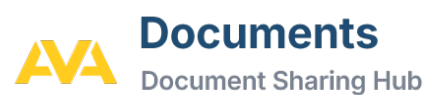


Australian/New Zealand Standard™

Cold-formed structural steel hollow sections



AS/NZS 1163:2016

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee BD-023, Structural Steel. It was approved on behalf of the Council of Standards Australia on 13 January 2016 and on behalf of the Council of Standards New Zealand on 21 January 2016.

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Australian Steel Institute
Austroads
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New Zealand Heavy Engineering Research Association
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Australian/New Zealand Standard™

Cold-formed structural steel hollow sections

Originated in Australia as AS A177—1969.
Previous and first joint edition AS/NZS 1163:2009.
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PREFACE

This Standard was prepared by the Standards Australia/Standards New Zealand Committee BD-023, Structural Steel, to supersede AS/NZS 1163:2009.

The objective of this Standard is to specify the requirements for manufacturers and suppliers of longitudinal welded cold-formed structural steel hollow sections for general structural and engineering applications.

This edition incorporates the following major changes to the previous edition:

- (a) Requirements for type testing and minimum production testing and inspections have been included in the normative Appendix on product conformity.
- (b) Test certificates are required to be available for all products produced to this Standard.
- (c) Alignment of definitions associated with test unit, test product, test sample, test specimen and test piece as noted in ISO 404, AS/NZS 3678, AS/NZS 3679.1 and AS/NZS 3679.2.
- (d) Inclusion of notations and additional definitions in Section 3.
- (e) The inclusion of cold-rolled and annealed coil with hot-rolled coil for steel feed.
- (f) Revision to the chemical composition part of the Standard, which includes a new set of limits for finished product analysis.
- (g) Provisions for suitability for zinc coating have been moved to the Appendix on purchasing guidelines.
- (h) Reformatting of the freedom from defects and testing provisions of the Standard.
- (i) Inclusion of the provision for individual length markings for New Zealand.
- (j) Minor revision to test and inspection certificates.
- (k) A new Appendix on formulae for calculating cross-section properties.
- (l) Definitions, clause numbering and layout across the four steel-product Standards AS/NZS 1163, AS/NZS 3678, AS/NZS 3679.1 and AS/NZS 3679.2 are consistent wherever possible.

A statement expressed in mandatory terms in a note to a table is deemed to be a requirement of this Standard.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

CONTENTS

	<i>Page</i>
1 SCOPE	4
2 NORMATIVE REFERENCES	4
3 DEFINITIONS AND NOTATIONS	5
4 DESIGNATION	9
5 MANUFACTURING PROCESS	9
6 CHEMICAL COMPOSITION	10
7 MANUFACTURING TOLERANCES	11
8 FREEDOM FROM DEFECTS	17
9 TESTING	18
10 MECHANICAL PROPERTIES	21
11 IDENTIFICATION, TEST AND INSPECTION CERTIFICATES	22
12 SAMPLING AND TESTING TO DEMONSTRATE PRODUCT CONFORMITY ..	24
13 ROUNDING OF NUMBERS	24
14 MANIPULATION	24
15 SECTION DESIGNATIONS, NOMINAL DIMENSIONS, CROSS-SECTION PROPERTIES AND MASSES	24
 APPENDICES	
A PURCHASING GUIDELINES	25
B PRODUCT CONFORMITY	27
C MANIPULATION	34
D SECTION DESIGNATIONS, DIMENSIONS AND CROSS-SECTION PROPERTIES	35
E FORMULAE FOR THE CALCULATION OF SECTIONAL PROPERTIES	45
 BIBLIOGRAPHY	 48

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard

Cold-formed structural steel hollow sections

1 SCOPE

This Standard specifies the requirements for the production and supply of cold-formed, electric resistance-welded, steel hollow sections used for structural purposes. It considers three strength grades, with or without impact properties, that are suitable for welding.

This Standard applies to structural hollow sections formed cold without subsequent heat treatment.

This Standard is intended for general structural and engineering applications. All grades specified in this Standard are suitable for—

- (a) welding, in accordance with AS/NZS 1554, Parts 1, 2, 5 and 7; and
- (b) fastening, as specified in AS 3990, AS 4100, AS/NZS 4600, AS 5100.6 and NZS 3404.

The Standard does not cover—

- (i) submerged arc-welded;
- (ii) helically welded; or
- (iii) U'ed and O'ed steel hollow sections.

Requirements for product conformity to this Standard are given in Appendix B.

Requirements for cold-bending of galvanized circular hollow sections are given in Appendix C.

NOTE: Guidelines to purchasers on requirements that should be specified by the purchaser and those that should or may be agreed on at the time of enquiry and order are given in Appendix A.

2 NORMATIVE REFERENCES

The following normative documents are referenced in this Standard:

NOTE: Documents referenced for informative purposes are listed in the Bibliography.

AS

1391	Metallic materials—Tensile testing at ambient temperature
1544	Methods for impact tests on metals
1544.2	Part 2: Charpy V-notch
1733	Methods for the determination of grain size in metals
2706	Numerical values—Rounding and interpretation of limiting values
3990	Mechanical equipment—Steelwork
4100	Steel structures
5100	Bridge design
5100.6	Part 6: Steel and composite construction

AS/NZS

1050	Methods for the analysis of iron and steel (series)
1050.1	Part 1: Sampling iron and steel for chemical analysis

AS/NZS

- 1554 Structural steel welding
- 1554.1 Part 1: Welding of steel structures
- 1554.2 Part 2: Stud welding (steel studs to steel)
- 1554.5 Part 5: Welding of steel structures subject to high levels of fatigue loading
- 1554.7 Part 7: Welding of sheet steel structures

- 4600 Cold-formed steel structures

ISO

- 643 Steels—Micrographic determination of the apparent grain size
- 2566 Steel—Conversion of elongation values
- 2566-1 Part 1: Carbon and low alloy steels
- 7870 Control charts
- 7870-3 Part 3: Acceptance control charts
- 10893 Non-destructive testing of steel tubes
- 10893-2 Part 2: Automated eddy current testing of seamless and welded (except submerged arc-welded) steel tubes for the detection of imperfections
- 10893-3 Part 3: Automated full peripheral flux leakage testing of seamless and welded (except submerged arc-welded) ferromagnetic steel tubes for the detection of longitudinal and/or transverse imperfections
- 10893-11 Part 11: Automated ultrasonic testing of the weld seam of welded steel tubes for the detection of longitudinal and/or transverse imperfections
- 14284 Steel and iron—Sampling and preparation of samples for the determination of chemical composition

NZS

- 3404 Steel Structures Standard
- 3404.1 Part 1: Materials, fabrication and construction

3 DEFINITIONS AND NOTATIONS

The notations used in this Standard are listed in Table 1.

For the purpose of this Standard, the definitions below apply.

3.1 Analysis

3.1.1 *Cast analysis*

Chemical analysis determined from test samples taken from the ladle, tundish or mould during casting.

3.1.2 *Product analysis*

Chemical analysis determined from a test sample of the finished product.

3.2 Batch

Hollow sections of the same size, nominal thickness and grade manufactured from the same heat, tube forming process (tube mill) and rolling (roll set up).

3.3 Can

To denote a capability or possibility that is available or that might occur.

3.4 Cold-formed hollow section

Hollow section formed and shaped at ambient temperature from a single strip of steel, both edges of which are continuously welded by the contact tip or induction coil electric resistance process.

3.5 Cold-rolled and annealed coil

Flat product manufactured by cold-rolling and subsequent annealing of hot-rolled coil.

Cold-rolled coil is hot-rolled coil that has been subjected to a cold-rolling reduction of more than 15%. The coil shall have a subcritical annealing cycle that recrystallises the structure and forms new ferrite grains. The resulting properties are similar to hot-rolled coil.

3.6 Crack

Narrow line of fracture on the surface.

3.7 Defects

Surface discontinuities, including cracks, laps and seams, in the base material and out-of-tolerance weld seams.

3.8 Factory production control

Operational techniques and all measures necessary to regulate and maintain the conformity of the product to the requirements of the relevant product Standard.

3.9 Fine grained steels

Steels which have an austenitic grain size of number 6 or finer when tested in accordance with AS 1733. Generally, steels are considered fine grained without the need for testing when the total aluminium content is greater than 0.020%, or when niobium $\geq 0.01\%$, titanium $\geq 0.01\%$ or vanadium $\geq 0.02\%$ are deliberately added as carbonitride formers.

NOTE: AS 1733 includes various recognized methods for grain size determination, including the McQuaid-Ehn method, and appropriate etching techniques.

3.10 Heat

A product of a ladle of steel melted in one vessel and processed under the same conditions.

3.11 Hot-rolled coil

Flat product manufactured by hot-rolling semi-finished products.

Includes products that have been subjected to a light cold-rolling pass, normally less than 5% reduction, known as a 'skin pass'.

3.12 Inspection

Judgement by competent personnel to determine acceptability against requirements.

3.13 Lap

Overlapping material partially connected with the base material.

3.14 Longitudinal direction

Direction parallel to the longitudinal weld seam.

3.15 Longitudinal weld seam

Continuous weld joining both edges of the single strip of steel used to form a hollow section.

3.16 Manufacturer

The business operating either the steel feed (Clause 5.1) or the finished product (Clause 5.2) manufacturing process.

3.17 May

Indicates the existence of an option.

3.18 Purchaser

Organization or person who is a recipient from a supplier of a steel product manufactured to this Standard.

3.19 Seams (defect)

Caused when defects in the semi-finished product are elongated and extended during rolling.

3.20 Shall

Indicates that a statement is mandatory.

3.21 Should

Indicates a recommendation.

3.22 Structural hollow sections

Tube intended to be used for structural purposes.

3.23 Supplier

An organization or person that provides a steel products manufactured to this Standard.

3.24 Testing

Chemical analysis tests and mechanical tests undertaken by an accredited laboratory as required by this Standard.

3.25 Test piece

Piece prepared for testing, made from a test specimen by a mechanical operation.

3.26 Test sample

Portion of material or product, or a group of items selected from a test batch or group by a sampling procedure.

3.27 Test specimen

Portion or a single item taken from the test sample for the purpose of eventually applying a particular test.

3.28 Transverse direction

Direction at right angles to the longitudinal weld seam.

3.29 Type testing

Testing performed to prove that the material is capable of conforming to the requirements of this Standard.

3.30 Unit

Length of hollow section.

TABLE 1
NOTATION

Symbol	Unit	Description
A	mm^2	cross-sectional area
A_{EL}	m^2/m	external surface area per unit length
A_{EM}	m^2/t	external surface area per unit mass
A_{cri}	mm^2	intermediate term for the calculation of internal corner radius properties
A_{cro}	mm^2	intermediate term for the calculation of external corner radius properties
A_{g}	mm^2	gross area of the cross-section
A_{h}	mm^2	intermediate term for the calculation of J and C
b	mm	nominal side dimension of a square hollow section (SHS) or shorter side of a rectangular hollow section (RHS)
C	mm^3	torsion modulus
c_1, c_2	mm	length of external corner profile of a square or rectangular hollow section
d	mm	nominal dimension of the longer side of a rectangular hollow section (RHS)
d_{i}	mm	inside diameter of a circular hollow section (CHS) (for calculation purposes)
d_{o}	mm	nominal outside diameter of a circular hollow section
$d_{\text{o,max.}}, d_{\text{o,min.}}$	mm	maximum and minimum outside external diameter of a circular hollow section, measured in the same plane
e	mm	deviation from straightness
h_{cri}	mm	intermediate term for the calculation of internal corner radius properties
h_{cro}	mm	intermediate term for the calculation of external corner radius properties
I	mm^4	second moment of area
I_{cri}	mm^4	intermediate term for the calculation of internal corner radius properties
I_{cro}	mm^4	intermediate term for the calculation of external corner radius properties
J	mm^4	torsion constant (polar moment of inertia for circular hollow sections only)
K	mm^2	intermediate term for the calculation of J and C
L	mm	length
L_{o}	mm	gauge length
m	kg/m	mass per unit length
n	—	diagonal axis passing through the opposing corner radii of a square hollow section (SHS)
o	%	out-of-roundness
R_{c}	mm	average of outer and inner corner radius for calculation purposes
r	mm	radius of gyration
r_{i}	mm	internal corner radius of a square or rectangular hollow section (for calculation purposes)
r_{o}	mm	external corner radius of a square or rectangular hollow section
S	mm^3	plastic section modulus
S_{o}	mm^2	original cross-sectional area
t	mm	nominal thickness
v	mm	total twist

(continued)

TABLE 1 (continued)

Symbol	Unit	Description
v_1	mm	twist measured at one end of a section
x	—	major principal axis
x_1	mm	concavity of a side of a square or rectangular hollow section
x_2	mm	convexity of a side of a square or rectangular hollow section
y	—	minor principal axis
Z	mm ³	elastic section modulus
θ	degrees	angle between adjacent sides of a square or rectangular hollow section
π	3.14159	pi

4 DESIGNATION

All grades shall be designated in the format shown in the following:

Examples:

AS/NZS 1163–C350

AS/NZS 1163–C350L0

where

AS/NZS 1163 = number of this Standard

C = cold-formed sections

350 = minimum yield strength in MPa (see Table 7)

L = guaranteed impact properties of the material (when applicable)

0 = low temperature impact test at 0°C (when applicable)

5 MANUFACTURING PROCESS

5.1 Steel feed

The steel shall be made by the basic oxygen process or an electric arc process.

Additional refining by vacuum arc remelt, electroslag refining or secondary steelmaking practices such as vacuum degassing or calcium injection, or both, is permitted.

The steel shall be fine grained and be made from fully killed, continuously cast steels. The coil shall be hot-rolled coil from a hot strip mill. Further processing of the coil by cold-rolling and annealing is permitted.

Cold-rolled coil is hot-rolled coil that has been subjected to a cold-rolling reduction of more than 15%. The coil shall have a subcritical annealing cycle that recrystallizes the structure and forms new ferrite grains. The resulting properties are similar to hot-rolled coil.

5.2 Finished product

The finished hollow section product shall be manufactured by the cold-forming process and use electric resistance-welding techniques to join the strip edges. The weld seam is to be longitudinal and shall have the external upset removed. There shall be no subsequent overall heat treatment on the finished product.

6 CHEMICAL COMPOSITION

6.1 General

The method of sampling for chemical analysis shall be in accordance with AS/NZS 1050.1 or ISO 14284. Chemical composition shall be determined in accordance with AS/NZS 1050 series Standards or other procedures that achieve the same, or better, degree of accuracy.

6.2 Cast analysis

A cast analysis of the steel shall be made from each heat to determine the proportions of the specified elements. In cases where it is impracticable to obtain samples from the liquid steel, analysis on test samples taken in accordance with AS/NZS 1050.1 or ISO 14284 may be reported as cast analysis.

The cast analysis of the steel shall conform to the limits given in Table 2 for the appropriate grade.

6.3 Product analysis

Chemical analysis of the finished product is not a requirement of this Standard. If the steel is subjected to a finished product analysis, the chemical composition shall conform to the limits given in Table 2 with the tolerances given in Table 3.

TABLE 2
CHEMICAL COMPOSITION

Grades (see Note 1)	Chemical composition (cast or product analysis) (see Note 2) % max.										
	C	Si	Mn	P	S	Cr	Mo	Al (see Note 3)	Ti	Micro-alloying elements	CE (see Note 4)
C250, C250L0	0.12	0.05	0.50	0.03	0.03	0.15	0.10	0.10	0.04	0.03 (see Note 5)	0.25
C350, C350L0	0.20	0.25	1.60	0.03	0.03	0.30	0.10	0.10	0.04	0.15 (see Note 6)	0.43
C450, C450L0	0.20	0.25 (see Note 7)	1.70	0.03	0.03	0.30	0.35	0.10	0.04	0.15 (see Note 6)	0.43

NOTES:

1 The use of sulphide modification manufacturing techniques for these grades is permitted.

2 The following elements may be present to the limits stated:

- (a) Copper 0.25%.
- (b) Nickel 0.25%.

3 Limits specified are for soluble or total aluminium.

4 Carbon equivalent (CE) is calculated from the following equation:

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

5 Applies to niobium and vanadium only. However, niobium greater than 0.010% is not permitted.

6 Applies to niobium, vanadium and titanium only. However, vanadium greater than 0.10% is not permitted.

7 For circular hollow sections (CHS), the silicon limit shall be 0.45.

TABLE 3
PRODUCT ANALYSIS TOLERANCES
FOR GRADES GIVEN IN TABLE 2

Element	Tolerance over maximum limit %
Carbon	0.02
Silicon	0.05
Manganese	0.10
Phosphorous	0.005
Sulphur	0.005
Chromium	0.05
Nickel	0.05
Molybdenum	0.03
Copper	0.04
Aluminium (total)	−0.005
Micro-alloying elements (niobium and vanadium only) for Grades C250, C250L0	0.06 with niobium no greater than 0.020
Micro-alloying elements (niobium, vanadium and titanium only) for Grades C350, C350L0, C450, C450L0	0.19 with vanadium no greater than 0.12

7 MANUFACTURING TOLERANCES

7.1 General

Tolerances and limits on the dimensions and mass of cold-formed hollow sections shall conform with the values given in—

- (a) Table 4, for shape and mass;
- (b) Table 5, for external corner profiles; and
- (c) Table 6, for length.

Where relevant, Tables 4, 5 and 6 shall be read in conjunction with Clause 7.2.

The internal corners of square and rectangular hollow sections shall be rounded.

NOTE: The internal corner profile is not specified.

TABLE 4
TOLERANCES FOR SHAPE AND MASS

Characteristic	Circular hollow sections	Square and rectangular hollow sections
External dimensions (d_o , d and b)	$\pm 1\%$, with a minimum of ± 0.5 mm and a maximum of ± 10 mm	$\pm 1\%$, with minimum of ± 0.5 mm
Thickness (t)	For $d_o \leq 406.4$ mm: $\pm 10\%$ For $d_o > 406.4$ mm: $\pm 10\%$ with a max of ± 2 mm	$\pm 10\%$
Out-of-roundness (o)	$\pm 2\%$ for hollow sections having a diameter to thickness ratio not exceeding 100 (see Note 1)	—
Concavity/convexity (see Note 2)	—	Max. 0.8% or 0.5 mm, whichever is greater
Squareness of sides	—	$90^\circ \pm 1^\circ$
External corner profile	—	See Table 5
Twist (v)	—	2 mm + 0.5 mm/m length
Straightness (see Note 3)	0.20% of total length	0.15% of total length
Mass (m) per unit length	Not less than 0.96 times the specified mass (Note 4) on individual lengths	

NOTES:

- 1 Where the diameter to thickness ratio exceeds 100, the tolerance on out-of-roundness becomes the subject of agreement between the manufacturer and purchaser.
- 2 The tolerance on convexity and concavity is independent of the tolerance on external dimensions.
- 3 The straightness tolerance applies to straightness in any one plane.
- 4 In lieu of any other requirement, the specified mass is considered to be the nominal mass as noted in Clause 15.

TABLE 5
EXTERNAL CORNER PROFILE

Perimeter mm	External corner profile (c_1 , c_2 or r_o) (see Note) mm
Equivalent to 50×50 or less	$1.5t$ to $3.0t$
Equivalent to greater than 50×50	$1.8t$ to $3.0t$

NOTE: The sides need not be tangential to the corner arcs.

TABLE 6
TOLERANCES ON LENGTH (see Note)

Type of length	Range mm	Tolerance
Random length	4000 to 16 000 with a range of 2000 per order item	10% of sections supplied may be below the minimum for the ordered range but not less than 75% of the minimum
Mill (or 'unspecified') length	All	+100 mm -0
Precision length	<6000	+5 mm -0
	$\geq 6000 \leq 10\ 000$	+15 mm -0
	>10 000	+5 mm + 1 mm/m -0

NOTE: The enquiry and order shall indicate the type of length required and the length or length range, as appropriate. Alternatively, length tolerances shall be specified at the time of order.

7.2 Measurement of size and shape

7.2.1 General

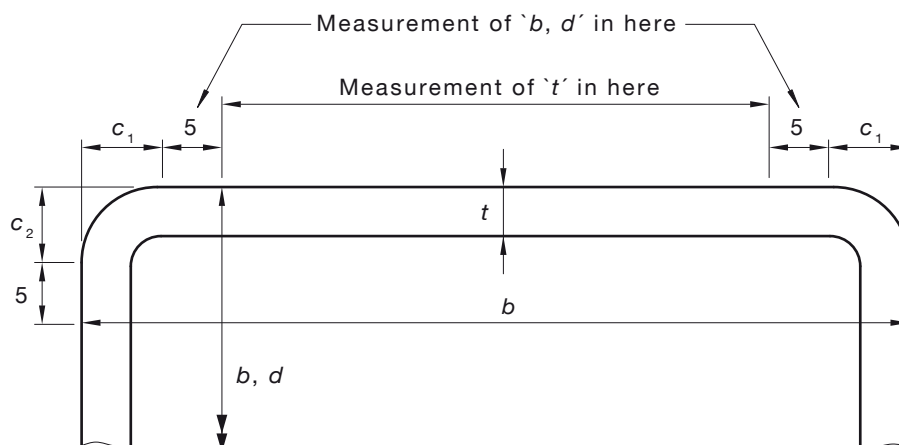
All external dimensions shall be measured at a distance from the end of the hollow section of not less than d_o for circular sections, b for square sections and d for rectangular sections, with a minimum of 100 mm.

7.2.2 External dimensions

For circular hollow sections, the diameter (d_o) shall be measured.

The limiting cross-sectional positions for measuring b and d of square and rectangular hollow sections are shown in Figure 1.

NOTE: A caliper gauge, circumference tape or other suitable device may be used at the discretion of the manufacturer.



NOTE: The 5 mm dimension is a maximum when measuring b or d , and a minimum when measuring t .

DIMENSIONS IN MILLIMETRES

FIGURE 1 LIMITING CROSS-SECTIONAL POSITIONS FOR MEASURING
DIMENSIONS b , d AND t FOR SQUARE OR RECTANGULAR HOLLOW SECTIONS

7.2.3 Thickness

The thickness (t) shall be measured at a position of not less than $2t$ or 25 mm, whichever is lesser, from the weld seam.

The limiting cross-sectional positions for measuring the thickness of square and rectangular hollow sections are shown in Figure 1.

NOTE: Thickness is normally measured within a distance of half the outside diameter or half the longer side length from the end of the section.

7.2.4 Out-of-roundness

The out-of-roundness (o) of a circular hollow section shall be calculated as a percentage, from the following equation:

$$o = \frac{d_{o\max} - d_{o\min}}{d_o} \times 100 \quad \dots 7.2.4$$

7.2.5 Concavity and convexity

The concavity (x_1) or the convexity (x_2) of the sides of a square or rectangular hollow section shall be measured as shown in Figure 2.

The percentage concavity or convexity shall be calculated as follows:

$$\frac{x_1}{b} \times 100\%$$

$$\frac{x_2}{b} \times 100\%$$

$$\frac{x_1}{d} \times 100\%$$

$$\frac{x_2}{d} \times 100\%$$

where

b and d are the lengths of the sides containing the concavity (x_1) or the convexity (x_2).

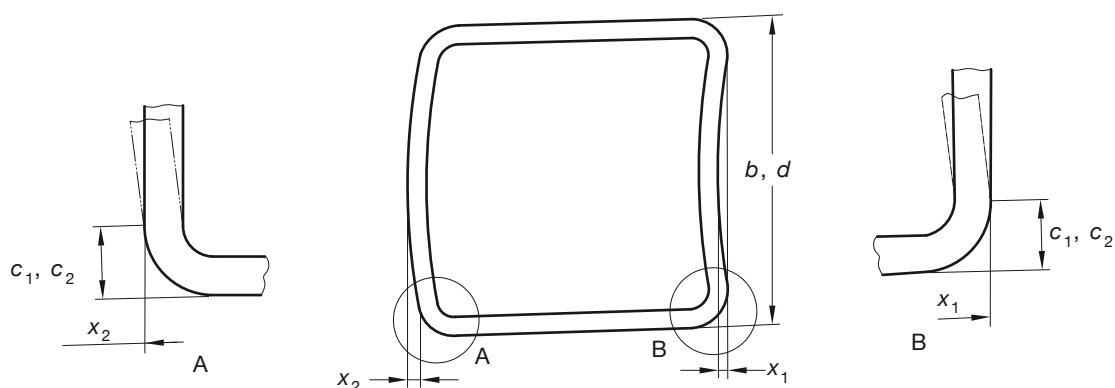


FIGURE 2 MEASUREMENT OF CONCAVITY/CONVEXITY OF SQUARE OR RECTANGULAR HOLLOW SECTIONS