AS/NZS 4671:2001
(Incorporating Amendment No. 1)

Australian/New Zealand Standard™

Steel reinforcing materials

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee BD-084, Reinforcing and Prestressing Materials. It was approved on behalf of the Council of Standards Australia on 18 January 2001 and on behalf of the Council of Standards New Zealand on 9 March 2001. It was published on 2 April 2001.

The following are represented on Committee BD-084:

Association of Consulting Engineers, Australia
Australian Chamber of Commerce and Industry
Australian Post Tensioning Association
Australian Steel Association
AUSTROADS
Bureau of Steel Manufacturers of Australia
Cement & Concrete Association of New Zealand
Galvanizers Association of Australia
Institution of Professional Engineers New Zealand
Master Builders Australia
National Precast Concrete Association Australia
New Zealand Manufacturers' Federation
Steel Reinforcement Institute of Australia

Keeping Standards up-to-date

Standards are living documents which reflect progress in science, technology and systems. To maintain their currency, all Standards are periodically reviewed, and new editions are published. Between editions, amendments may be issued. Standards may also be withdrawn. It is important that readers assure themselves they are using a current Standard, which should include any amendments which may have been published since the Standard was purchased.

Detailed information about joint Australian/New Zealand Standards can be found by visiting the Standards Australia web site at www.standards.com.au or Standards New Zealand web site at www.standards.co.nz and looking up the relevant Standard in the on-line catalogue.

Alternatively, both organizations publish an annual printed Catalogue with full details of all current Standards. For more frequent listings or notification of revisions, amendments and withdrawals, Standards Australia and Standards New Zealand offer a number of update options. For information about these services,

AS/NZS 4671:2001
(Incorporating Amendment No. 1)

Australian/New Zealand Standard™

Steel reinforcing materials

Originated in Australia as part of AS A81—1958, AS A82—1958, AS A83—1958, AS A84—1958, AS A92—1958 and AS A97—1965.
Previous Australian editions AS 1302—1991, AS 1303—1991 and AS 1304—1991.
Originated in New Zealand as part of NZS 197:1949 NZS 1255:1956, NZS 1693:1962, NZS 1879:1964 and NZS 3423P:1972.
Previous New Zealand editions NZS 3421:1975, NZS 3422:1975 and NZS 3402:1989.
AS 1302—1991, AS 1303—1991, AS 1304—1991, NZS 3421:1975, NZS 3422:1975 and NZS 3402:1989 jointly revised, amalgamated and redesignated AS/NZS:4671:2001.
Reissued incorporating Amendment No. 1 (5 June 2003).

PREFACE

This Standard was prepared by the Standards Australia/Standards New Zealand Committee BD/84, Reinforcing and Prestressing Materials, to supersede the following Standards:

AS 1302—1991 *Steel reinforcing bars for concrete*

AS 1303—1991 *Steel reinforcing wire for concrete*

AS 1304—1991 *Welded wire reinforcing fabric for concrete*

NZS 3402:1989 *Steel bars for the reinforcement of concrete*

NZS 3421:1975 *Specification for hard drawn mild steel wire for concrete reinforcement. Metric units*

NZS 3422:1975 *Specification for welded fabric of drawn steel wire for concrete reinforcement*

This Standard incorporates Amendment No. 1 (5 June 2003). 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.

To permit the reinforcing steel and reinforced concrete design industries with time to adjust to the new Standard, the above six standards will remain current and will be withdrawn 12 months from the date of publication of this Standard.

The objective of the Standard is to provide a single specification of material requirements for steel bars, wire and mesh, intended for use in reinforced concrete structures which have been designed in accordance with AS 3600 or NZS 3101.1.

Differences between this Standard and current Standards are briefly outlined below.

1 General

A major departure from the current Standards is that this document applies to reinforcement generally, irrespective of the process of its manufacture.

Although closely aligned technically with both ISO 6935, *Steel for the reinforcement of concrete,* and the European Pre-Standard DDENV 10080, *Steel for the reinforcement of concrete—Weldable ribbed reinforcing steel B500 — Technical delivery conditions for bars, coils and welded fabric,* the Standard is not classed as 'technically equivalent' to either of these documents primarily because—

(a) both ISO 6935 and ENV 10080 require mandatory third party assessment of compliance, contrary to the principles of Standards Australia and Standards New

the Grade 300 material corresponds closely to the current New Zealand Standard. Plain round material other than grade 300E is required to correspond to AS/NZS 3679.

Requirements for Grade 500 steel have been developed from ENV 10080, while those for earthquake-resistant applications have been developed from the current edition of NZS 3402.

3 Ductility classes

The need to provide reinforcement with ductility appropriate to earthquake-resistant concrete structures, coupled with recent investigations into the structural consequences of the relatively low ductility of cold-worked reinforcement, has led to the introduction of three ductility classes. These are distinguished in requirements by the letters 'L' (low), 'N' (normal) and 'E' (earthquake), placed immediately after the strength-grade number, corresponding with different minimum values for uniform elongation and maximum stress to yield stress ratio.

4 Chemical and mechanical properties

Adjustments have been made to the chemical composition, carbon equivalent, and mechanical properties parameters, as necessary, to satisfy the (sometimes conflicting) requirements of strength, ductility and weldability.

5 New inclusions

In addition to the items noted above the following new material has been included:

(a) *Production control* in all stages of manufacture is a specific requirement (Clauses 6.3 and 8) with the details of how it is to be achieved being spelt out in Appendix B.

(b) *Purpose-made meshes* are covered in Clause 7.5.4 and distinguished from the commonly available meshes, whereas only stock meshes were previously specified.

(c) *Identification* rules for the standard strength grades and ductility classes are given and illustrated in Clause 9 so that the different materials can be readily differentiated visually on site and distinguished from previously manufactured materials.

(d) *The bond test* in Appendix C has been introduced as an alternative means for demonstrating the ability of deformed reinforcement to develop sufficient bond to achieve its characteristic yield strength when embedded in concrete.

Statements expressed in mandatory terms in notes to tables are deemed to be requirements of this Standard.

CONTENTS

Page

FOREWORD

Prior to 1995, responsibility for the Australian/New Zealand Standards on steel reinforcing and prestressing materials lay with Committee BD-023, Structural Steels, whose interest and expertise were mainly oriented toward materials for steel structures rather than for concrete structures. In recognition of this and in pursuance of the Memorandum of Understanding between Standards Australia and Standards New Zealand, a new joint Australian/New Zealand committee (BD-084) was formed in December 1994 to take on the specific responsibility of upgrading and harmonizing the relevant reinforcing and prestressing materials Standards of both countries.

At about this time, the results of international and local research indicated markedly different ductile behaviour between concrete members containing either hot-rolled or cold-rolled reinforcement. As this has consequent implications in the design and detailing for both normal and earthquake-resistant structures, concerns were being expressed regarding the status of the current high strength steels and, in particular, welded mesh.

The Australian Standards most directly affected by the latter material are AS 2870, *Residential slabs and footings,* and AS 3600, *Concrete structures*. The Committees responsible for those Standards (BD-025 and BD-002 respectively) have reviewed the implications of the proposals in this Standard and as a result have taken the following actions:

(a) The latest edition of AS 2870 (June 1996) permits the substitution of ribbed-wire meshes, on an equivalent strength basis with a minimum uniform elongation requirement, for the plain-wire meshes generally specified in that Standard and foreshadows the introduction of this Standard.

(b) Committee BD-002 has set up a special Working Group to investigate the consequences, in both design and detailing requirements, of using low ductility steels for reinforcement. As an interim measure, Amendment 1 to AS 3600—1994 (August 1996) introduced limitations on the use of this material in negative moment regions and flagged other areas where caution in its use should be exercised. When the investigations have been completed and all the results assessed, it is anticipated that further amendments will be necessary and that they will be published at or about the same time as this Standard.

While this Standard theoretically provides for three ductility classes and three strength grades, it should be realized that some of the possible combinations are not technically achievable in practice. Furthermore, from a simple commercial viewpoint, it is unlikely that all achievable combinations will be produced in either country. Specifically, it is envisaged that 500E steels are unlikely to be used in Australia, it being considered that Australia's

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard
Steel reinforcing materials

1 SCOPE

This Standard specifies requirements for the chemical composition and the mechanical and geometrical properties of reinforcing steel used for the reinforcement of concrete in the form of—

(a) deformed or plain bars and coils;

(b) machine-welded mesh; and

(c) continuously threaded bars.

This Standard does not apply to prestressing steels, stainless steel reinforcement, epoxy-coated steels and galvanized steels.

NOTES:

1 Means for demonstrating compliance with this Standard are given in Appendix A.

2 Prestressing steels are covered by AS 1310, AS 1311, AS 1313.

3 Information on stainless steel reinforcement may be found in other internationally (accepted) Standards such as BS 6744 or ASTM A955M.

2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard.

AS	
1199	Sampling procedures and tables for inspection by attributes
1310	Steel wire for tendons in prestressed concrete
1311	Steel tendons for prestressed concrete—7-wire stress-relieved steel strand
1313	Steel tendons for prestressed concrete—Cold-worked high-tensile alloy steel bars for prestressed concrete
1391	Methods for tensile testing of metals
1399	Guide to AS 1199—Sampling procedures and tables for inspection by attributes
1554	Structural steel welding

SAI
HB 18 Guidelines for third-party certification and accreditation
HB 18.28 Guide 28: General rules for a model third-party certification scheme for products

3 DEFINITIONS

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

3.1 Ageing

Heating of the test specimen to 100 ±10°C, maintaining this temperature for a period of 1 h +15, −0 min and then cooling the specimen in still air to room temperature.

3.2 Bar

A straight length of reinforcing steel.

3.3 Characteristic value

3.3.1 *Lower characteristic value* (C_{vL})

The value of a property having a prescribed (high) probability (p) of being exceeded in a hypothetical unlimited series of standard tests.

NOTE: The probability of a test value being below this value is (1 – p) at a confidence level of 0.9.

3.3.2 *Upper characteristic value* (C_{vU})

The value of a property having a prescribed (high) probability (p) of not being exceeded in a hypothetical unlimited series of standard tests.

NOTE: The probability of a test value being above this value is (1 – p) at a confidence level of 0.9.

3.4 Decoiled steel

Reinforcing steel manufactured in coils and subsequently processed.

3.5 Deformed reinforcement

3.5.1 *Indented reinforcement*

Reinforcing steel with at least two rows of transverse indentations, which are distributed uniformly along the entire length.

3.5.2 *Ribbed reinforcement*

Reinforcing steel with at least two rows of transverse ribs, which are distributed uniformly along the entire length.

3.9 Mesh, overhang of

Length of longitudinal or transverse bars projecting beyond the centre of the outer crossing bar in the mesh. For twin bar mesh, the overhang is measured from the midpoint line of the adjacent bars (see Figure 3).

3.10 Mesh, pitch of

The centre-to-centre distance of bars in the mesh. For twin bar mesh, the pitch is measured between the midpoint of the adjacent bars (see Figure 3).

3.11 Mesh, purpose made

Mesh manufactured according to specific requirements.

3.12 Mesh, transverse bars in

Reinforcing steel perpendicular to the manufacturing direction of the mesh.

3.13 Mesh, twin bars in

Two bars of the same designation placed adjacent to each other as a pair.

3.14 Mesh, width of

The shortest side of the mesh, irrespective of the manufacturing direction.

3.15 Plain reinforcing steel

Reinforcing steel without surface deformations excluding identifying marks.

3.16 Reinforcing steel

Steel with a circular or practically circular cross-section, which is suitable for the reinforcement of concrete.

3.17 Rib, longitudinal

Uniform continuous protrusion parallel to the axis of the reinforcing steel.

3.18 Rib, transverse

Any protrusion on the surface of the product other than a longitudinal rib.

3.19 Steel producer

The organization responsible for producing reinforcing steel in bar or coil form from a hot-rolling process.

3.20 Steel processor

The organization responsible for subsequent processing of reinforcing steel supplied by a

c = the longitudinal pitch of the transverse deformations measured parallel to the axis of the reinforcing steel, in millimetres

d = the nominal diameter of a reinforcing steel, in millimetres

f_P = the specific projected area of transverse indentations

f_R = the specific projected area of transverse ribs

g = the circumferential gap between deformations

h = the rib height or indentation depth, in millimetres

k_i = a coefficient

L_n = the nominal length of a bar, in millimetres

n = the number of tests in a series of tests; or

= the number of longitudinal bars in a particular trench mesh

R_e = the value of the yield stress (or 0.2% proof stress) determined from a single tensile test in accordance with AS 1391, in megapascals

$R_{ek.L}$ = the lower characteristic value of the yield stress determined from a series of tensile tests, in megapascals

$R_{ek.U}$ = the upper characteristic value of the yield stress determined from a series of tensile tests, in megapascals

R_m = the value of the maximum tensile strength determined from a single tensile test in accordance with AS 1391, in megapascals

u = edge overhang of a bar in a mesh, in millimetres

w_c = the crest width of ribs

w_i = the indentation width

α = rib flank inclination (See Figure 2)

β = angle of inclination between the centre-line of the transverse deformation and the longitudinal axis of the reinforcing steel (see Figure 1)

5 CLASSIFICATION AND DESIGNATION

5.1 Classification

Reinforcing steel shall be classified by—

(a) shape, as characterized by the presence or absence of ribs or indentations on its surface;

(b) strength grade, as specified by the lower characteristic value of its yield stress (R_{eL});

(c) Ductility Class—by the letters L, N or E representing Low, Normal or seismic (Earthquake) ductility respectively, in accordance with Table 2.

(d) Size—by the numerical value of the nominal diameter expressed in millimetres.

The designators shall be stated in the order of shape, strength grade, ductility class and size.

Full designators shall be used in all communications unless the use of abbreviated forms causes no ambiguity, and the omitted characteristics can be readily distinguished or deduced.

NOTES:

1 For example, a deformed ribbed bar, of grade 500 MPa normal ductility steel with a nominal 16 mm diameter, would be designated as 'D500N16'.

2 In the example given in Note 1, if all the reinforcement ordered or required for a particular project was to be deformed ribbed bars of the same strength grade but varied in other characteristics, and there was a general note to this effect in the project plans and specifications, the designation may be abbreviated to 'N16'.

5.3 Standard grades

The standard grades of reinforcing steels, characterized by their strength grade and relative ductility class shall be as follows:

(a) 250N.

(b) 300E.

(c) 500L.

(d) 500N.

(e) 500E.

5.4 Designation of welded mesh

Welded mesh shall be designated by distinguishing letters or numbers in the following manner:

(a) Shape—by the letters, R, D, or I, representing plain (Round), Deformed ribbed, or deformed Indented, surfaces respectively.

(b) Strength grade—by the numerical value of the lower characteristic yield stress expressed in megapascals.

(c) Configuration of the orthogonal bars—by the letters S or R, representing Square or Rectangular configurations.

(d) Ductility Class—by the letters L, N or E representing Low, Normal or seismic (Earthquake) ductility respectively, in accordance with Table 2.

Full designators shall be used in all communications unless the use of abbreviated forms causes no ambiguity, and the omitted characteristics can be readily distinguished or deduced.

NOTES:

1 For example, a square mesh consisting of 9 mm diameter deformed ribbed bar at 200 mm centres, of grade 500 MPa low ductility steel, would be designated as 'D500SL92'.

2 In the example given in Note 1, if all the welded mesh ordered or required for a particular project was to be deformed ribbed bars, of the same strength grade but may vary in other characteristics, and there was a general note to this effect in the project plans and specifications, the designation may be abbreviated to 'SL92'.

6 MANUFACTURING METHODS

6.1 Production

Production methods, including method of deoxidization of the steel, shall be at the discretion of the steel producer and shall be reported if so requested.

6.2 Processing

6.2.1 *Bars and coils*

Processing methods for bars and coils shall be at the discretion of the steel processor and shall be reported if so requested.

Processing of coiled steel shall only be carried out in such a way that ensures the material properties of this Standard are met.

6.2.2 *Mesh*

All mesh shall be factory made and machine welded. The joints at the intersections of the longitudinal bars and the transverse bars shall be made by electrical resistance welding to provide shear resistant connections complying with Clause 7.2.5. Mesh that includes butt welded bars shall be permitted.

6.3 Manufacturing control

Production and processing shall be subject to continual control in accordance with Clause 8 and Appendix B.

7 CHEMICAL, MECHANICAL AND DIMENSIONAL REQUIREMENTS

7.1 Chemical composition and weldability

The chemical composition of the steels, expressed as percentages by mass of the non-ferrous constituents, shall be determined in accordance with the relevant item of Clause 8, and the results, including the calculated carbon equivalent, shall comply with the

7.2 Mechanical properties

7.2.1 *General*

Mechanical properties of the standard grades of reinforcing steels shall be determined in accordance with the relevant item of Clause 8 and the values obtained shall satisfy the appropriate criteria given in Table 2.

In all determinations of mechanical properties, the condition of test pieces at the time of testing shall be as given in Table 3.

TABLE 1

COMPOSITION OF REINFORCING STEELS

Type of analysis	Chemical composition, % max.							
	All grades			Carbon equivalent value (C_{eq}) for standard grades				
	C	P	S	250N	500L	500N	300E	500E
Cast analysis	0.22	0.050	0.050	0.43	0.39	0.44	0.43	0.49
Product analysis	0.24	0.055	0.055	0.45	0.41	0.46	0.45	0.51

TABLE 2

CHARACTERISTIC MECHANICAL PROPERTIES OF REINFORCING STEELS

Property		250N (Note 1)	500L (Note 2)	500N	300E (Seismic)	500E (Seismic)	Type of specified value
Yield stress (MPa)	$R_{ek.L}$	≥ 250	≥ 500	≥ 500	≥ 300	≥ 500	C_{vL}: p = 0.95
	$R_{ek.U}$	—	≤ 750	≤ 650	≤ 380	≤ 600	C_{vU}: p = 0.05
Ratio	R_m/R_e	≥ 1.08	≥ 1.03	≥ 1.08	≥ 1.15	≥ 1.15	C_{vL}: p = 0.90
		—	—	—	≤ 1.50	≤ 1.40	C_{vU}: p = 0.10
Uniform elongation A_{gt}(%)		≥ 5.0	≥ 1.5	≥ 5.0	≥ 15.0	≥ 10.0	C_{vL}: p = 0.90

NOTES:

1 Grade 250N may be supplied as plain round reinforcing steel complying with AS 3679.1, except that the tolerance on the diameter and roundness does not apply.

2 For 500L steels, the only requirement for $d < 5.0$ mm is $R_{ek.L} \geq 500$ MPa.

TABLE 3

CONDITION OF TEST PIECES FOR MECHANICAL PROPERTIES

7.2.2 *Tensile properties*

The yield stress (R_e), maximum tensile strength (R_m) and uniform elongation (A_{gt}) shall be determined in accordance with Clause 8.

The values for R_e and R_m shall be calculated using the nominal cross-sectional areas of the reinforcing steels.

For the yield stress (R_e) specified in Table 2, the lower yield stress shall apply. If an observable yield phenomenon is not present, the 0.2% proof stress ($R_{P0.2}$), or the stress for a total elongation of 0.5% ($R_{t0.5}$) shall be determined.

In cases of dispute, the 0.2% proof stress ($R_{P0.2}$) shall apply.

Test specimens shall have a maximum out-of-straightness of $L_n/50$.

7.2.3 *Bending and rebending properties*

This property applies to deformed reinforcing steels only. The suitability of bars for bending or rebending shall be determined by bending around the stated mandrel diameters and angles specified in Table 4.

For bars subject to the rebend test, after the initial 90° bend, the bars shall be aged and cooled and then bent in the reverse direction through the appropriate rebend angle specified by applying a constant force. After bending or rebending there shall be no visible evidence of cracking on the surface of the test bar, when inspected with the naked eye or with normal corrected vision.

A1 NOTE: In case of dispute the rebent bar may be subject to a tensile test and will be deemed to have passed the rebend requirements if the mechanical properties of this piece comply with Table 2.

TABLE 4

MANDREL DIAMETER AND ANGLE FOR BEND AND REBEND TEST

Nominal diameter (mm)	Mandrel diameter for ductility class			Bend angle	Bend angle after 90° initial bend
	L	N	E		
$d \leq 16$	$3d$			90°	20°
		$4d$	$4d$		90°
$d \geq 20$		$4d$	$4d$	180°	NA

7.2.4 *Fatigue strength*

7.3 Geometric properties

7.3.1 *Diameters, cross-sectional areas and masses*

Values for the preferred nominal diameter, cross-sectional area and mass for some reinforcing bars are given in Tables 5A and 5B.

When determined in accordance with the relevant item of Clause 8, the mass per metre length of any size bar shall have a tolerance of ±4.5%.

7.3.2 *Lengths of bars*

The nominal lengths of bars (L_n) shall be agreed at the time of order.

Unless otherwise specified, the permissible deviation from the nominal length shall be as follows:

(a) For $L_n \leq 7.0$ m .....+ 0, – 40 mm.

(b) For $7.0 \text{ m} < L_n < 12.0$ m .....+ 40, – 40 mm.

(c) For $L_n > 12.0$ m .....+ 60, – 40 mm.

NOTE: Bar lengths may use length tolerances as per AS/NZS 3679.1 by agreement.

7.3.3 *Straightness tolerance*

Unless specified otherwise, the tolerance on straightness shall be as follows:

(a) For $d \leq 16$ mm .....L_n / 50.

(b) For $d \geq 20$ mm .....L_n / 100.

7.3.4 *Coil size*

The mass and dimensions of the coils shall be agreed at the time of order.

TABLE 5A

PREFERRED NOMINAL DIAMETERS, CROSS-SECTIONAL AREAS AND MASSES FOR REINFORCING STEELS (AUSTRALIA ONLY)

Nominal diameter mm	Cross-sectional area mm^2	Mass per metre length, kg/m	Product grade and class
			500
12.0	113	0.888	N
16.0	201	1.58	N
20.0	314	2.47	N
24.0	452	3.55	N

TABLE 5B

PREFERRED NOMINAL DIAMETERS, CROSS-SECTIONAL AREAS AND MASSES FOR REINFORCING STEELS (NEW ZEALAND ONLY)

Nominal diameter mm	Cross-sectional area mm^2	Mass per metre length, kg/m	Product grade and class	
			300	500
6.0	28.3	0.222	E	E
10.0	78.5	0.617	E	E
12.0	113	0.888	E	E
16.0	201	1.58	E	E
20.0	314	2.47	E	E
25.0	491	3.85	E	E
32.0	804	6.31		E
40.0	1260	9.86		E

NOTE: The values for the mass per unit length given in Table 5B have been calculated from the values for the nominal diameter area using a density value of 7850 kg/m^3.

7.4 Surface geometry

7.4.1 *General*

The deformed steel bars and coils covered by this Standard shall be characterized by their surface geometry (dimensions, number and configuration of transverse and longitudinal ribs or indentations) by means of which increased bond with the concrete is achieved. The geometry of ribs or indentations shall comply with Clause 7.4.2.1, 7.4.2.2 and 7.4.2.3. For deformed reinforcement, achievement of the required bond with concrete shall be demonstrated by compliance with Clause 7.4.2.4 or by a bond test in accordance with Paragraph C4 of Appendix C.

NOTE: Geometry of indentations complying with Clause 7.4.2 does not imply similar high bond performance to ribbed bars complying with Clause 7.4.2.

7.4.2 *Geometry of ribs and indentations*

7.4.2.1 *General*

The reinforcing steels shall have two or more rows of parallel transverse ribs or indentations equally distributed around the circumference and with a uniform spacing along the entire length excepting identifying markings. For ribbed bars, longitudinal ribs may or may not be present.

The rib height (h) shall be $0.05d$ to $0.10d$ and the longitudinal spacing (c) of the ribs shall be between $0.5d$ to $1.0d$ (see Figures 1 and 2). The crest width of ribs (w_c) shall be not greater than $0.3c$.

The indentation depth (h) shall be between $0.03d$ and $0.10d$ and the longitudinal spacing (c) of the indentations shall be between $0.5d$ and $2.0d$ (see Figure C2, Appendix C). The width of indentations (w_i) shall be not less than $0.5c$.

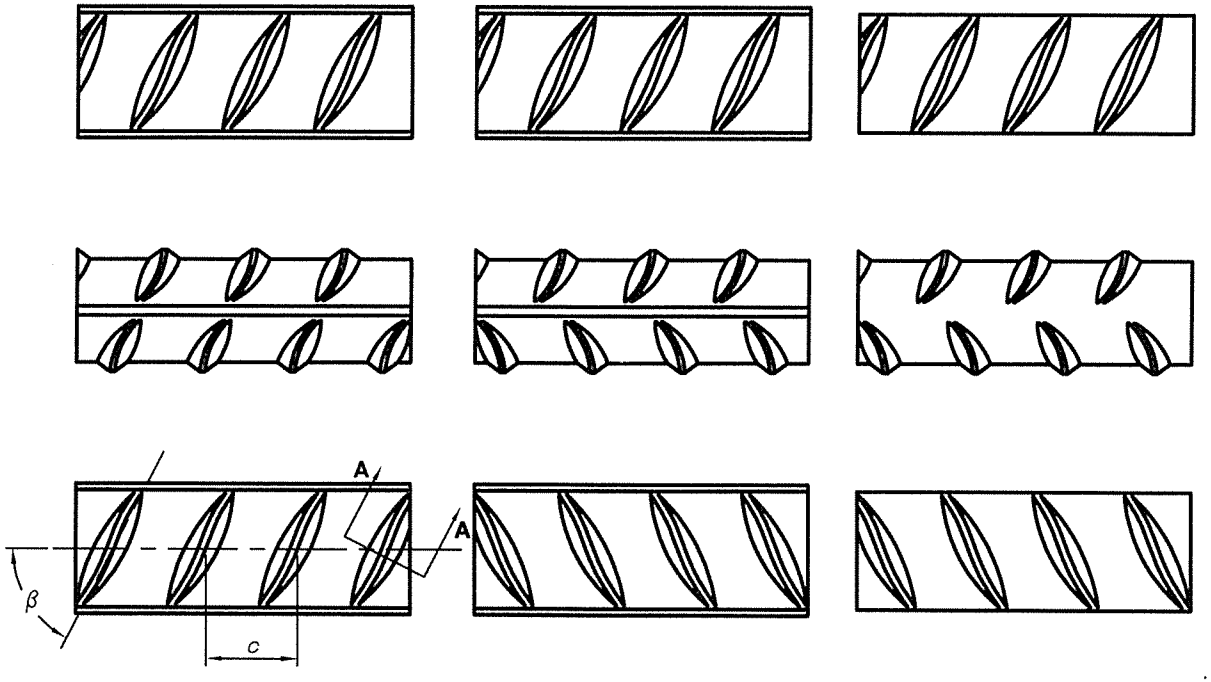
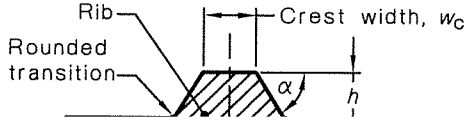


FIGURE 1 EXAMPLES OF RIB GEOMETRY

(Examples with two rows of transverse ribs)



7.4.2.4 *Specific projected area*

The specific projected area of ribs (f_R) or indentations (f_P), shall be determined in accordance with Appendix C. When so determined, the minimum value shall be as follows:

(a) For ribs (f_R):

(i) 0.036 for .....4.0 mm $\leq d <$ 5.0 mm..

(ii) 0.039 for .....5.0 mm $\leq d \leq$ 6.0 mm.

(iii) 0.045 for .....6.0 mm $< d \leq$ 8.0 mm.

(iv) 0.052 for .....8.0 mm $< d \leq$ 10.0 mm..

(v) 0.056 for .....10.0 mm $< d \leq$ 40.0 mm.

(b) For indentations (f_P):

(i) 0.012 for .....4.0 mm $\leq d <$ 5.0 mm.

(ii) 0.015 for .....5.0 mm $\leq d \leq$ 6.0 mm.

(iii) 0.020 for .....6.0 mm $< d \leq$ 8.0 mm.

(iv) 0.025 for .....8.0 mm $< d \leq$ 10.0 mm.

(v) 0.030 for .....10.0 mm $< d \leq$ 16.0 mm.

7.5 Form and dimensions of mesh

7.5.1 *General*

Each sheet shall contain not less than the number of bars appropriate to its specified length, width, pitch and overhang dimensions.

7.5.2 *Bar arrangement*

The bar arrangement shall be single bars, twin bars or a combination of these.

7.5.3 *Commonly available mesh*

Commonly available mesh sizes are specified in Table 6A (Australia only) and Table 6B (New Zealand only).

7.5.4 *Purpose-made mesh*

Purpose-made mesh shall be specified by bar designation and configuration.

NOTE: Before detailing purpose-made mesh, specifiers should ascertain any limitations on length, width, configuration, or mass of sheets that may be imposed by the manufacturing plant or equipment.

TABLE 6A

COMMONLY AVAILABLE MESH SIZES (AUSTRALIA ONLY)

Mesh type and reference number	Longitudinal bars		Cross-bars		Mass for 6 × 2.4 m sheets		Cross-sectional area/m width	
	No. × dia., mm	Pitch, @ mm	No. × dia., mm	Pitch, @ mm	Unit area, kg/m^2	Sheet, kg	Long'l bars, mm^2/m	Cross bars, mm^2/m
Rectangular								
RL1218	25 ×11.9	100	30 × 7.6	200	10.5	157	1112	227
RL1018	25 × 9.5	100	30 × 7.6	200	7.3	109	709	227
RL818	25 × 7.6	100	30 × 7.6	200	5.3	79	454	227
Square, with edge side-lapping bars								
SL102	10 × 9.5 + 4 × 6.75	200 100	30 × 9.5	200	5.6	80	354	354
SL92	10 × 8.6 + 4 × 6.0	200 100	30 × 8.6	200	4.6	66	290	290
SL82	10 × 7.6 + 4 × 6.0	200 100	30 × 7.6	200	3.6	52	227	227
SL72	10 × 6.75 + 4 × 5.0	200 100	30 × 6.75	200	2.8	41	179	179
SL62	10 × 6.0 + 4 × 5.0	200 100	30 × 6.0	200	2.2	33	141	141
Square, without edge side-lapping bars								
SL81	25 × 7.6	100	60 × 7.6	100	7.1	105	454	454
Trench meshes								
L12TM	n × 11.9	100	20 × 5.0	300	N/A	N/A	1112	65
L11TM	n × 10.7	100	20 × 5.0	300	N/A	N/A	899	65
L8TM	n × 7.6	100	20 × 5.0	300	N/A	N/A	454	65

A1 NOTE: The edge bars on SL meshes may be replaced by smaller edge wires of equal or greater cross-sectional area, in total, then the main longitudinal bars being replaced, provided the smaller bars meet the minimum ductility requirements of the bar or bars to be replaced.

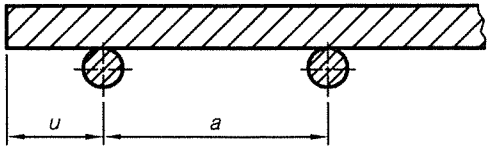
TABLE 6B

COMMONLY AVAILABLE MESH SIZES (NEW ZEALAND ONLY)

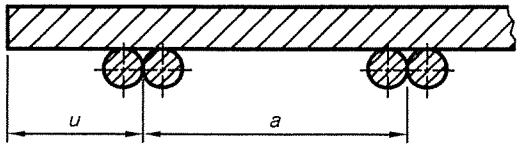
Mesh type and reference number	Longitudinal bars		Cross-bars		Mass for 6 × 2.4 m sheets		Cross-sectional area/m width	
	No. × dia., mm	Pitch, @ mm	No. × dia., mm	Pitch, @ mm	Unit area, kg/m^2	Sheet, kg	Long'l bars, mm^2/m	Cross bars, mm^2/m
Structural								
SE92	13 × 9.0	200	30 × 9.0	200	5.0	75	318	318
SE82	13 × 8.0	200	30 × 8.0	200	3.9	59	251	251
SE72	13 ×7.0	200	30 × 7.0	200	3.0	45	192	192
SE62	13 × 6.0	200	30 × 6.0	200	2.2	33	141	141
Non-structural								
SL51.5	17 × 5.3	150	40 × 5.3	150	2.2	32	147	147
SL41.5	17 × 4.0	150	40 × 4.0	150	1.3	19	84	84

7.5.5 *Pitch*

The pitch (a) of longitudinal bars and transverse bars shall not be less than 50 mm. The pitch shall be measured as shown in Figure 3. The tolerance of the pitch shall not be more than ±0.075 times the specified value.



(a) Single-bar meshes



(b) Twin-bar meshes

7.5.7 *Welds*

Welded joints shall withstand normal transport and handling without breaking. The presence of broken welds shall not constitute a cause for rejection unless—

(a) in mesh supplied in sheets, the number of broken welds per sheet exceeds 1% of the total number of welded joints; or

(b) in mesh supplied in rolls, the number of broken welds in any single continuous area of 15 m^2 measured over the full width of the mesh exceeds 1% of the total number of welded joints in that area; or

(c) more than 50% of the permissible maximum number of broken welds in Items (a) and (b) above are located on any one wire.

A1

7.5.8 *Deemed to comply rib or indentation geometry*

Where anchorage is to be provided by the cross-weld, the requirements for rib or indentation geometry shall be deemed to be satisfied, provided the rib height or indentation depth exceeds 0.03*d*.

8 SAMPLING AND TESTING FOR MANUFACTURING CONTROL

For the purpose of satisfying the requirements of Clause 6.3 and Clauses 7.1 to 7.5, the sampling and frequency of testing of the various types of reinforcing steel shall be in accordance with Appendix B, and the values of relevant material parameters for the samples shall be determined in accordance with Table 7.

TABLE 7

DETERMINATION OF REINFORCING STEEL MATERIAL PARAMETERS

Material parameter	Reinforcing type	Determined in accordance with
Chemical composition	All reinforcing steel	AS/NZS 1050
Yield stress (R_e) and tensile strength (R_m) (see Note)	All reinforcing steel	AS 1391, recorded to the nearest 1 MPa
Uniform elongation (A_{gt})	All reinforcing steel	Paragraph C2.2 of Appendix C
Weld shear strength	Mesh	Paragraph C5 of Appendix C
Bending and rebending properties	Deformed reinforcement	Clause 7.2.3
Geometric properties	Deformed reinforcement	Paragraph C3.1 and C3.2 of Appendix C
Mass per unit length	All reinforcing steel	Paragraph C3.3 of Appendix C

(a) *Deformed Grade 250N*—crescent-shaped transverse ribs inclined at 90° to the bar axis or two rows of inclined transverse ribs of uniform height reversing in direction on opposite sides of the bar, as shown in Figure 4.

(b) *Deformed Grade 300E*—identified by two rows of transverse ribs reversing in direction on opposite sides of the bar and having on one or two sides, two additional longitudinal marks joining two consecutive transverse ribs.

(c) *Deformed Grade 500L*—identified by three rows of transverse ribs or indentations with one row in the reverse direction to the other two.

(d) *Deformed Grade 500N*—identified by two or more continuous and clearly visible longitudinal marks in addition to longitudinal ribs if present, or by a minimum of two short transverse marking that are clearly distinguishable from the transverse ribs.

(e) *Deformed Grade 500E*—(excluding threaded bar) identified by two rows of transverse ribs reversing in direction on opposite sides of the bar and have on one or two sides, two missed deformations adjacent to two additional longitudinal bars joining two consecutive transverse ribs.

(f) *Plain Grade 250N*— no particular identifying features.

(g) *Plain Grade 300E*—identified by a raised dot.

(h) *Plain Grade 500E*—identified by a raised dot and dash.

(i) *Right-hand-threaded Grade 500E*—identified by one short transverse rib on one side of the bar.

9.2 Identification of the steel producer

Deformed reinforcement shall carry unique marks enabling the steel producer to be identified. Details of the steel producer's identification marking shall be made available on request.

9.3 Labelling of reinforcing steel

Each coil or bundle of reinforcing steel, including mesh, shall have a durable label attached on which the following shall be shown:

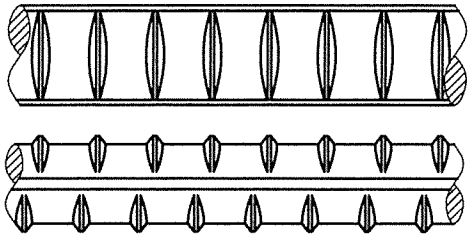
(a) For steel producers—

(i) the steel producer's name or trademark.

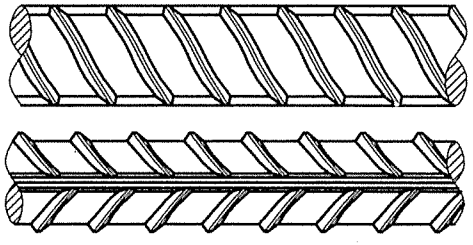
(ii) the designation of reinforcing steel.

(iii) the number of this Australian/New Zealand Standard.

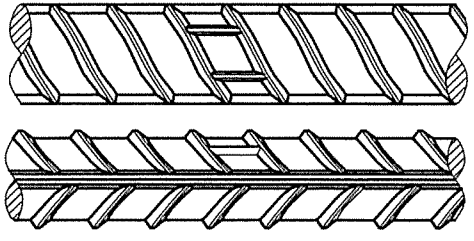
(iv) the heat number or batch number.



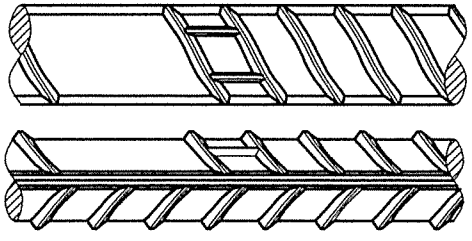
Grade 250 N (Bamboo)



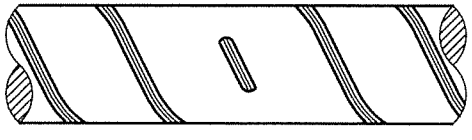
Grade 250 N



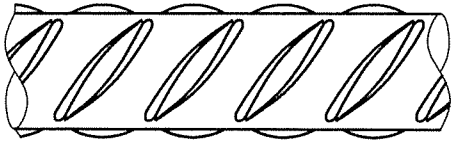
Grade 300 E



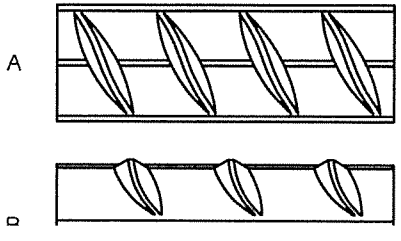
Grade 500 E

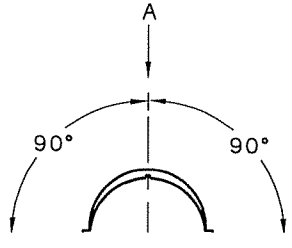


Grade 500 E (threaded)



Grade 500 L





APPENDIX A

MEANS FOR DEMONSTRATING COMPLIANCE WITH THIS STANDARD

(Informative)

A1 SCOPE

This Appendix sets out the following different means by which compliance with this Standard can be demonstrated by the manufacturer or supplier:

(a) Evaluation by means of statistical sampling.

(b) The use of a product certification scheme.

(c) Assurance using the acceptability of the supplier's quality system.

(d) Other such means proposed by the manufacturer or supplier and acceptable to the customer.

A2 STATISTICAL SAMPLING

Statistical sampling is a procedure which enables decisions to be made about the quality of batches of items after inspecting or testing only a portion of those items. This procedure will only be valid if the sampling plan has been determined on a statistical basis and the following requirements are met:

(a) The sample shall be drawn randomly from a population of product of known history. The history shall enable verification that the product was made from known materials at essentially the same time, by essentially the same processes and under essentially the same system of control.

(b) For each different situation, a suitable sampling plan needs to be defined. A sampling plan for one manufacturer of given capability and product throughput may not be relevant to another manufacturer producing the same items.

In order for statistical sampling to be meaningful to the customer, the manufacturer or supplier needs to demonstrate how the above conditions have been satisfied. Sampling and the establishment of a sampling plan should be carried out in accordance with AS 1199, guidance to which is given in AS 1399.

A3 PRODUCT CERTIFICATION

The purpose of product certification is to provide independent assurance of the claim by the

The quality assurance requirements need to be agreed between the customer and supplier and should include a quality or inspection and test plan to ensure product conformity.

A5 OTHER MEANS OF ASSESSMENT

If the above methods are considered inappropriate, determination of compliance with the requirements of this Standard may be assessed from the results of testing coupled with the manufacturer's guarantee of product conformance.

Irrespective of acceptable quality levels (AQLs) or test frequencies, the responsibility remains with the manufacturer or supplier to supply products that conform with the full requirements of the Standard.

APPENDIX B

MANUFACTURING CONTROL

(Normative)

B1 SCOPE AND GENERAL

B1.1 Scope

Manufacturing control shall apply to all aspects of production, from steel melting to the dispatch of end products to the purchasers (steel processors or customers).

B1.2 Application

Reinforcing steel shall be sampled and tested in accordance with Paragraph B3. The results shall satisfy both the batch and long-term quality levels in accordance with Paragraphs B4 and B6.

Where long-term quality levels are not available, steel shall be sampled, tested and evaluated in accordance with Paragraph B7.

B1.3 Definitions

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

B1.3.1 *Batch*

A quantity of reinforcing steel of the same surface geometry and diameter, of the same nominal strength grade and of the same ductility class; produced by essentially the same process from—

(a) the same cast and continuous period of production, for hot-worked products; or

(b) the same type of feed material, process, equipment and conditions, for cold-worked products but not exceeding 50 t of bars or coils or 1000 sheets of mesh, whichever is the less, unless specified otherwise.

B1.3.2 *Cold-worked products*

Bars and coils produced by cold rolling or cold drawing, or a combination of these, including mesh, and bars straightened from hot-rolled or cold-rolled coils.

B1.3.3 *Hot-worked products*

Bars and coils produced directly by hot-rolling.

B1.3.4 *Item*

n_b = the number of test values determined in a batch

n_p = the number of test values determined in a number of batches

$\overline{X}_b$ = the mean of individual test values determined in a particular batch

$\overline{X}_p$ = the mean of individual test values determined in a number of batches

x_n = the mean value of characteristic strength for n number of specimens

x_s = an individual test value

s = the estimated standard deviation of a population

s_n = the standard deviation for n number of specimens

B3 SAMPLING AND TESTING FREQUENCY

The minimum frequency of sampling and testing for each of the quality parameters specified and determined in accordance with Clause 8 of this Standard shall be as follows:

(a) For bars and coils:

(i) Chemical composition, one test per cast unless previously determined by the steel producer (see Note 1).

(ii) Mechanical properties, one test for each 50 t of product or part thereof, but not less than three tests per batch.

(iii) Bending properties, one test per batch.

(iv) Mass per unit length, one test (see Paragraph C3.3) per batch.

A1 (v) Surface geometry of deformed products, one test per batch (see Note 3).

(b) For decoiled products:

(i) Chemical composition, one test per batch unless previously determined by the steel producer (see Note 1).

(ii) Mechanical and bending properties, one test per diameter per machine per week (see Note 2).

A1 (iii) Deformation height or depth of deformed products, one test per day per machine and at each size change (see Note 3).

(c) For mesh:

A1 (i) Mechanical properties, one test per batch on each of two separate longitudinal bars and two separate transverse bars (i.e. 4 tensile tests). It shall be permissible

2 This testing is for evaluation of long-term quality level only, and is not a batch test for assessing compliance.

A1 3 Only rib heights or indentation depths to be measured for each batch, with circumferential gap and transverse rib spacing or indentation spacing to be measured at each roll change or adjustment.

B4 EVALUATION AND CONFORMANCE OF BATCH QUALITY PARAMETERS

B4.1 Tensile parameters

B4.1.1 *Batch parameters*

The value for a batch of each of the tensile parameters R_e, A_{gt} and (R_m/R_e) shall be taken as the mean $(\overline{X}_b)$ of the individual test values (x_s) from the sampled items.

$$\overline{X}_b = \Sigma x_s / n_b$$

B4.1.2 *Batch conformance*

A batch shall be deemed to conform with the tensile parameters specified in Table 2 if the following are satisfied:

(a) For R_e —

(i) $1.02\ R_{ek.L} \leq \overline{X}_b \leq 0.98\ R_{ek.U}$ and no individual test value of R_e is less than 0.95 $R_{ek.L}$ or greater than 1.05 $R_{ek.U}$; or

(ii) all test values of R_e fall between $R_{ek.L}$ and $R_{ek.U}$.

(b) For A_{gt} — $\overline{X}_b$ is not less than the specified value.

(c) For (R_m/R_e) — $\overline{X}_b$ is not less than the specified lower value or greater than the specified upper value.

If any requirements in Items (a), (b) or (c) above are not satisfied, the batch shall be deemed to be non-conforming and subject to further action in accordance with Paragraph B5.

B4.2 Other parameters

B4.2.1 *Chemical composition*

The chemical composition of reinforcing steel shall conform to the requirements listed in Table 1.

B4.2.2 *Shear strength of joints in mesh*

The shear strength of the tested welded joints shall satisfy the requirements of Clause 7.2.5.

B4.2.3 *Rebend suitability*

B5 ACTION ON NON-CONFORMING BATCHES

When a production batch is deemed to be non-conforming in accordance with Paragraph B4.1 or B4.2, the steel producer or steel processor, as appropriate, shall promptly isolate the batch by suitable means.

For the non-conforming batch, twice as many additional items shall be taken from the batch and tested for the particular non-conforming parameter(s) concerned. If the additional test results demonstrate conformance, then the batch shall be deemed to comply with the Standard, and all of the additional results included for long-term conformance (see Paragraph B6).

If any of the additional test results demonstrate non-conformance, then the batch shall be rejected as non-conforming and the steel producer or steel processor, as appropriate, shall take immediate action to minimize the probability of further non-conformances of the same kind. The results from the non-conforming batch shall be excluded from the long-term conformance calculations.

B6 DETERMINATION OF LONG-TERM QUALITY LEVEL

B6.1 General

Test results for the material tensile parameters R_e, A_{gt} and R_m/R_e shall be continually collected from the batch testing program, grouped under the same designation (see Clause 5.2) and their long-term characteristic values determined statistically in accordance with Paragraph B6.2.

A1 For each parameter, the determinations shall be made on a continual basis (but at intervals of not more than one month), covering the preceding six months test results or the last 200 consecutive test results.

NOTES:

1 The evaluation of long-term quality levels is based on the assumption that the distribution of a large number of test results is normal; however, this is not a requirement.

A1 2 The application of long-term quality compliance for mesh with respect to A_{gt} and R_m/R_e may be waived for Australia until the end of September 2003, while several statistical anomalies are resolved, It may be waived for mesh to be used in New Zealand where all batch test results are above specified values.

B6.2 Evaluation of results

B6.2.1 *Estimation of population parameters*

The mean ($\overline{X}_p$) and standard deviation (s) shall be estimated from the test results using the following equations, respectively:

B7 MATERIAL NOT COVERED BY LONG-TERM QUALITY LEVEL

B7.1 General

Steel not covered by long-term quality level complying with Paragraph B6 shall be assessed by acceptance tests on each batch.

B7.2 Extent of sampling and testing

For testing purposes, the batch shall be divided into test units each with a maximum mass of 100 t. Each test unit shall comprise products of the same steel grade and nominal diameter from the same cast. The steel producer or steel processor shall certify that all products in the test unit originate from the same cast.

Test specimens shall be taken from each test unit as follows:

(a) Fifteen test pieces or, if appropriate, 60 specimens (see Paragraph B7.4.1(b)), from different bars for testing in accordance with Paragraphs B7.3(a) and B7.3(b);

(b) Two test specimens from different bars, for testing in accordance with Paragraphs B7.3(c).

TABLE B1

STATISTICAL MULTIPLIER '*K*'

No. of samples (n_P)	Coefficient K at 90% confidence level	
	For R_e (p = 0.95)	for A_{gt}, R_m/R_e (p = 0.90)
5	3.40	2.74
6	3.09	2.49
7	2.89	2.33
8	2.75	2.22
9	2.65	2.13
10	2.57	2.07
11	2.50	2.01
12	2.45	1.97
13	2.40	1.93
14	2.36	1.90
15	2.33	1.87
16	2.30	1.84
17	2.27	1.82
18	2.25	1.80
19	2.23	1.78
20	2.21	1.77
30	2.08	1.66
40	2.01	1.60
50	1.97	1.56
60	1.93	1.53
70	1.90	1.51
80	1.89	1.49
90	1.87	1.48
100	1.86	1.47
150	1.82	1.43
200	1.79	1.41
250	1.78	1.40
300	1.77	1.39

(b) Inspection by attributes, i.e.

(i) behaviour in the rebend test;

(ii) deviations from the nominal cross-section; and

(iii) projected rib or indentation area or bond test.

(c) Chemical composition according to the product analysis.

All elements listed in Table 1 and the carbon equivalent (C_{eq}) shall be determined.

The test procedures shall be as described in Appendix C.

B7.4 Evaluation of results

B7.4.1 *Inspection by variables*

The following applies:

(a) When testing for the properties listed in Paragraph B7.3(a), the following shall be determined for the characteristic strength.

(i) All individual values for characteristic strength R_{ek} for the 15 test specimens.

(ii) The mean value for the characteristic strength x_{15} (for $n = 15$).

(iii) The standard deviation s_{15} (for $n = 15$).

The test unit shall be deemed to comply with this Australian/New Zealand Standard if all individual values of R_m/R_e and uniform elongation (A_{gt}) fall between the upper and lower characteristic values specified in Table 2, and the following conditions are fulfilled by the characteristic strength (see also Item (b) below):

$$\overline{x_{15}} - 2.33\, s_{15} \geq R_{ek.L}; \text{ and} \qquad \ldots \text{B7.4.1(1)}$$

$$\overline{x_{15}} + 2.33\, s_{15} \leq R_{ek.U} \qquad \ldots \text{B7.4.1(2)}$$

(b) If the condition for the characteristic strength stated in Item (a) is not fulfilled, a secondary calculation, the acceptability index (k) shall be determined, where—

$$k = \frac{\overline{x_{15}} - R_{ek.L}}{s_{15}} \qquad \ldots \text{B7.4.1(3)}$$

If $k \leq 2$, the batch shall deemed as non-conforming.

If $k > 2$, testing shall continue. Forty-five further test specimens shall be taken and tested from different items in the test unit, so that a total of 60 test results are available ($n = 60$).

The test unit shall be deemed to comply with this Australian/New Zealand Standard if

(b) If a maximum of two of the 15 results do not conform to this Standard, 45 further test specimens shall be taken and tested from different items in the test unit, making 60 test results available.

The unit shall be deemed to conform to this Standard if no more than two of the 60 test specimens fail the test.

B7.5 Test report

A test report shall be produced containing the following data:

(a) The steel producer's or steel processor's name or trademark.

(b) The nominal diameter of the reinforcing steel.

(c) The strength and ductility grade of the reinforcing steel.

(d) The marking on the reinforcing steel.

(e) The cast number.

(f) The date of testing.

(g) The mass of the test unit.

(h) The individual test results for all the properties specified in Paragraph B7.3.

APPENDIX C

REQUIREMENTS FOR DETERMINING THE MECHANICAL AND GEOMETRIC PROPERTIES OF REINFORCEMENT

(Normative)

C1 GENERAL

This Appendix sets out requirements for the determination of mechanical and geometric properties of reinforcement, which are additional to the requirements given in Clauses 7.2, 7.3, 7.4 and 8.

C2 MECHANICAL PROPERTIES

C2.1 General

Tests for the determination of the mechanical properties of reinforcement shall be carried out at ambient temperatures in the range 10°C to 35°C.

The condition of test pieces at the time of testing shall be in accordance with Clause 7.2.1 and Table 3.

Unless otherwise specified, tests on bars and coils shall be carried out on straight test specimens of full cross-section having no machining within the gauge length.

Test specimens cut from mesh shall include at least one welded intersection. Before testing a twin-bar specimen, the bar not under test shall be removed without damage to the bar to be tested.

C2.2 Tensile properties

C2.2.1 *Equipment*

Tensile testing equipment shall be Grade A as defined in AS 2193.

C2.2.2 *Uniform elongation*

A1 The uniform elongation (A_{gt}) shall be determined in accordance with ISO 15630-1 or ISO 15630-2 as appropriate except as in the following cases:

(a) All Classes of steels—from extensometer measurements at maximum force taken during tensioning; or

(b) Class E and Class N steels only—from measurements taken after failure.

For the purpose of Item (a), a minimum extensometer gauge length of 50 mm may be used.

C3.1.2 *Circumferential spacing of transverse ribs*

The sum of the circumferential gaps (g) between adjacent rows of transverse ribs shall be measured at each of three separate cross-sections and the mean value of the sum calculated. The measurement shall be reported to an accuracy of 0.1 mm.

C3.1.3 *Longitudinal spacing of transverse ribs*

The spacing of the transverse ribs (c) shall be taken as the length of the measuring distance divided by the number of the rib gaps contained within that length. The measuring distance is deemed to be the interval between the centre-line of a rib and the centre-line of another rib on the same side of the product, determined in a straight line parallel to the longitudinal axis of the product. The length of the measuring distance shall contain at least 10 rib gaps.

C3.1.4 *Calculation of the specific projected rib area (f_R)*

The specific projected rib area (f_R) shall be calculated from the following equation, and with reference to Figure C1:

$$f_R = k_i \frac{(\pi d - \Sigma g).h}{\pi\, d.c} \qquad \ldots \text{C3.1.4}$$

where

k_i = 0.72 for crescent shaped ribs; or

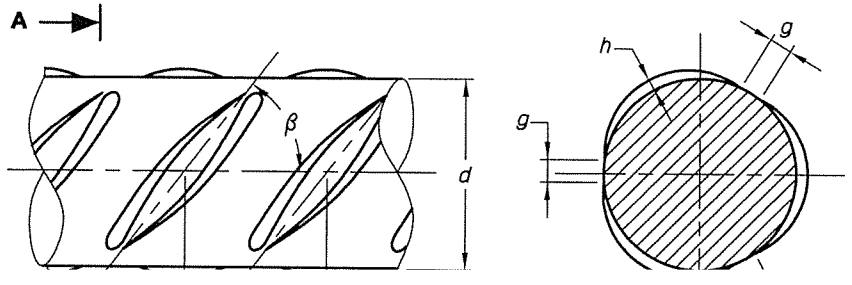
= 1.0 for uniform height ribs

d = the nominal diameter of the reinforcing steel

Σg = the sum, at a cross-section, of the circumferential gaps between adjacent rows of transverse ribs (see Paragraph C3.1.2)

h = the mean of the maximum rib heights (see Paragraph C3.1.1)

c = the longitudinal pitch of the transverse ribs (see Paragraph C3.1.3)



C3.2 Indentation geometry

C3.2.1 *Depths of transverse indentations*

The depth of transverse indentations (h) shall be measured for each row of indentations at the point where the indentation depth is greatest. The measurement shall be made to an accuracy 0.01 mm.

C3.2.2 *Circumferential spacing of transverse indentations*

The sum of the circumferential gaps (g) between adjacent rows of transverse indentations shall be measured at each of three separate cross-sections and the mean value of the sum calculated. The measurement shall be reported to an accuracy of 0.1 mm.

C3.2.3 *Longitudinal spacing of transverse indentations*

The spacing of the transverse indentations (c) shall be taken as the length of the measuring distance divided by the number of the indentation gaps contained within that distance. The measuring distance is deemed to be the interval between the centre-line of an indentation and the centre-line of another indentation on the same side of the product determined in a straight line parallel to the longitudinal axis of the product. The length of the measuring distance shall contain at least 10 indentation gaps.

C3.2.4 *Calculation of the specific projected indentation area (f_P)*

The specific projected indentation area (f_P) shall be calculated from the following equation, and with reference to Figure C2:

$$f_p = k_i \frac{(\pi d - \Sigma g).h}{\pi d.c} \qquad \ldots \text{C3.2.4}$$

k_i = 0.72 for indents of non-uniform depth; or

= 1.0 for indents of uniform depth

d = the nominal diameter of the reinforcing steel

Σg = the sum, at a cross-section, of the circumferential gaps between adjacent rows of transverse indentations

h = the mean of the maximum indentation depths

c = the longitudinal pitch of the transverse indentations (see Paragraph C3.2.3)

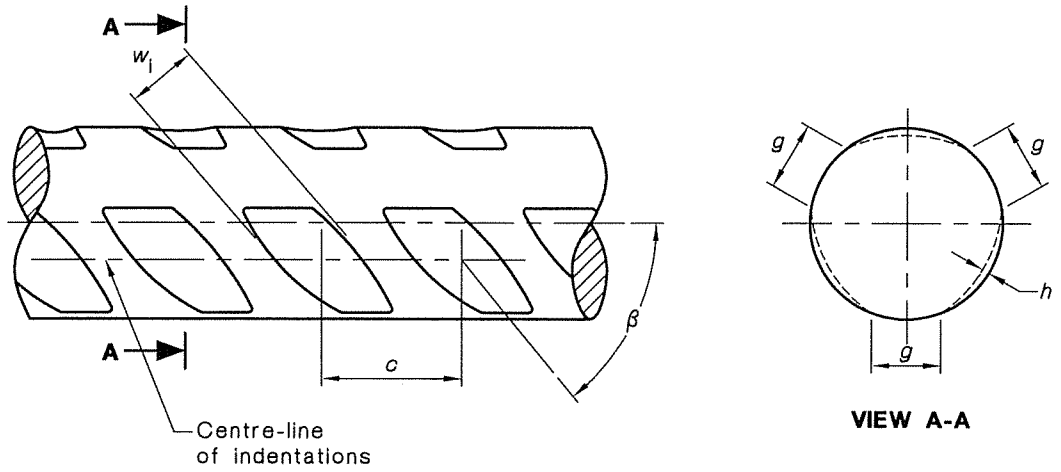


FIGURE C2 TERMS FOR SPECIFIC PROJECTED INDENTATION AREA

C3.3 Mass per unit length of reinforcing steels

C3.3.1 *General*

The mass per unit length of bars in a batch shall be determined in accordance with Paragraphs C3.3.2 and C3.3.3 and the result expressed in kg/m.

C3.3.2 *Test specimens*

The determination shall be carried out on test specimens of a combined length not less than the greater of 300 mm or 20*d*, for diameters not greater than or equal to 25 mm and not less than 500 mm for diameters greater than 25 mm.

C3.3.3 *Procedure*

The procedure for determination is as follows:

(a) Cut a test specimen from each of three bars randomly selected from the batch, the length of each specimen being at least the minimum length specified in Paragraph C3.3.2 plus two bar diameters.

(b) Grind the ends of each specimen perpendicular to the longitudinal axis of the bar.

(c) For each specimen—

(i) measure its length in millimetres to the nearest 1 mm;

C4.2 Test pieces

The surface deformations of the bars to be tested shall comply with the steel producer's or steel processor's published specification, and shall be as near to the minimum values as possible. Six test pieces of each size shall be tested. The length of each test piece shall be such to allow attachment of the stressing system and measuring device, generally at least 250 mm longer than the length of the concrete test prism. All test pieces shall be wire brushed to remove loose rust and mill scale.

C4.3 Test prisms or cylinders

For each of the test pieces, prepare a concrete test prism or cylinder having a square or circular cross-section of 150 mm width or diameter for bar sizes up to and including 20 mm, and 250 mm width or diameter for bar sizes over 20 mm. The length of the prism or cylinder (L) in millimetres shall be calculated as follows:

$$L = \frac{0.45 d . R_{ek.L}}{\sqrt{f_c}} \geq b \qquad \ldots \text{C4.3}$$

where

$R_{ek.L}$ = the specified lower characteristic yield stress of the steel, in megapascals

d = the nominal bar size, in millimetres

b = Width of prism sides or diameter of cylinder, in millimetres

f_c = the compressive strength of the concrete at time of test, in megapascals

Prepare the prism or cylinder using a sand-cement mortar mix that gives a concrete having a cylinder compressive strength of between 32 MPa and 40 MPa at the time of the pull-out test. Support the test piece so that it is rigidly embedded in and passes completely through the prism or cylinder of concrete along its longitudinal axis protruding approximately 20 mm from the bottom as cast. Reinforce the prism or cylinder along the embedded length with a helix of 6 mm diameter plain mild steel having a pitch of 25 mm, the outer diameter of the helix being 5 mm less than the side of the concrete section.

C4.4 Apparatus

The apparatus shall consist of a suitable testing device capable of accepting the test specimen and a suitable measuring device (see Figure C3).

C4.5 Procedure

Mount the test specimen in the testing device so that the bar is pulled axially from the prism. Arrange the test prism so that the end of the bar at which tension is applied is that which is projected from the top end of the prism as cast. Place rubber or plywood packing and bearing plate with central hole 2 d diameter between the top end of the

C4.6 Free-end slip

If the average free-end slip of the six test pieces does not exceed 0.2 mm, the surface geometry of reinforced steel represented by the test pieces shall be deemed to comply with the surface geometry requirements of this Standard.

C4.7 Test report

The test report shall contain the following:

(a) Mill of manufacture.

(b) Nominal diameter of test pieces.

(c) Surface geometry.

(d) Concrete compressive strengths at time of testing.

(e) The bond classification determined.

(f) Reference to this Australian/New Zealand Standard, i.e. AS/NZS 4671.

(g) Reference to this test method, i.e. Appendix C.

NOTE: Further information may be included by agreement.

C5 Mesh weld shear strength

A1

The weld shear strength of welded joints on mesh shall be determined in accordance with ISO 15630-2, except where it can be demonstrated by non-destructive means that the welded joints are capable of withstanding at least 5% more than the shear force specified in Clause 7.2.5 of this Standard.

In the event of a dispute, the ISO 15630-2 test procedure shall take precedence.

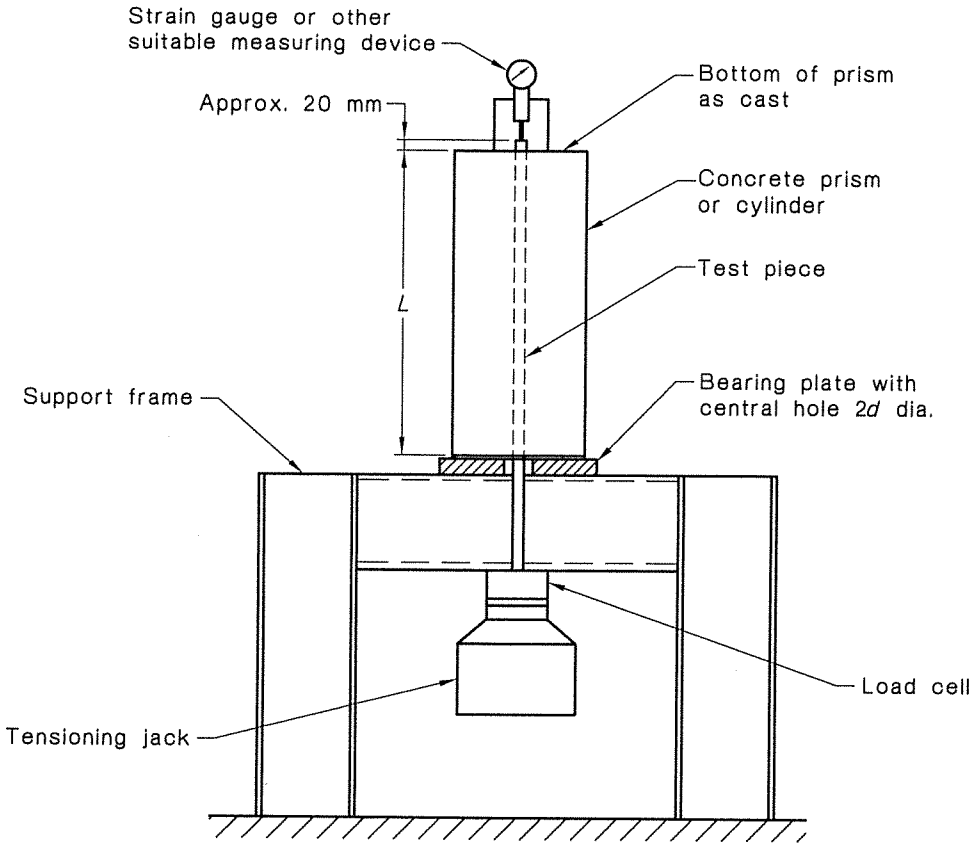


FIGURE C3 SAMPLE SCHEMATIC ARRANGEMENT OF BOND TEST EQUIPMENT AND TEST SPECIMEN

APPENDIX D

PURCHASING GUIDELINES

(Informative)

D1 INFORMATION TO BE SUPPLIED BY THE PURCHASER

The purchaser should supply the following information at the time of enquiry or order, after making due reference to the explanation, advice and recommendations contained in this Appendix:

(a) Designation of grade and Standard number.

(b) Quantity and delivery instructions.

(c) Dimensions of steel, e.g. bar size and length, mass of bundle or coil.

(d) Whether a test certificate or certificate of compliance is required.

(e) Any information concerning processing or end-use that the purchaser considers would assist the steel producer or steel processor (see Note).

(f) Whether it is the intention of the purchaser to inspect the steel at the steel producer's or steel processor's works.

(g) Any exceptions to the Standard and any special or supplementary requirements.

NOTE: Some mechanical properties (e.g. uniform elongation (A_{gt})) are quite sensitive to cold working. Hence, it is important that steel processors be aware that the properties of conforming batches of reinforcing steel may be rendered non-conforming by subsequent cold-working procedures, such as straightening, that are applied without due caution. The steel producer and steel processor should negotiate to ensure that the mechanical properties of the end product comply with the requirements of this Standard.

D2 CERTIFICATES OF COMPLIANCE AND TEST CERTIFICATES

D2.1 Certificate of compliance

A certificate of compliance states that the material has been tested and results comply with the appropriate material Standard.

D2.2 Test certificate

A test certificate shows such results as may be required by agreement between the purchaser and the steel producer or steel processor relating to—

(a) tests performed by the steel producer or steel processor for the purpose of establishing compliance with the appropriate material Standard; or

AMENDMENT CONTROL SHEET

AS/NZS 4671:2001

Amendment No. 1 (2003)

REVISED TEXT

SUMMARY: This Amendment applies to the Preface, Clauses 2, 7.2.3, 7.5.8, Table 6A, Paragraphs B3, B6.1, C2.2.2 and C5.

Published on 5 June 2003.

NOTES

NOTES

NOTES

Standards Australia

Standards Australia is an independent company, limited by guarantee, which prepares and publishes most of the voluntary technical and commercial standards used in Australia. These standards are developed through an open process of consultation and consensus, in which all interested parties are invited to participate. Through a Memorandum of Understanding with the Commonwealth government, Standards Australia is recognized as Australia's peak national standards body.

Standards New Zealand

The first national Standards organization was created in New Zealand in 1932. The Standards Council of New Zealand is the national authority responsible for the production of Standards. Standards New Zealand is the trading arm of the Standards Council established under the Standards Act 1988.

Australian/New Zealand Standards

Under an Active Co-operation Agreement between Standards Australia and Standards New Zealand, Australian/New Zealand Standards are prepared by committees of experts from industry, governments, consumers and other sectors. The requirements or recommendations contained in published Standards are a consensus of the views of representative interests and also take account of comments received from other sources. They reflect the latest scientific and industry experience. Australian/New Zealand Standards are kept under continuous review after publication and are updated regularly to take account of changing technology.

International Involvement

Standards Australia and Standards New Zealand are responsible for ensuring that the Australian and New Zealand viewpoints are considered in the formulation of international Standards and that

Standards Australia

STANDARDS NEW ZEALAND

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Amendment No. 1
to
AS/NZS 4671:2001
Steel reinforcing materials

REVISED TEXT

The 2001 edition of AS/NZS 4671 is amended as follows; the amendments should be inserted in the appropriate places.

SUMMARY: This Amendment applies to Clauses 2, 7.2.3, 7.5.8, Table 6A, Paragraphs B3, B6.1, C2.2.2 and C5.

Published on 5 June 2003.
Approved for publication in New Zealand on behalf of the Standards Council of New Zealand on 22 April 2003.

AMDT No. 1 JUNE 2003

Page 6 Clause 2

1 *Delete* the reference to ISO 10287 and *replace* with the following:

'15630-1 Steel for the reinforcement and prestressing of concrete—Test methods, Part 1: Reinforcing bars, wire rod and wire'

2 *Delete* the reference to ISO 10606 and *replace* with the following:

'15630-2 Steel for the reinforcement and prestressing of concrete—Test methods, Part 2: Welded fabric'

AMDT No. 1 JUNE 2003

Page 13 Clause 7.2.3

After the second paragraph *add* the following Note:

'NOTE: In case of dispute the rebent bar may be subject to a tensile test and will be deemed to have passed the rebend requirements if the mechanical properties of this test piece comply with Table 2.'

AMDT No. 1 JUNE 2003

Page 18 Table 6A

Delete the Note to the Table and *replace* with the following:

NOTE: The edge bars on SL meshes may be replaced by smaller edge wires of equal or greater cross-sectional area, in total, than the main longitudinal bars being replaced, provided the smaller bars meet the minimum ductility requirements of the bar or bars to be replaced.

AMDT
No. 1
JUNE
2003

Page 26 Paragraph B3 (b) (iii)

Add '(see Note 3)' to the end of the sentence.

AMDT
No. 1
JUNE
2003

Page 26 Paragraph B3 (c) (i)

Add the following sentence:

'It shall be permissible to sample from straightened and cut bars prior to welding, provided that it can be demonstrated that the welding does not adversely affect the mechanical properties.'

AMDT
No. 1
JUNE
2003

Page 26 Paragraph B3 (c) (iv)

Add '(see Note 3)' to the end of the sentence.

AMDT
No. 1
JUNE
2003

Page 26 Paragraph B3, Notes

Add the following Note to the Notes at the end of the Clause:

'3 Only rib heights or indentation depths to be measured for each batch, with circumferential gap and transverse rib spacing or indentation spacing to be measured at each roll change or adjustment.'

AMDT
No. 1
JUNE
2003

Page 28 Paragraph B6.1

1 *Delete* the second paragraph and *replace* with the following:

'For each parameter, the determinations shall be made on a continual basis (but at intervals of not more than one month), covering the preceding six months test results or the last 200 consecutive test results.'

2 *Add* a second Note as follows:

'2 The application of long-term quality compliance for mesh with respect to A_{gt} and R_m/R_e may be waived for Australia until the end of September 2003, while several statistical anomalies are resolved. It may be waived for mesh to be used in New Zealand where all batch test results are above specified values.'

AMDT
No. 1
JUNE
2003

Page 32 Paragraph C2.2.2 line 1

Delete 'ISO 10606' and *replace* with 'ISO 15630-1 or ISO 15630-2, as appropriate'.

AMDT
No. 1
JUNE
2003

Page 36 Paragraph C5

1 In line 2 *delete* 'ISO 10287' and *replace* with 'ISO 15630-2'.

2 In line 5 *delete* 'ISO 10287' and *replace* with 'ISO 15630-2'.