

Australian/New Zealand Standard™

**Structural steel—Hot-rolled plates,
floorplates and slabs**



AS/NZS 3678:2016

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New Zealand Heavy Engineering Research Association
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Australian/New Zealand Standard™

Structural steel—Hot-rolled plates, floorplates and slabs

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee BD-023, Structural Steel, to supersede AS/NZS 3678:2011.

This Standard incorporates Amendment No. 1 (December 2017). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

The objective of this Standard is to specify requirements for manufacturers and suppliers of hot-rolled plates, floorplates and slabs for general structural and engineering applications.

This edition includes the following major changes from 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) Labelling requirements have been added to enable products compliant with this Standard to be traceable back to their corresponding test certificate.
- (e) 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 practicable.
- (f) Additional definitions in Clause 3.
- (g) Notation clause removed as duplicated in document. All notation defined in line.
- (h) Sulfur limits for some Z grades.
- (i) Internal soundness clause added.
- (j) Tensile test dimensions defined.
- (k) Through thickness tested grades down to 12 mm thickness.
- (l) Mechanically tested grades up to 200 mm thickness.
- (m) L0 impact tested grades have been reintroduced.
- (n) 'None' impact designation has been removed.
- (o) Option for zinc coating classification referring to AS/NZS 2312.2, Clause 9.1.

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.....	5
4 DESIGNATION.....	8
5 MANUFACTURING PROCESS	9
6 CHEMICAL COMPOSITION	10
7 MANUFACTURING TOLERANCES	13
8 FREEDOM FROM DEFECTS.....	13
9 TESTING	16
10 MECHANICAL PROPERTIES	19
11 IDENTIFICATION, TEST AND INSPECTION CERTIFICATES.....	22
12 SAMPLING AND TESTING TO DEMONSTRATE PRODUCT CONFORMITY ..	24
13 ROUNDING OF NUMBERS.....	24
14 MANIPULATION	25
APPENDICES	
A PURCHASING GUIDELINES	26
B PRODUCT CONFORMITY	28
C COLD-BENDING AND HOT-FORMING OF PLATE DURING FABRICATION..	33
D NOT USED.....	34
E NOT USED.....	35
F STEEL FOR SEISMIC AND FRACTURE CRITICAL APPLICATIONS (NEW ZEALAND ONLY)	36
 BIBLIOGRAPHY	 38

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard**Structural steel—Hot-rolled plates, floorplates and slabs****1 SCOPE**

This Standard specifies requirements for the production and supply of hot-rolled structural steel plates and floorplates for mechanically-tested steels, analysis-only steels, and mechanically-tested weathering steels. This Standard also specifies requirements for the production and supply of wide slabs as fully-killed analysis-only steel.

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 3404.1.

This Standard does not cover the following:

- (i) Steel plates for pressure equipment.
- (ii) Hot-rolled steel flat products.
- (iii) Quenched and tempered plate – structural and pressure vessel steel.

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

NOTES:

- 1 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 Guidelines on cold-bending and hot-forming of plate during fabrication are given in Appendix C.

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
1365	Tolerances for flat-rolled steel products

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

- 404 Steel and steel products—General technical delivery requirements
- 2566 Steel—Conversion of elongation values
- 2566-1 Part 1: Carbon and low alloy steels
- 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

SAE

- J403 Chemical compositions of SAE carbon steels

3 DEFINITIONS

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

A group of rolled parent plates consisting of finished steel of the same yield stress gradation (see Table 7) and product form, treated in the same manner and from the same heat.

3.3 Can

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

3.4 Crack

Narrow line of fracture on the surface.

3.5 Defects

Surface discontinuity, including cracks, laps and seams, with a depth or area, or both, greater than a specified limiting value.

3.6 Edge conditions**3.6.1 Trimmed edge**

Edge produced by the removal of material by mechanical means or gas cutting, also referred to as sheared, slit or thermal-cut edge.

3.6.2 Untrimmed edge

Edge produced by the rolling between horizontal rolls, with or without vertical edging rolls, also referred to as mill, universal or rolled edge.

3.7 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.

3.8 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.

3.9 Floorplate

Hot-rolled product supplied flat, having a rolled raised pattern at regular intervals on one surface, with width greater than or equal to 900 mm, with a nominal thickness greater than or equal to 4.50 mm. Edges are either trimmed or untrimmed.

3.10 Heat

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

3.11 Imperfection

Surface discontinuities, other than cracks, lap and seams, with a depth or area or both less than or equal to a specified limiting value.

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 of the greatest extension of the steel during rolling (X direction).

3.15 Manufacturer

The business operating the hot rolling process producing the finished steel product.

3.16 May

Indicates the existence of an option.

3.17 Normalized

Steel produced by heating to a suitable temperature above the transformation range (typically 870°C to 930°C) and then cooling in still air to a temperature substantially below the transformation range.

3.18 Parent plate

Designates the whole of the plate which has the same thickness and heat treatment (if any) as that of the finished product, obtained from one slab. (Also known as ‘rolled plate’ or ‘mother plate’).

3.19 Plate

Hot-rolled product supplied flat, with a width greater than or equal to 900 mm, with nominal thickness greater than or equal to 4.50 mm. Edges are either trimmed or untrimmed.

3.20 Purchaser

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

3.21 Seams

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

3.22 Shall

Indicates that a statement is mandatory.

3.23 Should

Indicates a recommendation.

3.24 Slab

A semi-finished rolled or continuously-cast product with a rectangular cross-section, with thickness greater than 100 mm and a width-to-thickness ratio of not less than 4:1.

3.25 Supplier

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

3.26 Testing

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

3.27 Test piece

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

3.28 Test sample

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

3.29 Test specimen

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

3.30 Through-thickness direction

Direction perpendicular to the plate surface (Z direction).

3.31 Transverse direction

Direction at right angles to the direction of the greatest extension of the steel during rolling (Y direction).

3.32 Type testing

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

4 DESIGNATION

4.1 General

All grades shall be designated in accordance with the procedures specified in Clause 4.2 or Clause 4.4, as applicable. Additional modifications may be designated with the procedures specified in Clause 4.3, Clause 4.5 or Clause 4.6, as applicable. All designations shall include the number of this Australian/New Zealand Standard, i.e. AS/NZS 3678.

Grades designated with a WR prefix, offer enhanced atmospheric corrosion resistance over unalloyed grades.

4.2 Mechanically tested grades

Mechanically tested carbon and carbon-manganese grades and low alloy (weathering) grades shall be designated as follows:

Examples: AS/NZS 3678-250
AS/NZS 3678-WR350

where

AS/NZS 3678 = number of this Standard
250, 350 = grade designation
WR = weather-resistant

4.3 Additional properties

In addition to Clause 4.2, the grade designation for the steel may also indicate mechanical testing in accordance with the following:

- (a) *Through-thickness tensile properties* Where material has specified minimum through-thickness tensile properties, this is indicated by the suffix 'Z' indicating that the material has been through-thickness tested. This suffix is followed by the value of the guaranteed minimum reduction in area (see Clause 10.3).

Example: AS/NZS 3678-250Z25

- (b) *Impact properties* Where material has specified minimum impact properties, this is indicated by the quality suffix 'L' or 'Y' indicating that the material has been impact tested at the minimum energy requirement. The suffix is followed by the value of a temperature equal to the actual impact test temperature that is at or below 0°C.

Examples: AS/NZS 3678-WR350L0
AS/NZS 3678-350L20
AS/NZS 3678-350Y40

NOTE: A grade designated at one impact test temperature is suitable for use at all higher impact test temperatures.

- (c) Any combination of these additional properties is valid.

Example: AS/NZS 3678-350Y40Z35

- (d) For New Zealand only, a seismic grade designation suffix S0 is available (see Appendix F).

Example: AS/NZS 3678-300S0

4.4 Analysis grades

The designation for analysis grades shall consist of a five-digit alphanumeric system in accordance with the following:

- (a) First character, a letter indicating deoxidation practice, as follows:
 - (i) A = aluminium killed.
 - (ii) K = silicon killed, with or without aluminium additions.
- (b) A four-digit series designation whereby the first two digits indicate the type of steel, as follows:
 - (i) 10xx plain carbon steels.
 - (ii) 15xx carbon-manganese steels.

The last two digits indicate the approximate mean of the specified carbon range based on corresponding SAE J403 grade.

Example: AS/NZS 3678-A1006

4.5 Modification symbol

Modification symbols may be added to the grade designation specified in Clause 4.4.

The prefix letter 'X' shall be used to indicate a major deviation in chemical composition of any grade from the corresponding SAE J403 grade.

Example: AS/NZS 3678-XK1016

4.6 Fine grained steels

A fine grained modification symbol may be added to the grade designations specified in Clauses 4.2 and 4.4.

The suffix letter 'FG' shall be used to indicate that the material was produced using a fine grained steelmaking practice [see Paragraph A2, Item (q)].

Examples: AS/NZS 3678-250FG
 AS/NZS 3678-350Y40Z35FG
 AS/NZS 3678-K1016FG

NOTE: Fine grained steelmaking practice is a steelmaking practice that is intended to produce killed steel that is capable of meeting the requirements for fine austenitic grain size after post rolling reheating into the normalizing temperature range (Clause 3.17). This may have no effect on the grain size of the as rolled steel. Typically applicable to the control of the austenite grain size when the as rolled steel is subsequently reheated in the normalizing temperature range, such as for hot forming. (Refer to Appendix C, Paragraph C2).

5 MANUFACTURING PROCESS

5.1 Steel feed

The steel shall be made by either 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 fully killed and continuously cast.

5.2 Finished product

Unless otherwise agreed at the time of ordering, the delivery condition is at the manufacturer's discretion [see Paragraph A2, Item (n)].

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 Tables 1 and 2 for the appropriate grade.

6.3 Product analysis

The chemical analysis of the finished product is not a requirement of this Standard. If the steel is subjected to a product analysis, the analysis shall conform to the limits given in Table 1 or Table 2, and Table 3.

6.4 Residual elements

Elements not given in Table 1 or Table 2 for the relevant grade shall not be intentionally added to the steel without the agreement of the purchaser.

TABLE 1
CHEMICAL COMPOSITION—MECHANICAL PROPERTY GRADES

Grade designation (see Notes 1, 8 and 9)	Cast or product analysis %															
	C	Si		Mn	P (see Note 10)	S (see Note 9)	Cr (see Note 2)		Ni (see Note 2)	Cu (see Note 2)		Mo (see Note 2)	Al (see Notes 3 and 7)	Ti	Micro-alloying elements	CE (see Note 4)
	Max.	Min.	Max.	Max.	Max.	Max.	Min.	Max.	Max.	Min.	Max.	Max.	Max.	Max.	Max.	Max.
200	0.15	—	0.35	0.60	0.030	0.030	—	0.25	0.30	—	0.40	0.08	0.100	0.040	(see Note 5)	0.25
250	0.22	—	0.50	1.70	0.040	0.030	—	0.25	0.30	—	0.40	0.08	0.100	0.040	(see Note 5)	0.44
300	0.22	—	0.50	1.70	0.040	0.030	—	0.25	0.30	—	0.40	0.08	0.100	0.040	(see Note 5)	0.44
350	0.22	—	0.50	1.70	0.040	0.030	—	0.25	0.30	—	0.40	0.08	0.100	0.040	(see Note 6)	0.48
400	0.22	—	0.55	1.70	0.040	0.030	—	0.25	0.50	—	0.40	0.35	0.100	0.040	(see Note 6)	0.48
450	0.22	—	0.55	1.80	0.040	0.030	—	0.25	0.50	—	0.60	0.35	0.100	0.040	(see Note 6)	0.48
WR350	0.14	0.15	0.75	1.70	0.160	0.030	0.35	1.05	0.55	0.15	0.50	0.10	0.100	0.040	(see Note 6)	—

— = no specified limit

NOTES:

- The use of sulfide modification steelmaking techniques (such as Ca addition) is permitted for listed grades.
- Except for grades 450, 450Lxx, 450Yxx, WR350 and WR350Lxx, a Cr + Ni + Cu + Mo = 1.00% maximum applies.
- Limits specified are for both acid soluble and total aluminium.
- Carbon equivalent (CE) is calculated from the following equation based on actual cast or product analysis:

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$
- Niobium: 0.020% maximum. Vanadium: 0.050% maximum. Niobium plus vanadium: 0.06% maximum.
- Vanadium: 0.10% maximum. Niobium: 0.06% maximum. Niobium plus vanadium plus titanium: 0.15% maximum.
- Where a grade is ordered as fine grained steelmaking practice (Appendix A) see Clause 3.8 for minimum limits.
- Chemical composition requirements are the same for all impact tested and through thickness tensile tested variants, see Clause 4.3.
- For Z25 grades sulfur 0.008% maximum. Z35 grades sulfur 0.005% maximum.
- Boron shall not be intentionally added to the steel without the agreement of the purchaser.
- For WR350 the maximum phosphorus content of 0.16 wt% is only permitted for plate thicknesses up to 20 mm. For plate thicknesses over 20 mm to 80 mm, maximum phosphorus content is 0.04 wt%.

TABLE 2
CHEMICAL COMPOSITION—ANALYSIS GRADES

Grade (see Notes 1 and 5)	Cast analysis %											
	C		Si	Mn		P	S	Cr	Ni	Cu	Al (see Notes 2 and 3)	Ti
	Min.	Max.	Max.	Min.	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.
A1006	—	0.08	0.03	—	0.40	0.040	0.030	(see Note 4)	(see Note 4)	(see Note 4)	0.100	0.040
A1010	0.08	0.13	0.03	0.30	0.60	0.040	0.030	(see Note 4)	(see Note 4)	(see Note 4)	0.100	0.040
K1042	0.39	0.47	0.50	0.60	0.90	0.040	0.040	(see Note 4)	(see Note 4)	(see Note 4)	0.100	0.040
XK1016	0.12	0.18	0.50	0.80	1.20	0.040	0.040	(see Note 4)	(see Note 4)	(see Note 4)	0.100	0.040
XK1515	0.12	0.18	0.50	1.20	1.50	0.040	0.040	(see Note 4)	(see Note 4)	(see Note 4)	0.100	0.040

NOTES:

- 1 The use of sulfide modification steelmaking techniques (such as Ca addition) is permitted for listed grades.
- 2 Limits specified are for both acid soluble and total aluminium.
- 3 Where a grade is ordered as fine grained steelmaking practice (Appendix A) see Clause 3.8 for minimum limits.
- 4 The following elements may be present to the limits stated, subject to a total content of 1.00%:
 - (a) Copper: 0.40%.
 - (b) Nickel: 0.50%.
 - (c) Chromium: 0.25%.
 - (d) Molybdenum: 0.10%.
- 5 Boron shall not be intentionally added to the steel without the agreement of the purchaser.