in Table B.5.

Table B.4 Dimensions and dimensional tolerances of bridge beams

Unit: mm

Type		Height or thickness	Width (direction perpendicular to bridge axis)	Length (bridge axis direction)	
Slab bridge beam	Dimensions	350 to 1 000	700	Beam length L (m)	5.3 to 24.7
	Tolerances	±5	±5	In the case of $L \leq 10$ m	±10
				In the case of $L > 10$ m	$\pm L$ [a)]/1 000
Light-load slab bridge beam	Dimensions	225 to 400	700	Beam length L (m)	5.3 to 13.5
	Tolerances	±5	±5	In the case of $L \leq 10$ m	±10
				In the case of $L > 10$ m	$\pm L$ [a)]/1 000
T bridge beam	Dimensions	900 to 1 300	800	Beam length L (m)	18.6 to 24.7
	Tolerances	±5	±5	$\pm L$ [a)]/1 000	
Segment of bridge beam for highway bridge	Dimensions	1 400 to 3 300	1 300	Segment length L (m)	4.05 to 11.5
	Tolerances	+10 − 5	Upper width +10 − 5 Lower width ± 5	±10	

Note [a)] The beam length L is expressed in mm.

Table B.5 Dimensions and dimensional tolerances of deck slab

Unit: mm

Type		Thickness		Width (bridge axis direction)	Length (direction perpendicular to bridge axis)
Precast plate for composite deck slab	Dimensions	70 to 120		998	PC plate length L (m) PC beam: 1.57 to 3.12 Steel beam: 1.50 to 3.05
	Tolerances	+5 −2		+5 −3	+10 − 5
Precast deck slab for highway bridge	Dimensions	H_1	240 to 320	1 990	Deck slab length L (m) 7.9 to 18.5
		H_2	340 to 420		
	Tolerances	+10 0		+ 5 −10	+20 0

B.5 Bar arrangement

The bar arrangement (position of prestressing tendon and reinforcing bar) shall be as specified in **JIS A 5364** and a design document. However, as agreed between the parties concerned with delivery, the bar arrangement (positions of prestressing tendon and reinforcing bar) not based on the recommended specification may be adopted unless it compromises the performance of PC products (including the provisions of **B.3**).

B.6 Quality of concrete

B.6.1 Material and production method

The materials for concrete and the production method shall be as specified in clause **8**.

B.6.2 Compressive strength

The compressive strength of concrete shall satisfy the values of Table B.6 after the predetermined material aging.

The compressive strength for Group II shall be as agreed between the parties concerned with delivery.

Table B.6 Compressive strength of concrete

Unit: N/mm^2

Type		Compressive strength of concrete	
		At prestress introduction	At quality assurance
Bridge beam	Slab bridge beam	35 min.	50 min.
	Light-load slab bridge beam	42 min.	70 min.
	T bridge beam	35 min.	50 min.
	Segment of bridge beam for highway bridge	35 min.	50 min.
Deck slab	Precast plate for composite deck slab	30 min.	50 min.
	Precast deck slab for highway bridge	35 min.	50 min.

B.7 Test method

B.7.1 Compressive strength test of concrete

The compressive strength test of concrete shall be as specified in **JIS A 1108**.

The test piece shall be processed by the same curing as the product or be controlled properly.

B.7.2 Flexural strength test of product

The flexural strength test of product shall be as specified in **JIS A 5363**. As shown in Figure B.5 and Figure B.6, the flexural cracking load F shall be applied, and the product shall be examined for a crack.

In the case of the simple-beam structure, the load F may be calculated according to the following formula. In the case of the successive-beam structure, the load F shall be calculated according to the calculation of in-plane framing.

$$F = \left[(M - M_{d0}) \times \frac{4}{l - 2a} \right] - W \times g$$

where, F: flexural cracking load (kN)

M: flexural cracking strength (kN·m)

M_{d0}: bending moment by own weight of product (kN·m)

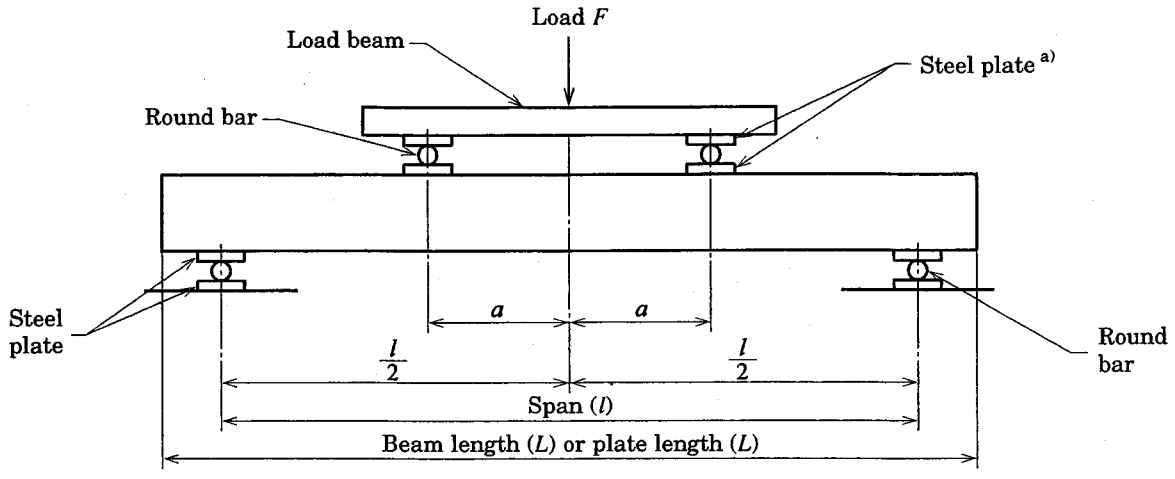
W: mass of loading equipment (t)

l: span (m)

a: loading position

In the case of bridge beam	$l < 10$ m	0.50 (m)
	$l \geq 10$ m	0.75 (m)
In the case of precast deck slab for highway bridge		0.25 (m)
In the case of precast plate for composite deck slab		0.20 (m)

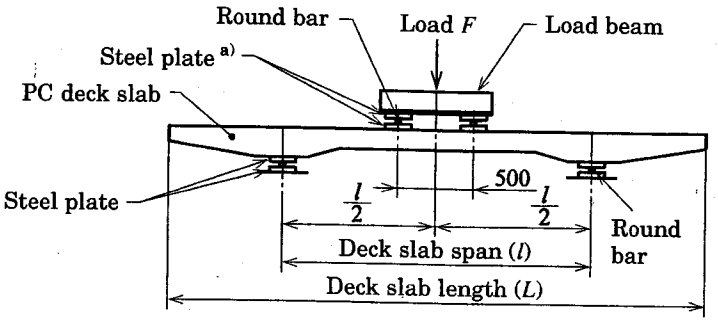
g: acceleration of gravity (use 9.81 m/s^2)



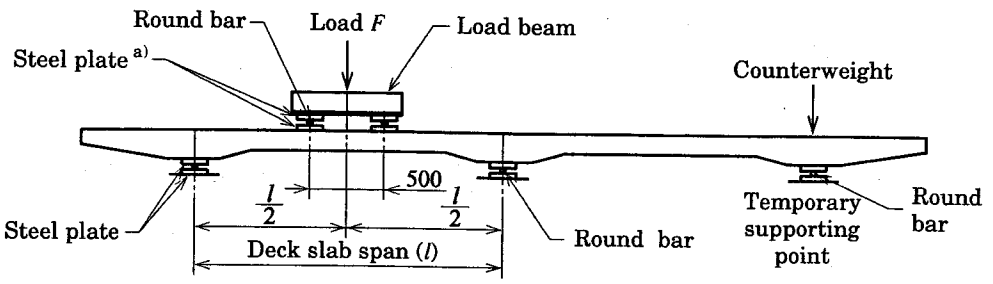
Note a) About 10 cm to 15 cm width.

Figure B.5 Loading method (bridge beam for highway bridge and precast plate for composite deck slab)

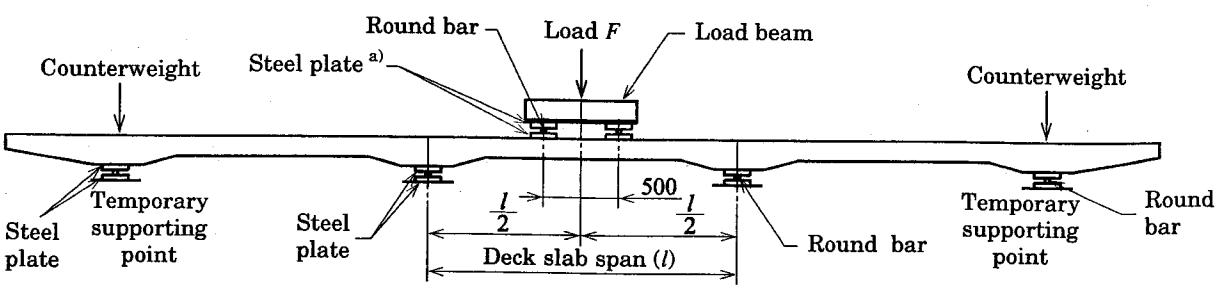
Unit: mm



a) Deck slab for two main beams



b) Deck slab for three main beams



c) Deck slab for four main beams

Note a) About 10 cm to 15 cm width.

Figure B.6 Loading method (precast deck slab for highway bridge)

B.8 Inspection

Inspections shall be as specified in **JIS A 5365** and the following.

a) **Final inspection** The final inspection of bridges shall be conducted on the appearance, performance, shape and dimensions, and shall be as follows.

1) **Appearance** As the inspection of the appearance, a 100 % inspection shall be conducted considering the characteristics of product, production method, production quantity, etc.

2) **Performance, shape and dimensions** As the inspections of performance, shape and dimensions, a 100 % inspection or a sampling inspection shall be applied.

When substitute characteristics are inspected by using an alternative test piece in place of inspecting performances of a product, the correlation between the properties of the test piece and those of the product shall be confirmed in advance.

3) **Size of inspection lot** The size of inspection lot shall be determined by the manufacturer in consideration of the characteristics of product, production method, production quantity, production period, quantity of ordered poles, etc.

b) **Delivery inspection** The delivery inspection of bridges shall be conducted on the appearance, shape and dimensions. The size of inspection lot and the sampling method shall be specified by the purchaser as agreed between the parties concerned with delivery. The delivery inspection may be omitted as agreed between the parties concerned with delivery.

B.9 Marking

The following items shall be marked on the bridges as specified in **JIS A 5361**.

a) Type or its abbreviation

b) Manufacturer's name or its abbreviation

c) Date of manufacture or its abbreviation

B.10 Others (recommended specification)

The recommended specification of Group I of bridges is shown in Table B.7.

Table B.7 Recommended specification

Structure-specific product group standard			Recommended specification
JIS A 5373	Annex B Bridges	Bridge beam	Recommended specification B-1 Bridge beams for highway bridge
			Recommended specification B-2 Segments of bridge beams for highway bridge
		Deck slab	Recommended specification B-3 Precast plates for composite deck slab
			Recommended specification B-4 Precast deck slabs for highway bridge

Recommended specification B-1
Bridge beams for highway bridge

B-1.1 Outline

This recommended specification describes the bridge beams for highway bridge in Group I of bridges (hereafter referred to as bridge beams) specified in Annex B.

B-1.2 Classification

The bridge beams shall be classified into the ordinary bridge beam and the light-load slab bridge beam according to the standard span as specified in Recommended specification B-1 Table 1, Recommended specification B-1 Table 2 and Recommended specification B-1 Table 3.

B-1.2.1 Ordinary bridge beams [1)]

The ordinary bridge beams shall be the slab bridge beams and T bridge beams, and as follows.

Note [1)] The ordinary bridge beams mean the bridge beams used for the national expressway, national highway, prefectural roads and important municipal roads, or other important roads specified by Road Traffic Act.

a) **Slab bridge beams** The slab bridge beams are shown in Recommended specification B-1 Table 1.

Recommended specification B-1 Table 1
Classification and flexural cracking strength of slab bridge beams

Standard span	Live load A [a]			Live load B [b]		
	Type	Beam height	Flexural cracking strength	Type	Beam height	Flexural cracking strength
m		mm	kN·m		mm	kN·m
5	AS05	350	148	BS05	350	153
6	AS06	350	170	BS06	350	182
7	AS07	400	211	BS07	400	227
8	AS08	400	253	BS08	400	271
9	AS09	450	294	BS09	450	314
10	AS10	450	338	BS10	450	370
11	AS11	450	370	BS11	500	433
12	AS12	450	405	BS12	500	475
13	AS13	500	478	BS13	500	526
14	AS14	500	532	BS14	550	610
15	AS15	550	616	BS15	600	696
16	AS16	600	702	BS16	600	764
17	AS17	650	862	BS17	650	863
18	AS18	700	962	BS18	700	960
19	AS19	750	1 050	BS19	750	1 140
20	AS20	750	1 150	BS20	800	1 260
21	AS21	800	1 270	BS21	850	1 440
22	AS22	850	1 470	BS22	900	1 640
23	AS23	900	1 630	BS23	950	1 780
24	AS24	950	1 830	BS24	1 000	2 020

— The interval between the bridge beam centres after assembling the beam into a bridge shall not exceed 0.77 m.

— The bridge beam shall have the angle of skew of 60 degrees or more after assembled to a bridge.

— The span to be used may be longer than the standard span by maximum 0.2 m, and shorter than the standard span by maximum 1 m, if required.

Notes [a] Of design vehicle loads specified in the Road Structure Ordinance, Live load A is intended for comparatively low frequency of travel by large vehicles.

[b] Of design vehicle loads specified in the Road Structure Ordinance, Live load B is intended for comparatively high frequency of travel by large vehicles.

b) **T bridge beams** T bridge beams are shown in Recommended specification B-1 Table 2.

Recommended specification B-1 Table 2
Classification and flexural cracking strength of T bridge beams

Standard span	Live load A [a)]			Live load B [b)]		
	Type	Beam height	Flexural cracking strength	Type	Beam height	Flexural cracking strength
m		mm	kN・m		mm	kN・m
18	AG18	900	1 270	BG18	1 000	1 450
19	AG19	1 000	1 490	BG19	1 000	1 500
20	AG20	1 000	1 560	BG20	1 100	1 790
21	AG21	1 100	1 890	BG21	1 100	1 910
22	AG22	1 100	1 920	BG22	1 200	2 270
23	AG23	1 200	2 280	BG23	1 200	2 300
24	AG24	1 200	2 310	BG24	1 300	2 690

— The interval between the bridge beam centres after assembling the beam into a bridge shall not exceed 1.08 m.

— The bridge beam shall have the angle of skew of 70 degrees or more after assembled into a bridge.

— The span to be used may be longer than the standard span by maximum 0.2 m, and shorter than the standard span by maximum 1 m, if required.

Notes [a)] Of design vehicle loads specified in the Road Structure Ordinance, Live load A is intended for comparatively low frequency of travel by large vehicles.

[b)] Of design vehicle loads specified in the Road Structure Ordinance, Live load B is intended for comparatively high frequency of travel by large vehicles.

B-1.2.2 Light-load slab bridge beams

The light-load slab bridge beams [2)] are shown in Recommended specification B-1 Table 3.

Note [2)] The light-load slab bridge beams mean bridge beams which are used for the roads where the design load is smaller than that of the ordinary bridge beams, which are not specified in Road Traffic Act.

Recommended specification B-1 Table 3
Classification and flexural cracking strength of light-load slab bridge beams

Standard span m	Type	Beam height mm	Flexural cracking strength kN·m
5	LS05	225	76.1
6	LS06	225	93.7
7	LS07	225	108
8	LS08	250	132
9	LS09	275	168
10	LS10	300	207
11	LS11	350	258
12	LS12	375	320
13	LS13	400	376

— The interval between the bridge beam centres after assembling the beam into a bridge shall not exceed 0.77 m.

— The bridge beam shall have the angle of skew of 60 degrees or more after assembled into a bridge.

— The span to be used may be longer than the standard span by maximum 0.2 m, and shorter than the standard span by maximum 1 m, if required.

B-1.3 Performance

The required performance of bridge beams is the flexural cracking strength. Cracking shall not occur when the cracking load calculated in **B.7.2** using the flexural cracking strength specified in Recommended specification B-1 Table 1, Recommended specification B-1 Table 2 and Recommended specification B-1 Table 3 is applied.

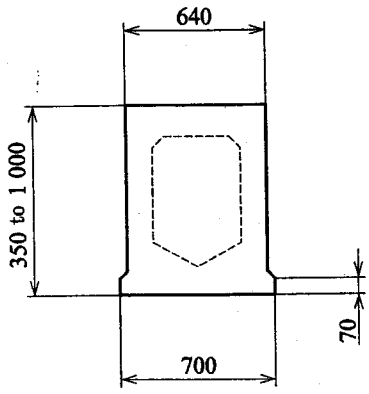
B-1.4 Shape, dimensions and dimensional tolerances

The shape, dimensions and dimensional tolerances of bridge beams shall be as specified in Recommended specification B-1 Figure 1, Recommended specification B-1 Figure 2, Recommended specification B-1 Figure 3 and Recommended specification B-1 Table 4.

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

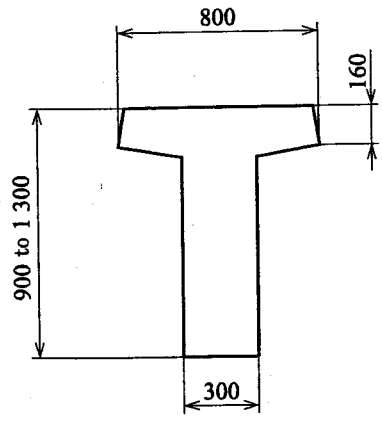
NOTE : As agreed between the parties concerned with delivery, the necessary attachment may be provided or the proper work may be performed unless it compromises the performance of bridge beam for highway bridge.

Unit: mm



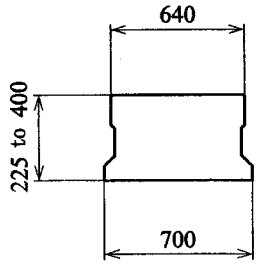
Recommended specification B-1 Figure 1 Shape and dimensions of slab bridge beam (ordinary bridge beam)

Unit: mm



Recommended specification B-1 Figure 2 Shape and dimensions of T bridge beam (ordinary bridge beam)

Unit: mm



Recommended specification B-1 Figure 3 Shape and dimensions of slab bridge beam (light-load slab bridge beam)

Recommended specification B-1 Table 4 Dimensional tolerances

Unit: mm

Division		Tolerances
Beam length L	$L \leq 10$ m	±10
	$L > 10$ m	$\pm \frac{L^{a)}}{1\,000}$
Outside dimension of cross-section		±5
Camber [b] of bridge beams		±8 [c]
Deflection of transverse direction		10

Notes [a] The beam length L is expressed in mm.

[b] The value of the centre of span.

[c] The number of the bridge beams used for one span is taken as one set, and this tolerance is for the average of camber for this set.

B-1.5 Bar arrangement

The bar arrangement of bridge beams shall be based on a design document, and as follows.

a) The covering of reinforcing bar and prestressing tendon shall be 25 mm or more.

b) The gap between the reinforcing bar and the prestressing tendon shall be 20 mm or more. As to the prestressing tendon, the gap shall be at least three times the diameter, and shall be at least 4/3 of the maximum dimension of coarse aggregates.

c) The reinforcing bar and the prestressing tendon shall be free from loose scale, oil, etc. which damage the adhesion of concrete, and shall be assembled and fixed to the right position.

B-1.6 Quality of concrete

The quality of concrete shall be as specified in **B.6**.

B-1.7 Flexural strength test of product

The flexural strength test of the product shall be as specified in **B.7.2**, and the load shall be uniformly distributed using a steel plate of about 10 cm to 15 cm in width and a round steel bar of a proper diameter.

B-1.8 Inspections

B-1.8.1 Inspection items

The inspection items of bridge beams 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

B-1.8.2 Inspection lot

The size of inspection lot of bridge beams 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 400 units or fractions thereof.

B-1.8.3 Inspection method

The inspection method of bridge beams 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, two bridge beams per lot shall be taken and inspected as specified in **B-1.7**. If both of the two conform to **B-1.3**, the lot shall be accepted. If neither of the two conforms, the lot shall be rejected. If one of the two does not conform to the provisions, the remainder of the lot shall be subjected to a 100 % inspection. If they conform to the provisions, the lot shall be accepted.

3) **Shape and dimensions** As the inspection of shape and dimensions, a 100 % inspection shall be conducted, and those conforming to the provisions of **B-1.4** 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)**.

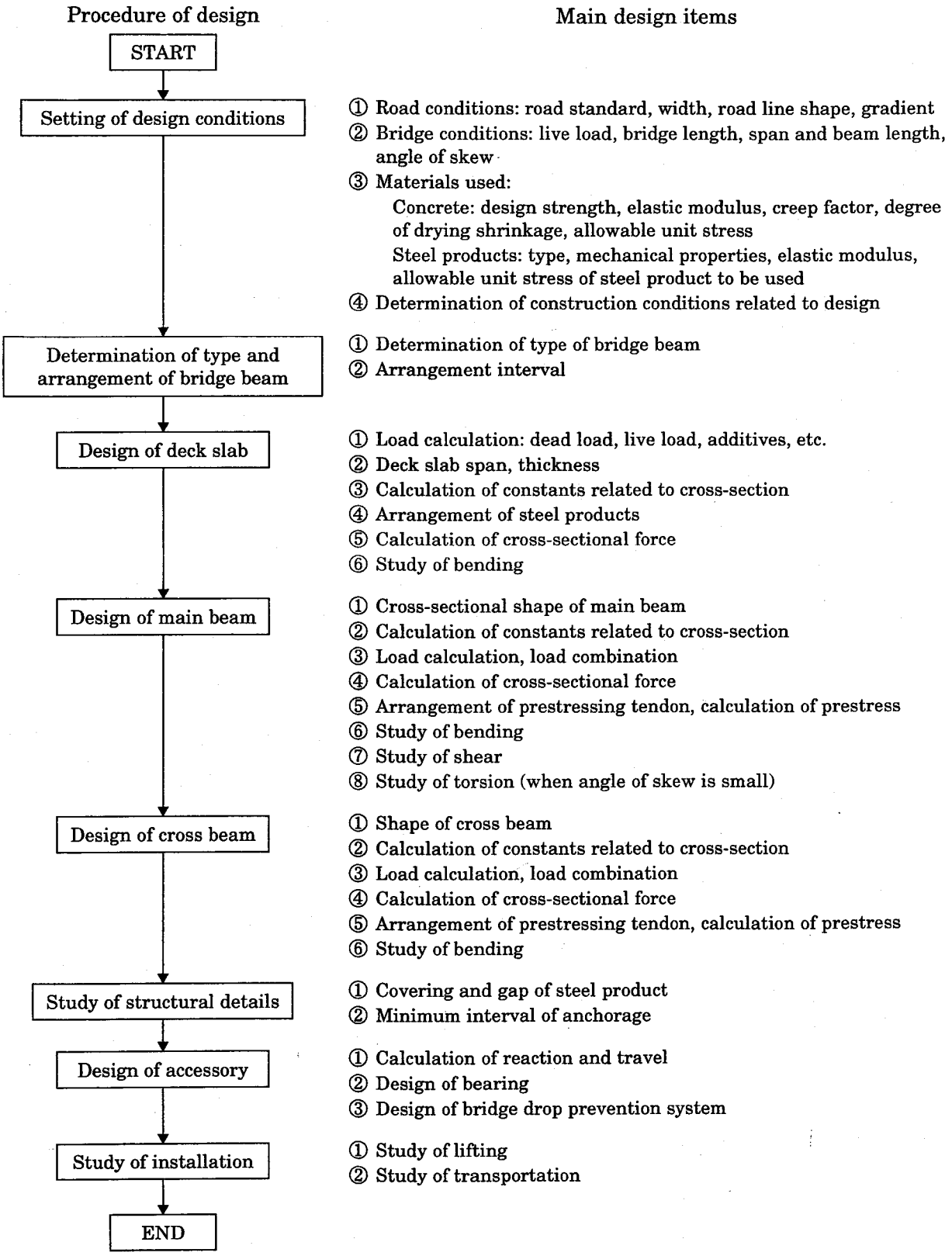
2) **Shape and dimensions** The shape and dimensions shall be inspected in the same way as **a) 3)**.

B-1.9 Marking

The bridge beams which conform to all the requirements of this Standard shall be marked as specified in **B.9**.

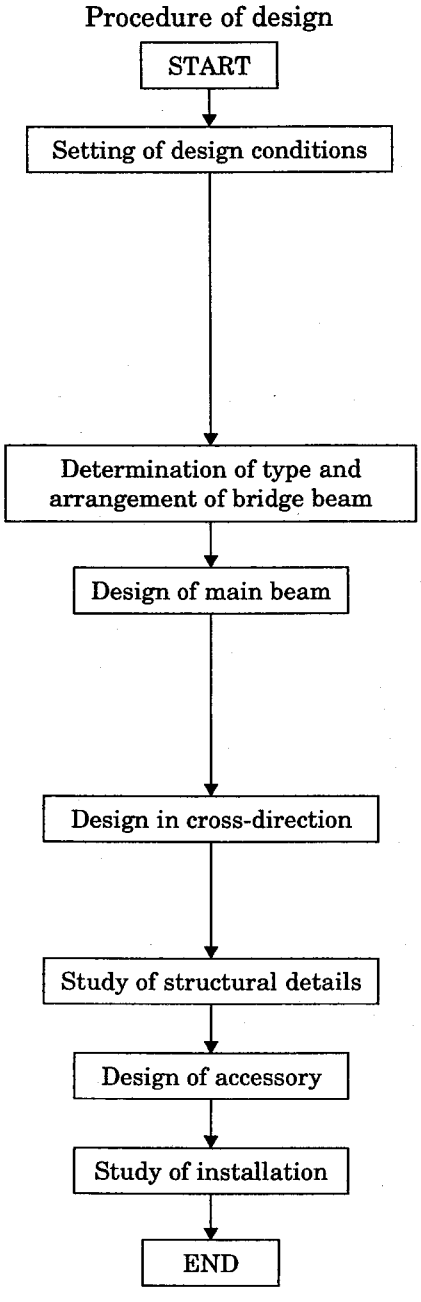
Recommended specification B-1
Procedure of design of bridge beam for highway bridge (informative)

The general procedure of design and the main design items of the bridge beam for highway bridge are shown below.



Recommended specification B-1
Procedure of design of light-load slab bridge beams (informative)

The general procedure of design and the main design items of the light-load slab bridge beams are shown below.



Main design items

① Road conditions: road standard, width, road line shape, gradient
② Bridge conditions: live load, bridge length, span and beam length, angle of skew
③ Materials used:
Concrete: design strength, elastic modulus, creep factor, degree of drying shrinkage, allowable unit stress
Steel products: type, mechanical properties, elastic modulus, allowable unit stress of steel product to be used
④ Determination of construction conditions related to design

① Determination of type of bridge beam
② Arrangement interval

① Cross-sectional shape of main beam
② Calculation of constants related to cross-section
③ Load calculation, load combination
④ Calculation of cross-sectional force
⑤ Arrangement of prestressing tendon, calculation of prestress
⑥ Study of bending

① Position of horizontal reinforcing bar
② Load calculation, load combination
③ Calculation of cross-sectional force
④ Study of bending

① Covering and gap of steel product
② Arrangement of anchorage

① Calculation of reaction and travel
② Design of bearing

① Study of lifting
② Study of transportation

Recommended specification B-2
Segments for bridge beams for highway bridges

B-2.1 Outline

This recommended specification describes the segments for bridge beams for highway bridges in Group I of bridges (hereafter referred to as segments for bridge beams) specified in Annex B.

B-2.2 Classification

The segments for bridge beams shall be divided according to the length of bridge beam as shown in Recommended specification B-2 Table 1. The segments for bridge beams consist of an edge, middle and central segments. At the time of manufacture, it is a reinforced concrete product (RC); however, at the time of use, several components are combined into a single body with prestressing tendon to form the prestressed concrete structure.

The types shown herein indicate the highway bridges of the main beam interval of 2.6 m to 3.8 m.

Recommended specification B-2 Table 1
Classification of segment for bridge beam and segment composition

Standard span of bridge beam	Type and number of edge segments	Type and number of middle segments	Type and number of central segments	Standard span of bridge beam	Type and number of edge segments	Type and number of middle segments	Type and number of central segments
25 m	Two pieces of T25-a	—	One piece of MD25-a	36 m	Two pieces of T36-a	Two pieces of M36-a	One piece of MD36-a
	Two pieces of T25-b	—	One piece of MD25-b		Two pieces of T36-b	Two pieces of M36-b	One piece of MD36-b
	Two pieces of T25-c	—	One piece of MD25-c		Two pieces of T36-c	Two pieces of M36-c	One piece of MD36-c
26 m	Two pieces of T26-a	—	One piece of MD26-a	37 m	Two pieces of T37-a	Two pieces of M37-a	One piece of MD37-a
	Two pieces of T26-b	—	One piece of MD26-b		Two pieces of T37-b	Two pieces of M37-b	One piece of MD37-b
	Two pieces of T26-c	—	One piece of MD26-c		Two pieces of T37-c	Two pieces of M37-c	One piece of MD37-c
27 m	Two pieces of T27-a	—	One piece of MD27-a	38 m	Two pieces of T38-a	Two pieces of M38-a	One piece of MD38-a
	Two pieces of T27-b	—	One piece of MD27-b		Two pieces of T38-b	Two pieces of M38-b	One piece of MD38-b
	Two pieces of T27-c	—	One piece of MD27-c		Two pieces of T38-c	Two pieces of M38-c	One piece of MD38-c
28 m	Two pieces of T28-a	—	One piece of MD28-a	39 m	Two pieces of T39-a	Two pieces of M39-a	One piece of MD39-a
	Two pieces of T28-b	—	One piece of MD28-b		Two pieces of T39-b	Two pieces of M39-b	One piece of MD39-b
	Two pieces of T28-c	—	One piece of MD28-c		Two pieces of T39-c	Two pieces of M39-c	One piece of MD39-c
29 m	Two pieces of T29-a	—	One piece of MD29-a	40 m	Two pieces of T40-a	Two pieces of M40-a	One piece of MD40-a
	Two pieces of T29-b	—	One piece of MD29-b		Two pieces of T40-b	Two pieces of M40-b	One piece of MD40-b
	Two pieces of T29-c	Two pieces of M29-c	One piece of MD29-c		Two pieces of T40-c	Four pieces of M40-c	One piece of MD40-c
30 m	Two pieces of T30-a	—	One piece of MD30-a	41 m	Two pieces of T41-a	Two pieces of M41-a	One piece of MD41-a
	Two pieces of T30-b	Two pieces of M30-b	One piece of MD30-b		Two pieces of T41-b	Four pieces of M41-b	One piece of MD41-b
	Two pieces of T30-c	Two pieces of M30-c	One piece of MD30-c		Two pieces of T41-c	Four pieces of M41-c	One piece of MD41-c
31 m	Two pieces of T31-a	Two pieces of M31-a	One piece of MD31-a	42 m	Two pieces of T42-a	Two pieces of M42-a	One piece of MD42-a
	Two pieces of T31-b	Two pieces of M31-b	One piece of MD31-b		Two pieces of T42-b	Four pieces of M42-b	One piece of MD42-b
	Two pieces of T31-c	Two pieces of M31-c	One piece of MD31-c		Two pieces of T42-c	Four pieces of M42-c	One piece of MD42-c
32 m	Two pieces of T32-a	Two pieces of M32-a	One piece of MD32-a	43 m	Two pieces of T43-a	Two pieces of M43-a	One piece of MD43-a
	Two pieces of T32-b	Two pieces of M32-b	One piece of MD32-b		Two pieces of T43-b	Six pieces of M43-b	One piece of MD43-b
	Two pieces of T32-c	Two pieces of M32-c	One piece of MD32-c		Two pieces of T43-c	Six pieces of M43-c	One piece of MD43-c
33 m	Two pieces of T33-a	Two pieces of M33-a	One piece of MD33-a	44 m	Two pieces of T44-a	Two pieces of M44-a	One piece of MD44-a
	Two pieces of T33-b	Two pieces of M33-b	One piece of MD33-b		Two pieces of T44-b	Six pieces of M44-b	One piece of MD44-b
	Two pieces of T33-c	Two pieces of M33-c	One piece of MD33-c		Two pieces of T44-c	Six pieces of M44-c	One piece of MD44-c
34 m	Two pieces of T34-a	Two pieces of M34-a	One piece of MD34-a	45 m	Two pieces of T45-a	Two pieces of M45-a	One piece of MD45-a
	Two pieces of T34-b	Two pieces of M34-b	One piece of MD34-b		Two pieces of T45-b	Six pieces of M45-b	One piece of MD45-b
	Two pieces of T34-c	Two pieces of M34-c	One piece of MD34-c		Two pieces of T45-c	Six pieces of M45-c	One piece of MD45-c
35 m	Two pieces of T35-a	Two pieces of M35-a	One piece of MD35-a	Omitted			
	Two pieces of T35-b	Two pieces of M35-b	One piece of MD35-b				
	Two pieces of T35-c	Two pieces of M35-c	One piece of MD35-c				

— For transportation and installation, the mass of one segment for bridge beams shall be 30 t or under, and the mass difference between segments shall be as small as possible.

— The bridge beam shall have a skew angle of 70 degrees or more after assembled into a bridge.

B-2.3 Performance

The compressive strength of concrete is used as substitute characteristic of segments for bridge beams. The compressive strength of concrete at the quality assurance shall be 50 N/mm^2 or more. The compressive strength of concrete at the introduction of prestress shall be 35 N/mm^2 or more.

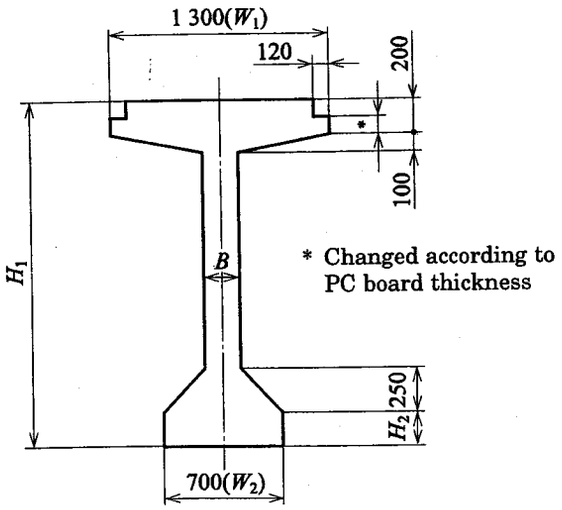
B-2.4 Shape, dimensions and dimensional tolerances

The shape, dimensions and dimensional tolerances of segments for bridge beams shall be as specified in Recommended specification B-2 Figure 1, Recommended specification B-2 Table 2, Recommended specification B-2 Table 3, Recommended specification B-2 Table 4 and Recommended specification B-2 Table 5.

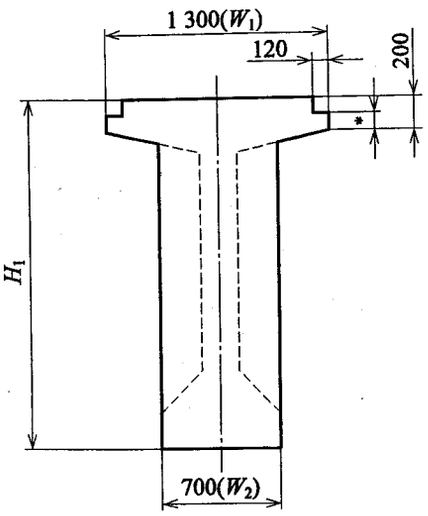
If the reference dimension is changed within the range specified in **B.4**, the manufacturer shall submit the data indicating that segments for bridge beams conform to Table B.3 in the design document or the performance test result when requested by the purchaser.

NOTE : As agreed between the parties concerned with delivery, the necessary attachment may be provided or the proper work may be performed unless it compromises the performance of segment for bridge beam.

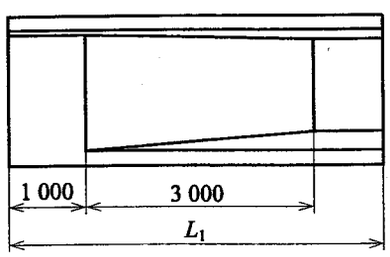
Unit: mm



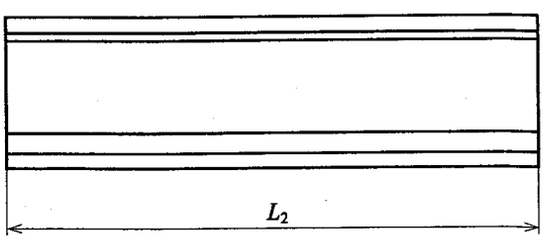
Middle cross-section



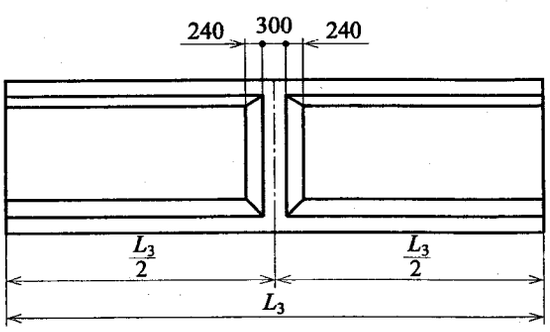
Supporting position cross-section



Edge segment



Middle segment



Central segment

Recommended specification B-2 Figure 1
Shape of segment for bridge beam

Recommended specification B-2 Table 2 Dimensions of edge segments

Unit: mm

Type		L_1	H_1	H_2	B
T25-	a	8 100	1 400	200	220
	b	8 100	1 600	200	220
	c	8 100	1 900	200	220
T26-	a	8 600	1 400	200	220
	b	8 100	1 700	200	220
	c	8 100	2 000	200	220
T27-	a	8 600	1 400	200	220
	b	8 600	1 700	200	220
	c	8 600	2 000	200	220
T28-	a	9 100	1 500	200	220
	b	9 100	1 800	200	220
	c	9 100	2 100	200	220
T29-	a	9 100	1 600	200	220
	b	9 100	1 900	200	220
	c	4 350	2 300	200	220
T30-	a	9 900	1 700	200	220
	b	4 900	2 000	200	220
	c	4 900	2 400	200	220
T31-	a	4 100	1 700	200	220
	b	5 400	2 000	200	220
	c	4 100	2 400	200	220
T32-	a	4 400	1 800	200	220
	b	4 400	2 100	200	220
	c	4 400	2 500	200	220
T33-	a	4 900	1 800	200	220
	b	4 900	2 100	200	220
	c	4 900	2 500	200	220
T34-	a	5 400	1 900	200	220
	b	5 400	2 200	200	220
	c	5 400	2 600	200	220
T35-	a	5 900	2 000	200	220
	b	5 900	2 300	200	220
	c	4 400	2 600	200	220
T36-	a	6 400	2 000	200	220
	b	6 400	2 300	200	220
	c	4 900	2 700	200	220
T37-	a	6 900	2 000	200	220
	b	6 900	2 300	200	220
	c	5 400	2 700	200	220
T38-	a	5 900	2 100	200	220
	b	5 900	2 400	200	220
	c	5 900	2 800	200	220
T39-	a	6 400	2 100	250	230
	b	6 400	2 500	250	230
	c	6 400	2 900	250	230
T40-	a	6 200	2 100	250	230
	b	6 950	2 500	250	230
	c	4 700	3 000	250	230
T41-	a	6 700	2 200	250	230
	b	4 700	2 600	250	230
	c	5 200	3 000	250	230
T42-	a	7 200	2 200	250	230
	b	5 200	2 600	250	230
	c	5 700	3 100	250	230
T43-	a	7 700	2 300	250	230
	b	4 450	2 700	250	230
	c	4 100	3 200	250	230
T44-	a	8 200	2 300	250	230
	b	4 600	2 700	250	230
	c	4 250	3 200	250	230
T45-	a	7 800	2 400	250	230
	b	4 400	2 800	250	230
	c	4 050	3 300	250	230

Recommended specification B-2 Table 3 Dimensions of middle segments

Unit: mm

Type		L_2	H_1	H_2	B
M29-	a	—	—	—	—
	b	—	—	—	—
	c	7 000	2 300	200	220
M30-	a	—	—	—	—
	b	7 000	2 000	200	220
	c	7 000	2 400	200	220
M31-	a	7 800	1 700	200	220
	b	7 000	2 000	200	220
	c	7 800	2 400	200	220
M32-	a	8 000	1 800	200	220
	b	8 000	2 100	200	220
	c	8 000	2 500	200	220
M33-	a	8 000	1 800	200	220
	b	8 000	2 100	200	220
	c	8 000	2 500	200	220
M34-	a	8 000	1 900	200	220
	b	8 000	2 200	200	220
	c	8 000	2 600	200	220
M35-	a	8 000	2 000	200	220
	b	8 000	2 300	200	220
	c	9 000	2 600	200	220
M36-	a	8 000	2 000	200	220
	b	8 000	2 300	200	220
	c	9 000	2 700	200	220
M37-	a	8 000	2 000	200	220
	b	8 000	2 300	200	220
	c	9 000	2 700	200	220
M38-	a	9 000	2 100	200	220
	b	9 000	2 400	200	220
	c	9 000	2 800	200	220
M39-	a	9 000	2 100	250	230
	b	9 000	2 500	250	230
	c	9 000	2 900	250	230
M40-	a	9 500	2 100	250	230
	b	9 000	2 500	250	230
	c	6 300	3 000	250	230
M41-	a	9 500	2 200	250	230
	b	6 500	2 600	250	230
	c	6 300	3 000	250	230
M42-	a	9 500	2 200	250	230
	b	6 500	2 600	250	230
	c	6 300	3 100	250	230
M43-	a	9 500	2 300	250	230
	b	5 000	2 700	250	230
	c	5 100	3 200	250	230
M44-	a	9 500	2 300	250	230
	b	5 100	2 700	250	230
	c	5 200	3 200	250	230
M45-	a	10 100	2 400	250	230
	b	5 300	2 800	250	230
	c	5 400	3 300	250	230
Omitted					

NOTE : A middle segment is unnecessary if a bridge beam consists of three segments (edge segment × 2 and central segment). Therefore, middle segments of span of 25 m to 28 m (M25 to M28) and some of those of 29 m and 30 m (M29-a, M29-b, M30-a) do not exist.

Recommended specification B-2 Table 4 Dimensions of central segments

Unit: mm

Type		L_3	H_1	H_2	B
MD25-	a	9 500	1 400	200	220
	b	9 500	1 600	200	220
	c	9 500	1 900	200	220
MD26-	a	9 500	1 400	200	220
	b	10 500	1 700	200	220
	c	10 500	2 000	200	220
MD27-	a	10 500	1 400	200	220
	b	10 500	1 700	200	220
	c	10 500	2 000	200	220
MD28-	a	10 500	1 500	200	220
	b	10 500	1 800	200	220
	c	10 500	2 100	200	220
MD29-	a	11 500	1 600	200	220
	b	11 500	1 900	200	220
	c	7 000	2 300	200	220
MD30-	a	11 000	1 700	200	220
	b	7 000	2 000	200	220
	c	7 000	2 400	200	220
MD31-	a	8 000	1 700	200	220
	b	7 000	2 000	200	220
	c	8 000	2 400	200	220
MD32-	a	8 000	1 800	200	220
	b	8 000	2 100	200	220
	c	8 000	2 500	200	220
MD33-	a	8 000	1 800	200	220
	b	8 000	2 100	200	220
	c	8 000	2 500	200	220
MD34-	a	8 000	1 900	200	220
	b	8 000	2 200	200	220
	c	8 000	2 600	200	220
MD35-	a	8 000	2 000	200	220
	b	8 000	2 300	200	220
	c	9 000	2 600	200	220
MD36-	a	8 000	2 000	200	220
	b	8 000	2 300	200	220
	c	9 000	2 700	200	220
MD37-	a	8 000	2 000	200	220
	b	8 000	2 300	200	220
	c	9 000	2 700	200	220
MD38-	a	9 000	2 100	200	220
	b	9 000	2 400	200	220
	c	9 000	2 800	200	220
MD39-	a	9 000	2 100	250	230
	b	9 000	2 500	250	230
	c	9 000	2 900	250	230
MD40-	a	9 500	2 100	250	230
	b	9 000	2 500	250	230
	c	6 300	3 000	250	230
MD41-	a	9 500	2 200	250	230
	b	6 500	2 600	250	230
	c	6 300	3 000	250	230
MD42-	a	9 500	2 200	250	230
	b	6 500	2 600	250	230
	c	6 300	3 100	250	230
MD43-	a	9 500	2 300	250	230
	b	5 000	2 700	250	230
	c	5 100	3 200	250	230
MD44-	a	9 500	2 300	250	230
	b	5 100	2 700	250	230
	c	5 200	3 200	250	230
MD45-	a	10 100	2 400	250	230
	b	5 300	2 800	250	230
	c	5 400	3 300	250	230

Recommended specification B-2 Table 5 Dimensional tolerances

Unit: mm

Division		Tolerances
Length	L_1 to L_3	±10
Upper width	W_1	+10 − 5
Lower width	W_2	± 5
Height	H_1	+10 − 5
— Multiple segments are joined and used as a bridge beam, so the tolerances on beam length (L') at the time of manufacture shall be for the sum of those of segments used, and it shall be $\pm(L'-5)$ and within −30 mm. — The unit of beam length (L') shall be m, and the unit of tolerances shall be mm.		

B-2.5 Bar arrangement

The bar arrangement of segments for bridge beams shall be based on a design document, and as follows.

a) The covering of reinforcing bar shall be 30 mm or more for upper flange, and 35 mm or more for the rest.

b) The gap between the reinforcing bars shall be 20 mm or more, and shall be at least 4/3 of the maximum dimension of coarse aggregates.

c) The reinforcing bar shall be free from loose scale, oil, etc. which damage adhesion of concrete, and shall be assembled and fixed to the right position, together with the sheath through which the prestressing tendon will be placed.

B-2.6 Quality of concrete

The quality of concrete shall be as specified in **B.6**.

B-2.7 Compressive strength test of concrete

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

B-2.8 Inspections

B-2.8.1 Inspection items

The inspection items of segments for bridge beams 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

B-2.8.2 Inspection lot

The size of inspection lot of segments for bridge beams 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 shall be one bridge beam.

B-2.8.3 Inspection method

The inspection method of segments for bridge beams 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** The inspection of performance shall be conducted as specified in **B-2.7** and those conforming to the provisions of **B-2.3** shall be accepted.

3) **Shape and dimensions** As the inspection of shape and dimensions, a 100 % inspection shall be conducted, and those conforming to the provisions of **B-2.4** 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)**.

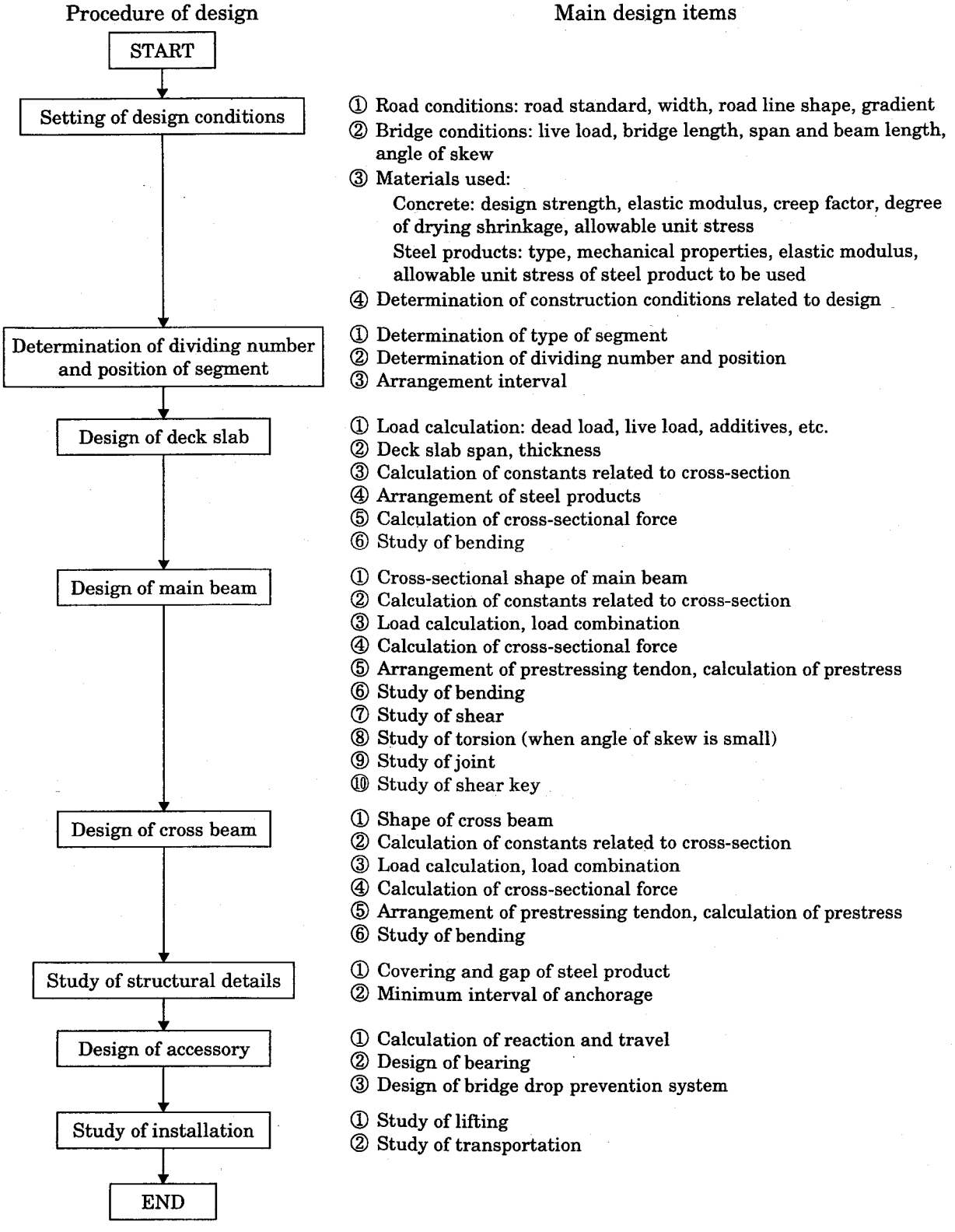
2) **Shape and dimensions** The shape and dimensions shall be inspected in the same way as **a) 3)**.

B-2.9 Marking

The segments for bridge beams which conform to all the requirements of this Standard shall be marked as specified in **B.9**.

Recommended specification B-2
Procedure of design of segments for bridge beams (informative)

The general procedure of design and the main design items of the segments for bridge beams are shown below.



Recommended specification B-3
Precast plate for composite deck slab

B-3.1 Outline

This recommended specification describes the precast plates for composite deck slabs in Group I of bridges (hereafter referred to as precast plates for composite deck slabs) specified in Annex B.

B-3.2 Classification

The precast plates for composite deck slabs shall be divided according to the span as shown in Recommended specification B-3 Table 1.

Recommended specification B-3 Table 1
Classification and flexural cracking strength of precast plates for composite deck slab

Type	Span of precast plate mm	Plate thickness mm	Flexural cracking strength kN·m
PCC–70–1	1 450	70	6.6
PCC–70–2	1 750	70	7.5
PCC–80	2 050	80	10.1
PCC–90	2 200	90	13.0
PCC–100	2 600	100	16.3
PCC–110	2 800	110	19.9
PCC–120	3 000	120	22.3

B-3.3 Performance

The required performance of precast plates for composite deck slabs shall be the flexural cracking strength. Cracking shall not occur when the cracking load calculated in **B.7.2** using the flexural cracking strength specified in Recommended specification B-3 Table 1 is applied.

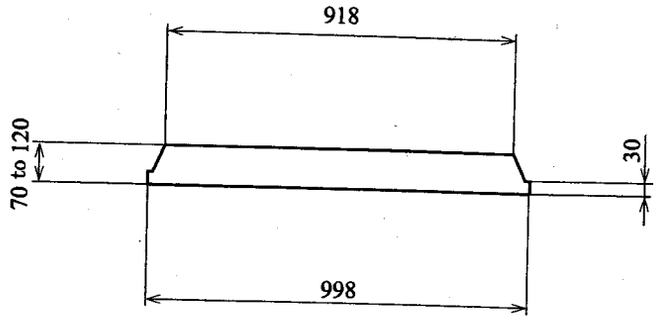
B-3.4 Shape, dimensions and dimensional tolerances

The shape, dimensions and dimensional tolerances of precast plates for composite deck slabs shall be as specified in Recommended specification B-3 Figure 1 and Recommended specification B-3 Table 2. The top face of precast plate shall have a suitable unevenness to combine the cast-in place concrete with the precast plate, and the thickness of plate shall be the intermediate value between the concave and convex thicknesses.

If the reference dimension is changed within the range specified in **B.4**, the manufacturer shall submit the data indicating that the precast plates for composite deck slabs conform to Table B.3 in the design document or the performance test result when requested by the purchaser.

NOTE : As agreed between the parties concerned with delivery, the necessary attachment may be provided or the proper work may be performed unless it compromises the performance of precast plate for composite deck slab.

Unit: mm



Recommended specification B-3 Figure 1
Shape and dimensions of precast plates for composite deck slabs

Recommended specification B-3 Table 2 Dimensional tolerances

Unit: mm

Division	Tolerances
Length (direction perpendicular to bridge axis)	+10 − 5
Width (bridge axis direction)	+ 5 − 3
Thickness (at convex part)	+ 5 − 2
Linearity of side face of plate	± 3
Perpendicularity of end face of plate	±10

B-3.5 Bar arrangement

The bar arrangement of precast plates for composite deck slabs shall be based on a design document, and as follows.

a) The covering of reinforcing bar and the prestressing tendon shall be 25 mm or more.

b) The gap between the reinforcing bar and the prestressing tendon shall be 20 mm or more. As to the prestressing tendon, the gap shall be at least three times the diameter, and shall be at least 4/3 of the maximum dimension of coarse aggregates.

c) The reinforcing bar and the prestressing tendon shall be free from loose scale, oil, etc. which damage the adhesion of concrete, and shall be assembled and fixed to the right position.

B-3.6 Quality of concrete

The quality of concrete shall be as specified in **B.6**.

B-3.7 Flexural strength test of product

The flexural strength test of the product shall be as specified in **B.7.2**, and the load shall be uniformly distributed using a steel plate of about 10 cm to 15 cm in width and a round steel bar of a proper diameter.

B-3.8 Inspections

B-3.8.1 Inspection items

The inspection items of precast plates for composite deck slabs 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

B-3.8.2 Inspection lot

The size of inspection lot of precast plates for composite deck slabs 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 be 20 manufacture lines or its fraction.

B-3.8.3 Inspection method

The inspection method of precast plates for composite deck slabs 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, two precast plates for composite deck slabs per lot shall be taken and inspected as specified in **B-3.7**. If both of the two conform to **B-3.3**, the lot shall be accepted. If neither of the two conforms, the lot shall be rejected. If one of the two does not conform to the provisions, 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 precast plate for composite deck slab is taken from two arbitrary manufacture lines respectively, and two plates in total shall be inspected. If both of the two conform to **B-3.4**, the lot shall be accepted. If one or more do not conform, one plate is taken from other four manufacture lines respectively, and four plates in total shall be inspected. If all the four conform to the provisions, the lines shall be accepted after the manufacture line which has produced the first non-conforming product is eliminated. If one or more of them do not conform, the remainder of the lot shall be subjected to a 100 % inspection.

For the manufacture line which has produced the non-conforming product, two more plates shall be taken and inspected. If both of the two conform to the provisions, the total plates after the non-conforming products are eliminated shall be accepted. If one or more plates do not conform to the provisions, the products from the manufacture line shall be subjected to a 100 % inspection.

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)**.

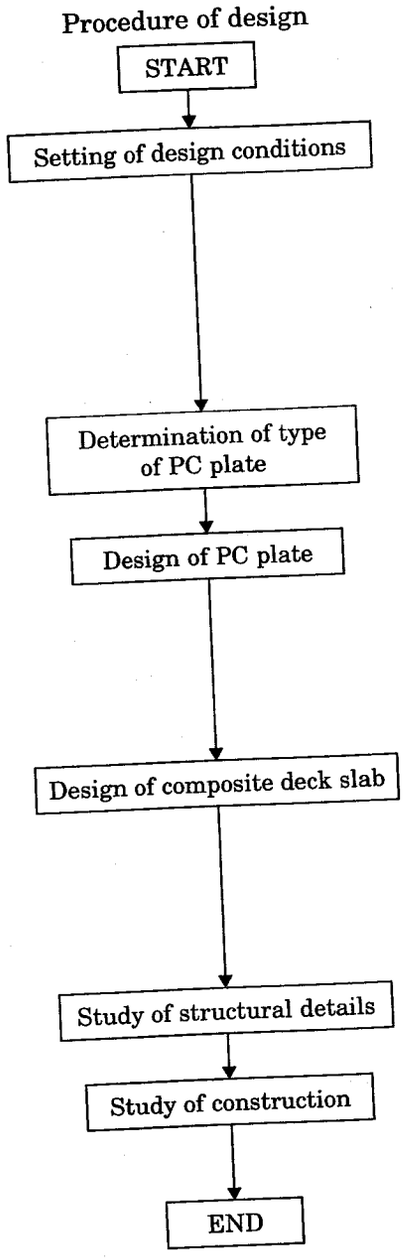
B-3.9 Marking

The precast plates for composite deck slabs which conform to all the requirements of this Standard shall be marked as specified in **B.9**.

Recommended specification B-3

Procedure of design of precast plates for composite deck slabs (informative)

The general procedure of design and the main design items of the precast plates for composite deck slabs are shown below.



Main design items

① Deck slab conditions: main beam interval, span of precast deck slab, thickness of precast deck slab, pavement thickness
② Materials used
Concrete: design strength, elastic modulus, creep factor, degree of drying shrinkage, allowable unit stress
Steel products: type, mechanical properties, elastic modulus, allowable unit stress of steel product to be used
③ Determination of construction conditions related to design

① Determination of type of PC plate

① Cross-sectional shape of PC plate
② Calculation of constants related to cross-section
③ Load calculation, load combination
④ Calculation of cross-sectional force
⑤ Arrangement of prestressing tendon, calculation of prestress
⑥ Study of bending

① Cross-sectional shape of composite deck slab
② Calculation of constants related to cross-section
③ Load calculation, load combination
④ Calculation of cross-sectional force
⑤ Arrangement of prestressing tendon, calculation of prestress
⑥ Study of bending

① Covering and gap of steel product

① Study of lifting
② Study of transportation
③ Study of placing of cast-in place concrete

Recommended specification B-4
Precast deck slabs for highway bridges

B-4.1 Outline

This recommended specification describes the precast deck slabs for highway bridges in Group I of bridges (hereafter referred to as precast deck slabs) specified in Annex B.

B-4.2 Classification

The precast deck slabs shall be divided according to the length of deck slab as shown in Recommended specification B-4 Table 1.

Recommended specification B-4 Table 1
Classification and flexural cracking strength of precast deck slabs

Type	Length of deck slab mm	Number of main beams	Main beam interval mm	Standard overhang length mm	Thickness of deck slab mm		Flexural cracking strength kN·m
					Centre of span (H_1)	Supporting position (H_2)	
PDS2– 7.9	7 900	2	4 000	1 950	250	350	142
PDS2– 8.9	8 900		4 100	2 400	250	350	127
PDS2– 9.4	9 400		4 400	2 500	260	360	137
PDS2– 9.9	9 900		4 700	2 600	270	370	152
PDS2–10.4	10 400		5 000	2 700	280	380	161
PDS2–11.2	11 200		5 600	2 800	310	410	198
PDS2–11.7	11 700		6 000	2 850	320	420	219
PDS3–12.2	12 200	3	4 700	1 400	240	340	185
PDS3–12.7	12 700		4 900	1 450	240	340	185
PDS3–13.2	13 200		5 100	1 500	240	340	198
PDS3–13.5	13 500		5 200	1 550	240	340	198
PDS3–13.7	13 700		5 300	1 550	250	350	206
PDS3–14.0	14 000		5 400	1 600	250	350	206
PDS3–14.5	14 500		5 600	1 650	260	360	215
PDS3–14.7	14 700		5 700	1 650	260	360	215
PDS3–15.0	15 000		5 800	1 700	260	360	229
PDS3–15.2	15 200		5 900	1 700	260	360	229
PDS3–15.5	15 500		6 000	1 750	270	370	238
PDS4–16.0	16 000	4	4 400	1 400	240	340	162
PDS4–16.5	16 500		4 500	1 500	240	340	162
PDS4–17.0	17 000		4 600	1 600	240	340	162
PDS4–17.5	17 500		4 700	1 700	240	340	174
PDS4–18.5	18 500		5 000	1 750	240	340	187

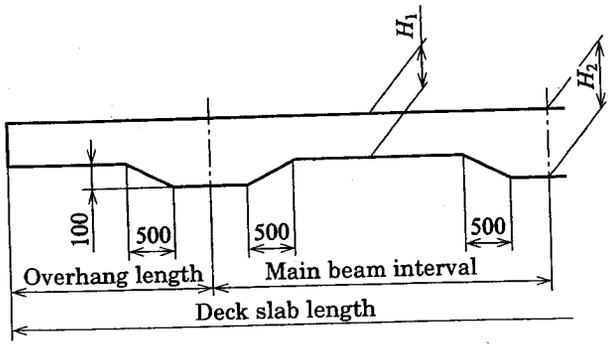
When applying to a curved bridge, etc., the following may be applied.

a) The length of overhang to be used may be distributed to right and left within 0.3 m from the standard overhang length.

b) The width of deck slab to be used may be changed within 0.1 m.

c) The centre of span (H_1) and the supporting position (H_2) are as specified in Recommended specification B-4 Figure 1.

Unit: mm



Recommended specification B-4 Figure 1
Shape and dimensions of precast deck slab
(direction perpendicular to bridge axis)

B-4.3 Performance

The required performance of precast deck slabs shall be the flexural cracking strength. Cracking shall not occur when the cracking load calculated in **B.7.2** using the flexural cracking strength specified in Recommended specification B-4 Table 1 is applied.

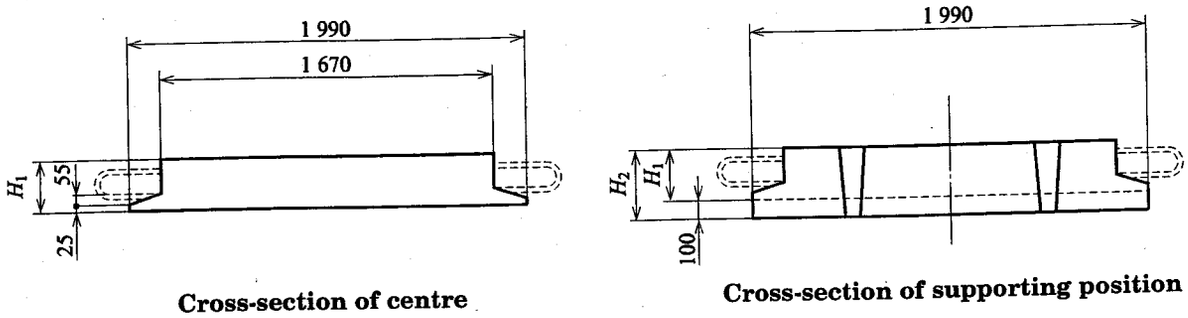
B-4.4 Shape, dimensions and dimensional tolerances

The shape, dimensions and dimensional tolerances of precast deck slabs shall be as specified in Recommended specification B-4 Figure 2 and Recommended specification B-4 Table 2.

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

NOTE : As agreed between the parties concerned with delivery, the necessary attachment may be provided or the proper work may be performed unless it compromises the performance of precast deck slab.

Unit: mm



Recommended specification B-4 Figure 2
Shape and dimensions of precast deck slab
(bridge axis direction)

Recommended specification B-4 Table 2 Dimensional tolerances

Unit: mm

Items	Tolerances
Length of deck slab	+20 0
Width of deck slab	+ 5 −10
Thickness of deck slab	+10 0

B-4.5 Bar arrangement

The bar arrangement of precast deck slabs shall be based on a design document, and as follows.

a) The covering of reinforcing bar and the prestressing tendon shall be 25 mm or more.

b) The gap between the reinforcing bar and the prestressing tendon shall be 20 mm or more. As to the prestressing tendon, the gap shall be at least three times the diameter, and shall be at least 4/3 of the maximum dimension of coarse aggregates.

c) The reinforcing bar and the prestressing tendon shall be free from loose scale, oil, etc. which damage the adhesion of concrete, and shall be assembled and fixed to the right position.

d) The covering of reinforcing bar and prestressing tendon on the top face of deck slab should be 30 mm or more, considering the interfilling part.

B-4.6 Quality of concrete

The quality of concrete shall be as specified in **B.6**.

B-4.7 Flexural strength test of product

The flexural strength test of the product shall be as specified in **B.7.2**, and the load shall be uniformly distributed using a steel plate of about 10 cm to 15 cm in width and a round steel bar of a proper diameter.

B-4.8 Inspections

B-4.8.1 Inspection items

The inspection items of precast deck slabs 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

B-4.8.2 Inspection lot

The size of inspection lot of precast deck slabs 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 400 units or fractions thereof.

B-4.8.3 Inspection method

The inspection method of precast deck slabs 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, two precast deck slabs per lot shall be taken and inspected as specified in **B-4.7**. If both of the two conform to **B-4.3**, the lot shall be accepted. If neither of the two conforms, the lot shall be rejected. If one of the two does not conform to the provisions, the remainder of the lot shall be subjected to a 100 % inspection, and those conform to the provisions shall be accepted.

3) **Shape and dimensions** As the inspection of shape and dimensions, a 100 % inspection shall be conducted, and those conforming to the provisions of **B-4.4** 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)**.

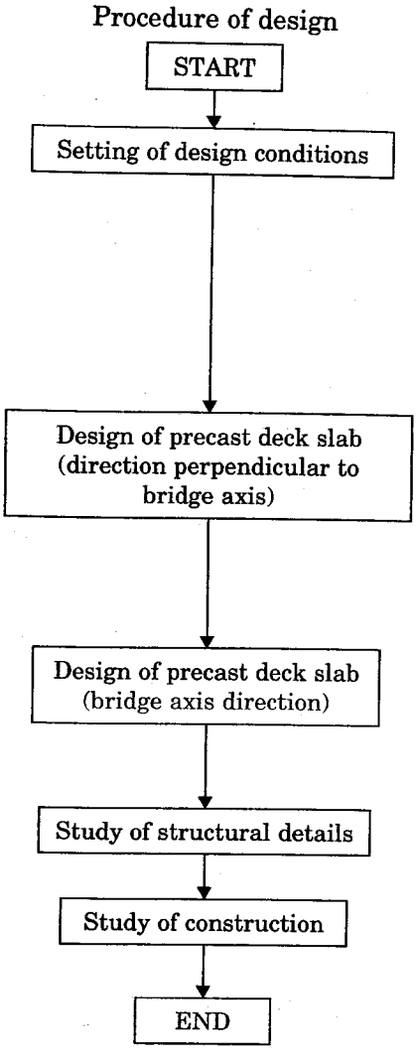
2) **Shape and dimensions** The shape and dimensions shall be inspected in the same way as **a) 3)**.

B-4.9 Marking

The precast deck slabs which conform to all the requirements of this Standard shall be marked as specified in **B.9**.

Recommended specification B-4
Procedure of design of precast deck slabs (informative)

The general procedure of design and the main design items of the precast deck slabs are shown below.



Main design items

① Deck slab conditions: main beam interval, span of precast deck slab, thickness of precast deck slab, pavement thickness
② Materials used
Concrete: design strength, elastic modulus, creep factor, degree of drying shrinkage, allowable unit stress
Steel products: type, mechanical properties, elastic modulus, allowable unit stress of steel product to be used
③ Determination of construction conditions related to design

① Cross-sectional shape of precast deck slab
② Calculation of constants related to cross-section
③ Load calculation, load combination
④ Calculation of cross-sectional force
⑤ Arrangement of prestressing tendon, calculation of prestress
⑥ Study of bending

① Calculation of cross-sectional force
② Arrangement of reinforcing bar
③ Study of bending
④ Design of loop joint

① Covering and gap of steel product

① Study of lifting
② Study of transportation

Annex C (normative)
Retaining walls

C.1 Outline

This Annex specifies Group I and Group II of retaining walls which are mainly used for revetment and earth retaining walls.

The prestressed concrete sheet piles made of precast prestressed concrete (hereafter referred to as sheet pile) specified in this Annex is also applicable to drainage canals.

C.2 Classification

The retaining walls shall be as classified as given in Table C.1, and Group I of retaining walls shall be classified as given in Table C.2.

Table C.1 Classification of retaining walls

Major division	Minor division
Retaining walls	PC wall
	Sheet pile
	Others

Table C.2 Classification of Group I of retaining walls

Type		Detail
	Division by shape	
Sheet pile	Flat type	See Recommended specification C-1.
	Slot type	
	Wavy type	

C.3 Performance

The required performance and the performance verification method of retaining walls shall be as follows.

a) **Product of Group I** The performance of product shall conform to the provisions of Recommended specification C-1.

b) **Product of Group II** The performance of product shall conform to the provisions of clause **4** and clause **5** of **JIS A 5362**, and shall be determined as agreed between the parties concerned with delivery. Table C.3 may be applied for general specifications.

Table C.3 Performance and performance verification method of retaining walls

Performance item	Performance	Performance verification method
Service performance	It shall be able to be used smoothly under a load expected during service, fulfilling the required function.	See design document, **C.7** or actual results.
Safety [a)]	It shall not fracture under a load expected in design.	See design document, **C.7** or actual results.
Durability [b)]	Cracking, ageing of material properties or the like due to the expected impact shall not deteriorate the required performance.	See design document or actual results.
Workability	It shall be transported, installed, assembled and joined safely and easily without abnormalities detrimental to use.	See design document or actual results.

Notes [a)] The verification on the safety shall be made when requested by the purchaser.

[b)] Durability may be verified by the actual results of similar products equivalent in water-cement ratio and/or air content as well as the covering of reinforcing bar, etc. and production method.

C.4 Shape, dimensions and dimensional tolerances

The shape, dimensions and dimensional tolerances of retaining walls shall be as follows. As to Group I, if the design concept is equivalent and the performance and the performance verification method are the same, the reference dimension may be changed within ± 10 % in response to the purchaser's demand, provided that the necessary performance is satisfied.

a) **Shape** Examples of shape of sheet pile are shown in Figure C.1, Figure C.2 and Figure C.3.

Unit: mm

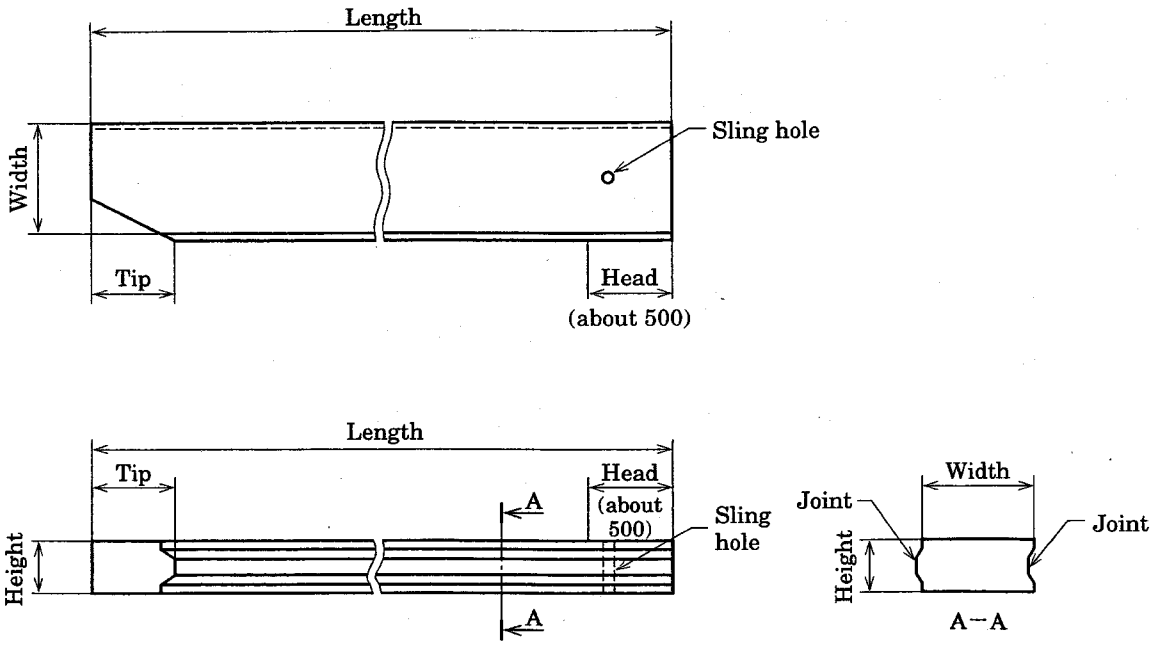


Figure C.1 Example of shape of sheet pile (flat type)

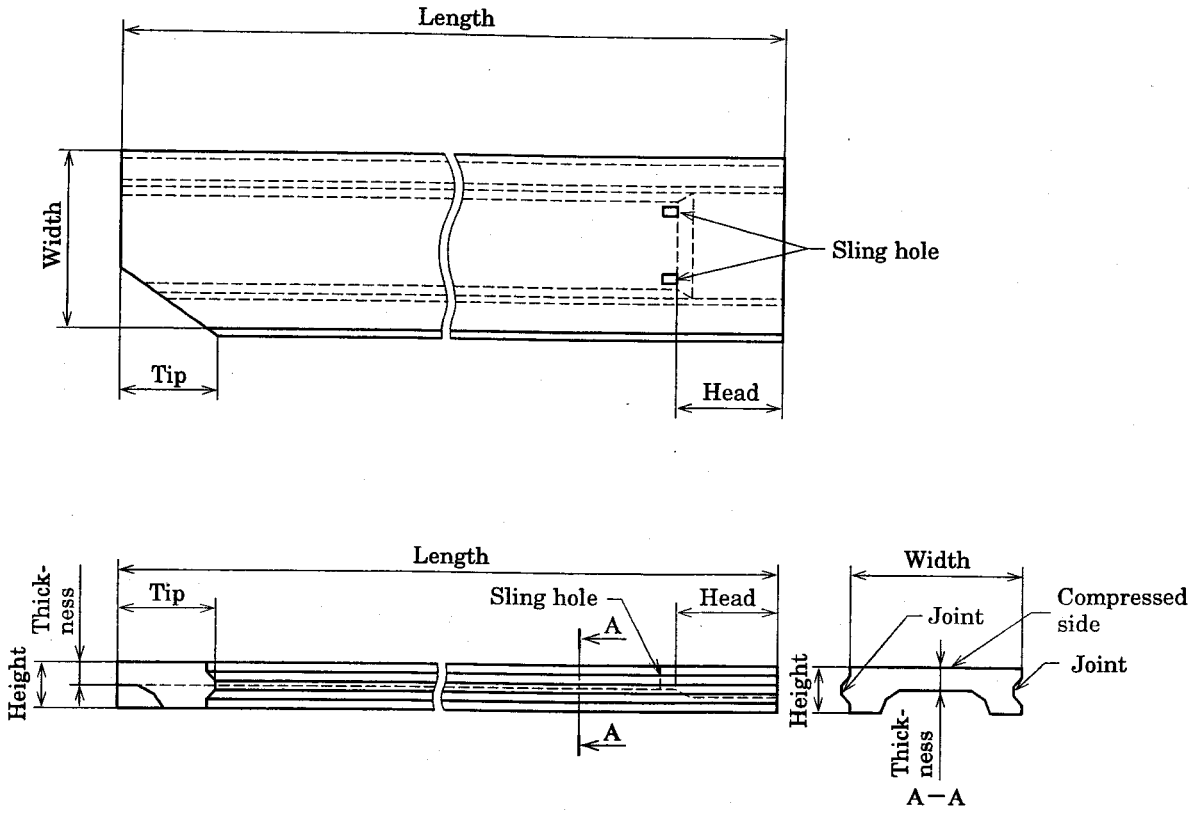


Figure C.2 Example of shape of sheet pile (slot type)

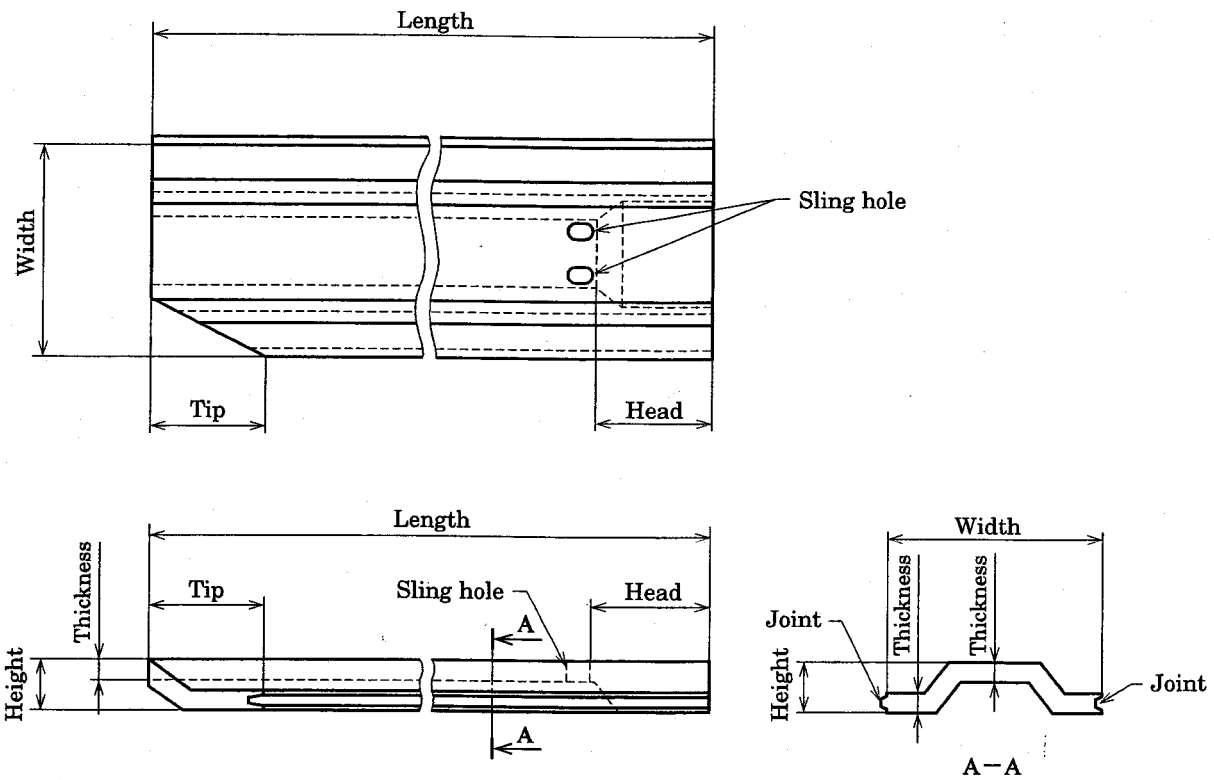


Figure C.3 Example of shape of sheet pile (wavy type)

b) **Dimensions and dimensional tolerances** The dimensions and dimensional tolerances of the products classified into Group I shall be as specified in Table C.4. The dimensions and dimensional tolerances of the products classified into Group II shall be as agreed between the parties concerned with delivery.

The dimensions of a tip are not specified.

Table C.4 Dimensions and dimensional tolerances of sheet piles

Unit: mm

Type			Width	Height	Thickness	Length
Sheet piles	Flat type	Dimensions	500	50 to 220	—	2 000 to 14 000
		Tolerances	+5 −2	+5 −2	—	±30
		Dimensions	996	50 to 220	—	2 000 to 14 000
		Tolerances	+7 −2	+7 −2	—	±30
	Slot type	Dimensions	996	90 to 350	45 to 100	2 000 to 14 000
		Tolerances	+7 −2	+7 −2	+7 −2	±30
	Wavy type	Dimensions	996, 1 246	120 to 1 200	60 to 130	3 000 to 25 000
		Tolerances	+7 −2	+7 −2	+7 −2	±30

NOTE 1 A face may be chamfered.

NOTE 2 The shape of head, tip and joint, presence/absence of sling holes and their positions may be appropriately changed as agreed between the parties concerned with delivery.

NOTE 3 As agreed between the parties concerned with delivery, the necessary attachment may be provided or the proper work may be performed unless it compromises the performance of sheet pile.

NOTE 4 The detail of tolerances is given in Recommended specification C-1.

C.5 Bar arrangement

The bar arrangement (positions of prestressing tendon and reinforcing bar) shall be as specified in **JIS A 5364** and a design document. However, as agreed between the parties concerned with delivery, the bar arrangement (positions of prestressing tendon and reinforcing bar) other than that of the recommended specification may be adopted unless it compromises the performance of PC products (including the provisions of **C.3**). The bar arrangement of sheet piles that satisfies **C.3** (positions of prestressing tendon and reinforcing bar) shall be determined by the manufacturer for each product.

C.6 Quality of concrete

C.6.1 Material and production method

The materials for concrete and the production method shall be as specified in clause **8**.

C.6.2 Compressive strength

The compressive strength of concrete shall satisfy the value specified in Table C.5 after the predetermined material aging is finished or at the time of prestress introduction.

The compressive strength for Group II shall be as agreed between the parties concerned with delivery.

Table C.5 Compressive strength of concrete

Unit : N/mm^2

Type	Predetermined material aging	At prestress introduction
Sheet pile	70 min.	35 min.
NOTE : For the compressive strength of concrete, Annex A of **JIS A 5364** may be referred to.		

C.7 Test method

C.7.1 Compressive strength test of concrete

The compressive strength test of concrete shall be as specified in **JIS A 1108**.

The test piece shall be processed by the same curing as the product or be controlled properly.

C.7.2 Flexural strength test of product

The flexural strength test of product shall be as specified in **JIS A 5363**.

C.8 Inspection

Inspections shall be as specified in **JIS A 5365** and the following.

a) **Final inspection** The final inspection of retaining walls shall be conducted on the appearance, performance, shape and dimensions, and shall be as follows.

1) **Appearance** As the inspection of the appearance, a 100 % inspection or a sampling inspection shall be conducted considering the characteristics of product, production method, production quantity, etc.

2) **Performance, shape and dimensions** As the inspections of performance, shape and dimensions, a sampling inspection shall be applied.

When substitute characteristics are inspected by using an alternative test piece in place of inspecting performances of a product, the correlation between the properties of the test piece and those of the product shall be confirmed in advance.

3) **Size of inspection lot** The size of inspection lot shall be determined by the manufacturer in consideration of the characteristics of product, production method, production quantity, production period, quantity of ordered poles, etc.

Any product in the inspection lot shall have the same characteristics, and shall be manufactured using the same materials, concrete mix proportion and manufacturing process, etc.

b) **Delivery inspection** The delivery inspection of retaining walls shall be conducted on the appearance, shape and dimensions. The size of inspection lot and the sampling method shall be specified by the purchaser as agreed between the parties concerned with delivery. The delivery inspection may be omitted as agreed between the parties concerned with delivery.

C.9 Marking

The following items shall be marked on the retaining walls as specified in **JIS A 5361**.

a) Classification or its abbreviation

b) Manufacturer's name or its abbreviation

c) Date of manufacture or its abbreviation

C.10 Others (recommended specification)

The recommended specification of Group I of retaining walls is shown in Table C.6.

Table C.6 Recommended specification

Structure-specific product group standard		Recommended specification
JIS A 5373	Annex C Retaining walls	Recommended specification C-1 Prestressed concrete sheet piles

Recommended specification C-1
Prestressed concrete sheet piles

C-1.1 Outline

This recommended specification describes the prestressed concrete sheet piles in Group I of retaining walls (hereafter referred to as sheet piles) in Annex C.

C-1.2 Classification

The sheet piles shall be divided according to the shape, dimensions and critical cracking width strength as shown in Recommended specification C-1 Table 1, Recommended specification C-1 Table 2, Recommended specification C-1 Table 3, Recommended specification C-1 Table 4, or Recommended specification C-1 Table 5.

Recommended specification C-1 Table 1
Flat sheet pile (nominal width 500 mm)

Type	Height H mm	Width B mm	Critical cracking width strength kN・m Per sheet	Critical cracking width strength kN・m Per metre	Ultimate flexural strength kN・m Per sheet	Ultimate flexural strength kN・m Per metre	Length (L) m 2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	9.0	10.0	11.0	12.0	13.0	14.0
SF 50H	50	500	2.7	5.4	5.4	10.8	○	○	○	○	○														
SF 60H	60		4.0	8.0	8.0	16		○	○	○	○	○	○												
SF 70H	70		5.5	11	11	22		○	○	○	○	○	○	○	○										
SF 80H	80		7.5	15	15	30			○	○	○	○	○	○	○										
SF 90H	90		10	20	20	40				○	○	○	○	○	○	○	○	○	○						
SF100H	100		11	22	22	44				○	○	○	○	○	○	○	○	○	○						
SF110H	110		15	30	30	60					○	○	○	○	○	○	○	○	○						
SF120H	120		18	36	36	72						○	○	○	○	○	○	○	○	○					
SF130H	130		22	44	44	88							○	○	○	○	○	○	○	○					
SF140H	140		25	50	50	100							○	○	○	○	○	○	○	○					
SF150H	150		29	58	58	116									○	○	○	○	○	○	○				
SF160H	160		34	68	68	136									○	○	○	○	○	○	○				
SF180H	180		42	84	84	168											○	○	○	○	○	○			
SF190H	190		45	90	90	180											○	○	○	○	○	○			
SF200H	200		51	102	102	204													○	○	○	○	○	○	
SF220H	220		65	130	130	260															○	○	○	○	○

NOTE : For the cross-section of flat sheet pile, there is no distinction between the compression side and the tension side.

Recommended specification C-1 Table 2
Flat sheet pile (nominal width 1 000 mm)

Type	Height H mm	Width of product B mm	Critical cracking width strength kN·m	Ultimate flexural strength kN·m	Length (L) m																		
					2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	9.0	10.0	11.0	12.0	13.0	14.0
SF 50	50	996	5.4	10.8	○	○	○	○	○														
SF 60	60		8.0	16		○	○	○	○	○	○												
SF 70	70		11	22		○	○	○	○	○	○	○	○										
SF 80	80		15	30			○	○	○	○	○	○	○										
SF 90	90		20	40				○	○	○	○	○	○	○	○	○	○						
SF100	100		22	44				○	○	○	○	○	○	○	○	○	○						
SF110	110		30	60					○	○	○	○	○	○	○	○	○						
SF120	120		36	72						○	○	○	○	○	○	○	○	○					
SF130	130		44	88							○	○	○	○	○	○	○	○					
SF140	140		50	100							○	○	○	○	○	○	○	○					
SF150	150		58	116									○	○	○	○	○	○	○				
SF160	160		68	136									○	○	○	○	○	○	○				
SF180	180		84	168											○	○	○	○	○	○			
SF190	190		90	180											○	○	○	○	○	○			
SF200	200		102	204													○	○	○	○	○	○	
SF220	220		130	260															○	○	○	○	○

NOTE : For the cross-section of flat sheet pile, there is no distinction between the compression side and the tension side.

Recommended specification C-1 Table 3
Slot sheet pile (nominal width 1 000 mm)

Type	Height *H* mm	Thickness *T* mm	Width of product *B* mm	Critical cracking width strength kN・m	Ultimate flexural strength kN・m	Length (*L*) m																				
						2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	11.0	12.0	13.0	14.0
SC 90A	90	45	996	5.9	11.8	○	○	○	○	○	○															
SC 90B				8.9	17.8		○	○	○	○	○	○														
SC 90C				12	24		○	○	○	○	○	○														
SC120	120	50		15	30					○	○	○	○	○	○											
SC150A	150	60		21	42					○	○	○	○	○	○											
SC150B				28	56					○	○	○	○	○	○											
SC175	175			35	70							○	○	○	○	○	○									
SC200A	200	70		41	82									○	○	○	○	○	○							
SC200B				53	106									○	○	○	○	○	○	○						
SC230	230			63	126										○	○	○	○	○	○	○					
SC255A	255			83	166											○	○	○	○	○	○	○	○			
SC255B				100	200													○	○	○	○	○	○	○		
SC275A	275			120	240													○	○	○	○	○	○	○		
SC275B				140	280															○	○	○	○	○	○	
SC300	300	100		160	320																	○	○	○	○	○
SC350	350			190	380																	○	○	○	○	○

NOTE : For the cross-section of slot sheet pile, there is a distinction between the compression side and the tension side.

Recommended specification C-1 Table 4
Wavy sheet pile (nominal width 1 000 mm)

Type	Height H	Thickness T	Width of product B	Critical cracking width strength	Ultimate flexural strength	Length (L) m																												
	mm	mm	mm	kN·m	kN·m	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0
SW120	120	60	996	15	30	○	○	○	○	○	○	○	○	○																	
SW160	160	80		20	40			○	○	○	○	○	○	○	○	○															
SW180	180			31	62			○	○	○	○	○	○	○	○	○															
SW225	225	100		42	84					○	○	○	○	○	○	○	○	○													
SW250	250			55	110							○	○	○	○	○	○	○	○	○											
SW275	275			73	146									○	○	○	○	○	○	○	○										
SW300	300	110		94	188									○	○	○	○	○	○	○	○	○									
SW325A	325			120	240											○	○	○	○	○	○	○	○								
SW325B				130	260											○	○	○	○	○	○	○	○	○							
SW350A	350	120		160	320													○	○	○	○	○	○	○	○						
SW350B				170	340															○	○	○	○	○	○						
SW400A	400			200	400															○	○	○	○	○	○	○					
SW400B				230	460																○	○	○	○	○	○					
SW450A	450			270	540																○	○	○	○	○	○	○				
SW450B				310	620																	○	○	○	○	○	○				
SW500A	500			350	700																	○	○	○	○	○	○				
SW500B				400	800																		○	○	○	○	○	○			
SW600A	600			500	1 000																			○	○	○	○	○	○	○	
SW600B				590	1 180																				○	○	○	○	○	○	○

NOTE : For the cross-section of wavy sheet pile, there is no distinction between the compression side and the tension side.

Recommended specification C-1 Table 5
Wavy sheet pile (nominal width 1 250 mm)

Type	Height H mm	Thickness T mm	Width of product B mm	Critical cracking width strength kN·m	Ultimate flexural strength kN·m	Length (L) m																	
						8.0	8.5	9.0	9.5	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0
SW 350W	350	130	1 246	133	266	○	○	○	○	○	○	○	○	○											
SW 400W	400			179	358			○	○	○	○	○	○	○	○	○									
SW 450W	450			230	460					○	○	○	○	○	○	○	○								
SW 500W	500			287	574						○	○	○	○	○	○	○	○							
SW 550W	550			325	650								○	○	○	○	○	○	○	○					
SW 600W	600			389	778								○	○	○	○	○	○	○	○	○				
SW 650W	650			430	860										○	○	○	○	○	○	○	○			
SW 700W	700			500	1 000											○	○	○	○	○	○	○	○		
SW 750W	750			543	1 086											○	○	○	○	○	○	○	○	○	
SW 800W	800			619	1 238												○	○	○	○	○	○	○	○	
SW 850W	850			664	1 328													○	○	○	○	○	○	○	○
SW 900W	900			747	1 494													○	○	○	○	○	○	○	○
SW 950W	950			794	1 588													○	○	○	○	○	○	○	○
SW1000W	1 000			884	1 768													○	○	○	○	○	○	○	○
SW1050W	1 050			933	1 866													○	○	○	○	○	○	○	○
SW1100W	1 100			1 029	2 058													○	○	○	○	○	○	○	○
SW1150W	1 150			1 081	2 162													○	○	○	○	○	○	○	○
SW1200W	1 200			1 183	2 366													○	○	○	○	○	○	○	○

NOTE : For the cross-section of wavy sheet pile, there is no distinction between the compression side and the tension side.

C-1.3 Performance

The performance of sheet piles shall be as follows.

C-1.3.1 Critical cracking width strength

The critical cracking width strength (0.05 mm or under in crack width) of sheet piles shall be the at least value specified in Recommended specification C-1 Table 1, Recommended specification C-1 Table 2, Recommended specification C-1 Table 3, Recommended specification C-1 Table 4 or Recommended specification C-1 Table 5.

C-1.3.2 Ultimate flexural strength

The ultimate flexural strength of sheet piles shall be the value equivalent to the value twice the critical cracking width strength, and at least the value specified in Recommended specification C-1 Table 1, Recommended specification C-1 Table 2, Recommended specification C-1 Table 3, Recommended specification C-1 Table 4 or Recommended specification C-1 Table 5.

C-1.4 Shape, dimensions and dimensional tolerances

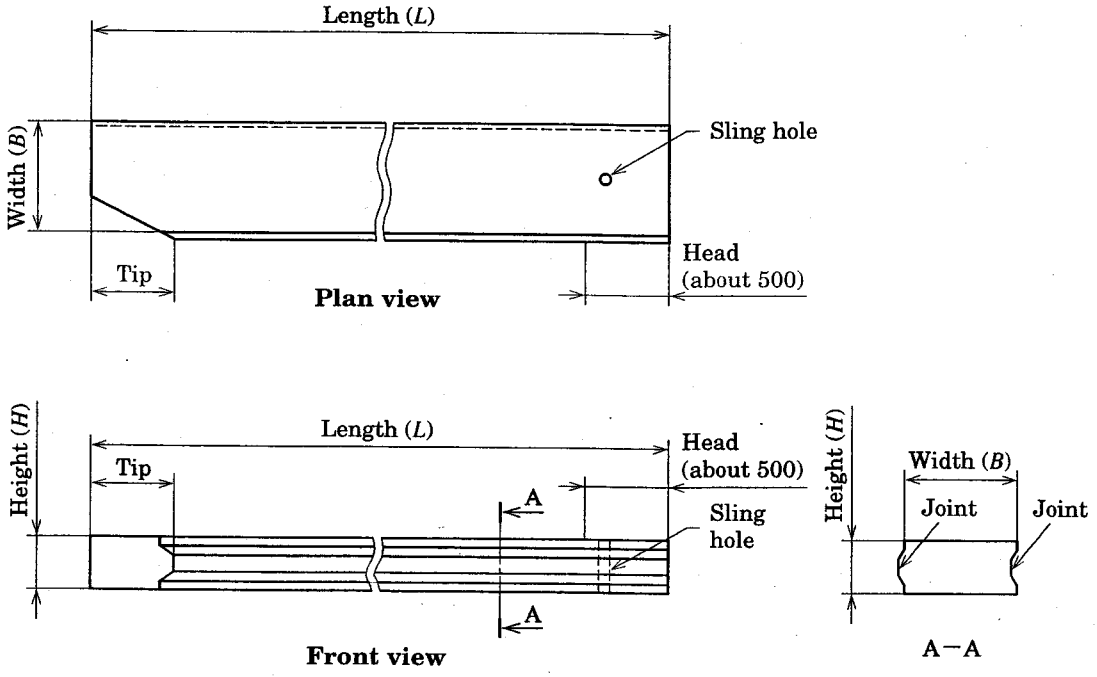
The shape of sheet piles shall be as specified in Recommended specification C-1 Figure 1, Recommended specification C-1 Figure 2, Recommended specification C-1 Figure 3 or Recommended specification C-1 Figure 4.

The dimensions and dimensional tolerances of sheet piles shall be as specified in Recommended specification C-1 Table 1, Recommended specification C-1 Table 2, Recommended specification C-1 Table 3, Recommended specification C-1 Table 4, Recommended specification C-1 Table 5 or Recommended specification C-1 Table 6.

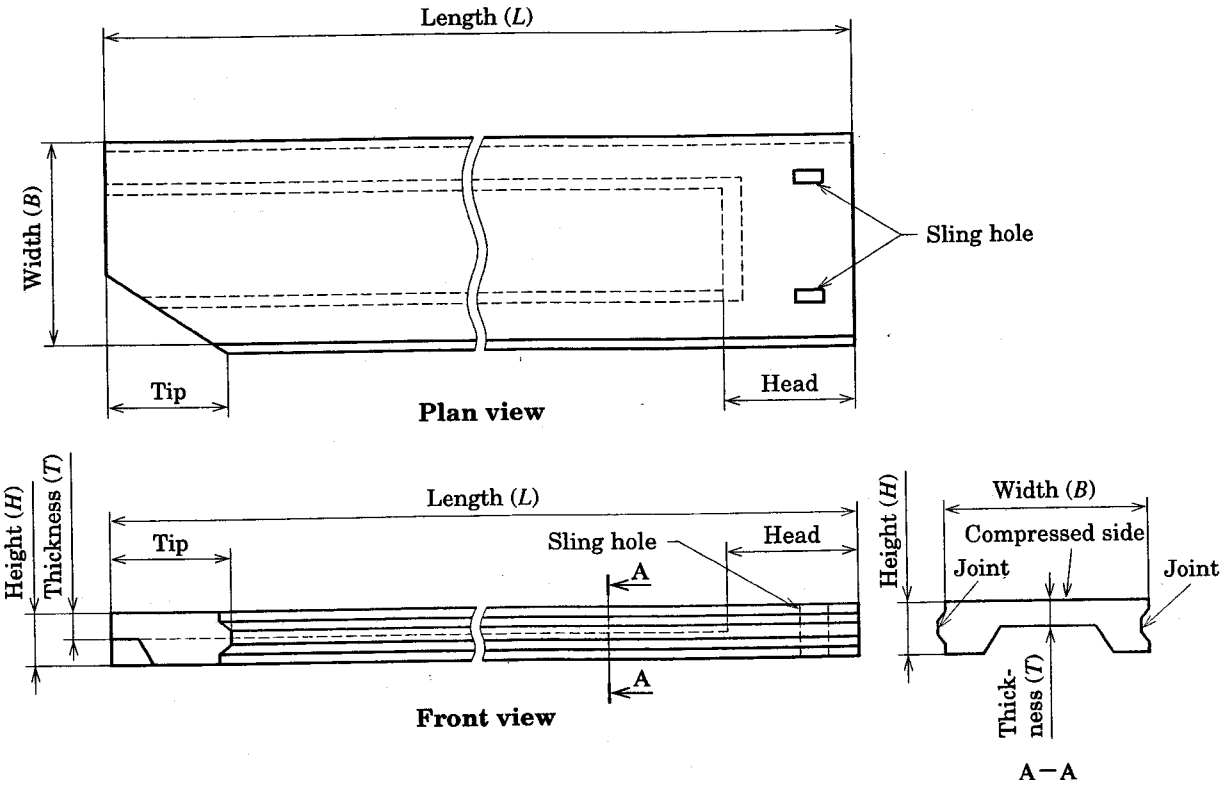
The tolerances on camber shall be as specified in Recommended specification C-1 Table 7.

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

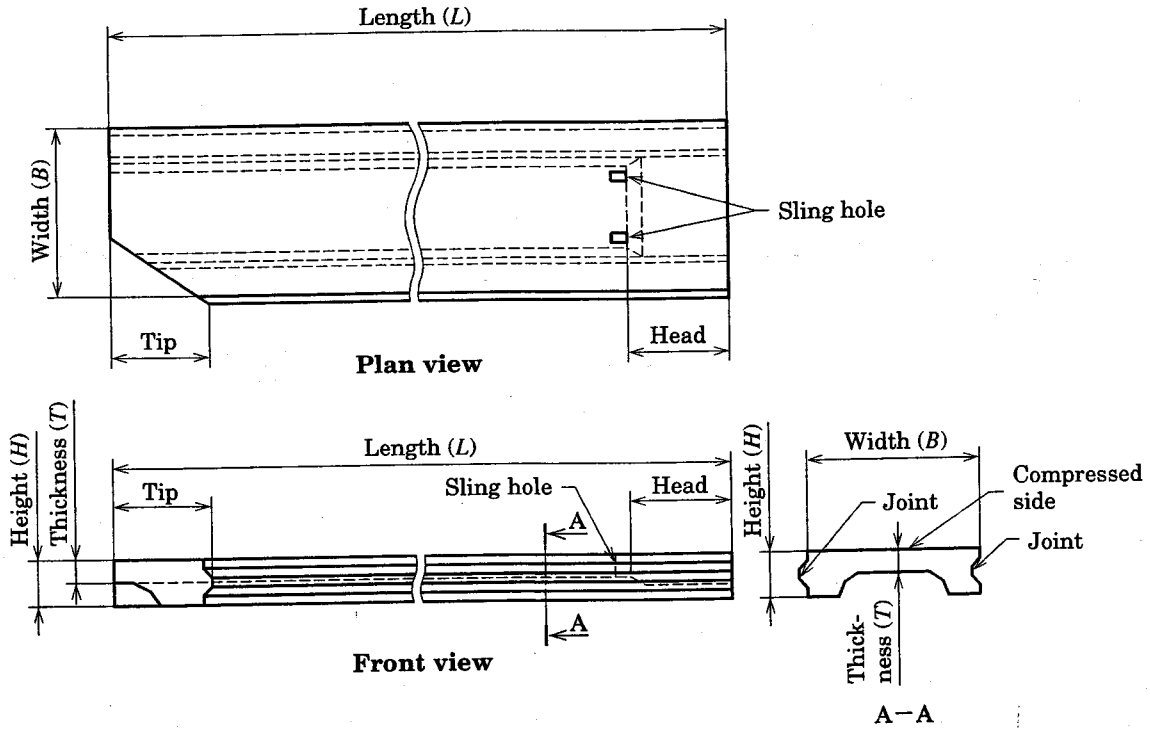
Unit: mm



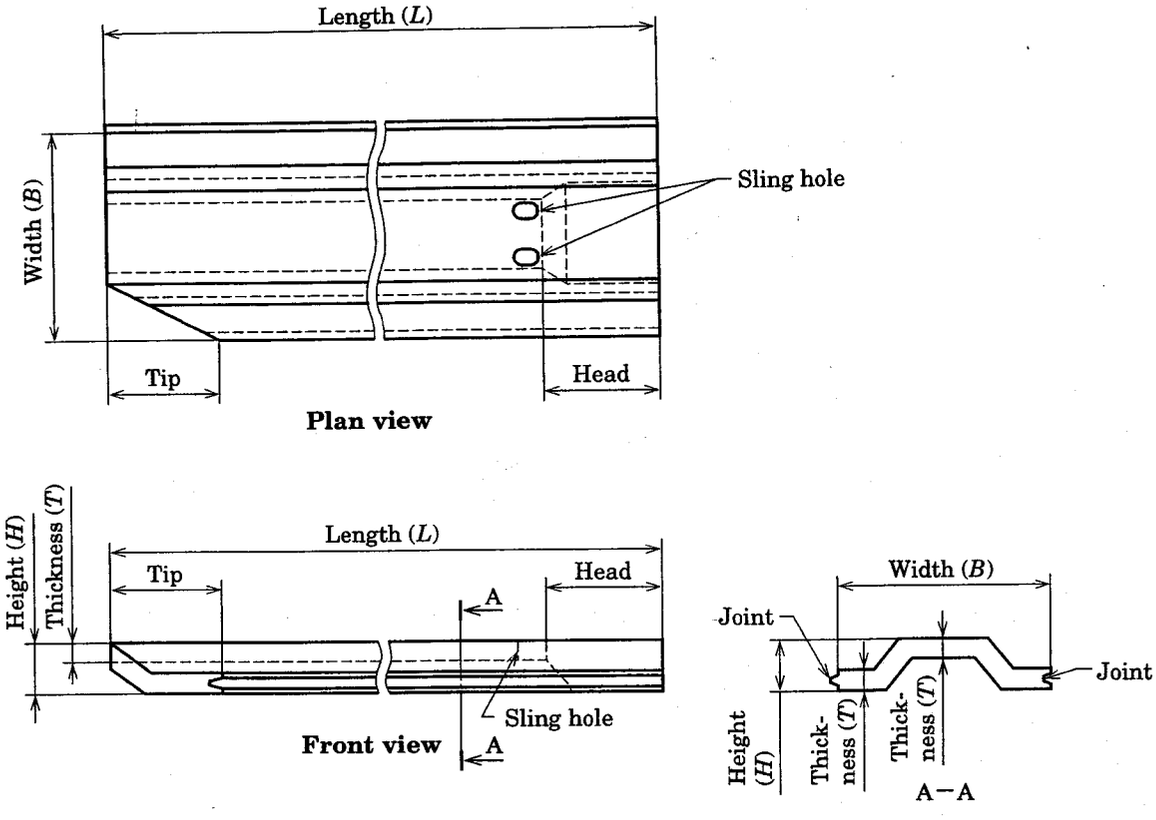
Recommended specification C-1 Figure 1 Shape of flat type



Recommended specification C-1 Figure 2 Shape of slot type (height 90 mm to 120 mm)



Recommended specification C-1 Figure 3 Shape of slot type (height 150 mm to 350 mm)



Recommended specification C-1 Figure 4 Shape of wavy type

Recommended specification C-1 Table 6
Dimensions and dimensional tolerances of sheet piles

Unit: mm

Type		Width	Height	Thickness	Length
Flat type	Dimensions	500	50 to 220	—	2 000 to 14 000
	Tolerances	+5 −2	+5 −2	—	±30
Flat type	Dimensions	996	50 to 220	—	2 000 to 14 000
	Tolerances	+7 −2	+7 −2	—	±30
Slot type	Dimensions	996	90 to 350	45 to 100	2 000 to 14 000
	Tolerances	+7 −2	+7 −2	+7 −2	±30
Wavy type	Dimensions	996, 1 246	120 to 1 200	60 to 130	3 000 to 25 000
	Tolerances	+7 −2	+7 −2	+7 −2	±30

Recommended specification C-1 Table 7
Tolerances on camber of sheet piles

Unit: mm

Camber	$L \leq 7\,000$	10
	$L > 7\,000$	15

C-1.5 Bar arrangement

The bar arrangement of sheet piles shall be as follows.

a) The covering of reinforcing bar shall be 12 mm or more.

b) The covering of prestressing tendon shall be 15 mm or more.

C-1.6 Quality of concrete

The quality of concrete shall be as specified in **C.6.2**.

C-1.7 Test method

C-1.7.1 Compressive strength test of concrete

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

C-1.7.2 Flexural strength test of product

The flexural strength test of sheet piles shall be conducted according to the loading methods specified in Recommended specification C-1 Figure 5, Recommended specification C-1 Figure 6 or Recommended specification C-1 Figure 7. The sheet piles shall be examined for cracking exceeding 0.05 mm in width at the crack width measurement point when the load equivalent to the critical cracking width strength specified in **C-1.3.1** is applied. Also, they shall be checked that the breakage does not occur when the load is applied up to the ultimate flexural strength in **C-1.3.2**.

The load to be applied shall be calculated according to the following formula.

$$F = \frac{6M}{l} - Wg$$

where, F: load to be applied (kN)

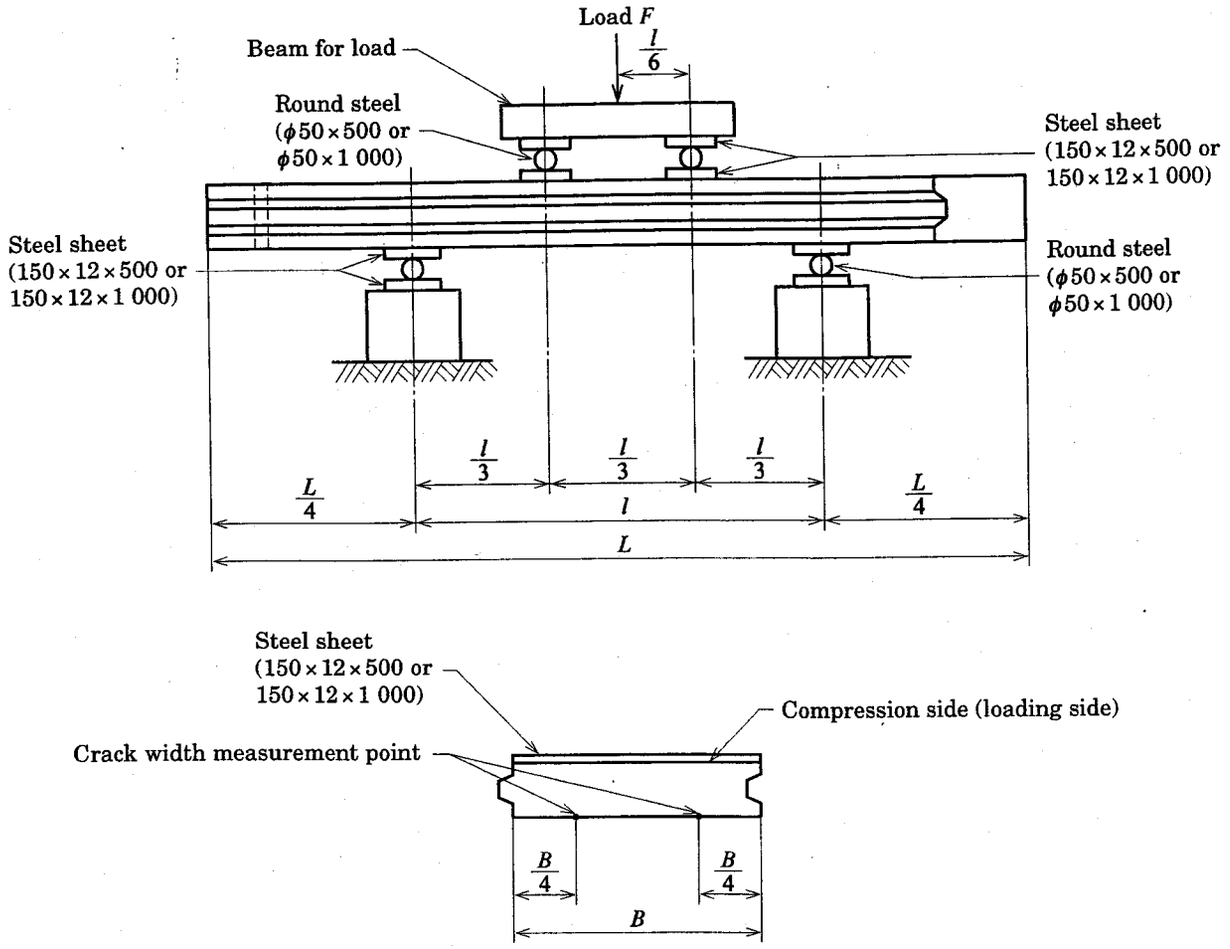
M: critical cracking width strength (kN·m)

l: span (m) $l = L/2$ and $b = l/3$
However, when l is smaller than $10H$, $l = 10H$.
H: height of sheet pile (m)

W: beam for load, total mass of round steel and steel sheet applied as force (t)
However, when beam for load is integrated into a tester, the mass of beam for load is not included.

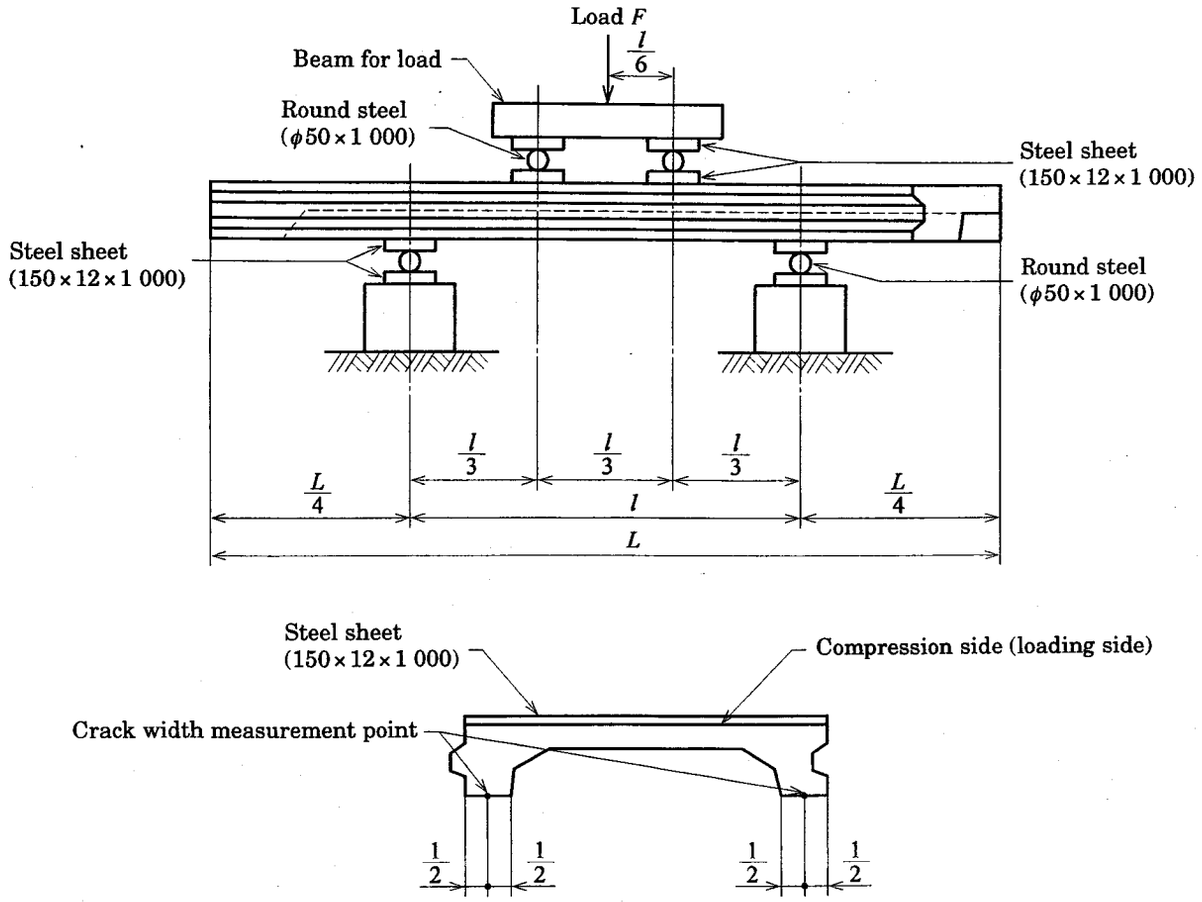
g: acceleration of gravity (use 9.81 m/s^2)

Unit: mm



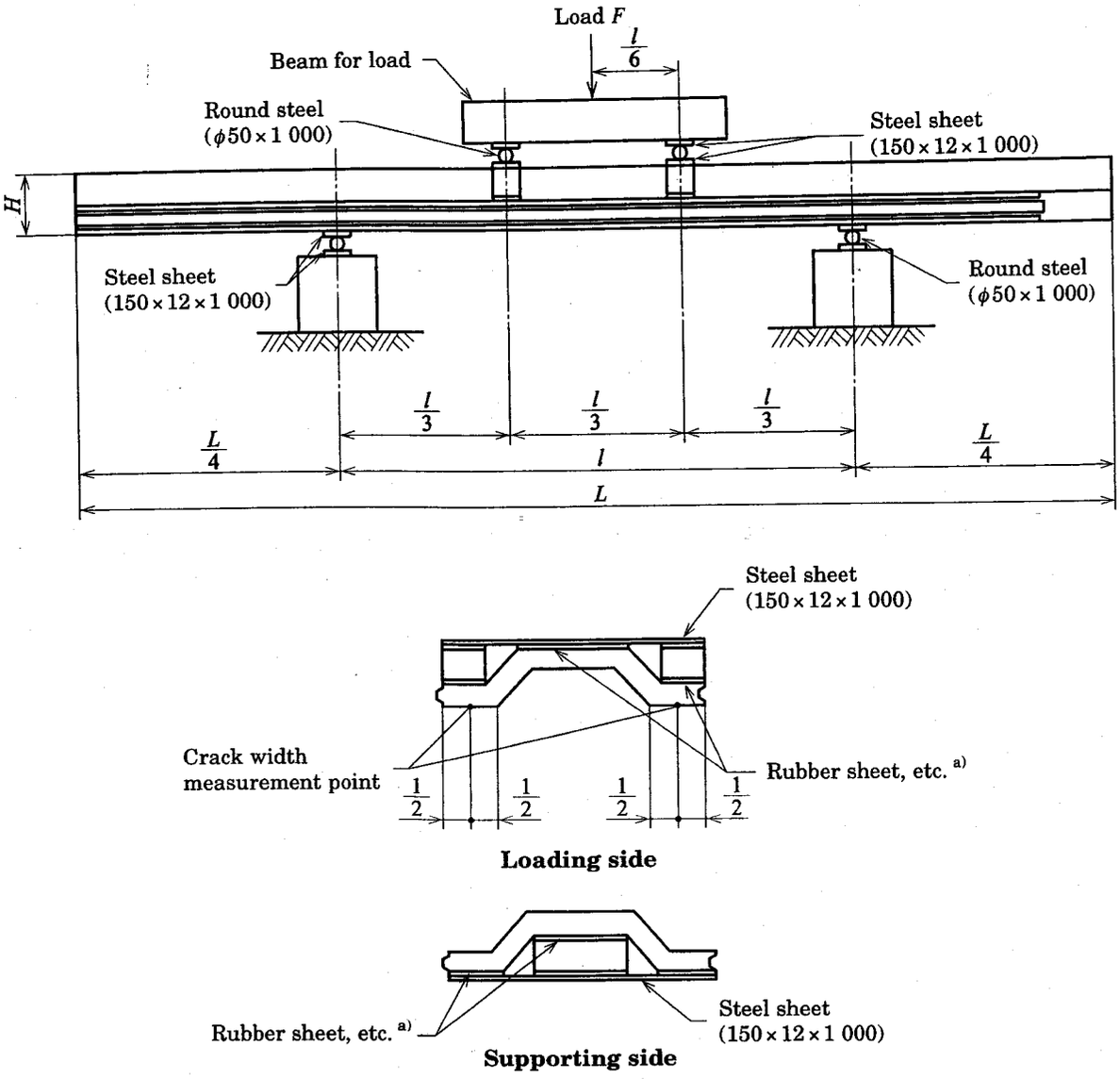
Recommended specification C-1 Figure 5
Flexural strength test method of sheet pile (flat type)

Unit: mm



Recommended specification C-1 Figure 6
Flexural strength test method of sheet pile (slot type)

Unit: mm



Note a) The rubber sheet, etc. should have such a hardness, thickness and width that the influence of the unevenness of the supporting position and the loading position can be absorbed or adjusted. In addition to the rubber sheet, mortar may be used.

Recommended specification C-1 Figure 7
Flexural strength test method of sheet pile (wavy type)

C-1.8 Inspections

C-1.8.1 Inspection items

The inspection items of sheet piles 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

C-1.8.2 Inspection lot

The size of inspection lot of sheet piles shall be decided by the manufacturer for final inspection, and by the purchaser for delivery inspection according to the agreement between the parties concerned with delivery in consideration of the characteristics of the product, production method, production quantity, production period, quantity of ordered poles, etc. One inspection lot may consist of 1 000 units or fractions thereof.

C-1.8.3 Inspection method

The inspection method of sheet piles shall be as follows.

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

1) **Appearance** The inspection of appearance shall be conducted by taking arbitrary number of sheet piles per lot. When they conform to the provisions of **5.1**, the lot shall be accepted. If one or more do not conform, the remainder of the lot shall be subjected to a 100 % inspection. If the remainder conforms to the provisions, the lot shall be accepted.

2) **Performance** As the inspection of the performance, two arbitrary sheet piles per lot shall be taken and inspected as specified in **C-1.7.2**. If both of the two conform to **C-1.3.1**, the lot shall be accepted. If neither of the two conforms, the lot shall be rejected. If one of the two does not conform to the provisions, four more sheet piles shall be taken from the lot. If all the four conform to the provisions, the lot shall be accepted after the first non-conforming product is eliminated. If one or more of them do not conform, the lot shall be rejected.

3) **Shape and dimensions** As the inspection of shape and dimensions, two arbitrary sheet piles per lot shall be taken. If they conform to **C-1.4**, the lot shall be accepted. If one or more do not conform, the remainder of the lot shall be subjected to a 100 % inspection. If the remainder conforms to the provisions, the lot 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)** or as follows.

When adopting the sampling inspection, two arbitrary poles are taken. If both of them conform to the provisions of **5.1**, the lot shall be accepted. If one or more do not conform, the remainder of the lot shall be subjected to a 100 % inspection. If the remainder conforms to the provisions, the lot shall be accepted.

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

C-1.9 Marking

The sheet piles which conform to all the requirements of this Standard shall be marked as specified in **C.9**.

The following matters shall also be included.

a) Length or its abbreviation

b) When there is a distinction between the compression side and the tension side, symbol or abbreviation indicating compression side or tension side

Annex D (normative)
Covered conduits

D.1 Outline

This Annex specifies Group I and Group II of covered conduits which are mainly used for the water passage, passage way, etc.

D.2 Classification

The covered conduits shall be classified as specified in Table D.1, and Group I shall be as specified in Table D.2.

Table D.1 Classification of covered conduits

Major division	Minor division
Covered conduits	Prestressed concrete tube
	Prestressed concrete box culvert
	Others

Table D.2 Types of Group I of covered conduits

Division by shape and type	Division by earth covering	Division by application	Division by strength	Detail
Prestressed concrete tube	—	Internal pressure tube External pressure tube	High pressure Class 1 to Class 3 Class 1 to Class 5	See recommended specification D-1.
Prestressed concrete box culvert	0.50 m to 1.50 m	External pressure	—	See recommended specification D-2.
	1.51 m to 3.00 m			
	3.01 m to 6.00 m			

NOTE 1 There are two types of prestressed concrete tubes. One is the internal pressure tube in which both internal and external pressures are exerted. The other is the external pressure tube in which only the external pressure is exerted.

NOTE 2 The prestressed concrete box culvert is generally used when only the external pressure is exerted.

D.3 Performance

The performance and the performance verification method of covered conduits shall be as follows.

a) **Product of Group I** The performance of product shall conform to the provisions of Recommended specification D-1 and Recommended specification D-2.

b) **Product of Group II** The performance of product shall conform to the provisions of clause **4** and clause **5** of **JIS A 5362**, and shall be determined as agreed between the parties concerned with delivery.

Table D.3 may be applied for general specifications.

Table D.3 Performance and performance verification method of covered conduits

Performance item	Performance	Performance verification method
Service performance	It shall be able to be used smoothly under a load [a] expected during service, fulfilling the required function. The surface contact to water-flow shall be as smooth as practically acceptable.	See design document or **D.7**.
Safety [b]	It shall not fracture under a load expected in design.	See design document or **D.7**.
Durability [c]	Cracking, ageing of material properties or the like due to the expected impact shall not deteriorate the required performance.	See design document or actual results.
Workability	It shall be transported, installed, assembled and joined safely and easily without abnormalities detrimental to use.	See design document or actual results.

Notes [a] When the strength against the internal water pressure is required, the internal water pressure shall also be verified.

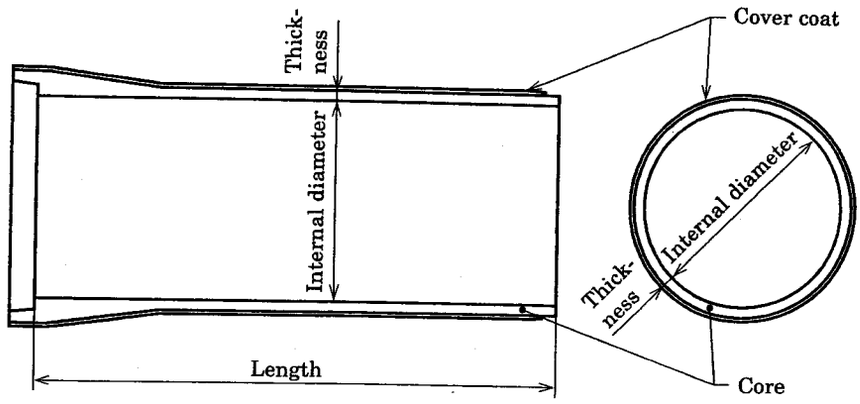
[b] The verification on the safety shall be made when requested by the purchaser.

[c] Durability may be verified by the actual results of similar products equivalent in water-cement ratio and/or air content as well as the covering of reinforcing bar, etc. and production method.

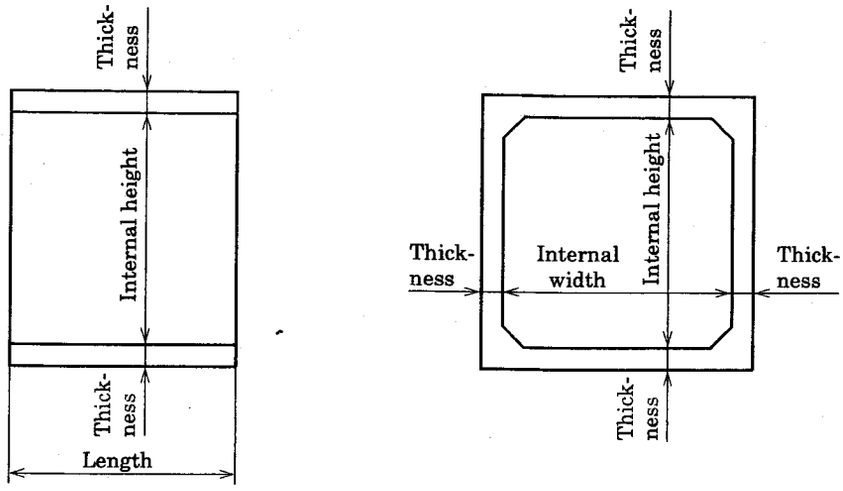
D.4 Shape, dimensions and dimensional tolerances

The shape, dimensions and dimensional tolerances of covered conduits shall be as follows. As to Group I, if the design concept is equivalent and the performance and the performance verification method are the same, the reference dimension may be changed within ± 10 % in response to the purchaser's demand, provided that the necessary performance is satisfied.

a) **Shape** An example of shape of covered conduits is shown in Figure D.1.



a) Prestressed concrete tube



b) Prestressed concrete box culvert

Figure D.1 Example of shape of covered conduit

b) **Dimensions and dimensional tolerances** The dimensions and dimensional tolerances of the products classified into Group I shall be as specified in Table D.4 and Table D.5. The dimensions and dimensional tolerances of the products classified into Group II shall be as agreed between the parties concerned with delivery.

1) **Prestressed concrete tube** The dimensions and dimensional tolerances of prestressed concrete tubes shall be as specified in Table D.4.

Table D.4 Dimensions and dimensional tolerances of covered conduits (prestressed concrete tube)

Unit: mm

Type		Internal diameter	Length	Thickness
Prestressed concrete tube	Dimensions	600 to 3 000	2 000 to 4 000	44 to 250
	Tolerances	±4 to ±12	$^{+10}_{-5}$	$^{+4}_{-2}$ to $^{+12}_{-6}$
The detail of tolerances is as specified in the recommended specification. — The thickness at the core part is used. — The inside and outside circumferences of the cross-section of a tube shall be practically a concentric circle, and the tube end shall be practically vertical to the tube axis. NOTE : Work such as chamfering or tube end reinforcing may be applied, unless it affects the shape of tube or compromises the strength of tube.				

2) **Prestressed concrete box culvert** The dimensions and dimensional tolerances of prestressed concrete box culvert shall be as specified in Table D.5.

Table D.5 Dimensions and dimensional tolerances of covered conduits (prestressed concrete box culvert)

Unit: mm

Type		Internal width × internal height	Length	Thickness
Prestressed concrete box culvert	Dimensions	600 × 600 to 5 000 × 2 500	1 000 to 2 000	125 to 530
	Tolerances	±4 to ±10	$^{+10}_{-5}$	$^{+4}_{-2}$ to $^{+8}_{-4}$
The detail of tolerances shall be as specified in the recommended specification. NOTE : Work such as chamfering or tube end reinforcing may be applied, unless it affects the shape of product or compromises its strength.				

D.5 Bar arrangement (position of prestressing tendon and reinforcing steel)

The bar arrangement shall be as specified in **JIS A 5364** and a design document. However, as agreed between the parties concerned with delivery, the bar arrangement other than that of the recommended specification may be adopted unless it compromises the performance of PC products (including the provisions of **D.3**). The bar arrangement of prestressed concrete tubes and the prestressed concrete box culverts that satisfies **D.3** shall be determined by the manufacturer for each product.

D.6 Quality of concrete

D.6.1 Material and production method

The materials for concrete and the production method shall be as specified in clause **8**.

D.6.2 Compressive strength

The compressive strength of concrete shall satisfy the values of Table D.6 after the predetermined material aging.

The compressive strength for Group II shall be as agreed between the parties concerned with delivery.

Table D.6 Compressive strength of concrete

Unit: N/mm^2

Type		Compressive strength	
		At prestress introduction	At quality assurance [b]
Prestressed concrete tube	Concrete	30 min.	50 min.
	Mortar [a]	—	35 min.
Prestressed concrete box culvert	Concrete	30 min.	40 min.

Notes [a] Cover-coat mortar for prestressing tendon protection.

[b] The compressive strength of both types at quality assurance means the reference strength in design of concrete.

D.7 Test method

D.7.1 Compressive strength test of concrete

The compressive strength test of concrete shall be as specified in **JIS A 1108**. The test piece shall be processed by the same curing as the product or be controlled properly.

D.7.2 Flexural strength test and internal pressure strength test of product

The flexural strength test and the internal pressure strength test of product shall be as specified in **JIS A 5363**.

D.8 Inspection

Inspections shall be as specified in **JIS A 5365** and the following.

a) **Final inspection** The final inspection of covered conduits shall be conducted on the appearance, performance, shape and dimensions, and shall be as follows.

1) **Appearance** As the inspection of the appearance, a 100 % inspection or a sampling inspection shall be conducted considering the characteristics of product, production method, production quantity, etc.

2) **Performance, shape and dimensions** As the inspections of performance, shape and dimensions, a sampling inspection shall be applied.

When substitute characteristics are inspected by using an alternative test piece in place of inspecting performances of a product, the correlation between the properties of the test piece and those of the product shall be confirmed in advance.

3) **Size of inspection lot** The size of inspection lot shall be determined by the manufacturer in consideration of the characteristics of product, production method, production quantity, production period, quantity of ordered poles, etc.

b) **Delivery inspection** The delivery inspection of covered conduits shall be conducted on the appearance, shape and dimensions. The size of inspection lot and the sampling method shall be specified by the purchaser as agreed between the parties concerned with delivery. The delivery inspection may be omitted as agreed between the parties concerned with delivery.

D.9 Marking

The following items shall be marked on the covered conduits as specified in **JIS A 5361**.

a) Classification or its abbreviation

b) Manufacturer's name or its abbreviation

c) Date of manufacture or its abbreviation

D.10 Others (recommended specification)

The recommended specification of Group I of cover conduits is shown in Table D.7.

Table D.7 Recommended specification

Structure-specific product group standard		Recommended specification
JIS A 5373	Annex D Covered conduits	Recommended specification D-1 Prestressed concrete tube
		Recommended specification D-2 Prestressed concrete box culvert

Recommended specification D-1
Prestressed concrete tube

D-1.1 Outline

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

D-1.2 Classification

The PC tubes shall be divided into the internal pressure tube and the external pressure tube, and further divided by the shape and the nominal designation range as shown in Recommended specification D-1 Table 1.

Recommended specification D-1 Table 1 Classification of PC tubes

Division by type		Division by shape and nominal designation range		Information
		Type S	Type NC	
Internal pressure tube	Class 1	600 to 1 650	—	Designed for both internal pressure and external pressure.
	Class 2	600 to 2 000		
	Class 3			
	Class 4			
	Class 5			
External pressure tube	High pressure Class 1	—	1 500 to 2 200	Designed for external pressure.
	High pressure Class 2		1 500 to 2 600	
	High pressure Class 3		1 500 to 3 000	
	Class 1	600 to 1 800	—	
	Class 2	600 to 2 000		
	Class 3			
	Class 4			
	Class 5			

D-1.3 Performance

The performance of PC tubes shall be as follows.

D-1.3.1 Flexural cracking strength

The flexural cracking strength of external pressure tube and internal pressure tube shall be at least the value specified in Recommended specification D-1 Table 2.

D-1.3.2 Ultimate flexural strength

The ultimate flexural strength shall be at least the value specified in Recommended specification D-1 Table 3.

D-1.3.3 Internal pressure strength for testing

The internal pressure strength in the internal pressure tube shall be at least the internal pressure strength for testing specified in Recommended specification D-1 Table 4.

D-1.3.4 Cracking internal pressure strength

When verifying the cracking internal pressure strength as agreed between the parties concerned with delivery, the strength shall be at least the value specified in Recommended specification D-1 Table 4.

Recommended specification D-1 Table 2
Flexural cracking strength of PC tubes

Unit: kN·m/m

Nominal designation	Internal pressure tube/external pressure tube												
	Flexural cracking strength												
	High pressure Class 1	High pressure Class 2	High pressure Class 3	Class 1		Class 2		Class 3		Class 4		Class 5	
				Type S	Type NC	Type S	Type NC	Type S	Type NC	Type S	Type NC	Type S	Type NC
600		—		12.02	—	10.42	—	8.61	—	6.79	—	5.83	—
700				14.50	—	12.38	—	10.26	—	8.01	—	6.89	—
800				17.64	—	15.08	—	12.52	—	9.67	—	8.39	—
900				21.57	—	18.37	—	14.85	—	11.49	—	9.73	—
1 000				25.46	—	21.74	—	17.67	—	13.95	—	11.82	—
1 100				29.23	—	24.77	—	20.70	—	16.04	—	13.13	—
1 200				33.51	—	28.65	—	23.80	—	18.74	—	16.21	—
1 350				39.28	—	33.62	—	27.72	—	21.59	—	18.52	—
1 500	83.04	67.25	56.73	47.11	48.57	40.32	41.73	33.79	35.15	26.47	27.78	22.55	23.83
1 650	91.80	74.48	62.94	55.33	57.17	48.18	49.95	40.16	41.87	31.58	33.22	26.71	28.31
1 800	100.74	81.90	69.34	63.87	66.20	54.86	57.09	44.92	47.04	35.29	37.31	30.32	32.28
2 000	113.15	95.74	88.77	—	78.33	63.64	66.14	53.94	56.39	42.15	44.55	35.92	38.28
2 200	125.97	106.85	99.20	—	91.55	—	78.94	—	65.93	—	52.55	—	45.28
2 400	—	139.25	118.43	—	105.93	—	91.35	—	76.35	—	60.94	—	53.02
2 600	—	153.03	130.49	—	121.48	—	104.80	—	87.67	—	70.99	—	61.53
2 800	—	—	167.35	—	138.25	—	119.34	—	99.94	—	81.51	—	70.84
3 000	—	—	182.24	—	156.28	—	134.99	—	113.19	—	92.95	—	81.00

Recommended specification D-1 Table 3
Ultimate flexural strength of PC tubes

Unit: kN·m/m

Nominal designation	Internal pressure tube/external pressure tube												
	Ultimate flexural strength												
	High pressure Class 1	High pressure Class 2	High pressure Class 3	Class 1		Class 2		Class 3		Class 4		Class 5	
				Type S	Type NC	Type S	Type NC	Type S	Type NC	Type S	Type NC	Type S	Type NC
600	—			18.65	—	16.13	—	13.28	—	10.43	—	8.92	—
700				22.45	—	19.12	—	15.78	—	12.25	—	10.48	—
800				27.24	—	23.21	—	19.18	—	14.71	—	12.69	—
900				33.23	—	28.20	—	22.67	—	17.38	—	14.62	—
1 000				39.13	—	33.29	—	26.88	—	21.03	—	17.69	—
1 100				44.82	—	37.80	—	31.40	—	24.08	—	19.50	—
1 200				51.23	—	43.60	—	35.97	—	28.01	—	24.03	—
1 350				59.79	—	50.89	—	41.61	—	31.97	—	27.14	—
1 500	127.00	102.18	85.63	71.46	72.75	60.78	61.99	50.51	51.65	39.01	40.06	32.85	33.86
1 650	139.80	112.57	94.42	83.63	85.28	72.38	73.94	59.78	61.23	46.28	47.62	38.63	39.91
1 800	152.72	123.09	103.34	96.16	98.32	81.99	84.00	66.36	68.21	51.22	52.90	43.40	45.00
2 000	170.35	142.98	132.03	—	115.49	94.38	96.33	79.12	81.00	60.59	62.39	50.78	52.53
2 200	188.28	158.22	146.20	—	134.03	—	114.19	—	93.75	—	72.70	—	61.28
2 400	—	206.54	173.79	—	153.96	—	131.03	—	107.45	—	83.22	—	70.77
2 600	—	225.14	189.70	—	175.30	—	149.08	—	122.15	—	95.92	—	81.04
2 800	—	—	244.12	—	198.09	—	168.36	—	137.86	—	108.88	—	92.11
3 000	—	—	263.50	—	222.35	—	188.89	—	154.61	—	122.77	—	104.00

Recommended specification D-1 Table 4
Internal pressure strength for testing and cracking internal pressure strength of PC tube

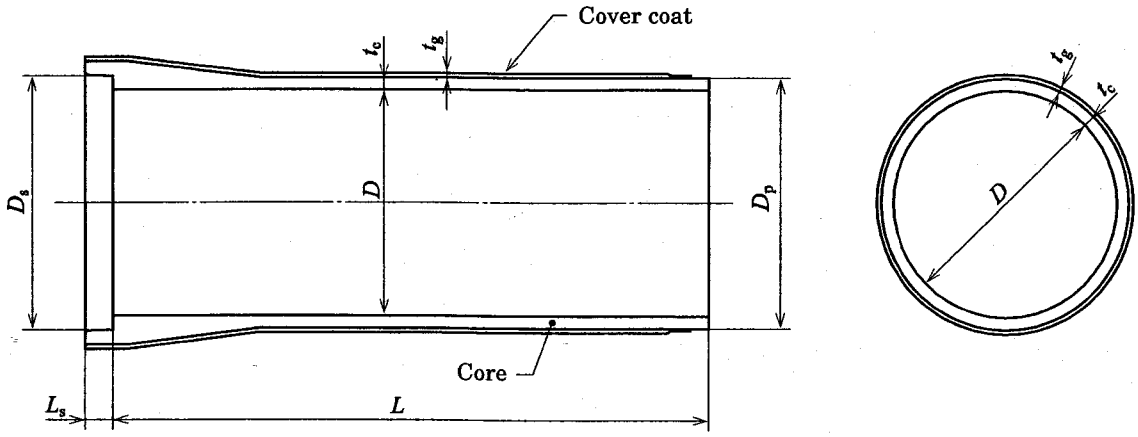
Type		Internal pressure strength for testing MPa	Cracking internal pressure strength MPa	Range of nominal designation
Internal pressure tube	Class 1	1.8	2.0	600 to 1 650
	Class 2	1.4	1.6	600 to 2 000
	Class 3	1.0	1.2	
	Class 4	0.6	0.8	
	Class 5	0.4	0.6	

D-1.4 Shape, dimensions and dimensional tolerances

The shape, dimensions and dimensional tolerances of PC tubes shall be as specified in Recommended specification D-1 Table 5, Recommended specification D-1 Table 6 and Recommended specification D-1 Table 7.

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



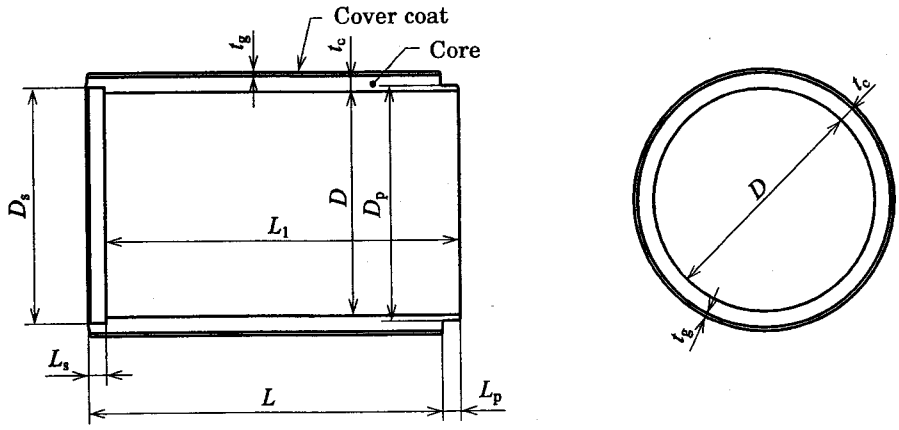
Unit: mm

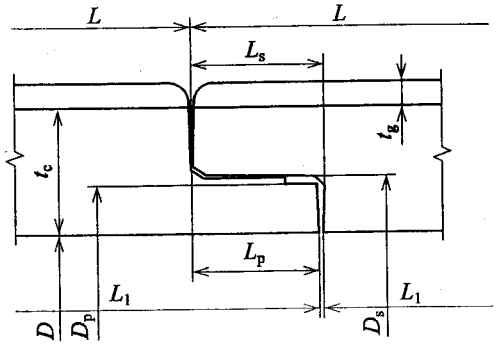
Nominal designation	Internal diameter D	Thickness of core t_c	External diameter of spigot D_p	Internal diameter of socket D_s	Depth of socket L_s	Thickness of cover coat t_g	Effective length [a] L	Mass (informative) (kg/m)
600	612	44	684	708	140	25 min.	4 000	410
700	724	46	800	824				480
800	828	52	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 −2	+2 −1	+1 −2	±5	+10 − 5	
1 000 to 1 350	±6	+6 −3	±2	±2			
1 500 to 2 000	±8	+8 −4					
2 200 to 2 400	±10	+10 − 5		±3			
2 600 to 3 000	±12	+12 − 6	+3 −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

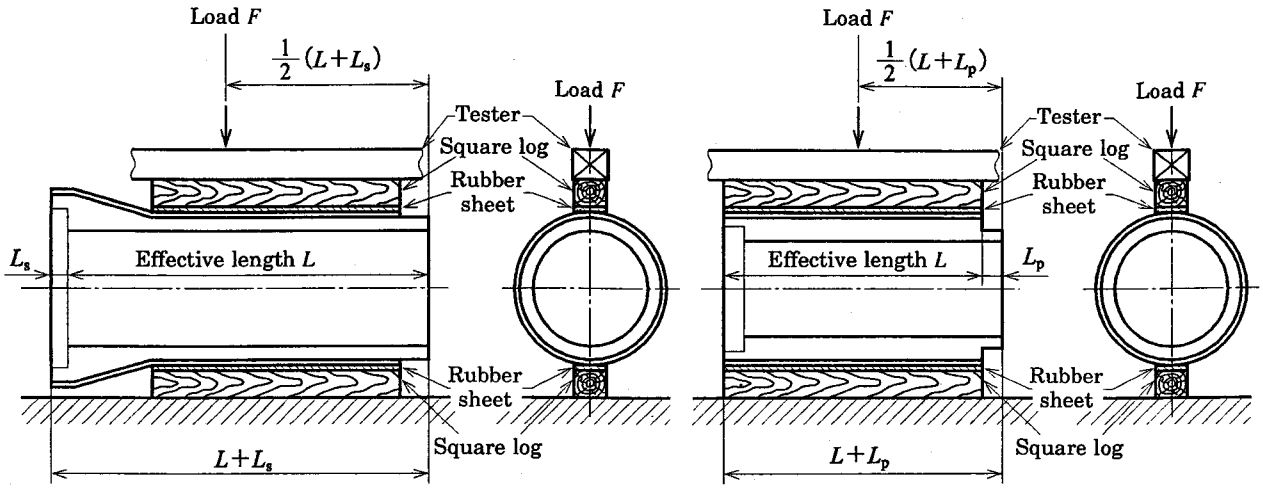
D-1.7.1 Compressive strength test of concrete

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

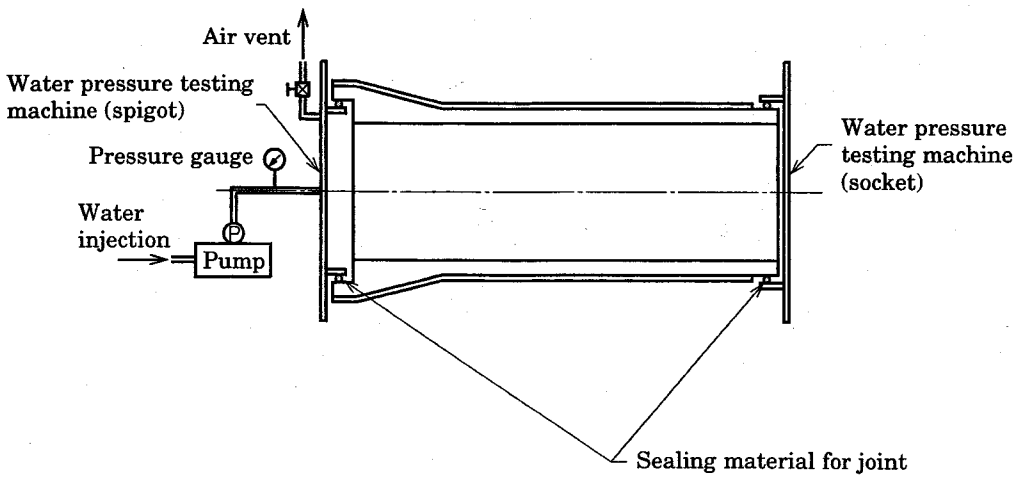
Recommended specification D-1 Table 8
Load corresponding to cracking strength and ultimate load of PC tube

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 mm	Division by applicable earth covering [a] m
Type 150	600 × 600	0.50 to 1.50
Type 300	to	1.51 to 3.00
Type 600	5 000 × 2 500	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

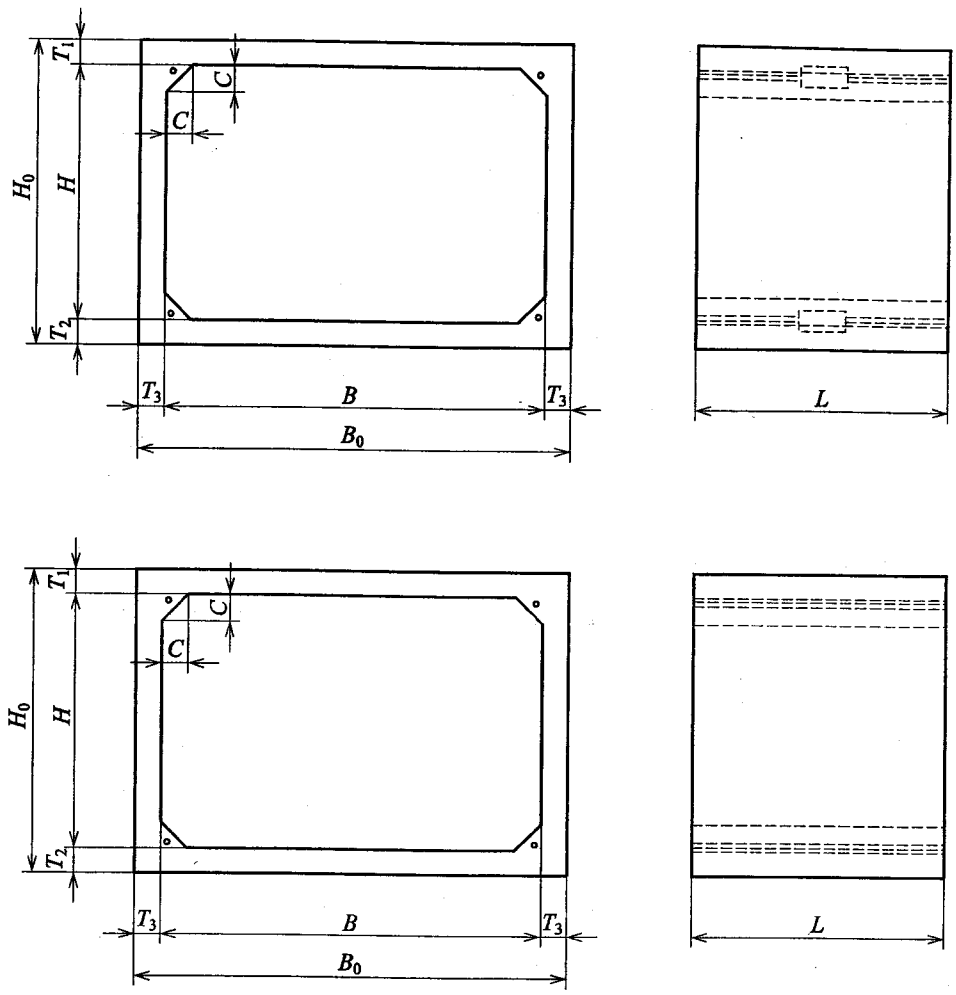
The shape, dimensions and dimensional tolerances of PC box culverts shall be as specified in Recommended specification D-2 Figure 1, Recommended specification D-2 Table 3 and Recommended specification D-2 Table 4.

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

Recommended specification D-2 Table 3
Dimension table of PC box culverts

Unit: mm

Nominal dimension	Dimension of covering division									
	Type 150, Type 300					Type 600				
	T_1	T_2	T_3	C	L [a)]	T_1	T_2	T_3	C	L [a)]
600 × 600	125	125	125	100	2 000	125	125	125	100	2 000
700 × 700	125	125	125	100	2 000	125	125	125	100	2 000
800 × 800	125	125	125	100	2 000	125	125	125	100	2 000
900 × 600	125	125	125	150	2 000	150	150	125	150	2 000
900 × 900	125	125	125	150	2 000	150	150	125	150	2 000
1 000 × 800	125	125	125	150	2 000	150	150	150	150	2 000
1 000 × 1 000	125	125	125	150	2 000	150	150	150	150	2 000
1 000 × 1 500	125	125	125	150	2 000	150	150	150	150	2 000
1 100 × 1 100	125	125	125	150	2 000	150	150	150	150	2 000
1 200 × 800	125	125	125	150	2 000	150	150	150	150	2 000
1 200 × 1 000	125	125	125	150	2 000	150	150	150	150	2 000
1 200 × 1 200	125	125	125	150	2 000	150	150	150	150	2 000
1 200 × 1 500	125	125	125	150	2 000	150	150	150	150	2 000
1 300 × 1 300	125	125	125	150	2 000	150	150	150	150	2 000
1 400 × 1 400	150	150	150	150	2 000	150	150	150	150	2 000
1 500 × 1 000	150	150	150	150	2 000	150	150	150	150	2 000
1 500 × 1 200	150	150	150	150	2 000	150	150	150	150	2 000
1 500 × 1 500	150	150	150	150	2 000	150	150	150	150	2 000
1 800 × 1 200	150	150	150	150	2 000	180	180	180	150	2 000
1 800 × 1 500	150	150	150	150	2 000	180	180	180	150	2 000
1 800 × 1 800	150	150	150	150	2 000	180	180	180	150	2 000
2 000 × 1 500	150	150	150	150	2 000	200	200	200	150	2 000
2 000 × 1 800	150	150	150	150	2 000	200	200	200	150	2 000
2 000 × 2 000	150	150	150	150	2 000	200	200	200	150	2 000
2 200 × 1 800	180	180	180	150	2 000	230	230	230	150	2 000
2 200 × 2 200	180	180	180	150	2 000	230	230	230	150	2 000
2 300 × 1 500	180	180	180	150	2 000	230	230	230	150	2 000
2 300 × 1 800	180	180	180	150	2 000	230	230	230	150	2 000
2 300 × 2 000	180	180	180	150	2 000	230	230	230	150	2 000
2 300 × 2 300	180	180	180	150	2 000	230	230	230	150	2 000
2 400 × 2 000	180	180	180	150	2 000	250	250	250	150	2 000
2 400 × 2 400	180	180	180	150	2 000	250	250	250	150	2 000
2 500 × 1 500	180	180	180	150	2 000	260	260	250	150	2 000
2 500 × 1 800	180	180	180	150	2 000	260	260	250	150	2 000
2 500 × 2 000	180	180	180	150	2 000	260	260	250	150	2 000
2 500 × 2 500	200	200	200	150	2 000	260	260	250	150	2 000
2 800 × 1 500	200	200	200	200	2 000	280	280	280	200	2 000
2 800 × 2 000	200	200	200	200	2 000	280	280	280	200	2 000
2 800 × 2 500	200	200	200	200	2 000	280	280	280	200	2 000
2 800 × 2 800	200	200	200	200	2 000	280	280	280	200	2 000

Recommended specification D-2 Table 3 (concluded)

Unit: mm

Nominal dimension	Dimension of covering division									
	Type 150, Type 300					Type 600				
	T_1	T_2	T_3	C	L [a)]	T_1	T_2	T_3	C	L [a)]
3 000 × 1 500	250	250	200	200	2 000	350	350	300	200	2 000
3 000 × 2 000	250	250	200	200	2 000	350	350	300	200	2 000
3 000 × 2 500	250	250	200	200	2 000	350	350	300	200	1 500
3 000 × 3 000	250	250	250	200	2 000	350	350	300	200	1 500
3 500 × 2 000	300	300	250	300	2 000	350	350	300	300	1 500
3 500 × 2 500	300	300	250	300	2 000	380	380	300	300	1 500
4 000 × 2 000	300	300	250	300	1 500	400	400	400	300	1 000
4 000 × 2 500	300	300	250	300	1 500	400	400	400	300	1 000
4 500 × 2 000	380	380	300	300	1 000	450	450	400	300	1 000
4 500 × 2 500	380	380	300	300	1 000	450	450	400	300	1 000
5 000 × 2 000	380	380	330	300	1 000	500	530	400	300	1 000
5 000 × 2 500	380	380	330	300	1 000	500	530	400	300	1 000
Note [a)] The effective length (L) may be 1 500 mm or 1 000 mm.										

Recommended specification D-2 Table 4
Dimensional tolerances of PC box culverts

Unit: mm

Nominal dimension	Dimensional tolerances		
	Internal width and internal height	Thickness	Effective length
600 × 600 to 900 × 900	± 4	+4 −2	+10 − 5
1 000 × 800 to 2 500 × 2 500	± 6	+6 −3	
2 800 × 1 500 to 3 000 × 3 000	± 7	+6 −4	
3 500 × 2 000 to 5 000 × 2 500	±10	+8 −4	

D-2.5 Bar arrangement

The bar arrangement of PC box culverts that satisfies **D-2.3** shall be determined by the manufacturer.

The covering of the steel products shall be of the diameter of steel products or more and 20 mm or more. The gap between the steel products shall be at least 5/4 of the maximum dimension of coarse aggregates.

D-2.6 Quality of concrete

The quality of concrete shall be as specified in **D.6.2**.

D-2.7 Test method

D-2.7.1 Compressive strength test of concrete

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

D-2.7.2 Flexural strength test of product

The flexural strength test of PC box culverts shall be conducted in such a way that the PC box culvert is installed as shown in Recommended specification D-2 Figure 2, and it is examined for cracking exceeding 0.05 mm in width when the load equivalent to the flexural cracking strength specified in Recommended specification D-2 Table 2 is applied to the centre of span of the top slab of 100 mm in width. The load equivalent to the flexural cracking strength is shown in Recommended specification D-2 Table 5.

When the flexural strength test is conducted, the load shall be uniformly distributed by inserting the rubber sheet[2)] to the pressure surface and the support surface with the loading width of 100 mm.

Note [2)] The rubber sheet should have such hardness, thickness and width that the influence of the unevenness of the supporting position and the loading position can be absorbed.

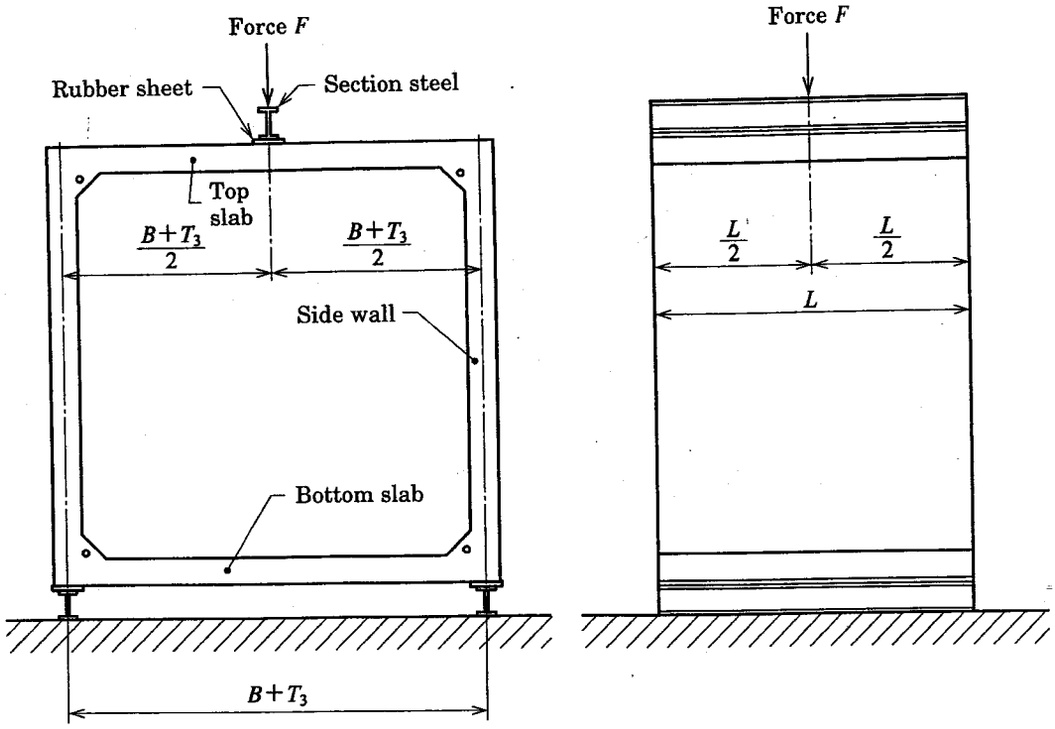
Recommended specification D-2 Table 5 Load applied to PC box culverts

Nominal dimension $B \times H$ (mm)	Load (kN/m)		
	Type 150	Type 300	Type 600
600 × 600	30.5	21.4	34.7
700 × 700	34.2	23.9	38.9
800 × 800	37.8	26.5	43.1
900 × 600	41.6	32.7	55.8
900 × 900	41.5	29.0	45.7
1 000 × 800	45.5	34.3	58.5
1 000 × 1 000	45.2	31.5	52.6
1 000 × 1 500	41.3	19.5	28.6
1 100 × 1 100	48.6	34.0	56.8
1 200 × 800	51.9	41.4	71.1
1 200 × 1 000	52.0	39.5	66.9
1 200 × 1 200	51.5	36.4	60.9
1 200 × 1 500	49.6	29.8	48.3
1 300 × 1 300	54.1	38.9	65.0
1 400 × 1 400	57.2	42.1	69.1
1 500 × 1 000	60.4	51.0	85.9
1 500 × 1 200	60.3	49.1	82.0
1 500 × 1 500	59.2	44.5	73.2
1 800 × 1 200	66.3	59.7	103
1 800 × 1 500	65.8	56.6	96.1
1 800 × 1 800	64.2	51.6	86.7
2 000 × 1 500	69.4	64.0	111
2 000 × 1 800	68.2	59.9	103

Recommended specification D-2 Table 5 (concluded)

Nominal dimension $B \times H$ (mm)	Load (kN/m)		
	Type 150	Type 300	Type 600
2 000 × 2 000	66.9	56.2	95.7
2 200 × 1 800	72.3	68.8	118
2 200 × 2 200	69.6	61.9	106
2 300 × 1 500	74.7	75.5	131
2 300 × 1 800	73.8	72.5	125
2 300 × 2 000	72.8	69.7	120
2 300 × 2 300	70.5	64.1	110
2 400 × 2 000	74.4	73.6	128
2 400 × 2 400	71.4	66.4	115
2 500 × 1 500	77.3	82.0	145
2 500 × 1 800	76.7	79.7	140
2 500 × 2 000	75.9	77.4	135
2 500 × 2 500	72.5	69.3	118
2 800 × 1 500	81.2	92.4	162
2 800 × 2 000	80.3	89.1	155
2 800 × 2 500	77.3	82.0	142
2 800 × 2 800	74.4	75.9	132
3 000 × 1 500	86.9	105	181
3 000 × 2 000	84.9	99.4	172
3 000 × 2 500	80.6	90.3	157
3 000 × 3 000	76.3	82.1	137
3 500 × 2 000	96.7	120	205
3 500 × 2 500	92.5	114	194
4 000 × 2 000	109	138	232
4 000 × 2 500	106	133	227
4 500 × 2 000	123	159	268
4 500 × 2 500	120	155	263
5 000 × 2 000	130	173	302
5 000 × 2 500	129	171	296

NOTE : The values in this table are the load applied to 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.



Recommended specification D-2 Figure 2
Flexural strength test method

D-2.8 Inspections

D-2.8.1 Inspection items

The inspection items of PC box culverts 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-2.8.2 Inspection lot

The size of inspection lot of PC box culverts 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, production method, production quantity, production period, quantity of ordered poles, etc. of product. One inspection lot may consist of 100 units or fractions thereof for each type.

D-2.8.3 Inspection method

The inspection method of PC box culverts 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 box culvert per lot shall be taken and inspected as specified in **D-2.7.2**. If it conforms to **D-2.3.1**, the lot shall be accepted. If it does not conform, two more PC box culverts shall be taken from the lot and reinspected. If both of them conform to the provisions, the lot shall be accepted after the first non-conforming product is eliminated. If one or more of them do not conform in the reinspection, the lot shall be rejected.

3) **Shape and dimensions** For the inspection of shape and dimensions, one arbitrary PC box culvert per lot shall be taken, and if it conforms to the provisions of **D-2.4**, the lot shall be accepted. If it does not conform, two more PC box culverts shall be taken from the lot and reinspected. If both of them conform to the provisions, the lot shall be accepted after the first non-conforming product is eliminated. If one or more of them do not conform in the reinspection, the remainder of the lot shall be subjected to a 100 % inspection, and only 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)** or as follows.

When adopting the sampling inspection, two arbitrary poles are taken. If both of them conform to the provisions of **5.1**, the lot shall be accepted. If one or more do not conform, all of the lot shall be subjected to a 100 % inspection. If they conform to the provisions, the lot shall be accepted.

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

D-2.9 Marking

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

Annex E (normative)
Piles

E.1 Outline

This Annex specifies Group I and Group II of piles which are mainly used for foundation piles.

E.2 Classification

The classification of piles shall be as specified in Table E.1, and that of Group I shall be as specified in Table E.2.

Table E.1 Classification of piles

Major division	Minor division
Piles	Prestressed concrete pile (PC pile, ST pile, knot pile)
	Prestressed reinforced concrete pile (PRC pile, PRC knot pile)
	Others

Table E.2 Classification of Group I of piles

Type	Division by external diameter mm	Division by effective prestress N/mm^2	Detail
Prestressed concrete piles (PC pile, ST pile, knot pile)	300 to 1 200	4.0 to 10.0	See recommended specification E-1.
— The effective prestress shall be obtained by calculation. The calculated value shall be in the range of ± 5 % of each value.			
NOTE : The piles of external diameter exceeding 1 200 mm may be adopted. In this case, performance values shall be as agreed between the parties concerned with delivery.			

E.3 Performance

The performance and the performance verification method shall be as follows.

a) **Product of Group I** The performance of product shall conform to the provisions of Recommended specification E-1.

b) **Product of Group II** The performance of product shall conform to the provisions of clause **4** and clause **5** of **JIS A 5362**, and shall be determined as agreed between the parties concerned with delivery. Table E.3 may be applied for general specifications.

Table E.3 Performance and performance verification method of piles

Performance item	Performance	Performance verification method
Service performance	It shall be able to be used smoothly under a load expected during service, fulfilling the required function.	See design document, **E.7** or actual results.
Safety [a)]	It shall not fracture under a load expected in design. Same performance for joint.	See design document, **E.7** or actual results.
Durability [b)]	Cracking due to the expected impact, ageing of material properties or the like shall not deteriorate the required performance.	See design document or actual results.
Workability	It shall be transported, installed, assembled and joined safely and easily without abnormalities detrimental to use.	See design document or actual results.

Notes [a)] The verification on the safety shall be made when requested by the purchaser.

[b)] Durability may be verified by the actual results of similar products equivalent in water-cement ratio and/or air content as well as the covering of reinforcing bar, etc. and production method.

E.4 Shape, dimensions and dimensional tolerances

The shape, dimensions and dimensional tolerances of piles shall be as follows. As to Group I, if the design concept is equivalent and the performance and the performance verification method are the same, the reference dimension may be changed within ± 10 % in response to the purchaser's demand, provided that the necessary performance is satisfied.

a) **Shape** An example of shapes of piles is shown in Figure E.1.

A PC pile has the hollow cylinder body of the same cross-section over the entire length. An ST pile is a PC pile having the diameter enlarged part at its end. A knot pile is a PC pile of which the body is provided with knots. The external diameter of the knot shall fall within such a range that the performance of the body is not compromised. Each pile may be provided with a suitable tip, joint or head, if necessary. The shapes of the products classified into Group II shall be as agreed between the parties concerned with delivery.

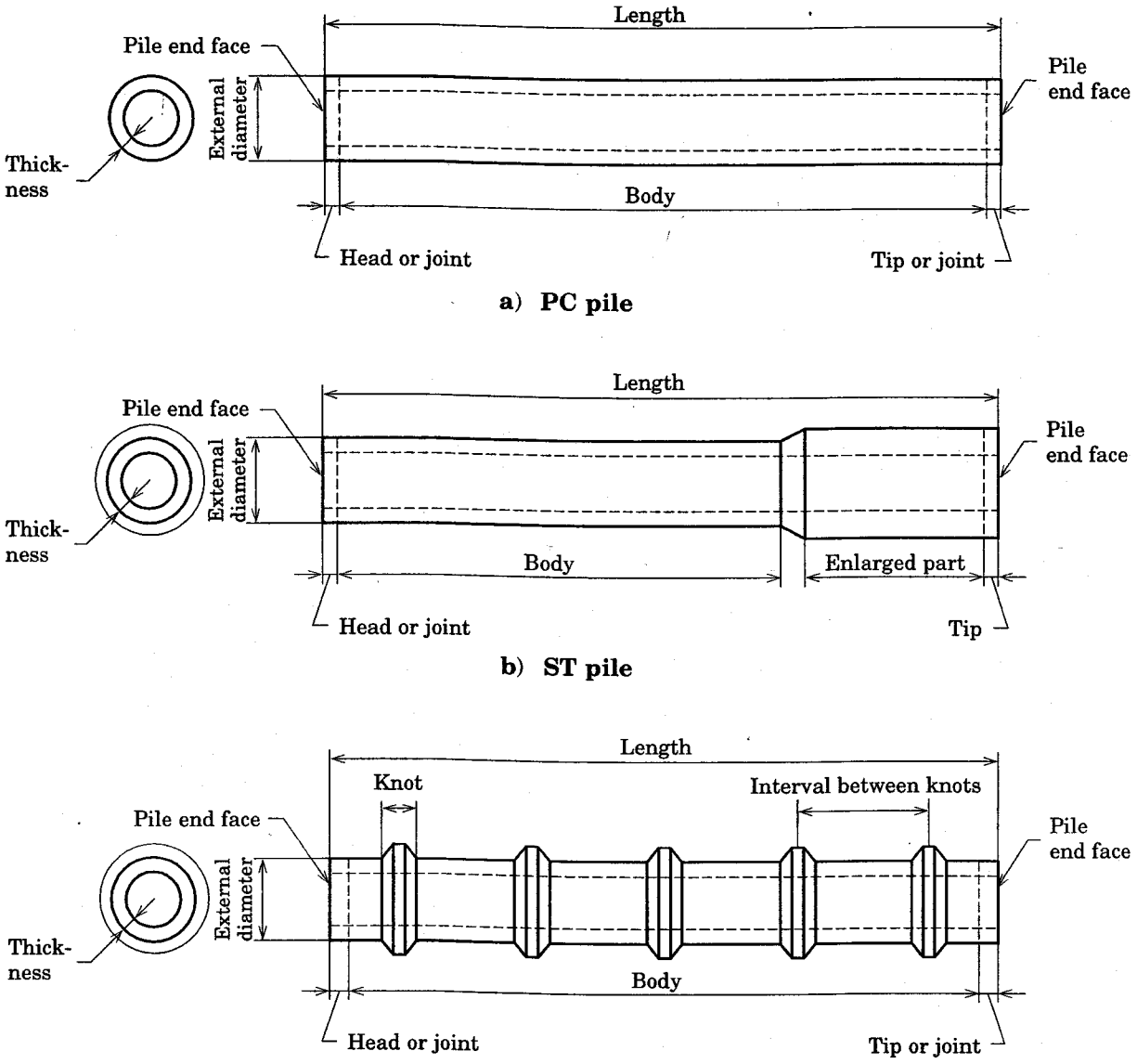


Figure E.1 Example of shapes of piles

b) **Dimensions and dimensional tolerances** The dimensions and dimensional tolerances of the products classified into Group I shall be as specified in Table E.4. The dimensions and dimensional tolerances of the products classified into Group II shall be as agreed between the parties concerned with delivery.

Table E.4 Dimensions and dimensional tolerances of piles

Type		External diameter mm		Wall thickness mm	Length m
Prestress concrete piles (PC pile, ST pile, knot pile)	Dimensions	300 to 600	700 to 1 200	60 to 150	4 to 15
	Dimensional tolerances	+5 −2	+7 −4	+Not specified −0	±0.3 (%) of length

— The length of a pile shall be designated in increments of 1 m.

— The external diameter of pile shall be the average of two values measured along each orthogonal axis in one cross-section of the body, which is rounded off to the integer.

— The thickness shall be the average of four values measured along each orthogonal axis in one cross-section of end part of the body, which is rounded off to the integer.

— The tolerances on external diameters of the diameter enlarged part and the knot of pile are not specified.

— The tolerances on length of diameter enlarged part on interval between knots of pile are not specified.

E.5 Bar arrangement

The bar arrangement shall be as specified in clause **7, JIS A 5364** and a design document. The bar arrangement of piles that satisfies **E.3** shall be determined by the manufacturer for each product.

E.6 Quality of concrete

E.6.1 Material and production method

The materials for concrete and the production method shall be as specified in clause **8**.

E.6.2 Compressive strength

The compressive strength of concrete shall be 80 N/mm^2 or more for the pile of 4.0 N/mm^2 in effective prestress and 85 N/mm^2 or more for the pile over 4.0 N/mm^2 after the predetermined material aging. The compressive strength at the time of prestress introduction shall be 40 N/mm^2 or more.

The compressive strength for Group II shall be as agreed between the parties concerned with delivery.

E.7 Test method

E.7.1 Compressive strength test of concrete

The compressive strength test of concrete shall be as specified in **JIS A 1108** or **JIS A 1136**.

The test piece shall be processed by the same curing as the product or be controlled properly.

E.7.2 Flexural strength test of product

The flexural strength test of product shall be as specified in **JIS A 5363**. The test for Group II shall be as agreed between the parties concerned with delivery.

a) In the flexural strength test, as shown in Figure E.2, 3/5 of the length of pile L shall be supported as a span l, and the load F equivalent to the flexural strength shall be applied at two positions over the centre of the span. The load F shall be calculated according to the following formula in consideration of its own weight.

$$F = \frac{40M - mgL}{6L - 10b}$$

where, F: load (kN)

M: flexural strength (kN·m)

L: length of pile (m)

m: mass of pile (t)

g: acceleration of gravity (use 9.81 m/s^2)

b: bending span (m) $b = 1.0$ as a reference

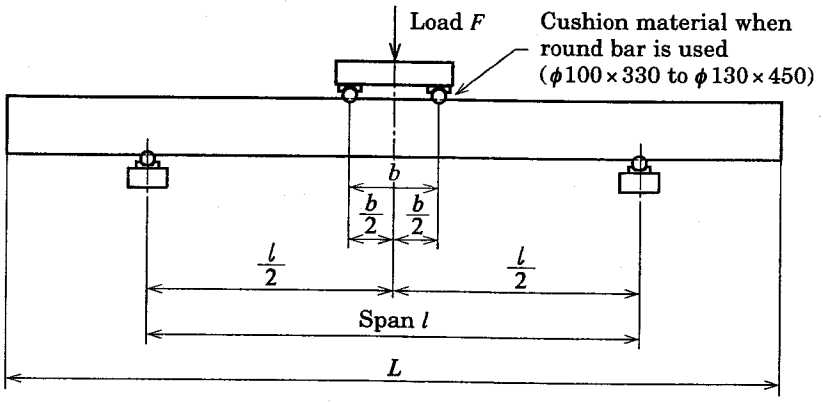


Figure E.2 Flexural strength test method of piles

When the effect from the shear force seems to become large at the time of the flexural strength test, the length of span l may be made larger than 3/5 of the length L of pile. The load F shall be calculated according to the following formula in consideration of its own weight.

$$F = \frac{8M - mg(2l - L)}{2(l - b)}$$

where, F: load (kN)

M: flexural strength (kN·m)

L: length of pile (m)

m: mass of pile (t)

g: acceleration of gravity (use 9.81 m/s^2)

l: span (m)

b: bending span (m) $b = 1.0$ as a reference

b) It shall be confirmed that the required performance is satisfied when the load F equivalent to the flexural cracking strength and the ultimate flexural strength is applied.

c) When the flexural strength test of a joint is conducted, the seam of joint shall be aligned with the centre of the span. Also, L at this time shall be the length after joining two piles.

If a local breakage is likely to occur at the loading position or the supporting position before the flexural break occurs on a pile, countermeasures shall be taken.

E.7.3 Axial-tension flexural strength test of product (reversed cyclic axial-tension flexural strength test)

The axial-tension flexural strength test shall be as follows. The test for Group II shall be as agreed between the parties concerned with delivery.

a) In the axial-tension flexural strength test, as shown in Figure E.3, a pile to which the axial-tension is applied shall be supported as a span l, and the load F equivalent to the flexural strength shall be applied at two positions over the centre of the span. The load F shall be calculated according to the following formula in consideration of its own weight.

In the case of a positive load,

$$F = \frac{8M - mg(2l - L) - 8\delta N}{2(l - b)}$$

In the case of a negative load,

$$-F = \frac{-8M - mg(2b - L) + 8\delta N}{2(l - b)} - mg$$

where, F: load (kN)

M: flexural strength (kN·m)

L: length of pile (m)

m: mass of pile (t)

g: acceleration of gravity (use 9.81 m/s^2)

l: span (m) $l \geq 7.0$ as a reference

δ: relative deflection of centre part (m)

N: axial-tension (kN)

b: bending span (m) $b = 1.0$ as a reference

b) The axial-tension N, load F, and number of positive/negative alternating cycles shall satisfy the following conditions.

1) The axial-tension N shall be secured constant till the completion of test.

2) The axial-tension N shall be one of three steps, N_1, N_2, and N_3, which are shown in the recommended specification.

3) While the axial-tension N is applied, the repeated load F shall be 1/1.2 each of the flexural cracking strength and the ultimate flexural strength The number of cycles shall be 10 or more.

One cycle is defined as one positive/negative sequence.

c) It shall be confirmed that the required performance is satisfied when the load F equivalent to the flexural cracking strength and the ultimate flexural strength are applied after the completion of positive/negative alternating repetition.

If a local breakage is likely to occur at the loading position or the supporting position before the flexural break occurs on a pile, countermeasures shall be taken.

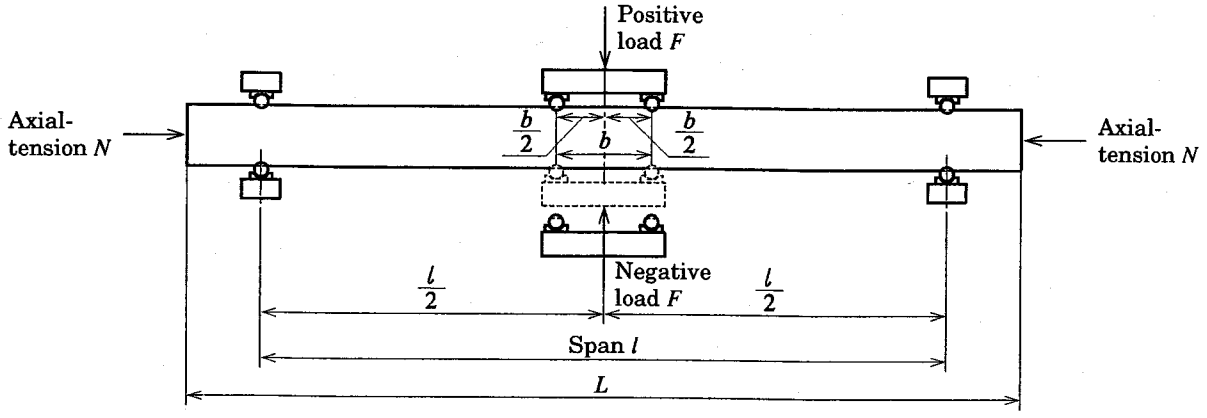


Figure E.3 Flexural strength test method of piles

E.7.4 Shearing strength test of product

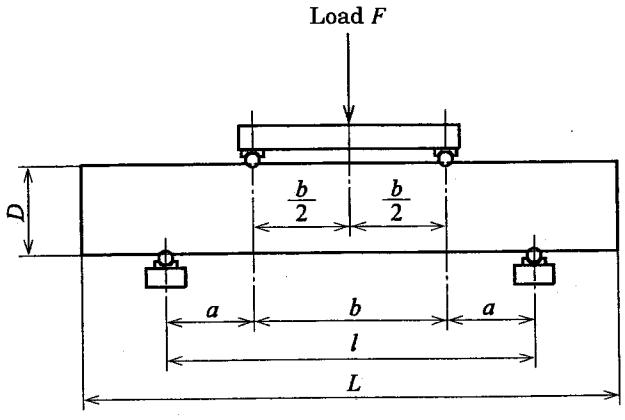
The shearing strength test of product shall be as specified in **JIS A 5363** and as follows. The test for Group II shall be as agreed between the parties concerned with delivery.

The shearing strength test shall be conducted as shown in Figure E.4 or Figure E.5. The load F to be applied in the case of Figure E.4 shall be calculated according to the following formula.

$$F = 2Q$$

where, F: load (kN)

Q: shearing strength (kN)



b : bending span (m) $b = 1.0$ as a reference
a : shearing span (m) $a = 1.0D$
D : external diameter (m)

Figure E.4 Shearing strength test method of piles (loading on simple beam)

The ejection length (m) of the test body in Figure E.4 shall be about $1.25D$ to $2.0D$.

The load F in Figure E.5 shall be calculated as follows.

$$F = \frac{Q(2a+b)}{b}$$

where, F : load (kN)
Q : shearing strength (kN)
b : distance between loading position and outside supporting position (m)
a : shearing span (m) $a = D - t/2$
D : external diameter (m)
t : thickness (m)

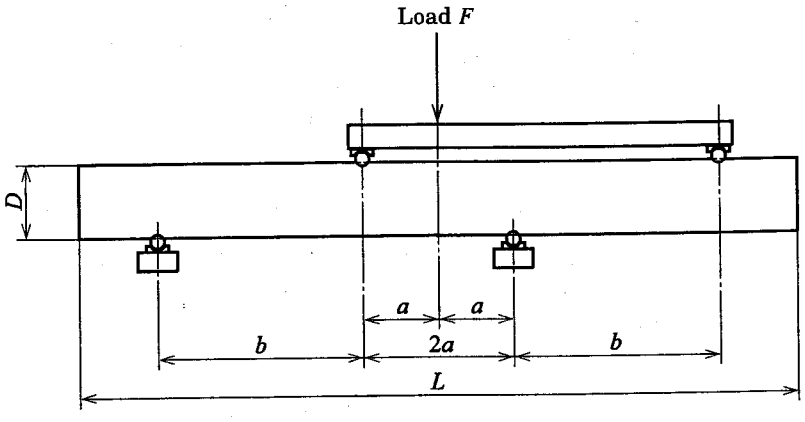


Figure E.5 Shearing strength test method of piles (loading on beam with one end overhanging)

It shall be confirmed that the required performance is satisfied when the load F equivalent to the shearing cracking strength and the ultimate flexural strength are applied.

If there is a possibility that a local breakage is likely to occur at the loading position or the supporting position before the shear break occurs on a pile, countermeasures shall be taken.

E.8 Inspections

Inspections shall be as specified in **JIS A 5365** and the following.

a) **Final inspection** The final inspection of piles shall be conducted on the appearance, performance, shape and dimensions, and shall be as follows.

1) **Appearance** As the inspection of the appearance, a 100 % inspection or a sampling inspection shall be conducted considering the characteristics of product, production method, production quantity, etc.

2) **Performance, shape and dimensions** As the inspections of performance, shape and dimensions, a sampling inspection shall be applied.

When substitute characteristics are inspected by using an alternative test piece in place of inspecting performances of a product, the correlation between the properties of the test piece and those of the product shall be confirmed in advance.

3) **Size of inspection lot** The size of inspection lot shall be determined by the manufacturer in consideration of the characteristics, production method, production quantity, production period, quantity of ordered poles, etc. of product.

Any product in the inspection lot shall have the same characteristics, and shall be manufactured using the same materials, concrete mix proportion, manufacturing process, etc.

b) **Delivery inspection** The delivery inspection of piles shall be conducted on the appearance, shape and dimensions. The size of inspection lot and the sampling method shall be specified by the purchaser as agreed between the parties concerned with delivery. The delivery inspection may be omitted as agreed between the parties concerned with delivery.

E.9 Marking

The following items shall be marked on the piles as specified in **JIS A 5361**. The PC pile, ST pile and knot pile among the piles manufactured by centrifugal force compaction shall be marked as PHC.

a) Type or its abbreviation

b) Manufacturer's name or its abbreviation

c) Date of manufacture or its abbreviation

E.10 Others (recommended specification)

The recommended specification of Group I of piles is shown in Table E.5.

Table E.5 Recommended specification

Structure-specific product group standard		Recommended specification
JIS A 5373	Annex E Piles	Recommended specification E-1 Prestressed concrete piles

Recommended specification E-1
Prestressed concrete piles

E-1.1 Outline

This recommended specification describes the prestressed concrete piles in Group I of piles (hereafter referred to as piles) in Annex E.

A PC pile is a pile of the same cross-section over the entire length. An ST pile is a PC pile having the diameter enlarged part at its end. A knot pile is a PC pile of which the body is provided with knots.

E-1.2 Classification

Piles shall be classified by the external diameter into 300 mm, 350 mm, 400 mm, 450 mm, 500 mm, 600 mm, 700 mm, 800 mm, 900 mm, 1 000 mm, 1 100 mm and 1 200 mm. Also, they shall be classified by the magnitude of effective prestress into Class A, Class B, and Class C (hereafter referred to as A, B and C, respectively).

The effective prestress of A, B and C of piles shall be 4.0 N/mm^2, 8.0 N/mm^2 and 10.0 N/mm^2, respectively.

E-1.3 Performance

The performance of piles shall be as follows.

E-1.3.1 Flexural cracking strength

The flexural cracking strength of piles shall be at least the value specified in Recommended specification E-1 Table 1 and Recommended specification E-1 Table 2.

E-1.3.2 Ultimate flexural strength

The ultimate flexural strength of piles shall be at least the value specified in Recommended specification E-1 Table 1 and Recommended specification E-1 Table 2 or more. For the joint, the ultimate flexural strength shall be the value specified in Recommended specification E-1 Table 1.

E-1.3.3 Shearing cracking strength

The shearing cracking strength of piles shall be at least the value specified in Recommended specification E-1 Table 3.

E-1.3.4 Ultimate flexural strength

The ultimate flexural strength of piles shall be at least the value specified in Recommended specification E-1 Table 3.

Recommended specification E-1 Table 1
Dimensions and flexural strength of piles (when axial-tension $N = 0$ kN is exerted)

Unit: kN·m

External diameter mm	Division	Thickness mm	Length m	Flexural cracking strength	Ultimate flexural strength
300	A	60	4 to 13	24.5	37.3
	B		4 to 15	34.3	61.8
	C			39.2	78.5
350	A	60	4 to 13	34.3	52.0
	B		4 to 15	49.0	88.3
	C			58.9	117.7
400	A	65	4 to 15	54.0	81.4
	B			73.6	132.4
	C			88.3	176.6
450	A	70	4 to 15	73.6	110.8
	B			107.9	194.2
	C			122.6	245.2
500	A	80	4 to 15	103.0	155.0
	B			147.2	264.9
	C			166.8	333.5
600	A	90	4 to 15	166.8	250.2
	B			245.2	441.4
	C			284.5	569.0
700	A	100	4 to 15	264.9	397.3
	B			372.8	671.0
	C			441.4	882.9
800	A	110	4 to 15	392.4	588.6
	B			539.6	971.2
	C			637.6	1 275
900	A	120	4 to 15	539.6	809.3
	B			735.8	1 324
	C			833.8	1 668
1 000	A	130	4 to 15	735.8	1 104
	B			1 030	1 854
	C			1 177	2 354
1 100	A	140	4 to 15	932.0	1 398
	B			1 324	2 384
	C			1 521	3 041
1 200	A	150	4 to 15	1 177	1 766
	B			1 668	3 002
	C			1 962	3 924

Recommended specification E-1 Table 2
Axial-tension flexural strength of piles

Unit: kN·m

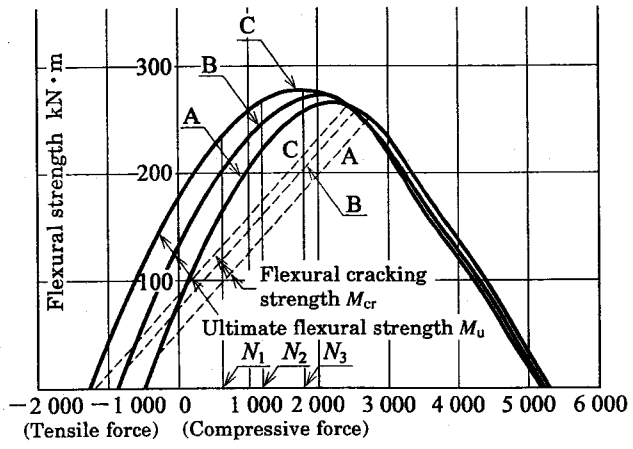
External diameter mm	Division	Flexural strength when axial-tension N_1 is exerted			Flexural strength when axial-tension N_2 is exerted			Flexural strength when axial-tension N_3 is exerted		
		Axial-tension N_1 kN	Flexural cracking strength M_{cr}	Ultimate flexural strength M_u	Axial-tension N_2 kN	Flexural cracking strength M_{cr}	Ultimate flexural strength M_u	Axial-tension N_3 kN	Flexural cracking strength M_{cr}	Ultimate flexural strength M_u
300	A	392.4	44.1	77.5	784.8	64.7	105.9	1 177	84.4	122.6
	B		54.0	95.2		74.6	117.7		94.2	127.5
	C		58.9	106.9		79.5	123.6		99.1	130.5
350	A	490.5	64.7	111.8	981.0	96.1	156.0	1 472	126.5	181.5
	B		79.5	140.3		109.9	173.6		141.3	188.4
	C		89.3	159.9		119.7	184.4		151.1	192.3
400	A	588.6	97.1	163.8	1 177	139.3	223.7	1 766	182.5	259.0
	B		116.7	201.1		158.9	249.2		202.1	269.8
	C		130.5	234.5		173.6	266.8		215.8	277.6
450	A	735.8	134.4	228.6	1 472	195.2	312.9	2 207	256.0	361.0
	B		168.7	291.4		229.6	353.2		290.4	379.6
	C		183.4	329.6		244.3	375.7		305.1	389.5
500	A	882.9	183.4	304.1	1 766	263.9	421.8	2 649	345.3	496.4
	B		227.6	392.4		309.0	483.6		389.5	527.8
	C		247.2	447.3		328.6	518.0		409.1	543.5
600	A	1 275	309.0	522.9	2 551	452.2	723.0	3 826	594.5	839.7
	B		388.5	671.0		530.7	823.1		673.9	886.8
	C		427.7	765.2		570.9	877.0		713.2	909.4
700	A	1 766	498.3	832.9	3 532	731.8	1 151	5 297	965.3	1 312
	B		606.3	1 034		840.7	1 282		1 074	1 366
	C		673.9	1 185		906.4	1 355		1 139	1 387
800	A	1 962	692.6	1 143	3 924	991.8	1 579	5 886	1 292	1 855
	B		839.7	1 446		1 140	1 796		1 440	1 967
	C		935.9	1 679		1 235	1 936		1 534	2 027
900	A	2 452	966.3	1 598	4 905	1 394	2 226	7 358	1 821	2 601
	B		1 165	2 009		1 595	2 516		2 024	2 748
	C		1 264	2 277		1 696	2 679		2 127	2 827
1 000	A	2 943	1 306	2 159	5 886	1 876	3 004	8 829	2 446	3 502
	B		1 598	2 750		2 167	3 403		2 736	3 697
	C		1 745	3 143		2 314	3 633		2 882	3 810
1 100	A	3 434	1 652	2 821	6 867	2 372	3 943	10 300	3 092	4 597
	B		2 030	3 646		2 735	4 538		3 440	4 907
	C		2 218	4 163		2 916	4 846		3 612	5 041
1 200	A	3 924	2 080	3 555	7 848	2 982	4 983	11 770	3 885	5 852
	B		2 552	4 598		3 435	5 754		4 319	6 272
	C		2 834	5 331		3 706	6 208		4 578	6 471

When the axial-tension flexural strength test and the reversed cyclic axial-tension flexural strength test are conducted as the performance verification of the body of pile, the intermediate diameter among diameters of usually manufactured piles shall be used as the representative external diameter. The axial tension at this time shall be N_3.

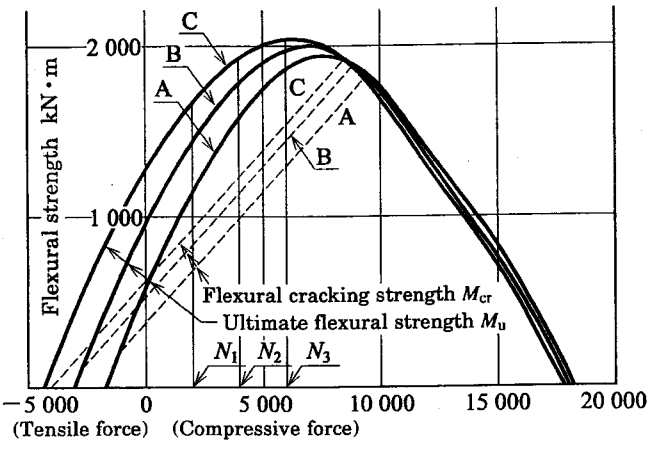
The length of PC pile used in this case shall be 8 m or more.

Recommended specification E-1 Table 2 (concluded)

Symbol	Explanation
N_4	Axial-tension almost equivalent to each ultimate flexural strength of A, B, and C in axial-tension and flexural strength relationship diagram.
N_3	Axial-tension of $N_4 \times 3/4$
N_2	Axial-tension of $N_4 \times 2/4$
N_1	Axial-tension of $N_4 \times 1/4$
M_{cr}	Flexural cracking strength
M_u	Ultimate flexural strength



External diameter 400 mm axial force, flexural strength relationship diagram (informative)



External diameter 800 mm axial force, flexural strength relationship diagram (informative)

Recommended specification E-1 Table 3 Shearing strength of piles

Unit: kN

External diameter mm	Wall thickness mm	Division	Shearing strength	
			Shearing cracking strength	Ultimate flexural strength
300	60	A	99.1	125
		B	126	160
		C	136	175
350	60	A	119	149
		B	150	190
		C	163	209
400	65	A	148	187
		B	187	234
		C	204	259
450	70	A	181	225
		B	228	293
		C	248	316
500	80	A	229	276
		B	288	359
		C	314	395
600	90	A	311	388
		B	392	506
		C	428	554
700	100	A	406	514
		B	512	677
		C	557	739
800	110	A	512	661
		B	647	863
		C	704	936
900	120	A	631	820
		B	797	1 063
		C	867	1 153
1 000	130	A	762	990
		B	961	1 289
		C	1 047	1 400
1 100	140	A	905	1 202
		B	1 142	1 561
		C	1 244	1 687
1 200	150	A	1 059	1 413
		B	1 337	1 823
		C	1 457	1 979

When the shearing strength test is conducted as the performance verification of the body of pile, the intermediate diameter among diameters of usually manufactured piles shall be used as the representative external diameter.

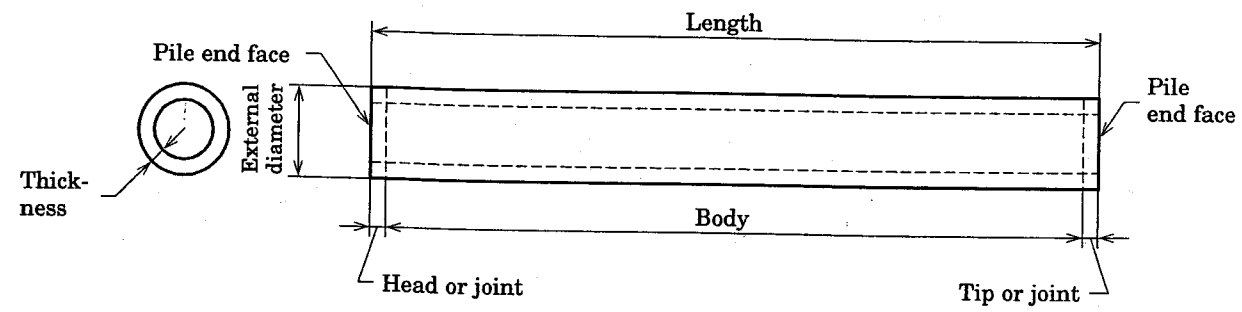
E-1.4 Shape, dimensions and dimensional tolerances

The shape, dimensions and dimensional tolerances of piles shall be as specified in Recommended specification E-1 Figure 1, Recommended specification E-1 Table 1 and Recommended specification E-1 Table 4.

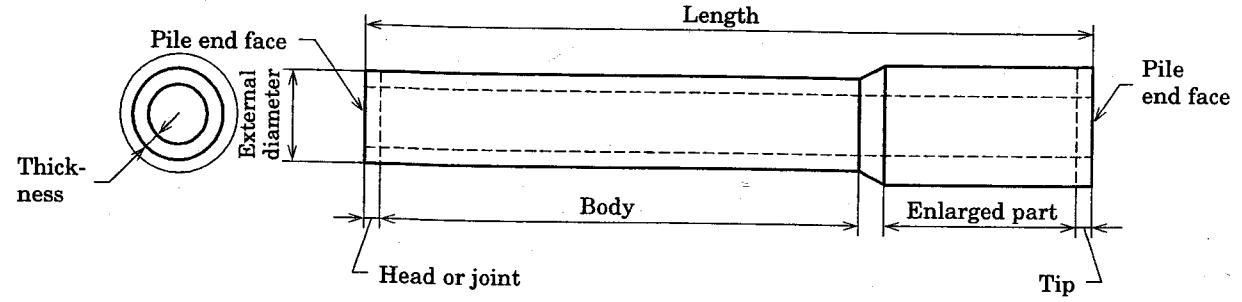
If the reference dimension is changed within the range specified in E.4, the manufacturer shall submit the data indicating that piles conform to Table E.3 in the design document or performance test result when requested by the purchaser.

The maximum length of the diameter enlarged part of ST pile shall be twice the external diameter of the diameter enlarged part. The maximum external diameter of knots of knot pile shall be the external diameter plus 150 mm or under for the external diameter of 450 mm or under, and the external diameter plus 200 mm or under for the external diameter of 500 mm or more. The interval between the knots shall be 1 m.

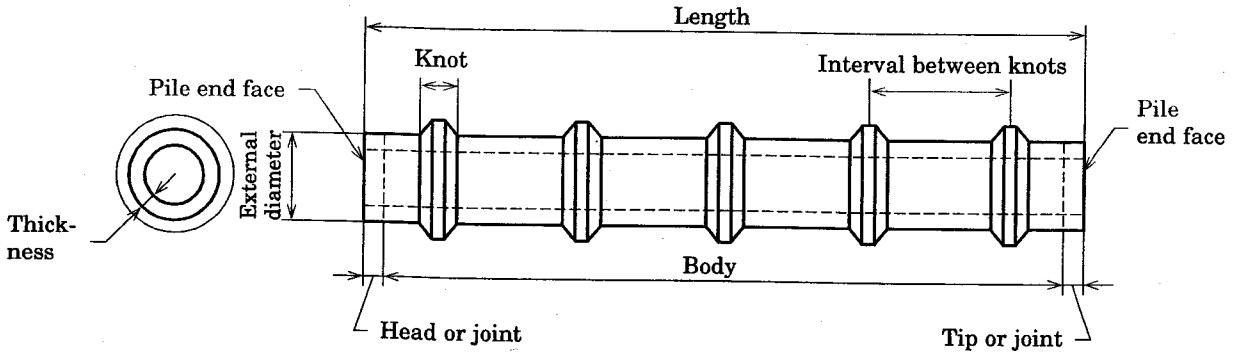
The lengths of a tip, joint and head are included in the length of a pile. The length of a metallic fixture attached to the tip after the manufacture shall not be included in the length of pile. There are a closed edge and an open edge in the tip. The tip may be attached to a upper pile or a middle pile to make a lower pile. The joint end face shall be perpendicular to the pile axis line within the deviation of 1 mm per 300 mm.



a) **PC pile**



b) **ST pile**



c) **Knot pile**

Recommended specification E-1 Figure 1 Shapes of piles

Recommended specification E-1 Table 4
Dimensions and dimensional tolerances of piles

Type		External diameter mm		Wall thickness mm	Length m
Prestress concrete pile (PC pile, ST pile, knot pile)	Dimensions	300 to 600	700 to 1 200	60 to 150	4 to 15
	Dimensional tolerances	+5 −2	+7 −4	+Not specified −0	±0.3 (%) of length

— The length of a pile shall be designated in increments of 1 m.

— The external diameter of pile shall be the average of two values measured along each orthogonal axis in one cross-section of the body, which is rounded off to the integer.

— The thickness shall be the average of four values measured along each orthogonal axis in one cross-section of end part of the body, which is rounded off to the integer.

— The tolerances on external diameters of the diameter enlarged part and the knot of pile are not specified.

— The tolerances on length of diameter enlarged part and the interval between knots of pile are not specified.

E-1.5 Bar arrangement

The bar arrangement of piles shall be as follows.

a) As to the prestressing tendons and the reinforcing bars arranged in axial direction, the ratio of reinforcing bar in terms of total cross-sectional area shall be 0.4 % or more, and the number shall be six or more. On each cross-section of pile, they shall be arranged as uniformly as possible along the circumference of concentric circles. This is intended to decrease directionality of the flexural strength of a pile. The gap between the prestressing tendon and the reinforcing bar shall be one or more times their diameters, and shall be at least 4/3 of the maximum dimension of coarse aggregates. When reinforcing bars are arranged in order to join the pile heads, etc., the arrangement of reinforcing bars and the required quantity of reinforcing bars shall be determined as agreed between the parties concerned with delivery.

b) The spiral reinforcing bar shall be arranged on the outside of longitudinal prestressing tendon and longitudinal reinforcing bar. The wire diameter of spiral reinforcing bars shall be 3 mm or more for the pile of 500 mm or under in external diameter, 4 mm or more for the pile of 600 mm to 1 000 mm in external diameter, and 5 mm or more for the pile of 1 100 mm to 1 200 mm in external diameter. The pitch shall be 110 mm or under.

The required quantity of spiral reinforcing bar for improvement of the shearing strength and the deformation performance shall be as agreed between the parties concerned with delivery.

c) The covering of prestressing tendon and spiral reinforcing bar shall be 15 mm or more.

d) The prestressing tendon and the reinforcing bar shall be free from loose scale, oil, etc. which damage the adhesion of concrete, and shall be assembled and fixed to the right position.

E-1.6 Quality of concrete

The quality of concrete shall be as specified in **E.6.2**.

The compressive strength shall be 80 N/mm^2 or more for Class A, and shall be 85 N/mm^2 or more for Class B and Class C.

E-1.7 Test method

E-1.7.1 Compressive strength test of concrete

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

E-1.7.2 Flexural strength test of product

The flexural strength test shall be as specified in **E.7.2**.

The mass of the body of PC pile used for the calculation of loading shall be the value specified in Recommended Specification E-1 Table 5.

E-1.7.3 Axial-tension flexural strength test of product (reversed cyclic axial-tension flexural strength test)

The axial-tension flexural strength test shall be as specified in **E.7.3**.

The mass of the body of PC pile used for the calculation of loading shall be the value specified in Recommended Specification E-1 Table 5.

E-1.7.4 Shearing strength test of product

The shearing strength test shall be as specified in **E.7.4**.

Recommended specification E-1 Table 5 Mass of PC piles

Unit: t

External diameter mm	Length											
	4 m	5 m	6 m	7 m	8 m	9 m	10 m	11 m	12 m	13 m	14 m	15 m
300	0.470	0.588	0.705	0.823	0.940	1.058	1.176	1.293	1.411	1.528	1.646	1.763
350	0.568	0.710	0.852	0.994	1.136	1.278	1.421	1.563	1.705	1.847	1.989	2.131
400	0.711	0.889	1.067	1.244	1.422	1.600	1.778	1.955	2.133	2.311	2.489	2.667
450	0.869	1.086	1.303	1.520	1.737	1.954	2.172	2.389	2.606	2.823	3.040	3.257
500	1.097	1.372	1.646	1.920	2.194	2.469	2.743	3.017	3.292	3.566	3.840	4.115
600	1.499	1.874	2.248	2.623	2.998	3.373	3.747	4.122	4.497	4.871	5.246	5.621
700	1.959	2.449	2.939	3.429	3.919	4.409	4.898	5.388	5.878	6.368	6.858	7.348
800	2.479	3.098	3.718	4.338	4.957	5.577	6.196	6.816	7.436	8.055	8.675	9.295
900	3.057	3.821	4.585	5.349	6.113	6.877	7.642	8.406	9.170	9.934	10.698	11.462
1 000	3.693	4.617	5.540	6.463	7.387	8.310	9.233	10.157	11.080	12.004	12.927	13.850
1 100	4.389	5.486	6.583	7.681	8.778	9.875	10.972	12.070	13.167	14.264	15.361	16.459
1 200	5.143	6.429	7.715	9.001	10.287	11.572	12.858	14.144	15.430	16.716	18.002	19.287

For convenience, the mass is calculated according to the following formula and rounded off to the third decimal place, assuming that the unit volume mass of PC pile is 2.60 t/m^3 and the value of π is 3.14.

$$m = \omega \pi t L (D - t)$$

where, m: mass of PC pile (t)
ω: unit volume mass of PC pile (t/m^3)
t: thickness (m)
L: length (m)
d: external diameter (m)

E-1.8 Inspections

E-1.8.1 Inspection items

The inspection items of piles 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

E-1.8.2 Inspection lot

The size of inspection lot of piles 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, production method, production quantity, production period, quantity of ordered poles, etc. of product. One inspection lot may consist of 3 000 units or fractions thereof.

E-1.8.3 Inspection method

The inspection method of piles 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 of flexural cracking strength, two arbitrary piles per lot shall be taken and inspected as specified in **E-1.7.2**. If both of the two conform to **E-1.3.1**, the lot shall be accepted. If neither of the two conforms, the lot shall be rejected. If only one of the two does not conform, the lot shall be reinspected. In the reinspection, four more piles shall be taken from the lot, and if all the four conform to the provisions, the lot shall be accepted after the first non-conforming product is eliminated. If one or more of them do not conform in the reinspection, the lot shall be rejected.

In the inspection of the ultimate load of the body, one of the first two piles in the inspection of the flexural cracking strength shall be inspected as specified in **E-1.7.2**. If it conforms to the provisions of **E-1.3.2**, the lot shall be accepted. If it does not conform, two more piles shall be taken from the lot and reinspected. If both of them conform to the provisions, the lot shall be accepted after the first non-conforming product is eliminated. If one or more of them do not conform in the reinspection, the lot shall be rejected.

3) **Shape and dimensions** For the inspection of shape and dimensions, two arbitrary piles per one lot shall be taken. If they conform to **E-1.4**, the lot shall be accepted. If one or more do not conform, the remainder of the lot shall be subjected to a 100 % inspection. If the remainder conforms to the provisions, the lot 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)** or as follows.

When adopting the sampling inspection, two arbitrary piles are taken. If both of them conform to the provisions of **5.1**, the lot shall be accepted. If one or more do not conform, the remainder of the lot shall be subjected to a 100 % inspection. If the remainder conforms to the provisions, the lot shall be accepted.

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

E-1.9 Marking

The PC piles, ST piles and knot piles which conform to all the requirements of this Standard shall be marked as specified in **E.9**. The piles manufactured by centrifugal force compaction shall be marked as PHC.

Annex F (informative)

Comparison table between previous and current editions of this Standard on technically significant revisions

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
2 Normative references	Deleted	2 Normative references	JIS A 1132 *Method of making and curing concrete specimens* JIS B 7505-1 *Aneroid pressure gauges—Part 1: Bourdon tube pressure gauges* JIS B 7721 *Tension/compression testing machines—Verification and calibration of the force-measuring system* JIS Z 8401 *Guide to the rounding of numbers*	These standards are quoted in other **JIS**s as normative references and some are overlapped with basic standards, etc. Basic standards, Annexes, Recommended specifications and quotation of clauses are reviewed.
5.1 Appearance	PC products shall be free from any flaw, crack, chip, camber, torsion (board products), etc. detrimental to practical use.	5.1 Appearance	The appearance shall be tested as specified in **9.1** and it shall be free from any flaw, crack, chip, camber, torsion (in the case of a board-like product), etc. which are detrimental to use. Moreover, the water-contact surface of PC products for water-channel shall be as smooth as practically acceptable.	In the previous edition, the test was supposed to be necessary. The smoothness of the water-contact surface is moved to relevant table in Annex D because it might affect water-flow.
5.2 Performance	The performance according to the type of PC products shall conform to the provisions of Table 2. The performance tests for the verification of performances shall be as specified in **9.2**.	5.2 Performance	The performance shall conform to the provisions of table 2 when tested as specified in clause **9**.	Performances of Group I and Group II are clearly divided. The performance and the performance test are divided, and only the performance is specified herein. In the case of conducting performance tests, **9.2** is referred to.

Current edition (**JIS A 5373** : 2016)		Previous edition (**JIS A 5373** : 2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
7 Bar arrangement and tolerances on bar arrangement	b) Tolerance on bar arrangement The tolerance on bar arrangement [2] ... within the range in which the required performance can be satisfied.	7 Bar arrangement (reinforcing bar and prestressing tendon) and tolerances on bar arrangement	b) Tolerances on bar arrangement The tolerances on bar arrangement [1] shall be specified by manufacturers, within the range where the dynamic characteristics and durability of components satisfy the predetermined required performance	The tolerances is left to the manufacturer's discretion within the range satisfying the performance.
10 Inspections	10.1 Division and items of inspections The inspections on PC products are divided into the final inspection and the delivery inspection and as follows. a) Final inspection The final inspection shall be conducted by the manufacturer of product on the following items. 10.3 Judgement on inspection The judgement method of inspection shall be as specified in **JIS A 5365**.	10 Inspections	10.1 Inspection items The inspection items of the final inspection conducted by the manufacturer and the delivery inspection conducted for confirmation at the time of acceptance shall be as follows. a) Final inspection items The final inspection items shall be as follows.	In order to conform to the basic standard **JIS A 5365**.
12 Marking	a) Characters "Group II" or its abbreviation	12 Marking	a) Characters "Group II"	
Annex A (normative) Poles A.3 Performance	The performance and the performance verification method shall be as follows. a) Product of Group I The performance of product shall conform to the provisions of Recommended specification A-1. b) Product of Group II The performance of product shall conform to the provisions of clause 4 and clause 5 of **JIS A 5362**, and shall be determined as agreed between the parties concerned with delivery. Table E.3 may be applied for general specifications.	Annex A (normative) Poles A.3 Performance	The performance of poles shall conform to the provisions of table A.3. In addition, the performance items of Group II shall be subjected to the agreement between the parties concerned with delivery.	It is made clear that Group I conforms to each Recommended specification and Group II conforms to the basic standard **JIS A 5362**.

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
A.3 Performance (continued)	Table A.3 Performance and performance verification method of poles (Excerpt) Performance item Service performance Safety a) Durability b) Workability	A.3 Performance (continued)	Table A.3 Performance of poles (Excerpt) Performance item Service stage performance End stage performance a) Deflection Durability b) Workability	In order to conform to **JIS A 5362**.
	Table A.3 (continued) Performance It shall be able to be used smoothly under a load expected during service, fulfilling the required function. It shall not fracture under a load expected in design. The same applies to performance for joint. Cracking, ageing of material properties or the like due to the expected impact shall not deteriorate the required performance. It shall be transported, installed, assembled and joined safely and easily without abnormalities detrimental to use.		Table A.3 (continued) Performance Shall be safe to the regular load assumed at the time of use, and crack width shall be less than the permissible value. Shall not break due to the load assumed at the time of end stage. A deflection due to the regular load assumed at the time of use shall be within the allowance value. Durability shall be secured against deterioration assumed. Workability for transportation, installation, assembly, etc. shall be secured.	

<table>
<tr><th colspan="2">Current edition (JIS A 5373:2016)</th><th colspan="2">Previous edition (JIS A 5373:2010)</th><th rowspan="2">Reason for revision</th></tr>
<tr><th>No. and title of clause</th><th>Content</th><th>No. and title of clause</th><th>Content</th></tr>
<tr><td rowspan="2">A.3 Performance (concluded)</td><td>Table A.3 (continued)
<table><tr><th>Performance verification method</th></tr><tr><td>See design document, A.7 or actual results.</td></tr><tr><td>See design document, A.7 or actual results.</td></tr><tr><td>See design document or actual results.</td></tr><tr><td>See design document or actual results.</td></tr></table></td><td rowspan="2">A.3 Performance (concluded)</td><td>Table A.3 (continued)
<table><tr><th>Performance check method</th></tr><tr><td>See design document or A.6.</td></tr><tr><td>See design document or A.6.</td></tr><tr><td>See design document or A.6.</td></tr><tr><td>See design document or actual results.</td></tr><tr><td>See design document or actual results.</td></tr></table></td><td>In order to conform to JIS A 5362.
Requirements are made clear.</td></tr>
<tr><td>Table A.3 (concluded)
The prestressing tendons whose durability on the stress corrosion cracking is confirmed shall be used for poles upon agreement between the parties concerned with delivery.
Notes a) The verification of the safety shall be made when requested by the purchaser.
b) Durability may be verified by the actual results of similar products equivalent in water-cement ratio and/or air content as well as the covering of reinforcing bar, etc. and production method.</td><td>Table A.3 (concluded)
Notes a) Confirmation of the end stage performance shall be made when requested by the purchaser.
b) Durability may be confirmed by the actual results of such similar products as are equivalent in terms of water-cement ratio and/or covering of reinforcing bar, etc.
The prestressing tendons whose durability on the stress corrosion cracking is confirmed under the agreement between the parties concerned with delivery shall be used for poles.</td><td>Durability is affected by air content and production method.</td></tr>
</table>

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
A.4 Shape, dimensions and dimensional tolerances	a) Shape An example of shapes of poles is shown in Figure A.1. A joint may be provided, if necessary. (Table A.4) — The tip diameter, bottom diameter and diameter shall be the average of two values measured along each orthogonal axis at one cross-section of the end face, which is rounded to integer.	A.4 Shape, dimensions and dimensional tolerances	a) Shape An example of shapes of poles is shown in figure A.1. (Table A.4) — The tip diameter, bottom diameter and diameter shall be the average of two values measured along each orthogonal axis.	It is made clear that poles called joint poles obtained by joining two or more poles to one pole also are taken as poles. Rounding method of numbers is made clear.
A.6 Quality of concrete	A.6.1 Material and production method The materials for concrete and the production method shall be as specified in clause 8.	A.7 Quality of concrete	A.7.1 Material and production method The material for concrete and the production method shall be as specified in **JIS A 5364**.	Overlap of normative references among basic standards, main body, Annexes and Recommended specifications of this Standard is reviewed, and a series of clauses and their expressions are harmonized.

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
A.6 Quality of concrete (concluded)	A.6.2 Compressive strength The compressive strength of concrete shall be 50 N/mm² or more after the predetermined material aging. The compressive strength at the time of prestress introduction shall be at least 1.7 times the prestress given at a supporting position, at least 1.3 times the prestress given at a loading position, and 25 N/mm² or more. The compressive strength for Group II shall be as agreed between the parties concerned with delivery.	A.7 Quality of concrete (concluded)	A.7.2 Compressive strength The compressive strength of concrete shall be verified by the compressive strength of the sample which has been processed by the same curing as the product or the compressive strength which has been controlled properly. When the predetermined material aging is finished, the compressive strength shall be 50 N/mm² or more. Moreover, the compressive strength at the time of prestress introduction shall be 1.7 or more times the prestress given at a supporting point, and 1.3 or more times the prestress given at a load point, and at the same time 25 N/mm² or more. In addition, products of Group II shall be subjected to the agreement between the parties concerned with delivery and the compressive strength of concrete may be as specified in Annex A of **JIS A 5364**.	The curing method of the sample is moved to the relevant test method in **A.7**. Annex A of **JIS A 5364** is deleted because it does not constitute the provisions of this Standard.
A.7 Test method	A.7.1 Compressive strength test of concrete The compressive strength test of concrete shall be as specified in **JIS A 1108** or **JIS A 1136**. The test piece shall be processed by the same curing as the product or be controlled properly. A.7.2 Flexural strength test of product The flexural strength test of product shall be as specified in **JIS A 5363**.	A.6 Test method	A.6.1 Compressive strength test The compressive strength test shall be as specified in **JIS A 1132** and **JIS A 1108**, or **JIS A 1136**. A.6.2 Bending strength test The bending strength test shall be as specified in **JIS A 5363**. The tester shall be of Class 1 or superior specified in **JIS B 7721**, or shall be at least equivalent in allowance thereto.	Overlap of normative references among basic standards, main body, Annexes and Recommended specifications of this Standard is reviewed, and a series of clauses and their expressions are harmonized.

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
Recommended specification A-1 Prestressed concrete poles A-1.2 Classification	"Height of supporting position" values are added to Recommended specification A-1 Table 1 Dimensions and cracking test load (Class 1), and the designations of product are added.	Recommended specification A-1 Prestressed concrete poles A-1.2 Classification	Recommended specification A-1 Table 1 Dimensions and crack test force (Class 1)	In accordance with Power distribution code (**JEAC 7001**) The designation of product is added according to the actual applications.
A-1.3 Performance	A-1.3.1 Class 1 poles The performance of Class 1 poles shall be as follows. a) Cracking test load The cracking test load on Class 1 pole (0.25 mm or under in crack width) shall be at least the value specified in Recommended specification A-1 Table 1. When this cracking test load is removed, the crack of exceeding 0.05 mm in width shall not remain. b) Ultimate load The ultimate load on Class 1 pole shall be at least twice the critical cracking width strength specified in Recommended specification A-1 Table 1. A-1.3.2 Class 2 poles The performance of Class 2 poles shall be as follows. a) Critical cracking width strength (Same as Class 1 poles) b) Ultimate flexural strength (Same as Class 1 poles) c) Deflection The deflection of Class 2 pole shall be such that the deflection of a 8 m pole at 6 m from the supporting position and the deflection of at least 9 m pole at 7 m from the supporting position shall not exceed 75 mm when the pole is subjected to the load equivalent to 2/3 of critical cracking width strength specified in Recommended specification A-1 Table 2.	A-1.3 Performance	A-1.3.1 Bending strength The body of pole of Class 1 shall be subjected to the bending strength test specified in **A-1.6.2**. When it receives the crack test force specified in recommended specification A-1 table 1, it shall not produce the crack of exceeding 0.25 mm in width. When this crack test force is removed, the crack of exceeding 0.05 mm in width shall not present. Moreover, it does not break with the value twice the crack test force specified in recommended specification A-1 table 1 for poles of Class 1. The body of pole of Class 2 shall be subjected to the bending strength test specified in **A-1.6.2**. When it receives the crack test bending moment specified in recommended specification A-1 table 2, it shall not produce the crack of exceeding 0.25 mm in width. A-1.3.2 Deformation The deformation of the pole of Class 2 shall be so that when it is subjected to the bending strength test specified in **A-1.6.2** and to 2/3 of the crack test bending moment specified in recommended specification A-1 table 2, the deflection of a 8 m pole at 6 m from the supporting point and the deflection of a 9 m or longer pole at 7 m from the supporting point shall not exceed 75 mm.	This is based on the review of the description method with the change of performance expression from bending strength to flexural strength.

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
A-1.4 Shape, dimensions and dimensional tolerances	Recommended specification A-1 Table 3 Dimensional tolerances — The tip diameter, bottom diameter and diameter shall be the average of two values measured along each orthogonal axis at one cross-section of the end face, which is rounded to integer. — The thickness shall be the average of four values measured along each orthogonal axis in one cross section of end face, which is rounded to integer.	A-1.4 Shape, dimensions and dimensional tolerances	Recommended specification A-1 table 3 Dimensional tolerances — The tip diameter, bottom diameter and diameter shall be the average of two values measured along each orthogonal axis. — The thickness shall be the average of four values measured along each orthogonal axis in one cross section of end face of body.	Rounding method of numbers is made clear.
A-1.5 Bar arrangement	c) The prestressing tendon and the longitudinal reinforcing bar shall be assembled by execution bars. These execution bars shall be arranged so that the performance of body is not compromised.	A-1.5 Bar arrangement	c) The redundant bar shall be spirally arranged on the outside of prestressing tendon and longitudinal reinforcing bar. The redundant bar shall be 2.7 mm or more in diameter. The pitch shall be 150 mm or less.	The redundant bar is not taken into consideration in terms of the performance of poles, and the provision is altered. Furthermore, the name is taken as execution bar.
	d) When prestressing tendons or longitudinal reinforcing bars are joined with execution bars by welding, it shall be guaranteed that the mechanical characteristics of prestressing tendons or longitudinal reinforcing bars do not fall short of each specified value due to welding.		e) When welding the redundant bar with prestressing tendon or the longitudinal reinforcing bar, it shall be guaranteed that welding does not decrease their mechanical characteristics below each specified value.	Description on execution bar is made clear.

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
A-1.7 Test method	A-1.7.2 Flexural strength test of product For the flexural strength test on Class 1 pole, a pole shall be installed as shown in recommended specification A-1 Figure 3 and be fixed by applying cushion materials, etc. At a loading position, the load shall be applied in a direction as perpendicularly to the axis of the pole as possible. Loading shall be applied up to the crack test load at a slow rate, and the crack width and the deflection shall be measured. The pole shall be examined for the crack exceeding 0.25 mm in width. After that, the load shall be removed, and the residual crack width shall be measured. Then, the pole shall be examined for the crack exceeding 0.05 mm in residual crack width. Further, the load shall be applied in the same way up to the ultimate load of the pole, if necessary. The crack test load and the ultimate load used for the test are shown in Recommended specification A-1 Table 4. The flexural strength test of Class 2 pole shall be the same as that of Class 1 pole. However, the load equivalent to the critical cracking width strength and the ultimate load shown in Recommended specification A-1 Table 5 shall be used for loading. Recommended specification A-1 Figure 3 Flexural strength test method of pole (example of Class 1) is described.	A-1.6 Strength test	A-1.6.2 Bending strength test The bending strength test shall be as specified in **A.6.2**. The tester shall be of Class 1 or superior specified in **JIS B 7721**, or shall be at least equivalent in allowance thereto.	Flexural test method is practically described.

<table>
<tr><th colspan="2">Current edition (JIS A 5373:2016)</th><th colspan="2">Previous edition (JIS A 5373:2010)</th><th rowspan="2">Reason for revision</th></tr>
<tr><th>No. and title of clause</th><th>Content</th><th>No. and title of clause</th><th>Content</th></tr>
<tr><td></td><td>Recommended specification A-1 Table 4 Cracking test load and ultimate load of pole (Class 1)
Unit: kN
<table>
<tr><th>Designation of product</th><th>Cracking test load</th><th>Ultimate load</th></tr>
<tr><td>7-14-1.5,
8-14-1.5</td><td>1.5</td><td>3.0</td></tr>
<tr><td>Same as above.</td><td></td><td></td></tr>
</table></td><td></td><td></td><td></td></tr>
<tr><td>A-1.7 Test method (concluded)</td><td><u>Recommended specification A-1 Table 5 Load equivalent to critical cracking width strength and ultimate load of pole (Class 2)</u>
Unit: kN
<table>
<tr><th>Designation of product</th><th>Height of loading position m</th><th>Load equivalent to critical cracking width strength</th><th>Ultimate load</th></tr>
<tr><td>8-35-N50</td><td>6.35</td><td>7.9</td><td>15.8</td></tr>
<tr><td>Same as above.</td><td></td><td></td><td></td></tr>
</table></td><td>A-1.6 Strength test (concluded)</td><td>(No description)</td><td>Numerical values of cracking test load and ultimate load of flexural strength test are made clear.</td></tr>
</table>

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
A-1.8 Inspections A-1.8.3 Inspection method	2) Performance As the inspection of the cracking test load (Class 1) or the critical cracking width strength (Class 2), two arbitrary poles per lot shall be taken and inspected as specified in **A-1.7.2**. If both of the two conform to **A-1.3**, the lot shall be accepted. If neither of the two conforms, the lot shall be rejected. If only one of the two does not conform, the lot shall be re-inspected by taking four more poles from the lot. If all the four conform to the provisions, the lot shall be accepted after the first non-conforming product is eliminated. If one or more of them do not conform in the reinspection, the lot shall be rejected. In the inspection of the ultimate load (Class 1) or the ultimate flexural strength (Class 2), one of the first two poles in the inspection of the cracking test load (Class 1) or the critical cracking width strength (Class 2) shall be inspected as specified in **A-1.7.2**. If it conforms to the provisions of **A-1.3**, the lot shall be accepted. If it does not conform, two more poles shall be taken from the lot and re-inspected. If both of them conform to the provisions, the lot shall be accepted after the first non-conforming product is eliminated. If one or more of them do not conform in the reinspection, the lot shall be rejected.	A-1.8 Inspections A-1.8.3 Inspection method	2) Performance For the inspection of the bending crack strength, two arbitrary poles per one lot shall be taken and inspected as specified in **A-1.6.2**. If both of the two conform to **A-1.3.1**, the lot shall be accepted. If neither of the two conforms, the lot shall be rejected. If only one of the two does not conform, the lot shall be re-inspected. In the re-inspection, four more poles shall be taken from the lot, and if all the four conform to the provisions, the lot shall be accepted after the first non-conforming product is eliminated. If one or more of them do not conform in the re-inspection, the lot shall be rejected. The bending strength shall be inspected as follows. One of the first two poles for bending crack strength inspection shall be inspected as specified in **A-1.6.2**. When it conforms to the provisions of **A-1.3.1**, the lot shall be accepted. If it does not conform, two more poles shall be taken from the lot for re-inspection, and if both of them conform to the provisions, the lot shall be accepted after the first non-conforming product is eliminated. If one or more of them do not conform in the re-inspection, the lot shall be rejected.	Bending strength is changed to flexural strength.

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<tr><th>No. and title of clause</th><th>Content</th><th>No. and title of clause</th><th>Content</th></tr>
<tr><td>Annex B
(normative)
Bridges
B.3 Performance</td><td>The performance and the performance verification method of bridges shall be as follows.
a) Product of Group I The performance of product shall conform to the provisions of Recommended specification B-1, B-2, B-3 or B-4.
b) Product of Group II The performance of product shall conform to the provisions of clause 4 and clause 5 of JIS A 5362, and shall be determined as agreed between the parties concerned with delivery. Table B.3 may be applied for general specifications.</td><td>Annex B
(normative)
Bridges
B.3 Performance</td><td>The performance of bridges shall conform to the provisions of table B.3.
In addition, the performance items of Group II shall be subjected to the agreement between the parties concerned with delivery.</td><td>It is made clear that Group I conforms to each Recommended specification and Group II conforms to the basic standard JIS A 5362.</td></tr>
<tr><td></td><td>
<table>
<tr><th>Performance item</th><th>Performance</th></tr>
<tr><td>Service performance</td><td>It shall be able to be used smoothly under a load expected during service, fulfilling the required function.</td></tr>
<tr><td>Safety a)</td><td>It shall not fracture under a load expected in design.</td></tr>
<tr><td>Durability b)</td><td>Cracking or ageing of material properties due to the expected impact shall not deteriorate the required performance.</td></tr>
<tr><td>Workability</td><td>It shall be transported, installed, assembled and joined safely and easily without abnormalities detrimental to use.</td></tr>
<tr><td colspan="2">Notes a) The verification on the safety ... by the purchaser.
b) Durability may be verified by the actual results of such products equivalent in water-cement ratio and/or air content as well as the covering of reinforcing bar, etc. and production method.</td></tr>
</table>
</td><td></td><td>
<table>
<tr><th>Performance item</th><th>Performance</th></tr>
<tr><td>Service stage performance</td><td>Shall be safe to the regular load assumed at the time of use, and crack width shall be less than the permissible value.</td></tr>
<tr><td>End stage performance a)</td><td>Shall not break due to the load assumed at the time of end stage.</td></tr>
<tr><td>Durability b)</td><td>Durability shall be secured against deterioration assumed.</td></tr>
<tr><td>Workability</td><td>Workability for transportation, installation, assembly, etc. shall be secured.</td></tr>
<tr><td colspan="2">Notes b) Confirmation of the end stage performance ... by the purchaser.
c) Durability may be confirmed by the actual results of such similar products as are equivalent in terms of water-cement ratio and/or covering of reinforcing bar, etc.</td></tr>
</table>
</td><td>In order to conform to JIS A 5362.

Durability is affected by air content and production method.</td></tr>
</table>

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
B.6 Quality of concrete	B.6.1 Material and production method The materials for concrete and the production method shall be as specified in clause **8**. B.6.2 Compressive strength The compressive strength of concrete shall satisfy the values of Table B.6 after the predetermined material aging.	B.7 Quality of concrete	B.7.1 Material and production method The material for concrete and the production method shall be as specified in **JIS A 5364**. B.7.2 Compressive strength The compressive strength of concrete shall be verified by the compressive strength of the sample which has been processed by the same curing as the product or the compressive strength which has been controlled properly. When the predetermined material aging is finished, the compressive strength shall satisfy the value specified in table B.6.	Clauses are replaced. These standards are quoted in other **JIS**s as normative references and some are overlapped with basic standards, etc. Basic standards, Annexes, Recommended specifications and quotation of clauses are reviewed.
B.7 Test method	B.7.1 Compressive strength test of concrete The compressive strength test of concrete shall be as specified in **JIS A 1108**. The test piece shall be processed by the same curing as the product or be controlled properly.	B.6 Test method	B.6.1 Compressive strength test The compressive strength test shall be as specified in **JIS A 1132** and **JIS A 1108**.	Clauses are replaced.

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
B.7.2 Flexural strength test of product	The flexural strength test of product shall be as specified in **JIS A 5363**. As shown in Figure B.5 and Figure B.6, the flexural cracking load F shall be applied, and the product shall be examined for the presence of a crack. In the case of the simple-beam structure, the load F may be calculated according to the following formula. In the case of the successive-beam structure, the load F shall be calculated according to the calculation of in-plane framing. F: flexural cracking load (kN) M: flexural cracking strength (kN·m) Note [a] About 10 cm to 15 cm width.	B.6.2 Bending strength test	A bending strength test shall be as specified in **JIS A 5363**. As shown in figure B.5 and figure B.6, the force F which is equivalent to the crack test bending moment shall be applied, and the existence of any crack shall be examined. The test shall be conducted after confirming that the compressive strength of a test piece is equal to or more than the specified value. The tester shall be of Class 1 or superior specified in **JIS B 7721**, or shall be at least equivalent in allowance thereto. F: loading force (kN) M: crack test bending moment (kN·m) Note [a] About 15 cm width for bridge beam and about 10 cm to 15 cm for deck slab.	Clauses are replaced. The calculation formula of load F is applicable only to a simple beam. The load F is calculated according to the calculation of in-plane framing in the case of the successive-beam structure.
Recommended specification B-1 Bridge beams for highway B-1.2.1 Ordinary bridge beams	Recommended specification B-1 Table 1 Classification and flexural cracking strength of T bridge beams Flexural cracking strength Recommended specification B-1 Table 2 Classification and flexural cracking strength of T bridge beams Recommended specification B-1 Table 3 Classification and flexural cracking strength of T bridge beams Flexural cracking strength	Recommended specification B-1 Bridge beams for highway bridges B-1.2.1 Ordinary bridge beam	Recommended specification B-1 Table 1 Classification and crack test bending moment of slab bridge beams Crack test bending moment Recommended specification B-1 Table 2 Classification and crack test bending moment of beam bridge beams Recommended specification B-1 Table 3 Classification and crack test bending moment of light-load slab bridge beam Crack test bending moment	The performance expression is changed from bending strength to flexural strength and the description method is reviewed.

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
B-1.3 Performance	The required performance of bridge beams is the flexural cracking strength. Cracking shall not occur when the cracking load calculated in **B.7.2** using the flexural cracking strength specified in Recommended specification B-1 Table 1, Recommended specification B-1 Table 2 and Recommended specification B-1 Table 3 is applied.	B-1.3 Performance	B-1.3.1 Bending strength The bridge beam shall be subjected to the bending strength test as specified in **B-1.6.2**. When it receives the crack test bending moment specified in recommended specification B-1 tables 1 to 3 or that obtained from the design document, it shall not produce the crack. When the crack test bending moment is obtained from a design document, the value shall be that when the tensile stress of a bridge beam lower edge becomes the effective prestress + 3.0 N/mm^2.	The calculation method of flexural cracking strength that is one of the performance indexes is expressed clearly.
B-1.6 Quality of concrete	The quality of concrete shall be as specified in **B.6**.	B-1.7 Quality of concrete	The compressive strength of concrete shall be as specified in **B.7.2**.	Clauses are replaced.
B-1.7 Flexural strength test of product	The flexural strength test of the product shall be as specified in **B.7.2**, and the load shall be uniformly distributed using a steel plate of about 10 cm to 15 cm in width and a round steel bar of a proper diameter.	B-1.6 Strength test	B-1.6.1 Compressive strength test The compressive strength test of bridge beams shall be as specified in **B.6.1**. B-1.6.2 Bending strength test The bending strength test of bridge beams shall be as specified in **B.6.2**. The tester shall be of Class 1 or superior specified in **JIS B 7721**, or shall be at least equivalent in allowance thereto. For loading, the force shall be uniformly distributed using a steel plate of about 15 cm in width and a round steel bar of a proper diameter.	Clauses are replaced. The performance expression is changed from bending strength to flexural strength, and the description method is reviewed.

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
Recommended specification B-2 Segments for bridge beams for highway bridges B-2.3 Performance	The compressive strength of concrete is used as substitute characteristic of segments for bridge beams. The compressive strength of concrete at the quality assurance shall be 50 N/mm^2 or more. The compressive strength of concrete at the introduction of prestress shall be 35 N/mm^2 or more.	Recommended specification B-2 Segments for bridge beams for highway bridges B-2.3 Performance	B-2.3.1 Compressive strength The segments for bridge beams shall be subjected to the compressive strength test as specified in **B-2.6.1**. The compressive strength as the product warranty shall be 50 N/mm^2 or more, and shall be 35 N/mm^2 or more at the time of prestress introduction.	It is because the compressive strength of concrete is used as alternative characteristic.
B-2.4 Shape, dimensions and dimensional tolerances	If the reference dimension is changed within the range specified in **B.4**, the manufacturer shall submit the data indicating that segments for bridge beams conform to Table B.3 in the design document or the performance test result when requested by the purchaser.	B-2.4 Shape, dimensions and dimensional tolerances	If the reference dimension is changed within the range as specified in **B.4**, the manufacturer shall present the data indicating that segments for bridge beams conform to **B.3** by the design document or the performance test when requested by the purchaser.	It is altered so as to be able to show conformity in the performance test result as well.
B-2.6 Quality of concrete	The quality of concrete shall be as specified in **B.6**.	B-2.6 Strength test	B-2.6.1 Compressive strength test The compressive strength test of segments for bridge beams shall be as specified in **B.6.1**. The tester shall be of Class 1 or superior specified in **JIS B 7721**, or shall be at least equivalent in allowance thereto.	Clauses are replaced.
		B-2.7 Quality of concrete	The compressive strength of concrete shall be as specified in **B.7.2**.	
B-2.7 Compressive strength test of concrete	The compressive strength test of concrete shall be as specified in **B.7.1**.			The compressive strength of concrete is taken as the alternative characteristics and the compressive strength test is added.

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
B-2.8 Inspections	B-2.8.1 Inspection items B-2.8.2 Inspection lot B-2.8.3 Inspection method 2) Performance The inspection of performance shall be conducted as specified in **B-2.7** .... B-2.9 Marking	B-2.8 Inspections	B-2.8.1 Inspection items B-2.8.2 Inspection lot B-2.8.3 Inspection method 2) Performance The inspection of performance shall be conducted as specified in **B-2.6.1** .... B-2.9 Marking	Overlap of normative references among main body, Annexes and Recommended specifications is reviewed, and a series of clauses and their expressions are harmonized.
Recommended specification B-3 Precast plate for composite deck slab B-3.3 Performance	The required performance of precast plates for composite deck slabs shall be the flexural cracking strength. Cracking shall not occur when the cracking load calculated in **B.7.2** using the flexural cracking strength specified in Recommended specification B-3 Table 1 is applied.	Recommended specification B-3 Precast plates for composite deck slabs B-3.3 Performance	B-3.3.1 Bending strength The precast plates for composite deck slabs shall be subjected to the bending strength test as specified in **B-3.6.2**. When it receives the crack test bending moment specified in recommended specification B-3 table 1, it shall not produce the crack. When the crack test bending moment is obtained from a design document, the value shall be that when the tensile stress of a precast plate lower edge becomes the effective prestress + 1.8 N/mm^2.	The performance expression is changed from bending strength to flexural strength and the description method is reviewed.
B-3.4 Shape, dimensions and dimensional tolerances	If the reference dimension is changed within the range specified in **B.4**, the manufacturer shall submit the data indicating that the precast plates for composite deck slabs conform to Table B.3 in the design document or the performance test result when requested by the purchaser.	B-3.4 Shape, dimensions and dimensional tolerances	If the reference dimension is changed within the range as specified in **B.4**, the manufacturer shall present the data indicating that precast plates for composite deck slabs conform to **B.3** by the design document or the performance test when requested by the purchaser.	It is altered so as to be able to show conformity in the performance test result as well.
B-3.6 Quality of concrete	The quality of concrete shall be as specified in **B.6**.	B-3.7 Quality of concrete	The compressive strength of concrete shall be as specified in **B.7.2**.	Clauses are replaced.

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
B-3.7 Flexural strength test of product	The flexural strength test of the product shall be as specified in **B.7.2**, and the load shall be uniformly distributed using a steel plate of about 10 cm to 15 cm in width and a round steel bar of a proper diameter.	B-3.6 Strength test	B-3.6.1 Compressive strength test The compressive strength test of precast plates for composite deck slabs shall be as specified in **B.6.1**. B-3.6.2 Bending strength test The bending strength test of precast plates for composite deck slabs shall be as specified in **B.6.2**. The tester shall be of Class 1 or superior specified in **JIS B 7721**, or shall be at least equivalent in allowance thereto.	Overlap of normative references among basic standards, main body, Annexes and Recommended specifications of this Standard is reviewed, and a series of clauses and their expressions are harmonized.
B-3.8.3 Inspection method	2) Performance As the inspection of the performance, two precast plates for composite deck slabs per lot shall be taken and inspected as specified in **B-3.7**	B-3.8.3 Inspection method	2) Performance For the inspection of performance, two precast plates for composite deck slabs per one lot shall be taken and conducted as specified in **B-3.6.2**	Overlap of normative references among basic standards, main body, Annexes and Recommended specifications of this Standard is reviewed, and a series of clauses and their expressions are harmonized.
Recommended specification B-4 Precast deck slabs for highway bridges B-4.3 Performance	The required performance of precast deck slabs shall be the flexural cracking strength. Cracking shall not occur when the cracking load calculated in **B.7.2** using the flexural cracking strength specified in Recommended specification B-4 Table 1 is applied.	Recommended specification B-4 Precast deck slabs for highway bridges B-4.3 Performance	B-4.3.1 Bending strength The precast deck slabs shall be subjected to the bending strength test as specified in **B-4.6.2**. When it receives the crack test bending moment specified in recommended specification B-4 table 1, it shall not produce the crack.	This is because the performance expression is changed from bending strength to flexural strength.
B-4.4 Shape, dimensions and dimensional tolerances	If the reference dimension is changed within the range specified in **B.4**, the manufacturer shall submit the data indicating that precast deck slabs conform to Table B.3 in the design document or the performance test result when requested by the purchaser.	B-4.4 Shape, dimensions and dimensional tolerances	If the reference dimension is changed within the range specified in **B.4**, the manufacturer shall present the data indicating that precast deck slabs conform to Table B.3 by the design document or the performance test when requested by the purchaser.	It is altered so as to be able to show conformity in the performance test result as well.

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
B-4.6 Quality of concrete	The quality of concrete shall be as specified in **B.6**.	B-4.7 Quality of concrete	The compressive strength of concrete shall be as specified in **B.7.2**.	Clauses are replaced.
B-4.7 Flexural strength test of product	The flexural strength test of the product shall be as specified in **B.7.2**, and the load shall be uniformly distributed using a steel plate of about 10 cm to 15 cm in width and a round steel bar of a proper diameter.	B-4.6 Strength test	B-4.6.1 Compressive strength test The compressive strength test of precast deck slabs shall be as specified in **B.6.1**. B-4.6.2 Bending strength test The bending strength test of precast plates for composite deck slabs shall be as specified in **B.6.2**. The tester shall be of Class 1 or superior specified in **JIS B 7721**, or shall be at least equivalent in allowance thereto. For loading, the force shall be uniformly distributed using a steel plate of about 10 cm to 15 cm in width and a round steel bar of a proper diameter.	Clauses are replaced.
B-4.8.3 Inspection method	a) Final inspection 2) Performance As the inspection of the performance, two precast deck slabs per lot shall be taken and inspected as specified in **B-4.7**. If both of the two conform to **B-4.3**, ...	B-4.8.3 Inspection method	a) Final inspection 2) Performance For the inspection of performance, two precast deck slabs per one lot shall be taken and inspected as specified in **B-4.6.2**. If both of the two conform to **B-4.3.1**, ...	Clauses are replaced.

<table>
<tr><th colspan="2">Current edition (JIS A 5373:2016)</th><th colspan="2">Previous edition (JIS A 5373:2010)</th><th rowspan="2">Reason for revision</th></tr>
<tr><th>No. and title of clause</th><th>Content</th><th>No. and title of clause</th><th>Content</th></tr>
<tr><td rowspan="2">Annex C (normative)
Retaining walls
C.3 Performance</td><td>The required performance and the performance verification method of retaining walls shall be as follows.
a) Product of Group I The performance of product shall conform to the provisions of Recommended specification C-1.
b) Product of Group II The performance of product shall conform to the provisions of clause 4 and clause 5 of JIS A 5362, and shall be determined as agreed between the parties concerned with delivery. Table C.3 may be applied for general specifications.</td><td rowspan="2">Annex C (normative)
Retaining walls
C.3 Performance</td><td>The performance of retaining walls shall conform to the provisions of table C.3.
In addition, the performance items of Group II shall be subjected to the agreement between the parties concerned with delivery.</td><td>In order to conform to JIS A 5362.</td></tr>
<tr><td>Table C.3 Performance and performance verification method of retaining walls
(Excerpt)<table><tr><th>Performance item</th></tr><tr><td>Service performance</td></tr><tr><td>Safety [a)]</td></tr><tr><td>Durability [b)]</td></tr><tr><td>Workability</td></tr></table></td><td>Table C.3 Performance of retaining walls
(Excerpt)<table><tr><th>Performance item</th></tr><tr><td>Service stage performance</td></tr><tr><td>End stage performance [a)]</td></tr><tr><td>Durability [b)]</td></tr><tr><td>Workability</td></tr></table></td><td>In order to conform to JIS A 5362.</td></tr>
</table>

<table>
<tr><th colspan="2">Current edition (JIS A 5373:2016)</th><th colspan="2">Previous edition (JIS A 5373:2010)</th><th rowspan="2">Reason for revision</th></tr>
<tr><th>No. and title of clause</th><th>Content</th><th>No. and title of clause</th><th>Content</th></tr>
<tr><td>C.3 Performance (concluded)</td><td>(Excerpt)<table><tr><th>Performance</th></tr><tr><td>It shall be able to be used smoothly under a load expected during service, fulfilling the required function.</td></tr><tr><td>It shall not fracture under a load expected in design.</td></tr><tr><td>Cracking, ageing of material properties or the like due to the expected impact shall not deteriorate the required performance.</td></tr><tr><td>It shall be transported, installed, assembled and joined safely and easily without abnormalities detrimental to use.</td></tr><tr><th>Performance verification method</th></tr><tr><td>See design document, C.7 or actual results.</td></tr><tr><td>See design document, C.7 or actual results.</td></tr></table>Notes [a] The verification on the safety shall be made when requested by the purchaser.
[b] Durability may be verified by the actual results of similar products equivalent in water-cement ratio and/or air content as well as the covering of reinforcing bar, etc. and production method.</td><td>C.3 Performance (concluded)</td><td>(Excerpt)<table><tr><th>Performance</th></tr><tr><td>Shall be safe to the regular load assumed at the time of use, and crack width shall be less than the permissible value.</td></tr><tr><td>Shall not break due to the load assumed at the time of end stage.</td></tr><tr><td>Durability shall be secured against deterioration assumed.</td></tr><tr><td>Workability for transportation, installation, assembly, etc. shall be secured.</td></tr><tr><th>Performance check method</th></tr><tr><td>See design document or C.6.</td></tr><tr><td>See design document or C.6.</td></tr></table>Notes [a] Confirmation of the end stage performance shall be made when requested by the purchaser.
[b] Durability may be confirmed by the actual results of such similar products as are equivalent in terms of water-cement ratio and/or covering of reinforcing bar, etc.</td><td>Made conform to JIS A 5362.

Durability is affected by air content and production method.</td></tr>
<tr><td>C.4 Shape, dimensions and dimensional tolerances</td><td>a) Shape Examples of shape of sheet pile are shown in Figure C.1, Figure C.2 and Figure C.3.</td><td>C.4 Shape, dimensions and dimensional tolerances</td><td>a) Shape Examples of shapes of retaining walls are shown in figure C.1 to figure C.3.</td><td>The shapes are not requirements but examples.
(The text and title of figure are made same.)</td></tr>
</table>

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
C.6 Quality of concrete	C.6.1 Materials and production methods The materials for concrete and the production method shall be as specified in clause 8.	C.7 Quality of concrete	C.7.1 Material and production method The material for concrete and the production method shall be as specified in **JIS A 5364**.	Clauses are replaced. These standards are quoted in other **JIS**s as normative references and some are overlapped with basic standards, etc. Basic standards, Annexes, Recommended specifications and quotation of clauses are reviewed.
	C.6.2 Compressive strength The compressive strength of concrete shall satisfy the value specified in Table C.5 after the predetermined material aging or at the time of prestress introduction. The compressive strength for Group II shall be as agreed between the parties concerned with delivery.		C.7.2 Compressive strength The compressive strength of concrete shall be verified by the compressive strength of the sample which has been processed by the same curing as the product or the compressive strength which has been controlled properly. When the predetermined material aging is finished or at the time of prestress introduction, the compressive strength shall satisfy the value specified in table C.5. In addition, products of Group II shall be subjected to the agreement between the parties concerned with delivery.	
C.7 Test method	C.7 Test method C.7.1 Compressive strength test of concrete The compressive strength test of concrete shall be as specified in **JIS A 1108**. The test piece shall be processed by the same curing as the product or be controlled properly. C.7.2 Flexural strength test of product The flexural strength test of product shall be as specified in **JIS A 5363**.	C.6 Test method	C.6 Test method C.6.1 Compressive strength test The compressive strength test shall be as specified in **JIS A 1132** and **JIS A 1108**. C.6.2 Bending strength test The bending strength test shall be as specified in **JIS A 5363**. The tester shall be of Class 1 or superior specified in **JIS B 7721**, or shall be at least equivalent in allowance thereto.	Clauses are replaced. These standards are quoted in other **JIS**s as normative references and some are overlapped with basic standards, etc. Basic standards, Annexes, Recommended specifications and quotation of clauses are reviewed.

<table>
<tr><th colspan="2">Current edition (JIS A 5373:2016)</th><th colspan="2">Previous edition (JIS A 5373:2010)</th><th rowspan="2">Reason for revision</th></tr>
<tr><th>No. and title of clause</th><th>Content</th><th>No. and title of clause</th><th>Content</th></tr>
<tr>
<td>Recommended specification C-1 Prestressed concrete sheet piles
C-1.2 Classification</td>
<td>C-1.2 Classification
The sheet piles shall be divided according to the shape, dimensions and critical cracking width strength as shown in Recommended specification C-1 Table 1, Recommended specification C-1 Table 2, Recommended specification C-1 Table 3, Recommended specification C-1 Table 4, or Recommended specification C-1 Table 5.
Recommended specification C-1 Table 1
<table>
<tr><th rowspan="2">Critical cracking width strength
kN・m</th><th colspan="2">Ultimate flexural strength
kN・m</th></tr>
<tr><th>Per sheet</th><th>Per metre</th></tr>
<tr><td></td><td>5.4
…
…</td><td>10.8
…
…</td></tr>
</table>
Recommended specification C-1 Table 2 to Table 5
<table>
<tr><th>Critical cracking width strength
kN・m</th><th>Ultimate flexural strength
kN・m</th></tr>
<tr><td></td><td>…
…</td></tr>
</table>
</td>
<td>Recommended specification C-1 Prestressed concrete sheet piles
C-1.2 Classification</td>
<td>C-1.2 Classification
The sheet piles shall be classified by the shape, dimensions and cracking moment as shown in recommended specification C-1 tables 1 to 5.
Recommended specification C-1 Table 1 to Table 5
<table>
<tr><th>Cracking moment
kN・m</th></tr>
</table>
</td>
<td>This is based on the review of the description method with the change of performance expression from cracking moment to strength.</td>
</tr>
</table>

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
C-1.3 Performance	The performance of sheet piles shall be as follows. C-1.3.1 Critical cracking width strength The critical cracking width strength (0.05 mm or under in crack width) of sheet piles shall be at least the value specified in Recommended specification C-1 Table 1, Recommended specification C-1 Table 2, Recommended specification C-1 Table 3, Recommended specification C-1 Table 4 or Recommended specification C-1 Table 5. C-1.3.2 Ultimate flexural strength The ultimate flexural strength of sheet piles shall be at least the value equivalent to the value twice the critical cracking width strength, and the value specified in Recommended specification C-1 Table 1, Recommended specification C-1 Table 2, Recommended specification C-1 Table 3, Recommended specification C-1 Table 4 or Recommended specification C-1 Table 5.	C-1.3 Performance	C-1.3.1 Bending strength The sheet pile shall be subjected to the bending strength test as specified in **C-1.6.2**. When it receives the cracking moment specified in recommended specification C-1 tables 1 to 5, it shall not produce the crack of over 0.05 mm in width.	This is because the performance expression is changed from bending strength to flexural strength.

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
C-1.4 Shape, dimensions and dimensional tolerances	The shape of sheet piles shall be as specified in Recommended specification C-1 Figure 1, Recommended specification C-1 Figure 2, Recommended specification C-1 Figure 3 or Recommended specification C-1 Figure 4. The dimensions and dimensional tolerances of sheet piles shall be as specified in Recommended specification C-1 Table 1, Recommended specification C-1 Table 2, Recommended specification C-1 Table 3, Recommended specification C-1 Table 4, Recommended specification C-1 Table 5 or Recommended specification C-1 Table 6. The tolerances on camber shall be as specified in Recommended specification C-1 Table 7. If the reference dimension is changed within the range specified in **C.4**, the manufacturer shall submit the data indicating that sheet piles conform to Table C.3 in the design document or performance test result when requested by the purchaser. Recommended specification C-1 Table 6 Dimensions and dimensional tolerances of sheet piles Recommended specification C-1 Table 7 Tolerances on camber of sheet piles	C-1.4 Shape, dimensions and dimensional tolerances	The shape, dimensions and dimensional tolerances of sheet piles shall be as specified in recommended specification C-1 figures 1 to 4 and recommended specification C-1 tables 1 to 6. The tolerances on curvature shall be as specified in recommended specification C-1 table 7. If the reference dimension is changed within the range as specified in C.4, the manufacturer shall present the data indicating that sheet piles conform to **C.3** by the design document or the performance test when requested by the purchaser. Recommended specification C-1 Table 6 Dimensions and dimensional tolerances Recommended specification C-1 Table 7 Tolerances on curvature	It is altered so as to be able to show conformity also by the performance test data.
C-1.6 Quality of concrete	The quality of concrete shall be as specified in **C.6.2**.	C-1.7 Quality of concrete	The compressive strength test of concrete shall be as specified in **C.7.2**.	Clauses are replaced.

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
C-1.7 Test method	C-1.7.1 Compressive strength test of concrete The compressive strength test of concrete shall be as specified in **C.7.1**. C-1.7.2 Flexural strength test of product The flexural strength test of sheet piles shall be conducted according to the loading methods specified in Recommended specification C-1 Figure 5, Recommended specification C-1 Figure 6 or Recommended specification C-1 Figure 7. The sheet piles shall be examined for the presence of cracking exceeding 0.05 mm in width at the crack width measuring point when the load equivalent to the critical cracking width strength specified in **C-1.3.1** is applied. Also, they shall be checked that the breakage does not occur when the load is applied up to the ultimate flexural strength in **C-1.3.2**.	C-1.6 Strength test	C-1.6.1 Compressive strength test The compressive strength test of sheet piles shall be as specified in **C.6.1**. C-1.6.2 Bending strength test When the sheet pile receives the force F equivalent to the cracking moment specified in recommended specification C-1 tables 1 to 5, the crack situation shall be investigated at the crack width measurement point shown in recommended specification C-1 figures 5 to 7. Moreover, the sheet pile shall be confirmed that it does not break when the force equivalent to twice the cracking moment specified in recommended specification C-1 tables 1 to 5 is applied.	Clauses are replaced. Overlap of normative references among basic standards, main body, Annexes and Recommended specifications of this Standard is reviewed, and a series of clauses and their expressions are harmonized.

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
C-1.7 Test method (concluded)	The load to be applied shall be calculated according to the following formula. $F = \frac{6M}{l} - Wg$ where, F : load to be applied (kN) M : critical cracking width strength (kN·m) l : span (m) $l = L/2$ and $b = l/3$ However, when l is smaller than $10H$, $l = 10H$. H : height of sheet pile (m) W : beam for load, total mass of round steel and steel sheet applied as force (t) However, when beam for load is integrated into a tester, the mass of beam for load is not included. g : acceleration of gravity (use 9.81 m/s²) ... Rubber sheet, etc. a) Note a) The rubber sheet, etc. should have such a hardness, thickness and width that the influence of the unevenness of the supporting position and the loading position can be absorbed or adjusted. In addition to the rubber sheet, mortar may be used. Recommended specification C-1 Figure 7 Flexural strength test method of sheet pile (wavy type)	C-1.6 Strength test (concluded)	The tester shall be of Class 1 or superior specified in **JIS B 7721**, or shall be at least equivalent in allowance thereto. ... Adjustor (rubber sheet, mor, etc.) Recommended specification C-1 Figure 7 Bending strength test (wavy type)	.... It is shown as reference that rubber sheet, etc. with hardness and size suitable to the product of which the test is performed should be selected.

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
Annex D (normative) Covered conduits D.3 Performance	The performance and the performance verification method of covered conduits shall be as follows. a) Product of Group I The performance of product shall conform to the provisions of Recommended specification D-1 and D-2. b) Product of Group II The performance of product shall conform to the provisions of clause 4 and clause 5 of **JIS A 5362**, and shall be determined as agreed between the parties concerned with delivery. Table D.3 may be applied for general specifications.	Annex D (normative) Covered conduits D.3 Performance	The performance of covered conduits shall conform to the provisions of table D.3. In addition, the performance items of Group II shall be subjected to the agreement between the parties concerned with delivery.	It is made clear that Group I conforms to each Recommended specification and Group II conforms to the basic standard **JIS A 5362**. In order to conform to **JIS A 5362**.

<table>
<tr><th colspan="2">Current edition (JIS A 5373:2016)</th><th colspan="2">Previous edition (JIS A 5373:2010)</th><th>Reason for revision</th></tr>
<tr><th>No. and title of clause</th><th>Content</th><th>No. and title of clause</th><th>Content</th><th></th></tr>
<tr>
<td>D.3 Performance (concluded)</td>
<td>Table D.3 Performance and performance verification method of covered conduits
<table>
<tr><th>Performance item</th><th>Performance</th></tr>
<tr><td>Service performance</td><td>It shall be able to be used smoothly under a load [a] expected during service, fulfilling the required function. The surface contact to water-flow shall be as smooth as practically acceptable.</td></tr>
<tr><td>Safety [b]</td><td>It shall not fracture under a load expected in design.</td></tr>
<tr><td>Durability [c]</td><td>Cracking, ageing of material properties or the like due to the expected impact shall not deteriorate the required performance.</td></tr>
<tr><td>Workability</td><td>It shall be transported, installed, assembled and joined safely and easily without abnormalities detrimental to use.</td></tr>
<tr><td colspan="2">[b] The verification on the safety ... by the purchaser.
[c] Durability may be verified by the actual results of similar products equivalent in water-cement ratio and/or air content as well as the covering of reinforcing bar, etc. and production method.</td></tr>
</table>
(Excerpt)</td>
<td>D.3 Performance (concluded)</td>
<td>Table D.3 Performance of covered conduits
<table>
<tr><th>Performance item</th><th>Performance</th></tr>
<tr><td>Service stage performance</td><td>Shall be safe to the regular load [a] assumed at the time of use, and crack width shall be less than the permissible value.</td></tr>
<tr><td>End stage performance [b]</td><td>Shall not break due to the load assumed at the time of end stage.</td></tr>
<tr><td>Durability [c]</td><td>Durability shall be secured against deterioration assumed.</td></tr>
<tr><td>Workability</td><td>Workability for transportation, installation, assembly, etc. shall be secured.</td></tr>
<tr><td colspan="2">[b] Confirmation of the end stage performance ... by the purchaser.
[c] Durability may be confirmed by the actual results of such similar products as are equivalent in terms of water-cement ratio and/or covering of reinforcing bar, etc.</td></tr>
</table>
(Excerpt)</td>
<td>Durability is affected by air content and production method.</td>
</tr>
</table>

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<tr><th colspan="2">Current edition (JIS A 5373:2016)</th><th colspan="2">Previous edition (JIS A 5373:2010)</th><th rowspan="2">Reason for revision</th></tr>
<tr><th>No. and title of clause</th><th>Content</th><th>No. and title of clause</th><th>Content</th></tr>
<tr><td>D.4 Shape, dimensions and dimensional tolerances</td><td>Table D.4 Dimensions and dimensional tolerances of covered conduits (pre-stressed concrete tube)
<table><tr><th colspan="2">Type</th><th>Internal diameter</th><th>Length</th><th>Thickness</th></tr><tr><td rowspan="2">Pre-stressed concrete tube</td><td>Dimensions</td><td>600 to 3 000</td><td>2 000 to 4 000</td><td>44 to 250</td></tr><tr><td>Tolerances</td><td>±4 to ±12</td><td>+10
−5</td><td>+4 to +12
−2 −6</td></tr><tr><td colspan="5">The detail of tolerances is as specified in the recommended specification.
.....
NOTE: ... such as chamfering or tube end reinforcing may be applied, unless it affects ... compromises the strength of tube.</td></tr></table>(Excerpt)</td><td>D.4 Shape, dimensions and dimensional tolerances</td><td>Table D.4 Dimensions and dimensional tolerances of covered conduits (pre-stressed concrete tube)
<table><tr><th colspan="2">Classification</th><th>Internal diameter</th><th>Length</th><th>Thickness</th></tr><tr><td rowspan="2">Pre-stressed concrete tube</td><td>Dimensions</td><td>500 to 3 000</td><td>2 000 to 5 000</td><td>40 to 250</td></tr><tr><td>Tolerances</td><td>±3 to ±12</td><td>+10
−5</td><td>+4 to +12
−2 −6</td></tr><tr><td colspan="5">For the details of the tolerances, see recommended specification.
.....
NOTE: Chamfer or tube end reinforcing are allowed, ... they do not compromise the strength ...</td></tr></table>(Excerpt)</td><td>500 in inside diameter is deleted and 5 000 in length is altered to 4 000 in length because there are no usage track records of 500 in inside diameter and 5 000 in length in terms of dimension. With deletion of 500 in inside diameter, thickness is specified as 44 or more and the tolerance on inside diameter is specified as ± 4.</td></tr>
<tr><td>D.6 Quality of concrete

D.7 Test method

D.7.2 Flexural strength test and internal pressure strength test of product</td><td>The flexural strength test and the internal pressure strength test of product shall be as specified in JIS A 5363.</td><td>D.6 Test method

D.7 Quality of concrete

D.6.2 Bending strength test and internal pressure strength test</td><td>The bending strength test and the internal pressure strength test shall be as specified in JIS A 5363.</td><td>Clauses are replaced.</td></tr>
</table>

<table>
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<tr><th>No. and title of clause</th><th>Content</th><th>No. and title of clause</th><th>Content</th><th></th></tr>
<tr>
<td>Recommended specification D-1 Prestressed concrete tube
D-1.2 Classification</td>
<td>Recommended specification D-1 Table 1 Classification of PC tubes
<table>
<tr><th colspan="2" rowspan="2">Division by type</th><th colspan="2">Division by shape and nominal designation range</th></tr>
<tr><th>Type S</th><th>Type NC</th></tr>
<tr><td rowspan="5">Internal pressure tube</td><td>Class 1</td><td>600 to 1 650</td><td rowspan="5">—</td></tr>
<tr><td>Class 2</td><td rowspan="4">600 to 2 000</td></tr>
<tr><td>Class 3</td></tr>
<tr><td>Class 4</td></tr>
<tr><td>Class 5</td></tr>
<tr><td rowspan="9">External pressure tube</td><td>High pressure Class 1</td><td rowspan="3">—</td><td>1 500 to 2 200</td></tr>
<tr><td>High pressure Class 2</td><td>1 500 to 2 600</td></tr>
<tr><td>High pressure Class 3</td><td>1 500 to 3 000</td></tr>
<tr><td>Class 1</td><td>600 to 1 800</td><td rowspan="8"></td></tr>
<tr><td>Class 2</td><td rowspan="4">600 to 2 000</td></tr>
<tr><td>Class 3</td></tr>
<tr><td>Class 4</td></tr>
<tr><td>Class 5</td></tr>
</table>
(Excerpt)</td>
<td>Recommended specification D-1 Prestressed concrete tubes
D-1.2 Type</td>
<td>Recommended specification D-1 Table 1 Types of PC tubes
<table>
<tr><th colspan="2" rowspan="2">Division by type</th><th colspan="3">Division by shape and nominal designation range</th></tr>
<tr><th>Type S</th><th>Type C</th><th>Type NC</th></tr>
<tr><td rowspan="5">Internal pressure tube</td><td>Class 1</td><td>500 to 1 650</td><td>—</td><td>—</td></tr>
<tr><td>Class 2</td><td rowspan="4">500 to 2 000</td><td rowspan="4">—</td><td rowspan="4">—</td></tr>
<tr><td>Class 3</td></tr>
<tr><td>Class 4</td></tr>
<tr><td>Class 5</td></tr>
<tr><td rowspan="9">External pressure tube</td><td>High pressure Class 1</td><td rowspan="3">—</td><td>900 to 1 350</td><td>1 500 to 2 200</td></tr>
<tr><td>High pressure Class 2</td><td>900 to 2 200</td><td>2 400 to 2 600</td></tr>
<tr><td>Class 1</td><td>500 to 1 800</td><td>900 to 3 000</td><td rowspan="6"></td></tr>
<tr><td>Class 2</td><td rowspan="4">500 to 2 000</td><td rowspan="5"></td></tr>
<tr><td>Class 3</td></tr>
<tr><td>Class 4</td></tr>
<tr><td>Class 5</td></tr>
</table>
(Excerpt)</td>
<td>The dimensions 600 to 3 000 are specified because there are no usage track records of 500 in inside diameter.

To respond to the required performance due to the revision of related standards.

Tubes of high pressure Class 1 to Class 3 (range of 900 to 1 350) are deleted due to the deletion of Type C. External pressure tubes of high pressure Class 1 to Class 3 (range of 1 500 to 3 000) are specified as Type NC.</td>
</tr>
</table>

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
D-1.3 Performance	The performance of PC tubes shall be as follows. D-1.3.1 Flexural cracking strength The flexural cracking strength of external pressure tube and internal pressure tube shall be at least the value specified in Recommended specification D-1 Table 2. D-1.3.2 Ultimate flexural strength The ultimate flexural strength shall be at least the value specified in Recommended specification D-1 Table 3. D-1.3.3 Internal pressure strength for testing The internal pressure strength in the internal pressure tube shall be at least the value specified in Recommended specification D-1 Table 4. D-1.3.4 Cracking internal pressure strength When verifying the cracking internal pressure strength as agreed between the parties concerned with delivery, the strength shall be at least the value specified in Recommended specification D-1 Table 4.	D-1.3 Performance D-1.3.1 Bending strength	The bending strength test of PC tubes specified in **D-1.6.1** shall be conducted. When the PC tube receives the cracking force specified in recommended specification D-1 table 2, it shall not produce any crack. Also, it does not break when the breaking force specified in recommended specification D-1 table 2 is applied.	The performance expression is changed from bending strength to flexural strength, and flexural cracking strength and ultimate flexural strength are defined based on the performance of each cracking. Nominal designation 500 is deleted because there are no usage track records.

<table>
<tr><th colspan="2">Current edition (JIS A 5373:2016)</th><th colspan="2">Previous edition (JIS A 5373:2010)</th><th>Reason for revision</th></tr>
<tr><th>No. and title of clause</th><th>Content</th><th>No. and title of clause</th><th>Content</th><th></th></tr>
<tr><td></td><td>Recommended specification D-1 Table 2
Flexural cracking strength of PC tubes
<table><tr><th rowspan="3">Nominal designation</th><th colspan="7">Internal pressure tube and external pressure tube</th></tr><tr><th colspan="7">Flexural cracking strength</th></tr><tr><th>High pressure Class 1</th><th>High pressure Class 2</th><th>High pressure Class 3</th><th>Class 1 Type S</th><th>Class 2 Type S</th><th>Class 3 Type S</th><th>Class 4 Type S</th></tr><tr><td>600</td><td></td><td></td><td></td><td>12.02</td><td>10.42</td><td>8.61</td><td>6.79</td></tr><tr><td>700</td><td></td><td></td><td></td><td>14.50</td><td>12.38</td><td>10.26</td><td>8.01</td></tr></table>(Excerpt)</td><td></td><td>Recommended specification D-1 Table 2
Bending strength force of PC tube
<table><tr><th rowspan="3">Nominal designation</th><th colspan="7">Type</th></tr><tr><th colspan="7">Internal pressure tube and external pressure tube</th></tr><tr><th colspan="7">Cracking force</th></tr><tr><th>High pressure Class 1</th><th>High pressure Class 2</th><th>High pressure Class 3</th><th>Class 1</th><th>Class 2</th><th>Class 3</th><th>Class 4</th></tr><tr><td>500</td><td></td><td></td><td></td><td>112</td><td>97</td><td>80</td><td>64</td></tr><tr><td>600</td><td></td><td></td><td></td><td>110</td><td>95</td><td>78</td><td>61</td></tr><tr><td>700</td><td></td><td></td><td></td><td>113</td><td>96</td><td>79</td><td>61</td></tr></table>(Excerpt)</td><td></td></tr>
</table>

<table>
<tr><th colspan="2">Current edition (JIS A 5373:2016)</th><th colspan="2">Previous edition (JIS A 5373:2010)</th><th rowspan="2">Reason for revision</th></tr>
<tr><th>No. and title of clause</th><th>Content</th><th>No. and title of clause</th><th>Content</th></tr>
<tr><td>D-1.3 Performance (concluded)</td><td>Recommended specification D-1 Table 4
Internal pressure strength for testing and cracking internal pressure strength of PC tube
<table><tr><th colspan="2">Type</th><th>Internal pressure strength for testing MPa</th><th>Cracking internal pressure strength MPa</th><th>Range of nominal designation</th></tr><tr><td rowspan="5">Internal pressure tube</td><td>Class 1</td><td>1.8</td><td>2.0</td><td>600 to 1 650</td></tr><tr><td>Class 2</td><td>1.4</td><td>1.6</td><td rowspan="4">600 to 2 000</td></tr><tr><td>Class 3</td><td>1.0</td><td>1.2</td></tr><tr><td>Class 4</td><td>0.6</td><td>0.8</td></tr><tr><td>Class 5</td><td>0.4</td><td>0.6</td></tr></table>(Excerpt)</td><td>D-1.3.2 Internal pressure strength</td><td>The internal pressure strength test specified in D-1.6.2 shall be conducted on the internal pressure tube. When the internal pressure tube receives the test internal pressure specified in recommended specification D-1 table 3, it shall not generate any leakage of water. Also, when it receives the cracking internal pressure specified in recommended specification D-1 table 3, it shall not produce any crack.
Recommended specification D-1 Table 3
Test internal pressure and cracking internal pressure of PC tube
<table><tr><th colspan="2">Type</th><th>Test internal pressure (MPa)</th><th>Cracking internal pressure (MPa)</th><th>Range of nominal designation</th></tr><tr><td rowspan="5">Internal pressure tube</td><td>Class 1</td><td>1.8</td><td>2.0</td><td>500 to 1 650</td></tr><tr><td>Class 2</td><td>1.4</td><td>1.6</td><td rowspan="4">500 to 2 000</td></tr><tr><td>Class 3</td><td>1.0</td><td>1.2</td></tr><tr><td>Class 4</td><td>0.6</td><td>0.8</td></tr><tr><td>Class 5</td><td>0.4</td><td>0.6</td></tr></table>(Excerpt)</td><td>Descriptions are brought together as a clause.

Nominal designation 500 is deleted because there are no usage track records.</td></tr>
</table>

<table>
<tr><th colspan="2">Current edition (JIS A 5373:2016)</th><th colspan="2">Previous edition (JIS A 5373:2010)</th><th>Reason for revision</th></tr>
<tr><th>No. and title of clause</th><th>Content</th><th>No. and title of clause</th><th>Content</th><th></th></tr>
<tr>
<td>D-1.4 Shape, dimensions and dimensional tolerances</td>
<td>Recommended specification D-1 Table 5 Shape and dimensions of PC tube, Type S
<table>
<tr><th>Nominal designation</th><th>Internal diameter
D</th><th>Thickness of core
t_c</th></tr>
<tr><td>600</td><td>612</td><td>44</td></tr>
<tr><td>700</td><td>724</td><td>46</td></tr>
<tr><td colspan="3">Work such as chamfering, notching, unevenness to the degree not detrimental to practical use may be applied, ... or compromises its strength.
Note [a] The effective length L may be 2 000 or 3 000.</td></tr>
</table>
(Excerpt)

Recommended specification D-1 Table 7 Dimensional tolerances
<table>
<tr><th rowspan="2">Range of nominal designation</th><th rowspan="2">Internal diameter
D</th><th>Effective length</th><th>Inner face length</th></tr>
<tr><th>Type S, Type NC
L</th><th>Type NC
L₁</th></tr>
<tr><td>600 to 900</td><td>±4</td><td colspan="2">+10
− 5</td></tr>
</table>
(Excerpt)</td>
<td>D-1.4 Shape, dimensions and dimensional tolerances</td>
<td>Recommended specification D-1 Table 4 Shape and dimension of PC tube, Type S
<table>
<tr><th rowspan="2">Nominal designation</th><th colspan="2">Internal diameter
D</th><th colspan="2">Thickness of core
t_c</th></tr>
<tr><th>I</th><th>II</th><th>I</th><th>II</th></tr>
<tr><td>500</td><td>500</td><td>500</td><td>42</td><td>40</td></tr>
<tr><td>600</td><td>612</td><td>600</td><td>44</td><td>44</td></tr>
<tr><td>700</td><td>724</td><td>700</td><td>46</td><td>46</td></tr>
<tr><td colspan="5">For the shape of PC tubes, where appropriate, processing is allowed if it does not affect the shape and it does not compromise the strength.
NOTE : The symbol I refers to the tube manufactured by centrifugal force, and the symbol II refers to the tube manufactured by rolling pressure.
Note [a] The effective length L may be 2 000, 3 000 or 5 000.</td></tr>
</table>
(Excerpt)

Recommended specification D-1 Table 7 Dimensional tolerances
<table>
<tr><th rowspan="2">Range of nominal designation</th><th rowspan="2">Internal diameter
D</th><th>Effective length</th><th>Inner face length</th></tr>
<tr><th>Type S, Type C, Type NC
L</th><th>Type C, Type NC
L₁</th></tr>
<tr><td>500</td><td>±3</td><td colspan="2">+10</td></tr>
<tr><td>600 to 900</td><td>±4</td><td colspan="2">− 5</td></tr>
</table>
(Excerpt)</td>
<td>Nominal designation 500 and Note [a] effective length are deleted because there are no usage track records. Only the centrifugal force method is applicable to the manufacture of core.

Nominal designation 500 is deleted. Type C is deleted in effective length and inner face length.</td>
</tr>
</table>

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
D-1.6 Quality of concrete D-1.7 Test methods 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 presence of 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 a hardness and width that the influence of the unevenness of the supporting position and the loading position can be absorbed.	D-1.7 Quality of concrete D-1.6 Strength test D-1.6.1 Bending strength test	For the bending strength test, the PC tubes shall be set as shown in recommended specification D-1 figure 1, the force shall be applied up the value of the cracking force specified in recommended specification D-1 table 2 multiplied by the effective length L, and the existence of any crack shall be examined. Furthermore, the force shall be applied up to the breaking force to confirm that the PC tube does not break. When the bending strength test is conducted, the rubber sheet of about 20 mm in thickness and the square log of about 150 mm × 150 mm shall be applied to the pressure surface and the support surface of the PC tube to ensure uniform distribution of force. The tester shall be of Class 1 or superior specified in **JIS B 7721**, or shall be at least equivalent in allowance thereto.	Clauses are replaced. "Strength test" is changed to "Test methods" because more than one test is conducted. "Quality of concrete" is moved behind and "**D-1.6**" is changed to "**D-1.7**". "Bending strength" is changed to "flexural strength". Also, "bending strength force" is changed to "flexural strength value", and the "load to be applied" is specified in the test method. It is shown as reference that rubber sheet with hardness and size suitable to the product of which the test is performed should be selected.

<table>
<tr><th colspan="2">Current edition (JIS A 5373:2016)</th><th colspan="2">Previous edition (JIS A 5373:2010)</th><th rowspan="2">Reason for revision</th></tr>
<tr><th>No. and title of clause</th><th>Content</th><th>No. and title of clause</th><th>Content</th></tr>
<tr><td></td><td>Recommended specification D-1 Table 8
Load corresponding to cracking strength and ultimate load of PC tube
<table><tr><th rowspan="3">Nominal designation</th><th colspan="7">Internal pressure tube/ external pressure tube</th></tr><tr><th colspan="7">Cracking load</th></tr><tr><th>High pressure Class 1</th><th>High pressure Class 2</th><th>High pressure Class 3</th><th>Class 1</th><th>Class 2</th><th>Class 3</th><th>Class 4</th></tr><tr><td>600</td><td></td><td></td><td></td><td>110</td><td>95</td><td>78</td><td>61</td></tr><tr><td>700</td><td></td><td></td><td></td><td>113</td><td>96</td><td>79</td><td>61</td></tr></table></td><td></td><td></td><td></td></tr>
<tr><td>D-1.7.3 Internal pressure strength test of product</td><td>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 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 the presence of any crack.</td><td>D-1.6.2 Internal pressure strength test</td><td>For the internal pressure strength test, a PC tube shall be set as shown in recommended specification D-1 figure 2, and the existence of leakage of water shall be examined when the pressure reaches the test internal pressure specified in recommended specification D-1 table 3, then the pressure shall be maintained for 3 min. Spots or water drops oozed on the surface of the tube are not deemed as the leakage of water. For the crack internal pressure, when the pressure reaches the value specified in recommended specification D-1 table 3, the existence of any crack shall be examined.
The pressure gauge of Grade 1.6 or superior specified in JIS B 7505-1 shall be used for the internal pressure strength test.</td><td></td></tr>
</table>

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
Recommended specification D-2 Prestressed concrete box culverts D-2.3 Performance	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 Prestressed concrete box culverts D-2.3 Performance	D-2.3.1 Bending strength The bending strength test of PC box culverts specified in **D-2.6.2** shall be conducted. When the PC box culvert receives the bending strength force specified in recommended specification D-2 table 2, it shall not produce the crack of width exceeding 0.05 mm. The checking on the performance to the breaking shall be as specified in **D.3** in accordance with the agreement between the parties concerned with delivery.	This is based on the review of the description method with the change of performance expression from bending strength to flexural strength.
D-2.4 Shape, dimensions and dimensional tolerances	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.	D-2.4 Shape, dimensions and dimensional tolerances	If the reference dimension is changed within the range as specified in **D.4**, the manufacturer shall present the data indicating that PC box culverts conform to **D.3** by the design document or the performance test when requested by the purchaser. NOTE 1 The shape of a product has a standard type and an inverted type. The shape of joint has a butting type, a fitting type, a receiving port type, and an insertion port type. NOTE 2 Products may have chamfer, packing window, sling hole or other processing which does not affect the shape and does not compromise the strength of PC box culverts.	It is altered so as to be able to show conformity in the performance test result as well.
D-2.6 Quality of concrete	The quality of concrete shall be as specified in **D.6.2**.	D-2.7 Quality of concrete	The compressive strength of concrete shall be as specified in **D.7.2**.	Clauses are replaced.

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
D-2.7 Test method		D-2.6 Strength test		Clauses are replaced.
D-2.7.1 Compressive strength test of concrete	The compressive strength test of concrete shall be as specified in **D.7.1**.	D-2.6.1 Compressive strength test	The compressive strength test of concrete shall be as specified in **D.6.1**.	Clauses are replaced.
D-2.7.2 Flexural strength test of product	The flexural strength test of PC box culverts shall be conducted in such a way that the PC box culvert is installed as shown in Recommended specification D-2 Figure 2, and it is examined for the presence of cracking exceeding 0.05 mm in width when the load equivalent to the flexural cracking strength specified in Recommended specification D-2 Table 2 is applied to the centre of span of the top slab of 100 mm in width. The load equivalent to the flexural cracking strength is shown in Recommended specification D-2 Table 5. When the flexural strength test is conducted, the load shall be uniformly distributed by inserting the rubber sheet [2)] to the pressure surface and the support surface with the loading width of 100 mm. Note [2)] The rubber sheet should have a hardness, thickness and width that the influence of the unevenness of the supporting position and the loading position can be absorbed.	D-2.6.2 Bending strength test	For the bending strength test, the PC box culvert shall be set as shown in recommended specification D-2 figure 2, the bending strength force specified in recommended specification D-2 table 2 shall be applied at the centre of span of the top slab in width of 100 mm, then the existence of any crack of width exceeding 0.05 mm shall be examined. When the bending strength test is conducted, the loading width shall be 100 mm and the rubber sheet shall be applied to the pressure surface and the support surface of the PC box culvert to ensure uniform distribution of force.	Overlap of normative references among main body, Annexes and Recommended specifications is reviewed, and a series of clauses and their expressions are harmonized. It is shown as reference that rubber sheet with hardness and size suitable to the product of which the test is performed should be selected.

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
D-2.8.3 Inspection method	a) Final inspection 2) Performance As the inspection of the performance, one arbitrary PC box culvert per lot shall be taken and inspected as specified in **D-2.7.2**. If it conforms to **D-2.3.1**, the lot shall be accepted. If it does not conform, two more PC box culverts shall be taken from the lot and reinspected. If both of them conform to the provisions, the lot shall be accepted after the first nonconforming product is eliminated. If one or more of them do not conform in the reinspection, the lot shall be rejected. b) Delivery inspection 1) Appearance The appearance shall be inspected in the same way as **a) 1)** or as follows. When adopting the sampling inspection, ... 2) Shape and dimensions The shape and dimensions shall be inspected in the same way as **a) 3)**.	D-2.8.3 Inspection method	a) Final inspection 2) Performance For the inspection of the performance, one arbitrary PC box culvert per one lot shall be taken and inspected as specified in **D-2.6.2**. If it conform to **D-2.3.1**, the lot shall be accepted. If it does not conform, two more PC box culverts shall be taken from the lot and reinspected, and if two of them conform to the provisions, the lot shall be accepted after the first nonconforming product is eliminated. If one or more of them do not conform, the lot shall be rejected. b) Delivery inspection 1) Appearance The appearance shall be inspected in the same way as **a) 1)**. When adopting the sampling inspection, ... 2) Shape and dimensions The shape and dimensions shall be inspected in the same way as **a) 3)**.	Subclause numbers are organized.
Annex E (normative) Piles E.2 Classification	Table E.2 Classification of Group I of piles (Excerpt) Deleted	Annex E (normative) Piles E.2 Classification	Table E.2 Classification of Group I of piles (Excerpt) – The PC pile has the same cross section over the entire length. The ST pile is a PC pile having the cross section which enlarges toward on one end.	The description overlapped is deleted.

<table>
<tr><th colspan="2">Current edition (JIS A 5373:2016)</th><th colspan="2">Previous edition (JIS A 5373:2010)</th><th rowspan="2">Reason for revision</th></tr>
<tr><th>No. and title of clause</th><th>Content</th><th>No. and title of clause</th><th>Content</th></tr>
<tr>
<td>E.3 Performance</td>
<td>The performance and the performance verification method shall be as follows.
a) Product of Group I The performance of product shall conform to the provisions of Recommended specification E-1.
b) Product of Group II The performance of product shall conform to the provisions of clause 4 and clause 5 of JIS A 5362, and shall be determined as agreed between the parties concerned with delivery. Table E.3 may be applied for general specifications.
Table E.3 Performance and performance verification method of poles
(Excerpt)
<table>
<tr><th>Performance item</th></tr>
<tr><td>Service performance</td></tr>
<tr><td>Safety [a)]</td></tr>
<tr><td>Durability [b)]</td></tr>
<tr><td>Workability</td></tr>
</table>
</td>
<td>E.3 Performance</td>
<td>E.3.1 Performance of body of piles
The performance of body of piles shall conform to the provisions of table E.3.
In addition, the performance items of Group II shall be subjected to the agreement between the parties concerned with delivery.
Table E.3 Performance of body of piles
(Excerpt)
<table>
<tr><th>Performance item</th></tr>
<tr><td>Service stage performance</td></tr>
<tr><td>End stage performance [a)]</td></tr>
<tr><td>Durability [b)]</td></tr>
<tr><td>Workability</td></tr>
</table>
</td>
<td>It is made clear that Group I conforms to each Recommended specification and Group II conforms to the basic standard JIS A 5362.</td>
</tr>
</table>

<table>
<tr><th colspan="2">Current edition (JIS A 5373:2016)</th><th colspan="2">Previous edition (JIS A 5373:2010)</th><th rowspan="2">Reason for revision</th></tr>
<tr><th>No. and title of clause</th><th>Content</th><th>No. and title of clause</th><th>Content</th></tr>
<tr><td rowspan="2">E.3 Performance (continued)</td><td>Table E.3 (continued)
<table><tr><th>Performance</th></tr><tr><td>It shall be able to be used smoothly under a load expected during service, fulfilling the required function.</td></tr><tr><td>It shall not fracture under a load expected in design.
Same performance for joint.</td></tr><tr><td>Cracking due to the expected impact, ageing of material properties or the like shall not deteriorate the required performance.</td></tr><tr><td>It shall be transported, installed, assembled and joined safely and easily without abnormalities detrimental to use.</td></tr></table></td><td rowspan="2">E.3 Performance (continued)</td><td>Table E.3 (continued)
<table><tr><th>Performance</th></tr><tr><td>Shall be safe to the regular load assumed at the time of use, and crack width shall be less than the permissible value.</td></tr><tr><td>Shall not break due to the load assumed at the time of end stage.</td></tr><tr><td>Durability shall be secured against deterioration assumed.</td></tr><tr><td>Workability for transportation, installation, assembly, etc. shall be secured.</td></tr></table></td><td rowspan="2">In order to conform to JIS A 5362.</td></tr>
<tr><td>Table E.3 (continued)
<table><tr><th>Performance verification method</th></tr><tr><td>See design document, E.7 or actual results.</td></tr><tr><td>See design document, E.7 or actual results.</td></tr></table></td><td>Table E.3 (continued)
<table><tr><th>Performance check method</th></tr><tr><td>See design document or E.6.</td></tr><tr><td>See design document or E.6.</td></tr></table></td></tr>
</table>

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
E.3 Performance (concluded)	Table E.3 (concluded) Notes a) The verification on the safety shall be made when requested by the purchaser. b) Durability may be verified by the actual results of similar products equivalent in water-cement ratio and/or air content as well as the covering of reinforcing bar, etc. and production method.	E.3 Performance (concluded)	Table E.3 (concluded) Notes a) Confirmation of the end stage performance shall be made when requested by the purchaser. b) Durability may be confirmed by the actual results of such similar products as are equivalent in terms of water-cement ratio and/or covering of reinforcing bar, etc.	Durability is affected by air content and production method.
	Deleted		E.3.2 Performance of joint part The performance of joint part shall be as follows. a) Bending strength of joint part The joint part shall not break when it is subjected to the break bending moment of the end stage performance for the body specified in **E.3.1**. b) Connectivity (squareness of joint end face) The joint end face shall be at right angles with the pile axis line within the deviation of 1 mm per 300 mm.	The performance of joint is included in Table E.3 because it needs to be the same as that of body.

<table>
<tr><th colspan="2">Current edition (JIS A 5373:2016)</th><th colspan="2">Previous edition (JIS A 5373:2010)</th><th rowspan="2">Reason for revision</th></tr>
<tr><th>No. and title of clause</th><th>Content</th><th>No. and title of clause</th><th>Content</th></tr>
<tr><td rowspan="2">E.4 Shape, dimensions and dimensional tolerances</td><td>a) Shape An example of shapes of piles is shown in Figure E.1.
A PC pile has the hollow cylinder body of the same cross section over the entire length. An ST pile is a PC pile having the diameter enlarged part at its end. A knot pile is a PC pile of which the body is provided with knots. The external diameter of the knot shall fall within such a range that the performance of the body is not compromised. Each pile may be provided with a suitable tip, a joint or a head, if necessary. The shapes of the products classified into Group II shall be as agreed between the parties concerned with delivery.</td><td rowspan="2">E.4 Shape, dimensions and dimensional tolerances</td><td>a) Shape An example of shapes of piles is shown in figure E.1.
A PC pile and a PRC pile have a hollow cylinder body, having a suitable tip, a joint or a head, if needed. An ST pile has a diameter enlarged part at its end. The maximum length of the diameter enlarged part shall be twice the external diameter of the diameter enlarged part. Also, an ST pile may be provided with a suitable tip, a joint or a head, if needed. The knot pile is a PC pile of which the body is provided with knots. The external diameter of the knot shall be such a degree that the performance of the body is not compromised. Also, the knot pile may be provided with a suitable tip, a joint or a head, if needed.</td><td>The description overlapped is deleted.</td></tr>
<tr><td>Table E.4 Dimensions and dimensional tolerances of piles
(Excerpt)<table><tr><th colspan="2">External diameter
mm</th></tr><tr><th>300 to 600</th><th>700 to 1 200</th></tr><tr><td>+5
−2</td><td>+7
−4</td></tr></table></td><td>Table E.4 Dimensions and dimensional tolerances of piles
(Excerpt)<table><tr><th colspan="2">External diameter
mm</th></tr><tr><th>300 to less than 700</th><th>700 to 1 200</th></tr><tr><td>+5
−2</td><td>+7
−4</td></tr></table></td><td>Correction of erroneous description.
Specification of dimensional tolerances is clarified.</td></tr>
</table>

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
E.4 Shape, dimensions and dimensional tolerances (concluded)	Table E.4 (continued) Thickness mm 60 to 150 +Not specified. −0	E.4 Shape, dimensions and dimensional tolerances (concluded)	Table E.4 (continued) Thickness mm 60 to 230 +Not specified. −0	
	Table E.4 (concluded) — The external diameter of pile shall be the average of two values measured along each orthogonal axis in one cross-section of the body, which is rounded to integer. — The thickness shall be the average of four values measured along each orthogonal axis in one cross-section of end part of the body, which is rounded to integer. — The tolerances on external diameters of the diameter enlarged part and the knot of pile are not specified. — The tolerances on length of diameter enlarged part and the interval between knots of pile are not specified.		Table E.4 (concluded) — The outside diameter of a pile shall be the average of two values measured along the axis perpendicular to a cross section of the body. — The thickness of a pile shall be the average of four values measured along the axis perpendicular to a cross section of end face of the body.	

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
E.5 Bar arrangement	The bar arrangement shall be as specified in clause 7, **JIS A 5364** and a design document. The bar arrangement of piles that satisfies **E.3** shall be determined by the manufacturer for each product.	E.5 Bar arrangement	The bar arrangement shall be as specified in **JIS A 5364** and a design document. However, according to the agreement between the parties concerned with delivery, the bar arrangement other than that of the recommended specification may be adopted in the range in which the product performance (including the provisions of **E.3**) is not compromised. For the bar arrangement of the piles, the manufacturer shall define the bar arrangement so as to satisfy **E.3** for each product.	The description is deleted because it is unnecessary for Group II.
E.6 Quality of concrete	E.6.1 Material and production method The materials for concrete and the production method shall be as specified in clause 8. E.6.2 Compressive strength The compressive strength of concrete shall be 80 N/mm^2 or more for the pile of 4.0 N/mm^2 in effective prestress and 85 N/mm^2 or more for the pile of over 4.0 N/mm^2 after the predetermined material aging. The compressive strength at the time of prestress introduction shall be 40 N/mm^2 or more. The compressive strength for Group II shall be as agreed between the parties concerned with delivery.	E.7 Quality of concrete	E.7.1 Material and production method The material for concrete and the production method shall be as specified in **JIS A 5364**. E.7.2 Compressive strength The compressive strength of concrete shall be verified by the compressive strength of the sample which has been processed by the same curing as the product or the compressive strength which has been controlled properly. When the predetermined material aging is finished, the strength shall be 80 N/mm^2 or more for the effective prestress of 4.0 N/mm^2, and the strength shall be 85 N/mm^2 or more for the effective prestress of over 4.0 N/mm^2. Moreover, the compressive strength at the time of prestress introduction shall be 40 N/mm^2 or more. In addition, products of Group II shall be subjected to the agreement between the parties concerned with delivery and the compressive strength of concrete may be as specified in Annex A of **JIS A 5364**.	The description is only for the compressive strength. The curing method of test piece is moved to **E.7.1**. Annex A of **JIS A 5364** is deleted because it does not constitute the provisions of this Standard.

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No. and title of clause	Content	No. and title of clause	Content	
E.7 Test method	E.7.1 Compressive strength test of concrete The compressive strength test of concrete shall be as specified in **JIS A 1108** or **JIS A 1136**. The test piece shall be processed by the same curing as the product or be controlled properly. E.7.2 Flexural strength test of product The flexural strength test of product shall be as specified in **JIS A 5363**. The test for Group II shall be as agreed between the parties concerned with delivery. a) In the flexural strength test, as shown in Figure E.2, 3/5 of the length of pile L shall be supported as a span l, and the load F equivalent to the flexural strength shall be applied at two points over the centre of the span. The load F shall be calculated according to the following formula in consideration of its own weight. $F = \frac{40M - mgL}{6L - 10b}$ where, F: load (kN) M: flexural strength (kN·m) L: length of pile (m) m: mass of pile (t) g: acceleration of gravity (use 9.81 m/s^2) b: bending span (m) $b = 1.0$ as a reference	E.6 Test method	E.6.1 Compressive strength test The compressive strength test shall be as specified in **JIS A 1132** and **JIS A 1108**, or **JIS A 1136**. E.6.2 Bending strength test The bending strength test shall be as specified in **JIS A 5363** and as follows. The tester shall be of Class 1 or superior specified in **JIS B 7721**, or shall be at least equivalent in allowance thereto. a) The bending strength of body shall be tested as shown in figure E.2. The length of 3/5 of pile length L shall be supported as a span B, the force F shall be applied at the centre of the span, and the loading force F shall be calculated from the bending moment according to the following formula. $F = \frac{40M - mgL}{6L - 10A}$ where, F: loading force (kN) M: bending moment (kN·m) m: mass of pile (t) g: standard acceleration of gravity (9.81 m/s^2) L: length of pile (m) A: bending span (m) $A = 1.0$	Clauses are replaced. $b = 1.0$ is taken as a reference because the bending span is set at 1.0 m or more in some flexural tests of joint.

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
E.7 Test method (continued)	When the effect from the shear force seems to become large at the time of the flexural strength test, the length of span l may be made larger than 3/5 of the length L of pile. The load F shall be calculated according to the following formula in consideration of its own weight. $F = \frac{8M - mg(2l - L)}{2(l - b)}$ where, F : load (kN) M : flexural strength (kN · m) L : length of pile (m) m : mass of pile (t) g : acceleration of gravity (use 9.81 m/s²) l : span (m) b : bending span (m) $b = 1.0$ as a reference b) It shall be confirmed that the required performance is satisfied when the load F equivalent to the flexural cracking strength and the ultimate flexural strength are applied. c) When the flexural strength test of a joint is conducted, the seam of joint shall be aligned with the centre of the span. Also, L at this time shall be the length after joining two piles.	E.6 Test method (continued)	When the effect of a shear force seems to become large at the time of the bending strength test, the length of span B may be made larger than 3/5 the length L of a pile. In this case, the loading force shall be calculated from the bending moment according to the following formula. $F = \frac{8M - mg(2B - L)}{2(B - A)}$ where, F : loading force (kN) M : bending moment (kN · m) m : mass of pile (t) g : standard acceleration of gravity (9.81 m/s²) B : span (m) L : length of pile (m) A : bending span (m) $A = 1.0$ b) The pile shall be confirmed that it does not break when it is subjected to the force F equivalent to the break bending moment. c) For the bending strength test of joint, the seam of joint shall be made coincident at the centre of span, then, the procedure of **a**) and **b**) shall be conducted.	This is based on the review of the description method with the change of performance expression from bending strength to flexural strength.

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No. and title of clause	Content	No. and title of clause	Content	
E.7 Test method (continued)	E.7.3 Axial-tension flexural strength test of product (reversed cyclic axial-tension flexural strength test) The axial-tension flexural strength test shall be as follows. The test for Group II shall be as agreed between the parties concerned with delivery. a) In the axial-tension flexural strength test, as shown in Figure E.3, a pile to which the axial-tension is applied shall be supported as a span l, and the load F equivalent to the flexural strength shall be applied at two positions over the centre of the span. The load F shall be calculated according to the following formula in consideration of its own weight.	E.6 Test method (continued)	E.6.3 Axial-tension bending strength test (positive/negative alternating repetition axial-tension bending strength test) The axial-tension bending strength test shall be as follows. The tester shall be of Class 1 or superior specified in **JIS B 7721**, or shall be at least equivalent in allowance thereto. a) For the axial-tension bending strength test of the body, as shown in figure E.3, the span part of B of the pile with the axial-tension N shall be supported, and the force F shall be applied at the centre of span. According to the following formula, the loading force F shall be calculated from the bending moment.	This is based on the review of the description method with the change of performance expression from bending strength to flexural strength. The span is specified as $B \geq 7.0$; however, it is made $l \geq 7.0$ as a reference in consideration of the case where it is under 7 m due to the knots, etc. According to the past records of the flexural test, the fact that the effect of shearing force becomes small if $l \geq 6D + 1.0$ m is satisfied.

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No. and title of clause	Content	No. and title of clause	Content	
	In the case of a positive load, $F = \frac{8M - mg(2l - L) - 8\delta N}{2(l - b)}$ In the case of a negative load, $-F = \frac{-8M - mg(2b - L) + 8\delta N}{2(l - b)} - mg$ where, F : load (kN) M : flexural strength (kN · m) L : length of pile (m) m : mass of pile (t) g : acceleration of gravity (use 9.81 m/s²) l : span (m) $l \geq 7.0$ as a reference δ : relative deflection of centre part (m) N : axial-tension (kN) b : bending span (m) $b = 1.0$ as a reference		In the case of a positive force, $F = \frac{8M - mg(2B - L) - 8\delta N}{2(B - A)}$ In the case of a negative force, $-F = \frac{-8M - mg(2A - L) + 8\delta N}{2(B - A)} - mg$ where, F : loading force (kN) M : bending moment (kN · m) m : mass of pile (t) g : standard acceleration of gravity (9.81 m/s²) L : length of pile (m) B : span (m) $B \geq 7.0$ δ : relative deflection of centre part (m) N : axial-tension (kN) A : bending span (m) $A = 1.0$	

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
E.7 Test method (concluded)	b) The axial-tension *N*, load *F*, and number of positive/negative alternating cycles shall satisfy the following conditions. 3) While the axial-tension *N* is applied, the repeated load *F* shall be 1/1.2 each of the flexural cracking strength and the ultimate flexural strength. The number of cycles shall be 10 or more. One cycle is defined as one positive/negative sequence. c) It shall be confirmed that the required performance is satisfied when the load *F* equivalent to the flexural cracking strength and the ultimate flexural strength are applied after the completion of positive/negative alternating repetition. E.7.4 Shearing strength test of product The shearing strength test of product shall be as specified in **JIS A 5363** and as follows. The test for Group II shall be as agreed between the parties concerned with delivery. The shearing strength test shall be conducted as shown in Figure E.4 or Figure E.5. The load *F* to be applied in the case of Figure E.4 shall be calculated according to the following formula.	E.6 Test method (concluded)	b) The axial-tension *N*, loading force *F*, and positive/negative alternating number of cycles shall satisfy the following conditions. 3) While the axial-tension *N* is applied, the repeated loading force *F* shall produce the moment of 1/1.2 each of the crack bending moment and the break bending moment. The number of cycles shall be 10 or more. One cycle is defined as one positive/negative sequence. c) It shall be confirmed that the pile does not break when it is subjected to the force *F* equivalent to the break bending moment after the completion of positive/negative alternating repetition. In addition, the loading force *F* shall be calculated according to the formula specified in a). E.6.4 Shear strength test The shear strength test of body shall be as specified in **JIS A 5363** and the following. The tester shall be of Class 1 or superior specified in **JIS B 7721**, or shall be at least equivalent in allowance thereto. The shear strength test of body shall be conducted using the method shown in figure E.4 or figure E.5. When using the method shown in figure E.4, the loading force shall be calculated from the shear strength according to the following formula.	This is based on the review of the description method with the change of performance expression from bending strength to flexural strength. The provision is revised because the shearing breakage test on the loading to simple beam is possible in the shearing test. The performance of joint is included in Table E.3 because it needs to be the same as that of body as the general performance.

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No. and title of clause	Content	No. and title of clause	Content	
	$F = 2Q$ where, F: load (kN) Q: shearing strength (kN) Deleted		$F = 2Q$ where, F: loading force (kN) Q: shear strength (kN) E.6.5 Measuring method of squareness of joint end face For the measurement of squareness of the joint end face, a square shall be set as it in line with the axis of external diameter of a pile, and the amount of inclinations about the external diameter of a pile shall be measured.	
Recommended specification E-1 Prestressed concrete piles E-1.1 Outline	This recommended specification describes the prestressed concrete piles in Group I of piles (hereafter referred to as piles) in Annex E. A PC pile is a pile of the same cross-section over the entire length. An ST pile is a PC pile having the diameter enlarged part at its end. A knot pile is a PC pile of which the body is provided with knots.	Recommended specification E-1 Prestressed concrete piles E-1.1 Outline	This recommended specification describes the prestressed concrete piles in Group I of piles (hereafter referred to as "PC piles") in Annex E. The pile with diameter enlarged part at its end (ST pile) and that provided with knots on the body (knot pile) are included.	The names of piles are defined.

Current edition (**JIS A 5373**:2016)		Previous edition (**JIS A 5373**:2010)		Reason for revision
No. and title of clause	Content	No. and title of clause	Content	
E-1.3 Performance	The performance of piles shall be as follows. E-1.3.1 Flexural cracking strength The flexural cracking strength of piles shall be at least the value specified in Recommended specification E-1 Table 1 and Recommended specification E-1 Table 2. E-1.3.2 Ultimate flexural strength The ultimate flexural strength of piles shall be at least the value specified in Recommended specification E-1 Table 1 and Recommended specification E-1 Table 2. For the joint the ultimate flexural strength shall be at least the value specified in Recommended specification E-1 Table 1. E-1.3.3 Shearing cracking strength The shearing cracking strength of piles shall be at least the value specified in Recommended specification E-1 Table 3. E-1.3.4 Ultimate flexural strength The ultimate flexural strength of piles shall be at least the value specified in Recommended specification E-1 Table 3.	E-1.3 Performance	E-1.3.1 Bending strength The bending strength of the pile body and the pile joint shall be as follows. a) Pile body The PC pile body shall be subjected to the bending strength test as specified in **E-1.6.2**. When it receives the crack bending moment specified in recommended specification E-1 tables 1 and 2, it shall not produce any crack. Also, the PC pile body shall not break with the value of break bending moment specified in recommended specification E-1 tables 1 and 2. b) Pile joint The PC pile joint shall be subjected to the bending strength test specified in **E-1.6.2** and shall not break with the value of break bending moment specified in recommended specification E-1 table 1. E-1.3.2 Shear strength The PC pile body shall be subjected to the bending strength test as specified in **E-1.6.4**. When it receives the shear crack strength specified in recommended specification E-1 table 3, it shall not produce any crack. Moreover, it shall not break with the value of shear break strength specified in recommended specification E-1 table 3. E-1.3.3 Connectability (squareness of joint end face) The joint end face shall be at right angles with the pile axis line within the deviation of 1 mm per 300 mm.	This is based on the review of the description method with the change of performance expression from bending strength to flexural strength. The connectivity of joint is included in E-1.4. The provision of connectivity is changed to that of shape, dimensions and dimensional tolerances.

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No. and title of clause	Content	No. and title of clause	Content	
E-1.3 Performance (concluded)	Recommended specification E-1 Table 1 Dimensions and flexural strength (when axial-tension $N = 0$ kN is exerted) Recommended specification E-1 Table 2 Axial-tension flexural strength of piles Flexural cracking strength Ultimate flexural strength Recommended specification E-1 Table 3 Shearing strength of piles Shearing cracking strength Ultimate flexural strength Recommended specification E-1 Table 2 Axial-tension flexural strength of piles When the axial-tension flexural strength test and the reversed cyclic axial-tension flexural strength test are conducted as the performance verification of the body of pile, the intermediate diameter among diameters of usually manufactured piles shall be used as the representative external diameter. The axial tension at this time shall be N_3.	E-1.3 Performance (concluded)	Recommended specification E-1 Table 1 Dimensions and bending strength (at application of axial-tension $N = 0$ kN) Recommended specification E-1 Table 2 Axial-tension bending strength Crack bending moment Break bending moment Recommended specification E-1 Table 3 Shear break strength Shear crack strength Shear break strength Recommended specification E-1 Table 2 Axial-tension bending strength When the performance check of the PC pile body involves the axial-tension bending strength test and the positive/negative alternating repetition axial-tension bending strength test, the representation external diameter shall be around the middle diameter of piles which are usually manufactured. The axial tension at this time shall be N_3.	Terms are altered.

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No. and title of clause	Content	No. and title of clause	Content	
E-1.4 Shape, dimensions and dimensional tolerances	The maximum length of the diameter enlarged part of ST pile shall be twice the external diameter of the diameter enlarged part. The maximum external diameter of knots of knot pile shall be the external diameter plus 150 mm or under for the external diameter of 450 mm or under, and the external diameter plus 200 mm or under for the external diameter of 500 mm or more. The interval between the knots shall be 1 m. Recommended specification E-1 Figure 1 Shape of pile c) The requirements of knots and interval between knots are added. Recommended specification E-1 Table 4 Dimensions and dimensional tolerances — The external diameter of pile shall be the average of two values measured along each orthogonal axis in one cross-section of the body, which is rounded to integer. — The thickness shall be the average of four values measured along each orthogonal axis in one cross-section of end part of the body, which is rounded to integer. — The tolerances on external diameters of the diameter enlarged part and the knot of pile are not specified. — The tolerances on length of diameter enlarged part and the interval between knots of pile are not specified.	E-1.4 Shape, dimensions and dimensional tolerances	An ST pile is a PC pile having a diameter enlarged part at its end. The maximum length of the diameter enlarged part shall be twice the external diameter of the diameter enlarge part. A knot pile is a PC pile of which the body is provided with knots. The external diameter of a knot part shall be in the range in which the performance of the body is not compromised, and for that whose external diameter is 450 mm or less, it shall be not more than the said external diameter + 150 mm, and for that whose external diameter is 500 mm or more, it shall be not more than the said external diameter + 200 mm. Moreover, the interval between knot parts shall be 1 m. Moreover, the interval between knot parts shall be 1 m. Recommended specification E-1 Figure 1 Shape of pile Recommended specification E-1 Table 4 Dimensions and dimensional tolerances — The outside diameter of a pile shall be the average of two values measured along the axis perpendicular to a cross section of the body. — The thickness of a pile shall be the average of four values measured along the axis perpendicular to a cross section of end face of the body.	The shapes of ST pile and knot pile are described in Annex, and only numerical values of dimensions are described herein. The dimensional tolerances are clarified.

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No. and title of clause	Content	No. and title of clause	Content	
E-1.5 Bar arrangement	a) ... The gap between the prestressing tendon and the reinforcing bar shall be one or more times their diameters, and shall be at least 4/3 of the maximum dimension of coarse aggregates. When reinforcing bars are arranged in order to join the pile heads, etc., the arrangement of reinforcing bars and the required quantity of reinforcing bars shall be determined as agreed between the parties concerned with delivery.	E-1.5 Bar arrangement	a) ... The gap between the prestressing tendon and the reinforcing bar shall be 1 or more times their diameters, and shall be 4/3 or more times the maximum dimension of coarse aggregates.	The description when the reinforcing bars are arranged in order to join the pile heads is added.
E-1.7 Test method	The mass of the body of PC pile used for the calculation of loading shall be the value specified in Recommended Specification E-1 Table 5. Recommended specification E-1 Table 5 Mass of PC piles ... is calculated according to the following formula and rounded off to the third decimal place .... Deleted	E-1.6 Strength test	In addition, the mass of PC pile body used for calculation of a loading force may be as specified in recommended specification E-1 table 5. Recommended specification E-1 Table 5 Mass of PC piles Note a) ... is calculated ... is rounded off to the third decimal place in accordance with **JIS Z 8401**. E-1.6.5 Measurement test of squareness of joint end face The measurement test of the squareness of a joint end face shall be as specified in **E.6.5**.	Rounding method of numbers is made clear. The measuring method of squareness with limited instruments is deleted because the usage of other reasonable measuring instruments and measuring methods are made available.

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No. and title of clause	Content	No. and title of clause	Content	
E-1.8 Inspections E-1.8.3 Inspection method a) Final inspection	2) Performance As the inspection of the performance of flexural cracking strength, two arbitrary piles per lot shall be taken and inspected as specified in **E-1.7.2**. If both of the two conform to **E-1.3.1**, the lot shall be accepted. If neither of the two conforms, the lot shall be rejected. If only one of the two does not conform, the lot shall be reinspected. In the reinspection, four more piles shall be taken from the lot, and if all the four conform to the provisions, the lot shall be accepted after the first non-conforming product is eliminated. If one or more of them do not conform in the reinspection, the lot shall be rejected. In the inspection of the ultimate load of the body, one of the first two piles in the inspection of the flexural cracking strength shall be inspected as specified in **E-1.7.2**. If it conforms to the provisions of **E-1.3.2**, the lot shall be accepted. If it does not conform, two more piles shall be taken from the lot and reinspected. If both of them conform to the provisions, the lot shall be accepted after the first non-conforming product is eliminated. If one or more of them do not conform in the reinspection, the lot shall be rejected.	E-1.8 Inspections E-1.8.3 Inspection method a) Final inspection	2) Performance For the inspection of the bending crack strength of the body, two arbitrary piles per one lot shall be taken and inspected as specified in **E-1.6.2**. If both of the two conform to **E-1.3.1**, the lot shall be accepted. If neither of the two conforms, the lot shall be rejected. If only one of the two does not conform, the lot shall be re-inspected. In the re-inspection, four more piles shall be taken from the lot, and if all the four conform to the provisions, the lot shall be accepted after the first non-conforming product is eliminated. If one or more of them do not conform in the re-inspection, the lot shall be rejected. The bending break strength of the body shall be inspected as follows. One of the first two piles for bending crack strength inspection shall be inspected as specified in **E-1.6.2**. When it conforms to the provisions of **E-1.3.1**, the lot shall be accepted. If it does not conform, two more piles shall be taken from the lot for re-inspection, and if both of them conform to the provisions, the lot shall be accepted after the first non-conforming product is eliminated. If one or more of them do not conform in the re-inspection, the lot shall be rejected.	The expression of performance is changed.

Errata for JIS (English edition) are printed in *Standardization and Quality Control*, published monthly by the Japanese Standards Association, and also provided to subscribers of JIS (English edition) in *Monthly Information*.

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