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ESSENTIAL TECHNICAL DATA ON STEEL REINFORCEMENT

Build with OneSteel Reinforcing

About OneSteel Reinforcing

OneSteel Reinforcing is Australia's premier supplier of steel reinforcing solutions for commercial, residential and civil construction as well as rural, industrial and mining.

A national branch and distributor network services customers Australia wide by supplying quality steel reinforcing products to Australia's largest construction companies through to the home renovator.

OneSteel Reinforcing has ACRS third party certified world-class manufacturing and provides innovative engineered reinforcing solutions to reduce labour needs and streamline construction.

We started as Aquila Steel in 1928 so we have a long history. Along the way we have incorporated other leading reinforcing businesses such as Boral Steel, Queensland Welded Mesh, Marner Steel & Mesh, and BHP Reinforcing Products. In the year 2000 we became OneSteel Reinforcing.

Reinventing reinforcing with innovative construction and mining solutions

500PLUS® REBAR - The first high strength reinforcing bar

500PLUS® BAMTEC® - The world's fastest steelfixing system

500PLUS® ROMTECH® - An innovative tunnel support system of rebar girders

500PLUS® PREFAB - Our wide range of off-site prefabricated elements

ECO-REO™ - Economical and environmental REBAR, REOMESH® & Decking products

ONESLAB® - Our complete supply package for detached house slabs

ONEMESH® - Wide range of square, rectangular and trench meshes

UTEMESH® - Compact, easy to carry mesh for driveways, paths and patios

TRUSSDEK® - Long span composite suspended floor system

MINEMESH™ - Tailored roof support system for coal & metalliferous mines

Along with REODATA, we also have a range of reinforcing essentials, guides and resources that will benefit your next project including:

REOWORKS – comprehensive CD and DVD combination for everything on REO including case studies, videos and technical data.

REO CALCULATOR – for steel reinforcement area calculations.

REO WIRE GAUGE – for measuring REOMESH® wire diameters.

REO BAR GAUGE – for measuring REBAR diameters.

NATIONAL PRODUCT & SERVICES CATALOGUE – the most comprehensive guide to reinforcing available anywhere today.

REINFORCING.COM – the online resource for products, technical data, case studies and testimonials that's right at your fingertips.

REINFORCING.TV – our YouTube™ channel where you can see our products and services in action and listen to our customers talking about the benefits they get from using our reinforcing solutions.

To keep you up to date on all our reinforcing products, visit the 'Register for Updates' page at www.reinforcing.com

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ECO-REO™ - Sustainable Reinforcing Products

OneSteel Reinforcing has introduced a selected range of REBAR, REOMESH® and Decking products.

These are products that can provide a more sustainable use of materials in structures.

These carry the additional branding of **ECO-REO™, ECO-BAR™ or ECO-MESH™,** as they can provide economic and environmental benefits compared to traditional reinforcing steels.

* **ECONOMICAL –** The products can give more cost-efficient cover and economy in the number of sheets or bars, or the volume of steel needed to efficiently reinforce the structure and meet the design intent of the project.

* **ENVIRONMENTAL –** OneSteel's manufacturing of reinforcing steel utilises energy reducing Polymer Injection Technology (PIT) and recycled steel scrap content.

* Supporting information on environmental claims for specific OneSteel Reinforcing ECO-REO™ products is available on the 'Technical Resources' page of the OneSteel Reinforcing website **www.reinforcing.com**

eco reo™
economical • environmental

If customers talk to OneSteel Reinforcing in the early stages of the project we can suggest ways of redesigning the reinforcing such as spacing and diameters to optimise material use.

ECO-BAR™ products include:

- **500PLUS® BAMTEC®** – Engineered reinforcing bar carpets can allow the size and positioning of reinforcing steel to be optimised with variable bar diameters, spacings and lengths.
- **500PLUS® PREFAB** – Prefabricated reinforcement can be produced more efficiently in the factory than on site, enabling reduced labour and time, and also generating less waste and scrap.

500PLUS® BAMTEC®

500PLUS® PREFAB

ecobar™

ECO-MESH™ products include ONEMESH® MADE-TO-SIZE and UTEMESH®

- Customised special run ONEMESH® can minimise duplication of reinforcing steel that results from excess lapping and scrap losses due to trimming of mesh sheets.
- Engineered and tailored mesh solutions can include variable wire spacing, diameters and ductilities, and optimised mesh size (length and width).
- Examples are the new UTEMESH® and the extra large (up to 9 m x 3 m) ONEMESH® MADE-TO-SIZE sheets which can give more cost-efficient solutions by reducing the number of sheets used on projects.

ECO-REO™ products include TRUSSDEK®

- Like reinforcing bar carpets and special meshes, TRUSSDEK® panels can reduce lapping and steel intensity and also serves as a permanent formwork system, thereby eliminating other formwork and the need for backpropping.
- Spacing between TRUSSDEK® panels can be optimised to reduce material, and concrete savings due to voiding of TRUSSDEK® panels can be significant.
- The volume of the steel reinforcing bars or mesh in a TRUSSDEK® slab can be up to 60% of that used in a conventional one-way reinforced-concrete slab.
- TRUSSDEK® panels can span up to 8.0 metres, which in steelframed buildings can potentially lead to the complete elimination of the secondary steel beams.

OneSteel Reinforcing and Green Star® Steel Credit Points

- If customers talk to OneSteel Reinforcing in the early stages of the project we can suggest ways of redesigning the reinforcing such as spacing and diameters to optimise material use.
- This can improve the sustainability credentials of the project allowing the awarding of Green Star® steel credit points where appropriate as well as potentially reducing the costs of reinforcing steel in the project.
- OneSteel Reinforcing can encourage the practice of moving product off site into prefabrication which fulfils the intent to reduce waste on site. This can provide the opportunity for dematerialisation and potentially speeding up construction, using our off site optimal fabrication techniques such as **500PLUS® BAMTEC®, 500PLUS® PREFAB** and **ONEMESH® MADE TO SIZE.**
- OneSteel Reinforcing is keen to assist customers in making progress towards adopting more sustainable practices. For more information on Green Star® related products visit **www.reinforcing.com**

OneSteel Reinforcing can meet the new Green Star® steel credit requirements

- OneSteel has a valid 14001 Environmental Management System in place.
- OneSteel is a member of the World Steel Association's Climate Action Programme.
- At least 60% of OneSteel Reinforcing steel is produced using Polymer Injection Technology – an energy reducing process in manufacturing.
- At least 95% of all OneSteel Reinforcing rebar and reomesh meets or exceeds 500 MPa strength grade.
- At least 15% by mass of all OneSteel Reinforcing REBAR and REOMESH® can be produced using off site optimal fabrication techniques for agreed projects.

Green Building Council documentation requirements

- Documentation to demonstrate compliance with optimal fabrication techniques is required from the steel fabricator/reinforcement processor in the form of a short report on where optimal steel manufacturing techniques are claimed, the optimal off site fabrication techniques used in the building, and the quantities (by mass) of steel used in each optimal off site fabrication technique.
- **OneSteel Reinforcing can confirm pre-project by letter that it can meet the requirements, and will also complete the post-project GBCA Criteria 3 & 4 charts required for the project.**

For more information on GBCA documentation visit www.gbca.com.au

REBAR & REO WIRE
Product Designations

AS/NZS 4671* Designation	OneSteel Designation**	Yield Stress (MPa)	Ductility Class***	Product Description	Source Material Type	Size Range
D500N_	N_	500	N	Hot rolled deformed rebar (500PLUS®REBAR)	TEMPCORE (TC) MICROALLOY (MA) CONTISTRETCH (CS)	N12 - N40 straight stock lengths N10, N12, N16 off coil
R250N_	R_	250	N	Hot rolled round rebar	Mild Steel	R6, R10, R12 off coil R16 -R28 straight stock lengths
D250N_****	S_	250	N	Hot rolled deformed rebar (POOLSTEEL®)	Mild Steel	S12
D500L_	RW_	500	L	Cold rolled ribbed wire	Mild Steel	RW5 - RW12 off coil
R500L_	W_	500	L	Cold drawn round wire	Mild Steel	W4 - W12 off coil

* AS/NZS 4671 : 2001 Steel reinforcing materials, D = Deformed, R = Round, N = Normal Ductility, L = Low Ductility
** _ indicates bar diameter (mm), N = Normal, R = Round, S = Structural, RW = Ribbed Wire, W = Wire
*** Uniform Strain Limits N : Normal (≥5%) L : Low (≥1.5%)
**** POOLSTEEL®

500PLUS® REBAR Stock Lengths & Approximate Lengths per Tonne

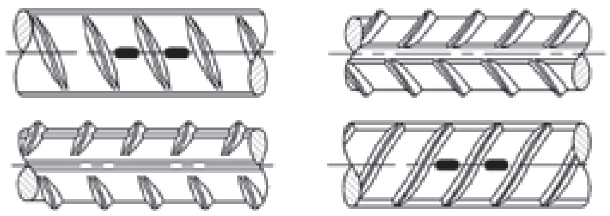
Bar diameter (mm)	Length (m)							Length (m/t)	Mass (kg/m)*
	6	7	8	9	10	12	15		
10	264	-	-	-	-	-	-	1582	0.632
12	183	157	137	122	110	92	-	1099	0.910
16	103	88	77	69	62	51	-	617	1.619
20	66	56	50	44	40	33	26	395	2.528
24	46	39	24	31	28	23	18	275	3.640
28	34	29	25	22	20	17	14	202	4.955
32	26	22	19	17	15	13	10	155	6.471
36	20	17	15	14	12	10	9	122	8.910
40	-	-	-	-	-	-	7	99	10.112

Note: Shaded areas are standard stock lengths. Not all stock lengths and diameters are available at all OneSteel Reinforcing branches. * Invoice weight – includes rolling margin of 2.5%

500PLUS® REBAR Identification Markings

Identification markings are rolled into the different types of REBAR and the wire in REOMESH® so the manufacturing facility of origin and steel type can be identified. The identifiers for REBAR have been standardised as a combination of horizontal and/or diagonal marks placed between the ribs at intervals as shown pictorially for each mill:

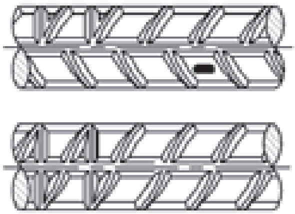
Sydney Bar Mill



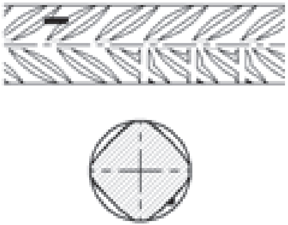
500N TEMPCORE (TC) | 250N S12 POOLSTEEL

500PLUS® REBAR
Identification Markings

Newcastle Rod Mill

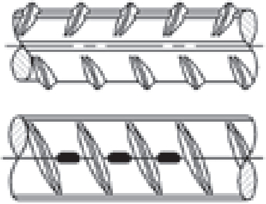


500N MICROALLOY (MA)



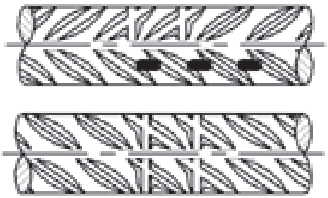
CONTISTRETCH

Laverton Bar Mill



500N TEMPCORE (TC)

Laverton Rod Mill



500N MICROALLOY (MA)

500PLUS® REBAR
Detailing Information

	Cross-sectional area (mm²) Bar diameter (mm)								
Number of Bars	10	12	16	20	24	28	32	36	40
1	78	113	201	314	452	616	804	1020	1260
2	156	226	402	628	904	1232	1608	2040	2520
3	234	339	603	942	1356	1848	2412	3060	3780
4	312	452	804	1256	1808	2464	3216	4080	5040
5	390	565	1005	1570	2260	3080	4020	5100	6300
6	468	678	1206	1884	2712	3696	4824	6120	7560
7	546	791	1407	2198	3164	4312	5628	7140	8820
8	624	904	1608	2512	3616	4928	6432	8160	10080
9	702	1017	1809	2826	4068	5544	7236	9180	11340
10	780	1130	2010	3140	4520	6160	8040	10200	12600
Mass (kg/m)*	0.632	0.910	1.619	2.528	3.640	4.955	6.471	8.190	10.112
Min. Hole Dia. (mm)**	12	15	20	25	29	34	39	44	49

500PLUS® REBAR

* Invoice weight - includes rolling margin of 2.5%

** Minimum hole diameter for clearance

Bar Spacing* (mm)	Cross-sectional area per unit width (mm^2/m) Bar diameter (mm)								
	10	12	16	20	24	28	32	36	40
100	780	1130	2010	3140	4520	6160	8040	10200	12600
125	624	904	1608	2512	3616	4928	6432	8160	10080
150	520	753	1340	2093	3013	4107	5360	6800	8400
175	446	646	1149	1794	2583	3520	4594	5829	7200
200	390	565	1005	1570	2260	3080	4020	5100	6300
225	347	502	893	1396	2009	2738	3573	4533	5600
250	312	452	804	1256	1808	2464	3216	4080	5040
275	284	411	731	1142	1644	2240	2924	3709	4582
300	260	377	670	1047	1507	2053	2680	3400	4200

*Measured centre-to-centre

Stress Development & Lap Splicing of Straight Deformed Bars in Tension

In AS 3600 : 2009, Clause 13.1.2.2 requires that the basic development length ($L_{sy.tb}$) to develop the yield stress (f_{sy}) of a straight deformed bar in tension shall be calculated as follows:

$$L_{sy.tb} = \frac{0.5k_1k_3f_{sy}d_b}{k_2\sqrt{f'_c}} \geq 29k_1d_b$$ where

k_1 = 1.3 for horizontal bars with more than 300 mm of concrete cast below the bars; or
= 1.0 for all other bars

k_2 = $(132 - d_b)/100$

k_3 = $[0.7 \leq \{1.0 - 0.15(c_d - d_b)/d_b\} \leq 1.0]$

f_{sy} = characteristic yield stress of the reinforcing bars (500 MPa)

d_b = nominal bar diameter (mm)

c_d = the least clear concrete cover (mm) to the bars (c), or half the clear distance between adjacent parallel bars developing stress (a), whichever is the lesser (mm), noting that the upper and lower bounds on k_3 mean that $d_b \leq c_d \leq 3d_b$ when substituted into the formula for k_3

f'_c = the concrete compressive strength grade, but not to exceed 65 MPa when substituted into above formula

The value of $L_{sy.tb}$ so calculated shall be multiplied by 1.3 if lightweight concrete (as defined in AS 3600) is used and/or by 1.3 for structural elements built with slip forms.

In accordance with Clause 13.1.2.3 of AS 3600 : 2009, the refined development length ($L_{sy.t}$) shall be determined as follows:

$$L_{sy.t} = k_4k_5L_{sy.tb} \quad \text{with } 0.7 \leq k_3k_4k_5 \leq 1.0$$ where

k_4 = $[0.7 \leq \{1.0 - K\lambda\} \leq 1.0]$

k_5 = $[0.7 \leq \{1.0 - 0.04\rho_p\} \leq 1.0]$

K & λ account for transverse reinforcement - see fig. 13.1.2.3(B) of AS 3600 : 2009

ρ_p = transverse compressive pressure at ultimate load (MPa)

Stress Development & Lap Splicing of Straight Deformed Bars in Tension

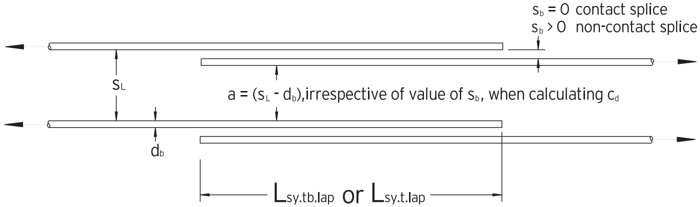
In accordance with Clause 13.2.2 of AS 3600 : 2009, the same formulae shall be used appropriately to calculate the basic lap length **($L_{sy.tb.lap}$)** or refined lap length **($L_{sy.t.lap}$)**. Due account shall be taken of the presence of lapped bars when determining clear distance (a) to calculate c_d - see figure (opposite). For bars lapped in the same plane, clear distance (a) shall be determined assuming contact lapped splices, i.e. lapped bars touching each other, even if the lapped splices are non-contact.

A factor k_7 also has to be applied in the calculations, according to the following equations **(viz. k_7**= 1.25, unless the cross-sectional area of the bars outside the laps equals at least twice the area required for strength, and no more than half the bars are spliced at any section, i.e. splices are staggered according to Fig. 13.2.2(ii) of AS 3600, in which case **k_7 = 1.0):**

$$L_{sy.tb.lap} = k_7 L_{sy.tb} \quad \text{... (basic)}$$

$$L_{sy.t.lap} = k_7 L_{sy.t} \geq 29 k_1 d_b \quad \text{... (refined)}$$

Case of 100% of bars spliced together in one plane (no splices staggered):



Non-contact lapped splices have these same values of lap length **($L_{sy.tb.lap}$** and **$L_{sy.t.lap}$)** in wide elements or members (e.g. beam flanges, band beams, slabs, walls, blade columns) and also in narrow elements or members where the clear distance **(s_b)** between each pair of bars being spliced does not exceed **$3d_b$**. Otherwise, in narrow elements or members, lap lengths increase to **$L_{sy.tb}$ + 1.5s_b** or **$L_{sy.t}$ + 1.5s_b**, if larger.

AS 3600 : 2009 Quick Reference Table - Tensile Development Lengths (Basic $L_{sy.tb}$ and Refined $L_{sy.t}$) and Tensile Lap Lengths (Basic $L_{sy.tb.lap}$ and Refined $L_{sy.t.lap}$)

(Above Table: refer to page 22)

The Table has been derived (with values given in millimetres rounded up to the nearest 10 mm, and also in multiples of bar diameter (d_b)), with the following assumptions applying:

- For beam webs and columns, and other types of "narrow" elements or members, the clear concrete cover (c) shall be the minimum distance from the representative bar to any adjacent concrete surface.
- The clear distance (a) between adjacent parallel bars developing stress equals at least twice the clear concrete cover (c). A longer lap might be required if this condition is not satisfied.
- Clear concrete cover (c) shall not be less than bar diameter (d_b).
- In narrow elements or members, the clear distance (s_b) between each pair of bars being spliced does not exceed $3d_b$. This requirement does not apply to splices in wide elements or members like slabs.
- As a practical limit, bar diameter (d_b) does not exceed 20 mm in 20 MPa concrete.
- The maximum centre-to-centre spacing between adjacent parallel bars being spliced is 300 mm.
- k_1 = 1.0. i.e. horizontal bars do not have more than 300 mm of concrete cast below them (which for example, excludes horizontal bars in walls), or else the bars are vertical. In accordance with Clause 13.1.2.2 development and lap lengths can increase by up to 30% if more than 300 mm of concrete is cast below the bars.
- The detrimental effects of lightweight concrete or slip-forming need to be allowed for separately according to Clause 13.1.2.2

Stress Development & Lap Splicing of Straight Deformed Bars in Tension

Lap lengths have been calculated conservatively by ignoring any beneficial effects of possible staggering or lower bar stress levels, i.e. k_7 has been assumed to equal 1.25.

The design solutions are presented in five groups according to the different combinations of minimum concrete cover (c) and concrete compressive strength grade (f'_c) given in Table 4.10.3.2 of AS 3600 : 2009, for common Exposure Classifications A1, A2, B1 and B2, that apply when standard formwork and compaction are used.

For A1 or A2 Exposure Classification, for cases when bar diameter (d_b) exceeds the minimum allowable concrete cover (c) (according to Table 4.10.3.2), design solutions have been determined by assuming c = 25, 30, 35, 40 or 40 mm for d_b = 24, 28, 32, 36 or 40 mm respectively, and are shown in bold in the AS 3600 : 2009 Quick Reference Table.

The solutions represent the maximum development or lap length required for all possible combinations of c and f'_c applicable to each particular group.

Refined development and lap lengths ($L_{sy.t}$ **and** $L_{sy.t.lap}$) have been calculated assuming the product $k_3k_4k_5$ = 0.7, i.e. the maximum possible benefit is provided by confinement from transverse reinforcement and/or pressure. It follows that, depending on the value of k_3, $0.7 \leq k_4k_5 \leq 1.0$.

It is left up to the designer to confirm that there is sufficient transverse reinforcement (accounted for by k_4) and/or transverse pressure (accounted for by k_5) to justify using a refined development or lap length if it is less than the corresponding basic development or lap length ($L_{sy.tb}$ **or** $L_{sy.tb.lap}$).

Where reinforcing bars of different sizes are lapped together, the tensile lap length should equal the larger of the tensile lap length ($L_{sy.tb.lap}$ **or** $L_{sy.t.lap}$) for the smaller diameter bar, or the tensile development length ($L_{sy.tb}$ **or** $L_{sy.t}$) for the larger diameter bar.

Stress Development & Lap Splicing of Straight Deformed Bars in Tension

AS 3600 : 2009 Quick Reference Table
Tensile Development Lengths – ($L_{sy.tb}$ and $L_{sy.t}$) & Tensile Lap Lengths ($L_{sy.tb.lap}$ and $L_{sy.t.lap}$) of Straight D500N Bars

Exposure Classification	Development or Lap Length		Bar Diameter d_b (mm) 10	12	16	20	24	28	32	36	40
A1 f'_c = 20 or 25 MPa	$L_{sy.tb}$	mm (bar diameters)	390 (39.0)	500 (41.7)	740 (46.3)	1000 (50.0)	**1100 (45.8)**	**1330 (47.5)**	**1580 (49.4)**	**1840 (51.1)**	**2170 (54.3)**
	$L_{sy.t}$		320 (32.0)	390 (32.5)	540 (33.8)	700 (35.0)	**770 (32.1)**	**940 (33.6)**	**1120 (35)**	**1310 (36.4)**	**1520 (38.0)**
	$L_{sy.tb.lap}$		490 (49.0)	630 (52.5)	930 (58.1)	1250 (62.5)	**1380 (57.5)**	**1660 (59.3)**	**1970 (61.6)**	**2300 (63.9)**	**2720 (68.0)**
	$L_{sy.t.lap}$		400 (40.0)	490 (40.8)	670 (41.9)	880 (44.0)	**970 (40.4)**	**1180 (42.1)**	**1400 (43.8)**	**1640 (45.6)**	**1900 (47.5)**
A1 $f'_c \geq$ 32 MPa	$L_{sy.tb}$	mm (bar diameters)	310 (31.0)	400 (33.3)	590 (36.9)	790 (39.5)	**980 (40.8)**	**1180 (42.1)**	**1390 (43.4)**	**1630 (45.3)**	**1920 (48.0)**
	$L_{sy.t}$		260 (26.0)	310 (25.8)	430 (26.9)	550 (27.5)	**690 (28.8)**	**830 (29.7)**	**990 (30.9)**	**1160 (32.2)**	**1340 (33.5)**
	$L_{sy.tb.lap}$		380 (38.0)	500 (41.7)	730 (45.6)	990 (49.5)	**1220 (50.8)**	**1470 (52.5)**	**1740 (54.4)**	**2040 (56.7)**	**2400 (60.0)**
	$L_{sy.t.lap}$		320 (32.0)	390 (32.5)	540 (33.8)	690 (34.5)	**860 (35.8)**	**1040 (37.1)**	**1230 (37.1)**	**1450 (40.3)**	**1680 (42.0)**

Stress Development & Lap Splicing of Straight Deformed Bars in Tension

A2 $f'_c \geq 20$ MPa	$L_{sy.tb}$	mm (bar diameters)	320 (32.0)	390 (32.5)	600 (37.5)	830 (41.5)	1070 (44.6)	1330 (47.5)	**1580 (49.4)**	**1840 (51.1)**	**2170 (54.3)**
	$L_{sy.t}$		320 (32.0)	390 (32.5)	540 (33.8)	700 (35.0)	780 (32.5)	940 (33.6)	**1120 (35.0)**	**1310 (36.4)**	**1520 (38.0)**
	$L_{sy.tb.lap}$		400 (40.0)	490 (40.8)	750 (46.9)	1030 (51.5)	1340 (55.8)	1660 (59.3)	**1970 (61.6)**	**2300 (63.9)**	**2720 (68.0)**
	$L_{sy.t.lap}$		400 (40.0)	490 (40.8)	680 (42.5)	870 (43.5)	970 (40.4)	1180 (42.1)	**1400 (43.8)**	**1640 (45.6)**	**1900 (47.5)**
B1 $f'_c \geq 25$ MPa	$L_{sy.tb}$	mm (bar diameters)	290 (29.0)	350 (29.2)	480 (30.0)	690 (34.5)	930 (38.8)	1190 (42.5)	1470 (45.9)	1770 (49.2)	2090 (52.3)
	$L_{sy.t}$		290 (29.0)	350 (29.2)	480 (30.0)	620 (31.0)	780 (32.5)	940 (33.6)	1120 (35.0)	1320 (36.7)	1520 (38.0)
	$L_{sy.tb.lap}$		360 (36.0)	440 (36.7)	600 (37.5)	860 (43.0)	1160 (48.3)	1480 (52.9)	1830 (57.2)	2210 (61.4)	2620 (65.5)
	$L_{sy.t.lap}$		360 (36.0)	440 (36.7)	600 (37.5)	780 (39.0)	970 (40.4)	1180 (42.1)	1400 (43.8)	1640 (45.6)	1900 (47.5)
B2 $f'_c \geq 32$ MPa	$L_{sy.tb}$	mm (bar diameters)	290 (29.0)	350 (29.2)	460 (28.8)	610 (30.5)	820 (34.2)	1050 (37.5)	1290 (40.3)	1560 (43.3)	1850 (46.3)
	$L_{sy.t}$		290 (29.0)	350 (29.2)	460 (28.8)	550 (27.5)	690 (28.8)	830 (29.6)	990 (30.9)	1160 (32.2)	1350 (33.8)
	$L_{sy.tb.lap}$		360 (36.0)	440 (36.7)	580 (36.3)	760 (38.0)	1030 (42.9)	1310 (46.8)	1620 (50.6)	1950 (54.2)	2310 (57.8)
	$L_{sy.t.lap}$		360 (36.0)	440 (36.7)	580 (36.3)	690 (34.5)	860 (35.8)	1040 (37.1)	1230 (38.5)	1450 (40.3)	1680 (42.0)

Stress Development & Lap Splicing of Straight Deformed Bars in Tension

It can be seen from the AS 3600 : 2009 Quick Reference Table that:

- Development and lap lengths generally reduce as the Exposure Classification becomes more severe, i.e. moving from A1 to B2, which is due to the general increase in concrete cover (c); and
- Basic development and lap lengths ($L_{sy.tb}$ and $L_{sy.tb.lap}$) can be significantly longer than refined lengths ($L_{sy.t}$ and $L_{sy.t.lap}$), particularly for large diameter bars, which can justify additional calculations for beams and columns with confining fitments, etc.

Examples:

1. Fully anchor horizontal N16@250 crs in top face of a 250 mm deep cast-in-situ slab, f'_c= 32 MPa and top cover (c) of 40 mm for B1 Exposure Classification.

   Clear distance, a= 250-16 = 234 > 2c, which has to be satisfied for the Quick Reference Table to be used. Since this combination of f'_c and c is given in Table 4.10.3.2, the AS 3600 : 2009 Quick Reference Table for B1 Exposure Classification may be used directly.

   It follows that for d_b = 16 mm, $L_{sy.tb}$ = $L_{sy.t}$ = 480 mm or 30.0 d_b, i.e. the basic and refined tensile development lengths are equal in this case.

2. Lap same bars as in Example 1, in either contact or non-contact splices, to fully develop f_{sy} outside lapped splices which are not staggered.

   Clear distance, a = 250 - 2 x 16 = 218 > 2c, which has to be satisfied for the AS 3600 : 2009 Quick Reference Table to be used. Since a slab is a wide member, there is no restriction on the value of s_b for non-contact splices. It follows that $L_{sy.tb.lap}$ = $L_{sy.t.lap}$ = 600 mm or 37.5 d_b, i.e. the basic and refined tensile lap lengths are also equal in this case, but 25% greater than their corresponding development length.

Stress Development & Lap Splicing of Straight Deformed Bars in Tension

In AS 3600 : 2001, Clause 13.1.2.1 requires that the development length ($L_{sy.t}$) to develop the yield stress (f_{sy}) of a straight, deformed bar in tension shall be calculated as follows:

$$L_{sy.t} = \frac{k_1 k_2 f_{sy} A_b}{(2a + d_b)\sqrt{f'_c}} \geq 29 k_1 d_b \quad \text{where}$$

k_1 = 1.25 for horizontal bars with more than 300 mm of concrete cast below the bars; or
= 1.0 for all other bars

k_2 = 1.7 for bars in slabs and walls if the clear distance between adjacent parallel bars developing stress is not less than 150 mm;
= 2.2 for longitudinal bars in beams or columns with fitments; or
= 2.4 for all other longitudinal bars

f_{sy} = characteristic yield stress of the reinforcing bars (500 MPa)

d_b = nominal bar diameter (mm)

A_b = cross-sectional area of a single reinforcing bar (mm²)

$2a$ = twice the cover to the bars (c), or the clear distance between adjacent parallel bars developing stress (s_c), whichever is the lesser, noting that in the formula its value should be bounded according to $2d_b \leq 2a \leq 6d_b$ (mm)

f'_c = the concrete compressive strength grade, but not to exceed 65 MPa when substituted into above formula

In accordance with Clause 13.2.2, the same formula shall be used to calculate the tensile lap length ($L_{sy.t.lap}$), with due account taken of the presence of the lapped bars when determining the clear distance, s_c. For bars in the same plane, the clear distance should be determined assuming contact lapped splices, i.e. lapped bars touch each other, while non-contact lapped splices are equally acceptable and have the same value of tensile lap length ($L_{sy.t.lap}$).

AS 3600 : 2001 Quick Reference Table - Tensile Development Length ($L_{sy.t}$) and Tensile Lap Length ($L_{sy.t.lap}$)

The AS 3600 : 2001 Quick Reference Table of tensile development length ($L_{sy.t}$) and tensile lap length ($L_{sy.t.lap}$) has been derived based on the same assumptions, when applicable, to those on which the AS 3600 : 2009 Quick Reference Table is based. Also, k_2 = 1.7 for bars in slabs or walls, so clear distance (s_c) has to be at least 150 mm.

Note: Clear distance (s_c) is represented by the symbol "a" in AS 3600 : 2009.

Stress Development & Lap Splicing of Straight Deformed Bars in Tension

AS 3600 : 2001 Quick Reference Table Tensile Development Length ($L_{sy.t}$) & Tensile Lap Length ($L_{sy.t.lap}$) of Straight D500N Bars

Exposure Classification	Development or Lap Length		Bar Diameter d_b (mm) 10	12	16	20	24	28	32	36	40
A1 f′$_c$ = 20 or 25 MPa	Slab/Wall	mm (bar diameters)	300 (30.0)	410 (34.2)	680 (42.5)	1000 (50.0)	**1040 (43.3)**	**1190 (42.5)**	**1340 (41.9)**	**1490 (41.4)**	**1780 (44.5)**
	Beam/Column		390 (39.0)	530 (44.2)	880 (55.0)	1290 (64.5)	**1340 (55.8)**	**1540 (55.0)**	**1730 (54.1)**	**1930 (53.6)**	**2300 (57.5)**
	Other		420 (42.0)	580 (48.3)	960 (60.0)	1400 (70.0)	**1470 (61.3)**	**1680 (60.0)**	**1890 (59.1)**	**2110 (58.6)**	**2510 (62.8)**
A1 f′$_c$ ≥ 32 MPa	Slab/Wall	mm (bar diameters)	290 (29.0)	350 (29.2)	540 (33.8)	790 (39.5)	**920 (38.3)**	**1050 (37.5)**	**1180 (36.9)**	**1320 (36.7)**	**1570 (39.3)**
	Beam/Column		310 (31.0)	420 (35.0)	700 (43.8)	1020 (50.5)	**1190 (49.6)**	**1360 (48.6)**	**1530 (47.8)**	**1710 (47.5)**	**2040 (51.0)**
	Other		330 (33.0)	460 (38.3)	760 (47.5)	1110 (55.5)	**1300 (54.2)**	**1480 (52.9)**	**1670 (52.2)**	**1860 (51.7)**	**2220 (55.5)**

Stress Development & Lap Splicing of Straight Deformed Bars in Tension

A2 f′$_c$ ≥ 20 MPa	Slab/Wall	mm (bar diameters)	290 (29.0)	350 (29.2)	480 (30.0)	470 (29.4)	**920 (38.3)**	**1190 (42.5)**	**1340 (41.9)**	**1490 (41.4)**	**1780 (44.5)**
	Beam/Column		290 (29.0)	380 (31.7)	620 (38.8)	910 (45.5)	**1190 (49.6)**	**1540 (55.0)**	**1730 (54.1)**	**1930 (53.6)**	**2300 (57.5)**
	Other		300 (30.0)	410 (34.2)	680 (42.5)	990 (49.5)	**1300 (54.2)**	**1680 (60.0)**	**1890 (59.1)**	**2110 (58.6)**	**2510 (62.8)**
B1 f′$_c$ ≥ 25 MPa	Slab/Wall	mm (bar diameters)	290 (29.0)	350 (29.2)	470 (29.4)	580 (29.0)	730 (30.4)	940 (33.6)	1080 (33.8)	1320 (36.7)	1570 (39.3)
	Beam/Column		290 (29.0)	350 (29.2)	470 (29.4)	700 (35.0)	950 (39.6)	1220 (43.6)	1400 (43.8)	1710 (47.5)	2040 (51.0)
	Other		290 (29.0)	350 (29.2)	520 (32.5)	760 (38.0)	1040 (43.3)	1330 (47.5)	1520 (47.5)	1860 (51.7)	2220 (55.5)
B2 f′$_c$ ≥ 32 MPa	Slab/Wall	mm (bar diameters)	290 (29.0)	350 (29.2)	470 (29.4)	580 (29.0)	700 (29.2)	820 (29.3)	950 (29.7)	1090 (30.3)	1300 (32.5)
	Beam/Column		290 (29.0)	350 (29.2)	470 (29.4)	580 (29.0)	750 (31.3)	980 (35.0)	1230 (38.4)	1410 (39.2)	1680 (42.0)
	Other		290 (29.0)	350 (29.2)	470 (29.4)	590 (29.0)	820 (34.2)	1070 (38.2)	1340 (41.9)	1530 (42.5)	1830 (45.8)

Positioning Tolerances for Reinforcement to AS 3600 : 2009

In accordance with Clause 17.5.3:

	Application	Allowable Deviation
Position controlled by cover	Beams, slabs, columns and walls	-5, +10 mm
	Slabs on ground	-10, +20 mm
	Footings cast in ground	-10, +40 mm
Position not controlled by cover	End of reinforcement	50 mm
	Spacing of bars or fitments in walls, slabs, beams or columns	10% of the specified spacing or 15 mm whichever is greater

Note: A positive value indicates the amount the cover may increase and a negative value indicates the amount the cover may decrease relative to the specified cover.

Calculating Reinforcing & Accessory Quantities

Accessories for REOMESH®

Mesh Round Up: Slab Area (m^2) ÷ 12.5 = No. of 6 x 2.4 m sheets
Bar Chairs: Slab Area (m^2) ÷ 0.56 = No. of bar chairs
Polythene Film: Slab Area (m^2) ÷ 180 = No. of 200 m^2 rolls
Duct Tape: 2 rolls per 200 m^2 roll of polythene film

Accessories for REBAR

Bar Chairs: Slab area (m^2) ÷ 0.56 = No. of bar chairs
Tie Wire: 3 kg per tonne of REBAR (for bar sizes up to 20 mm)
1.5 kg per tonne of REBAR (for bar sizes above 20 mm)

Accessories for Strip Footings

Trench Mesh: Footing Length (m) ÷ 5.4 = No. of 6 m lengths
Prefab Cages: Footing Length (m) ÷ 5.4 = No. of 6 m cages
Support Chairs: 7 chairs per 6 m length

REBAR

No. of Bars: Round Up $\left(\frac{\text{Coverage Length (m)}}{\text{(Bar Spacing (m))}} \right) + 1$

Bar Length: Concrete dimension (mm) - ∑ {cover each end (mm)}
Stock Bars: Allow for lapping of bars when calculating No. of Bars

Spirals

Diameter: Concrete dimension (mm) - cover each side (mm)
Pitch: Specified on drawing. Maximum of half diameter of spiral
No. of Turns: Round Up $\left(\frac{\text{Coverage Length (m)}}{\text{(Pitch (m))}} \right) + 3$

500PLUS® REBAR
Standard Hooks and Cogs

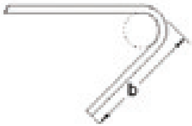
In accordance with Clause 13.1.2.6 of AS 3600 : 2009, a standard hook or cog provides half of the tensile development length for that end of the bar, measured from the outside of the hook/cog. In accordance with Clause 13.1.2.7, their details are as follows.

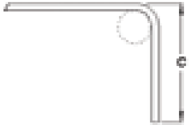
	**Standard Hook**	A hook consisting of a 180° bend around the appropriate pin complying with Clause 17.2.3.2 with a straight extension of $4d_b$ or 70 mm, whichever is greater, or a hook consisting of a 135° bend with the same internal diameter and length as for a hook with a 180° bend
	**Standard Cog**	A cog consisting of a 90° bend around the appropriate pin complying with Clause 17.2.3.2 but not greater than $8d_b$ and having the same total length as required for a 180° hook of the same diameter bar

Standard Hooks & Cogs to Clause 13.1.2.7 of AS 3600 : 2009

Minimum Dimensions:

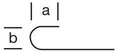
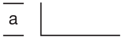
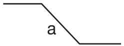
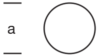
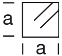
D500N bar diameter, d_b (mm)	Pin diameter factor, f_p (Pin diameter $d_p=f_pd_b$)	180° hook	135° hook	90° cog
		a (mm)	b (mm)	c (mm)
10	4 for fitments	100	120	140
	5	105	130	155
12	4 for fitments	110	130	155
	5	115	145	170
16	4 for fitments	120	150	185
	5	130	165	205
20	4 for fitments	140	180	220
	5	150	200	245
24	4 for fitments	170	220	265
	5	180	240	295
28	5	210	280	345
32	5	240	320	395
36	5	270	355	440
40	5	300	395	490





Minimum Dimensions for Standard Shapes Processed to AS 3600 : 2009

Minimum Dimensions (mm) for R REBAR **Standard Shapes that can be processed complying with AS 3600 : 2009**

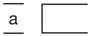
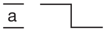
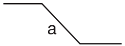
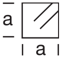
Rebar Type and Size									
Pin Size	4d_b		5d_b	5d_b	5d_b	5d_b	-	3d_b	
	a*	b	a*	a	a	a	a	a	a
R6	165	40	200	80	90	80	150	150	150
R10	175	60	230	130	150	130	170	180	180
R12	185	75	250	155	160	155	200	195	195

The pin sizes used in this table are for mild steel bars, which are not to be subsequently straightened or rebent. Values indicated are a guide only and may vary depending on equipment of supply locations. Some values are governed by processing equipment rather than minimum code requirements. If you require a shape smaller than indicated please contact your OneSteel Reinforcing representative for possible alternatives.

Minimum Dimensions for Standard Shapes Processed to AS 3600 : 2009

Minimum Dimensions (mm) for Class N 500PLUS® REBAR

Standard Shapes that can be processed complying with AS 3600 : 2009

Rebar Type and Size								
Pin Size	$5d_b$		$5d_b$	$5d_b$	$5d_b$	$5d_b$	-	$4d_b$
	a	b	a	a	a	a	a	a - other
N10	130	80	170	130	150	130	400	140
N12	135	95	190	160	160	155	400	160
N16	150	125	220	210	210	210	420	210
N20	175	155	260	260	260	260	500	260
N24	205	185	315	315	315	315	550	315
N28	235	220	365	365	365	365	600	365
N32	265	250	420	420	420	420	800	420
N36	295	280	470	470	470	470	1000	-
N40	325	310	520	520	520	520	1200	-

The pin sizes used in this table are for hot-rolled deformed bars, which are not to be subsequently straightened or rebent. Values indicated are a guide only and may vary depending on equipment of supply locations. Some values are governed by processing equipment rather than minimum code requirements. If you require a shape smaller than indicated please contact your OneSteel Reinforcing representative for possible alternatives.

500PLUS® REBAR

Technical Note

Rebar Bending and Rebending / Straightening

Standard names and use:

- Bending of 500PLUS® REBAR should be carried out in accordance with Clause 17.2.3 of AS 3600 : 2009
- If engineers/builders request pin diameters smaller than those required by AS 3600, such bends can only be supplied if the engineer gives written approval to the order.
- Rebending 500PLUS® REBAR on site – due to limitations of adequate rebending facilities on site, we recommend that the customer's attention is drawn to the guidelines set out in AS 3600 and in the OneSteel Reinforcing 500PLUS® technical notes.
- Care must be taken when bending, straightening or rebending is performed on a construction site to ensure that the bend radii are not formed below the prescribed minimum sizes in AS 3600.
- OneSteel Reinforcing recommends that 500PLUS® TEMPCORE® be used in such situations for use as pull-out bars rather than MICROALLOY or CONTISTRETCH rebar.

Note: TEMPCORE®, MICROALLOY and CONTISTRETCH and all galvanized rebar have different minimum recommended bending pin diameters.

Processing 500PLUS® REBAR and Wire to AS 3600 : 2009

Bending Reinforcing Bars to Clause 17.2.3.2:

Product Use	Product Description	Pin Size
(a) Fitments	Ribbed or round Grade 500 wire & Grade 250 rebar	$3d_b$
	D500N bars	$4d_b$
(b) Reinforcement that is to be galvanized or epoxy coated (before or after bending)	≤ 16 mm diameter	$5d_b$
	≥ 20 mm diameter	$8d_b$
(c) Reinforcement in which the bend is intended to be straightened or rebent *	≤ 16 mm diameter	$4d_b$
	20 mm or 24 mm diameter	$5d_b$
	≥ 28 mm diameter	$6d_b$
(d) Other than specified in (b) or (c)	Reinforcement of any grade	$5d_b$

Standard Processing Tolerances:

Product Use	Tolerance	Allowable Tolerance
On any overall dimension for bars or mesh except where used as a fitment	≤ 600 mm overall	-25, +0 mm
	≤ 600 mm overall	-40, +0 mm
On any overall dimension for bars or mesh used as a fitment	Deformed bars and mesh	-15, +0 mm
	Plain round bars and wire	-10, +0 mm
For offset dimension of a cranked bar		-0, +10 mm

The nominal internal diameter of a reinforcement bend or hook shall be taken as the diameter of the pin around which the reinforcement is bent. The diameter of the pin shall be not less than the value determined from the above table as appropriate. **Note:** TEMPCORE®, MICROALLOY and CONTISTRETCH and all galvanized rebar have differing recommended bending pin diameters.

* Must be indicated on drawing that bars are to be straightened or rebent.

• OneSteel Reinforcing recommends that 500PLUS® TEMPCORE® be used in such situations for use as pull-out bars rather than MICROALLOY or CONTISTRETCH rebar.

500PLUS® REBAR

Bending/Rebending

A number of situations may arise where bars must be bent or rebent on site, or where pre-bent bars must be straightened. For smaller diameter bars (i.e., 10, 12 & 16 mm), this is preferably performed at ambient temperature, as this has the least effect on steel properties. In accordance with Clause 17.2.3.1 of AS 3600 : 2009, to cold bend D500N bars not exceeding 16mm in diameter:

- the initial bend should be performed around a mandrel or former of diameter not less than $4d_b$;
- do not use impact blows to bend or rebend the steel; and
- take care to minimise mechanical damage to the bar surface and visually inspect rebent area for cracks.

Rebending or straightening should be performed using a powered bending tool, or a pipe with an internal diameter not greater than 2x the nominal bar diameter.

Bending Properties

Diameter (mm)	AS/NZS 4671 Requirements	AS 3600 Requirements	500PLUS® TEMPCORE® Capability	500PLUS® MICROALLOY or CONTISTRETCH Capability	Galvanized Bars*
≤ 16	$4d_b$ @ 90 deg	$5d_b$ generally, but $4d_b$ for fitments	$2d_b$ @ 180 deg	$3d_b$ @ 180 deg	$5d_b$ @ 180 deg
≥ 20	$4d_b$ @ 180 deg	$5d_b$ generally, but $4d_b$ for fitments	$3d_b$ @ 180 deg	Not produced	$8d_b$ @ 180 deg

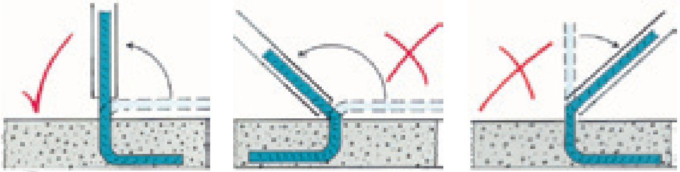
* The bending limits shown in this column have been specified in AS 3600 to minimise spalling of the galvanized coating.

Bending & Rebending
500PLUS® REBAR

For larger diameter bars, the application of heat (e.g. from an acetylene flame) may be used to reduce the bending force, but a reduction in bar strength may result. Ref: AS 3600 : 2009 Clause 17.2.3.1 (b).

Further details on bending/rebending and welding 500PLUS® REBAR can be found at **www.reinforcing.com**

A pipe must not be used to make the initial bend, or to rebend back past the straight position. Rebending of bars that have been bent prior to galvanizing is not recommended, as cracking on the inside of the original bend may result.



Rebending Properties

Diameter (mm)	AS/NZS 4671 Requirements	500PLUS® TEMPCORE® Capability	500PLUS® MICROALLOY or CONTISTRETCH Capability	AS 3600 Limits
≤ 16	$4d_b$	$2d_b$ @ 180 deg	$3d_b$ @ 180 deg	$4d_b$
$20 \leq d_b \leq 24$	-	$3d_b$ @ 180 deg	Not produced	$5d_b$
$28 \leq d_b \leq 36$	-	$6d_b$	-	$6d_b$

500PLUS® REBAR

500PLUS REBAR

After heating, the resultant ambient temperature properties of reinforcing steels may be significantly altered. This is an important consideration if heat has been applied to assist with bending bars through welding or the effect of fire. To effectively control the temperature during the heating or welding process the use of temperature control crayons is recommended.

Heating

Heating should be avoided if the original bar properties are required. Bending should always be around a former of the appropriate size (refer processing to AS 3600). AS 3600 : 2001 states in Clause 19.2.3.1 and AS 3600 : 2009 in Clause 17.2.3.1 that reinforcement may be bent hot, provided that all of the following are complied with:

i) the steel is heated uniformly through & beyond the portion to be bent;

ii) the temperature of the steel does not exceed 600°C;

iii) the bar is not cooled by quenching; and

iv) if during heating the temperature of the bar exceeds 450°C, the characteristic yield stress (f_{sy}) of the steel after bending shall be taken as 250 MPa.

Welding

500PLUS® REBAR produced by the TEMPCORE®, MICROALLOYED and CONTISTRETCH processes has maximum carbon equivalent (Ceq) of 0.44 and, as such, requires no pre-heating prior to welding.

Pre-heating is not required when bars are welded in accordance with AS/NZS 1554 Part 3. Hydrogen controlled electrodes are required for all weld types, and matching strength electrodes are required for butt welds.

Note: Some types of welded splices can reduce the ductility of the connected bars.

Threading 500PLUS® REBAR

The design tensile capacities of fine-threaded 500PLUS® REBAR can be determined in accordance with AS 4100*. Based on the results of testing, fine-threaded 500PLUS® REBAR has a reduced characteristic yield stress equal to 75% of the normal characteristic yield stress (500 MPa) and a reduced characteristic tensile strength equal to 85% of the normal characteristic tensile strength (540 MPa) based on the thread stress area. It follows that OneSteel Reinforcing 500PLUS® REBAR when cut with AS 1275** metric threads and fitted with AS 1112*** Property Class 5 nuts, has the values of design tensile capacity specified in the adjoining table. These design tensile capacities are based on the effective tensile stress areas (A_s) from AS 1275**, a strength reduction factor $\phi = 0.8$, and a characteristic tensile strength equal to 0.85 x 540 = 459 MPa.

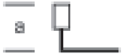
^ Denotes second choice thread size. Nuts may be difficult to obtain. N.B. Engineers should be aware that threading reinforcing bars this way also reduces the ductility to less than the minimum requirements for Class N bars specified in AS/NZS 4671.

Design Tensile Capacity = ϕ A_s x 0.85 x TS where TS = 540 MPa

* AS 4100 : 1998 Steel structures,
** AS 1275 : 1985 Metric screw threads for fasteners
*** AS 1112 : 2000 ISO metric hexagon nuts

Bar Diameter (mm)	Normal Thread Size (mm)	Stress Area (mm^2)	500PLUS® REBAR Design Tensile Capacity (kN)
N12	M10	58	21
N16	M12	84	31
N20	M16	157	58
N24	M20	245	90
N28	M24	353	130
N32	M30	561	205
N36	M33^	694	255
N40	M36	817	300

500PLUS® REBAR

	Diameter				
	RB12	RBA16	RBA20	RB25	RB32
Cross sectional Area (mm^2)	113	201	314	491	804
Yield Stress (MPa)	500	500	500	500	500
Design Yield Capacity (kN)	56.5	100.6	157.0	245.5	402.0
Design Tensile Capacity (kN)	61.0	108.5	169.6	265.1	434.2
Max. Tensile Working Load (kN)	39.0	70.0	109.0	171.0	281.0
Design Shear Capacity (0.62 min ult) (kN)	37.8	67.3	105.2	164.4	269.2
Minimum Hole for Clearance (mm)	15	20	24	29	38
 Minimum Length 'a' for L bar with Coupler (mm) ($5d_b$ pin)	145	185	230	295	365

Note: OneSteel Reinforcing does not recommend the use of REIDBAR™ for formwork ties.
FWB: 880 MPa Formwork bar is available for this application.

500PLUS® REIDBAR™ is a hot-rolled, continuously coarse-threaded, steel reinforcing bar that complies with the requirements in AS/NZS 4671 for Class N reinforcement. When used in conjunction with accessories, it offers the designer flexibility to overcome challenging design or buildability issues. These tables list the material properties and the common accessories available for 500PLUS® REIDBAR™.
A 500PLUS® REIDBAR™ Design Guide and case studies are available from OneSteel Reinforcing or **www.reinforcing.com**

Coupler	RB12C	RBA16C	RBA20C	RB25C	RB32C
Threaded Insert**	RB12TI	RBA16TI	RBA20TI	RB25TI	RB32TI
Grout Sleeve	-	RBA16GS	RBA20GS	RB25GS	RB32GS
Nut***	RB12N	RBA16N	RBA20N	RB25N	RB32N

All accessories develop the breaking strength of 500PLUS® REIDBAR™.
Galvanized fittings available in most sizes.
** The load that a threaded insert can provide is dependent on its anchorage (refer to REIDBAR™ Design Guide) *** Nuts have a minimum strength corresponding to a bar stress of $1.15f_{sy}$

500PLUS® PREFAB

ecobar™

500PLUS® PREFAB

500PLUS® PREFAB products reduce the steelfixing of major structural components such as piles, ground beams, pad footings, columns, beams, arches and lattice girders.

This allows builders and construction companies to take advantage of the many benefits from utilising modular construction.

Incorporating 500PLUS® PREFAB from OneSteel Reinforcing:

- Reduces on-site steelfixing and labour costs
- Minimises site congestion
- Enables faster, more economical construction
- Ensures accuracy and quality
- Allows for design flexibility
- Simplifies handling
- Improves OH&S

500PLUS® BAMTEC® Reinforcing Carpets

500PLUS® BAMTEC® is the world's fastest steel fixing system. It involves prefabricating reinforcing steel "carpets" to a wide range of shapes and sizes.

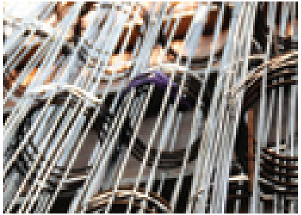
Individual reinforcing bars are welded to flexible steel straps and the resultant "carpet" is rolled up for transport and handling.

The carpets can contain hundreds of bars which may be of different length and diameter, with variable spacings and accommodate complex shapes and penetrations.

When needed on site, the carpet is simply lifted into place and unrolled onto continuous bar chairs.

Benefits

- Faster construction
- Save up to 80% on steel-fixing costs
- Ideal for suspended slabs, slab on ground, CRCP and tilt-up panels
- Improves cost effectiveness of slab construction
- Variable spacing and bar diameters available
- Improved accuracy and quality
- Less material wastage and scrap
- Redesign and detailing assistance available
- Can contribute to earning Green Star® points on projects
- Less bending and carrying
- Easier chairing and no bars to sort
- Simpler marking plan

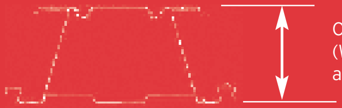


500PLUS® BAMTEC®
Reinforcing Carpets

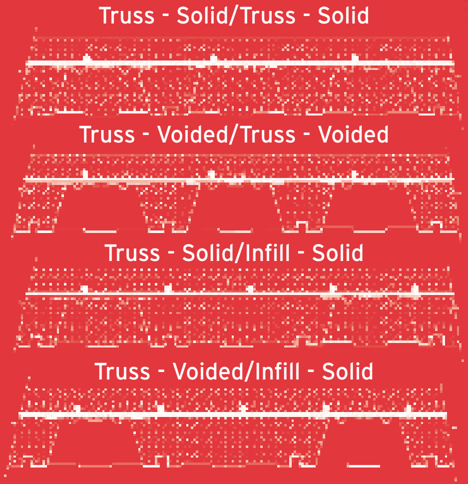
Product Code examples	Size (mm)
N10BM	10 mm
N12BM	12 mm
N16BM	16 mm
N20BM	20 mm
N24BM	24 mm
N28BM	28 mm
N32BM	32 mm
N36BM	36 mm

TRUSSDEK®
Long Span Structural Decking

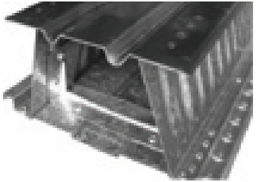
Average concrete depth saving in voided slabs (mm) (TRUSSDEK® panels are precambered in the factory to prevent concrete ponding)		
TRUSSDEK® Panel Code	TRUSSDEK® Composite Slab Type (see figures opposite)	
	Truss-Voided/Truss-Voided	Truss-Voided/Infill-Solid
TD90	55	25
TD110	65	30
TD140	75	35
TD160	85	40
e.g. Average depth of a 200 mm deep TRUSSDEK® composite slab type Truss-Voided/Truss-Voided with TD140 panels equals 200 - 75 =125 mm		

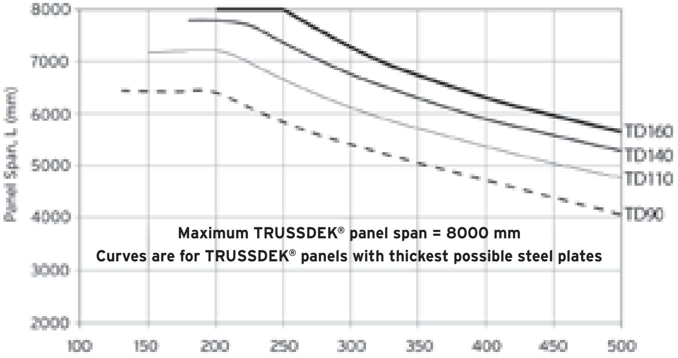


Overall depth of TRUSSDEK® panels is 90, 110, 140 or 160 mm
(Where required, pre-punched holes in webs – 50 x 90 mm
at variable spacings).



TRUSSDEK
Long Span Structural Decking





Overall Composite Slab Depth D_{cs} (mm)

Span Chart for Truss - Voided/Truss - Voided Slabs in Unpropped Construction using Simply-Supported Panels

500PLUS® ROMTECH® Tunnel Girders




500PLUS® ROMTECH® Lattice Girders, in conjunction with shotcrete, are becoming an increasingly popular strata control method in tunnelling applications. Suitable for use in hard rock or soft ground conditions, 500PLUS® ROMTECH® Lattice Girders provide a high strength-to-weight ratio.

ROMTECH Lattice Girders are manufactured in low-tolerance jigs to ensure dimensional accuracy. However, the fact that the units can be fabricated just days before being required, means last minute changes to profiles can be incorporated, and the various sections manufactured to suit the required excavation and installation sequence.

The light weight sections simplify transport and handling, and simple connection details makes them easy to install on site.

Depending on the ground conditions, they may be held in place during construction by soil or rock anchors, and are supported by standard or adjustable footplates at the invert of the tunnel.

500PLUS® ROMTECH®

POOLSTEEL®

Specifically developed for use in concrete swimming pools, OneSteel Reinforcing's 250S Grade 12 mm POOLSTEEL® is a ductile steel that is preferred by steelfixers over other types of concrete pool reinforcing steels available.

Having a deformed profile enables a superior bond to be achieved with the concrete ensuring a quality result.

Ground movement can exert extreme forces on the walls of a swimming pool. The strength and ductility of POOLSTEEL® enables these forces to be resisted while controlling cracking, thereby contributing to the longevity of the pool structure.

- Provides maximum design flexibility
- Specially developed for concrete pool construction
- Independently certified by ACRS
- Easy to bend and form

ONEMESH®
Square & Rectangular

ONEMESH® Properties Slab Mesh (6 m x 2.4 m)		Square Meshes* (SL) with edge lap wires									Rectangular Meshes* (RL)					
		SL53* (WA Only)	**SL63*** (WA Only)	**SL52**	**SL62**	**SL72**	**SL82**	**SL92**	**SL102**	**SL81**	**RL718**	**RL818**	**RL918**	**RL1018**	**RL1118**	**RL1218**
Cross-sectional Area (mm²/m)	Longitudinal Wires	60	94	89	141 **157**	179 **190**	227 **247**	290 **303**	354 **372**	454 **495**	358 **390**	454 **495**	581 **634**	709 **774**	899 **982**	1112 **1215**
	Cross Wires	60	94	89	141 **152**	179 **192**	227 **243**	290 **311**	354 **380**	454 **470**	227 **243**	227 **243**	227 **243**	227 **243**	227 **243**	227 **243**
Sheet Mass (kg)		15	21	20	33	41	52	66	80	105	67	79	93	109	130	157

* SL53 and SL63 are 6 m x 2.3 m

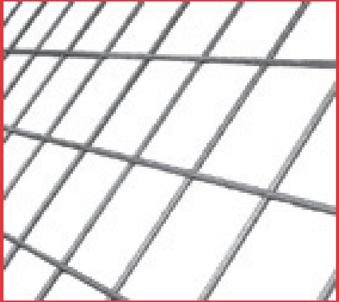
Note: Cross-sectional areas (mm²/m) shown in bold are average rather than minimum values that apply to meshes lap-spliced in accordance with AS 3600 : 2001 or AS 3600 : 2009. See Technical Note 6 "Design to AS 3600 : 2001 of Suspended Concrete Floors Reinforced with Class L Mesh" at SRIA's website www.sria.com.au for more design information.

ONEMESH®
Trench Mesh

		L8TM200	L8TM300	L8TM400	L11TM200	L11TM300	L11TM400	L12TM200	L12TM300	L12TM400
Width (mm)*		200	300	400	200	300	400	200	300	400
Mass (kg)		7.0	9.1	11.2	13.5	17.8	22.0	16.8	22.1	27.3
Longitudinal Wires	No.	3	4	5	3	4	5	3	4	5
	Cross-sectional Area (mm^2)	136	181	227	270	360	450	334	445	556

* Standard length = 6 m

Lapped Splices for ONEMESH® Mesh in Tension or Compression



In AS 3600 : 2001, Clause 13.2.3 states that the two outermost transverse wires of one sheet of mesh must overlap the two outermost transverse wires of the sheet being lapped, as shown below.

Overlap of ends of sheets (with overhang)

Overlap of sides of sheets

Overlap of side and end of sheets

The same requirements for full-strength tensile laps apply in Clause 13.2.3 of AS 3600 : 2009, but with additional criteria about the minimum spacing of transverse wires, which are all satisfied by using ONEMESH®.

ONEMESH® Identification Markings

- Identification markings are rolled into the different types of REBAR and wire in REOMESH® to identify the manufacturing facility of origin.
- The identifiers for REOMESH® have been standardised as a combination of horizontal and diagonal marks placed between the ribs at intervals.
- Before 2010, OneSteel Reinforcing rolled the word 'one' into wire for REOMESH®.

onemesh®

onemesh® made to size

utemesh®

Reinforcing wire/mesh identifiers for manufacturing facilities

AS/NZS 4671 Grade 500L: 5 - 14 mm

Brisbane - Acacia Ridge™	- / -
Sydney - Revesby™	- /
Melbourne - Sunshine™	// -
Perth - Forrestfield™	- - /

Footing Cages

		L8TM Top & Bottom		L11TM Top & Bottom		L12TM Top & Bottom		8TM200 Top & 11TM200 Bottom
		Cage Width (mm)						
Depth (mm)	Product Code	200	300	200	300	200	300	200
200	QLD	ZC110	ZC12	ZC111	ZC11	-	-	-
	NSW	8ZC2020	8TC3020	11ZC2020	11TC3020	12ZC020	-	-
300	QLD	ZC210	ZC17	ZC711	ZC18	ZC9Y	-	ZC7A
	NSW	8ZC2028	8TC3030	11ZC2028	11TC3030	12ZC2028	12TC3028	-
400	QLD	ZC310	FC19	ZC811	FC20	-	-	FC8A
	NSW	8ZC2040	-	11ZC2040	-	12ZC2040	-	-

Note: Standard length = 6 m

UTEMESH®

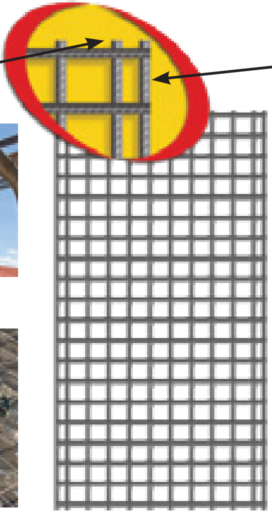
The new UTEMESH® is the compact 4 m x 2 m mesh that's safe and legal to transport on utes and small trucks without overhang.

The new UTEMESH® design features reduced flying ends from 100 mm to 20 mm, minimising the risk of injury when loading, unloading, carrying, placing and tying.

The new UTEMESH® offers more cost-efficient mesh cover and economy in the number of sheets used. Reduced edge lap improves cover by up to 8% across and along the sheet.

UTEMESH® is well-suited for small slabs such as driveways, patios, sheds and pavements.

UTEMESH® complies with Australian Standard AS/NZS 4671 : 2001 Steel reinforcing materials and is ACRS Quality Certified.



HANDIMESH®
General Purpose Mesh

HANDIMESH® is a range of general purpose welded mesh products.

Available in different specifications including:

- Pre-galvanized and bright wire
- Sheets and rolls
- Half and full sheets
- Flush cut

Applications include:

- Fencing
- Shelving
- Security and gates
- Safety guarding
- Point-of-sale displays

Product code	Length (m)	Width (m)	Line Wire (mm)	Cross Wire (mm)	Mass* (kg)
G112A	3	2.4	2.50@25	2.50@25	23
G112AHS	2	1.2	2.50@25	2.50@25	8
G122AHS	2	1.2	2.50@25	2.50@50	6
G113	3	2.4	3.15@25	3.15@25	36
G122A	3	2.4	2.50@25	2.50@50	17
G123	3	2.4	3.15@25	3.15@50	27
G224	3	2.4	4.00@50	4.00@50	29
G225	3	2.4	5.00@50	5.00@50	44
G224HS	2	1.2	4.00@50	4.00@50	10
G234	3	2.4	4.00@50	4.00@75	24
G234HS	2	1.2	4.00@50	4.00@75	8
G235	3	2.4	5.00@50	5.00@75	38
G334HS	1.2	2.0	4.00@75	4.00@75	7
G445A	3	2.4	5.60@100	5.60@100	29
G444HS	2	1.2	4.00@100	4.00@100	5
G465A	3	2.4	5.60@50	5.60@50	25
**B224	3	2.4	4.00@50	4.00@50	29
**B234	3	2.4	4.00@50	4.00@75	24
**B235	3	2.4	5.00@50	5.00@75	38
**B445A	3	2.4	5.60@100	5.60@100	29

* Nominal values only ** Made from bright wire

IRONBARK® Rural Mesh

IRONBARK® is a range of mesh products specifically developed for rural applications including stockyard, gates and infill panels, rolls of wire and accessories.

The IRONBARK® range includes sheets, rolls, fencing and gates, and there's a full range of heights and panel spacings to suit your needs.

The IRONBARK® range of rural mesh products requires no maintenance and has proven its strength by enduring our tough Australian conditions year in, year out.

The benefits of IRONBARK® include:

- Secure your livestock
- Mixed and single stock farming
- Sheep, pig, goat, cattle, horse etc
- Vermin proof, fire-proof and rot-proof

ironbark® rural mesh

Product code	Length (m)	Width (m)	Horizontal Spacing (mm)	Vertical Spacing (mm)	Wire Dia (mm)	Mass* (kg)
STG5109	6	0.9	100	250	5	13
STG51011	6	1.1	100	250	5	15
STG569	6	0.9	100	150	5	15
STG5611	6	1.1	100	150	5	18
STB569	6	0.9	100	150	5	15
STB5611	6	1.1	100	150	5	18
STHG8812	6	1.2	100	200	8	45
STG5615	6	1.5	150	150	5	24
STG5109R	30	0.9	100	250	5	63
STG51011R	30	1.1	100	250	5	76
STG569R	30	0.9	100	150	5	75
STG5611R	30	1.1	100	150	5	90
STG5615R	60	1.5	150	150	5	194.5
STB569R	30	0.9	100	150	5	73
STB5611R	30	1.1	100	150	5	88
FGI8	2.35	1.1	100	195.5	5	7
FGI10	2.95	1.1	100	196.4	5	8
FGI12	3.55	1.1	100	197	5	10
FGI14	4.15	1.1	100	197.4	5	11
FGI16	4.75	1.1	100	197.7	5	13

Fixing of Reinforcement - AS 3600 : 2009, Clause 17.2.5

All reinforcement, including secondary reinforcement provided for the purpose of maintaining main reinforcement and tendons in position, shall be supported and maintained in position within the tolerances given in Clause 17.5.3 until the concrete has hardened. Bar chairs, spacers and tie wires used for this purpose shall be made of concrete, steel or plastics, as appropriate.

Splicing of Reinforcement - AS 3600 : 2009, Clause 13.2.1 (b)

The splice shall be made by welding, by mechanical means, by end-bearing or by lapping.

Development length of headed reinforcement in tension - AS 3600 : 2009, Clause 13.1.4

A head used to develop a deformed bar in tension shall consist of a nut or plate, having either a round, elliptical or rectangular shape, attached to the end(s) of the bar by welding, threading or swaging of suitable strength to avoid failure of the steel connection at ultimate load.

In addition - (a) the bar diameter (d_b) shall not exceed 40 mm; and (b) the net bearing area of head shall be not less than 4 times the cross-sectional area of the bar. See other requirements in AS 3600 : 2009 Clause 13.1.4

If the cross-sectional area of the head of the headed reinforcement, or the area of the end plate for deformed bars mechanically anchored with an end plate in the plane perpendicular to the axis of the bar, is at least 10 times the cross-sectional area of the bar, the bar shall be considered to have a tensile development length ($L_{sy.t}$) measured from the inside face of the head equal to 0.8 times the development length of a hooked bar (with a 180° degree bend) of the same diameter.

Vapour barriers and damp-proofing membranes

AS 2870 : 2011, Clause 5.3.3.1

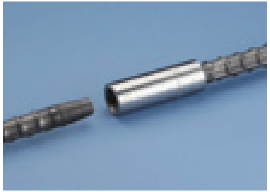
The raft or slab shall be provided with a vapour barrier, or where required, a damp-proofing membrane.

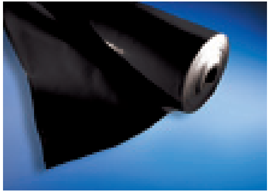
AS 2870 : 2011, Clause 5.3.3.2

The materials required for vapour barriers and damp-proofing membrane are as follows:

(a) 200 µm (0.2 mm) thick polyethylene film in accordance with Clause 5.3.3.3 (a)

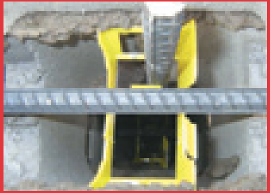
(b) Film branded continuously 'AS 2870 Concrete underlay, 0.2 mm - Medium (or high as appropriate) impact resistance', together with manufacturer's or distributor's name, trademark or code.



accessories
concrete & building

Accessories - Concrete & Building
BLOCKAID©



Bar chairs for block wall construction

- BLOCKAID© is an easy to use "bar chair" for reinforced masonry block walls.
- BLOCKAID© is fitted into the top of masonry blocks to securely locate the horizontal and vertical reinforcing steel within the block wall.

Advantages of BLOCKAID© include:

- Accurate location of horizontal and vertical bars
- Accurate alignment of control joint dowels
- Alignment the vertical bars adjacent to starter bars
- Eliminates the need to tie bars in place
- Ensures adequate grout cover as per AS3700 : 2001
- Fully compatible with existing core filling practices
- Reduces construction time by simplifying steel fixing
- Reduces material cost by eliminating vertical steel laps
- Reduces critical project cost by reducing steel fixing time

$A_{st}.f_{sy}$ - Product of reinforcing steel area **(A_{st})**,mm^2 and reinforcement yield stress **(f_{sy})**, MPa - gives nominal tensile capacity of a reinforcing bar - units generally kilo Newtons (kN) by dividing product by 1000.
Band Beam - Wide beam with width significantly greater than depth, generally about 1200 to 2400 wide, used in buildings and carparks to minimuse structural floor depth. Either reinforced or post-tensioned concrete depending on the span and design loads.
Beam - A narrow member in a building structure predominantly acting in flexure, generally horizontal.
Bending Moment - Internal action effect due to bending, normally resolved about a principal axis at a cross-section of a structural member.
Bond Strength - Normally expressed as the average ultimate stress that can develop at the interface between a bar and concrete when longitudinal slip occurs.
500N CONTISTRETCH (CS) - 500 MPa low carbon bar : strength achieved by continuous stretching process.
Centre Heave - Generally refers to deformation of a housing slab caused by the contraction of the expansive (clay) soils around the edge of a house - generally caused by drying out of the soils around house edge - opposite would be edge heave.
Column - A narrow vertical member in a building as distinct from a wall, normally under combined compression and bending.
Compression - An internal state of compressive stress prependicular to a cross-section.
Compression Member - A structural member predominantly in compression.
Cover - Minimum clear distance from an exposed concrete surface to closest bar - for durability design not just to main bars but to closest bar which is generally a stirrup or a tie. Insufficient cover is a major cause of reinforcement corrosion in concrete.
Creep - Property of concrete (dependant upon its constituents and internal state of stress) where a concrete element will deform due to sustained stress during its life. This is very important in the calculation of long-term deflections, and in prestressed/post-tensioned concrete design as an element can lose a significant proportion of its prestress.
Decking - Profiled steel sheeting or structural steel decking used as a dual formwork, reinforcement system.
Deflection - Normally the maximum vertical or horizonal movement of a structural member or a building frame, measured relative to the member supports or between adjacent floor levels in the case of sway.

Design Load - The combination of factored loads (e.g. imposed, wind etc.) for the applicable limit state (e.g. serviceability, stability, strength, fire, etc.), assumed to be applied to a structural member or building.
Detailing - Process whereby an engineer's sketch is transformed into an engineering drawing - generally performed by a draftsman - this is then used by the reinforcing scheduler.
Ductility (Reinforcement) - See Uniform Strain or Elongation.
Ductility (Member) - Ability of a member to deform under load - relevant to moment redistribution and especially important for seismic design of structures.
Edge Beam - The beam around a floor perimeter, generally cast integrally with a concrete slab, which may form part of the beam flange.
Edge Heave - Generally refers to deformation of a housing slab caused by swelling of the expansive (clay) soils around the edge of a house - generally caused by excessive moisture around house edge - opposite would be centre heave.
Edge Rebate - Notch cast in corner of beam - common in edge beam footing of brick veneer house to allow for brickwork to start below level of timber framing - done for aesthetic and waterproofing reasons.
Elastic Design - When the design action effects associated with a redundant member of a building are computed assuming elastic behaviour of the steel and concrete, which affects the relative stiffnesses.
Embedment - The length of reinforcement measured past a critical section that is bonded to the concrete.
Finite Element Analysis - A sophisticated form of numerical analysis traditionally used to model complex components or members acted on by different actions including temperature and increasingly being used to model whole 3-D concrete structures.
Flexural Tensile Strength - The maximum tensile stress reached in the extreme tensile fibre before the concrete cracks, normally measured in a small concrete beam test.
In Situ - In the actual position at the job site.
Lapping of Mesh - The over-lapping of two or more adjacent sheets of mesh which is necessary in order to achieve continuity of the reinforcement.
Ligatures - General term for stirrups or ties - term more used in reinforcing manufacture than in design. Superseded by the general term "fitments" in AS 3600 : 2009.
Lightweight Concrete - AS 3600 : 2009 defines lightweight concrete as "Concrete having a saturated surface-dry density in the range 1800 - 2100 kg/m^3".
Lintel - Beam type element generally supporting masonry over an opening. Can be concrete but more often than not is a steel angle.

Load Factor - Factor by which a load is increased when computing design loads for the applicable limit state, e.g. serviceability, stability, strength, fire, etc).

500N MICROALLOY (MA) - 500 MPa bar : strength achieved by additions of alloying elements.

Modulus of Elasticity - Slope of elastic portion of stress/strain curve for a particular material, e.g. steel or concrete (same as Young's modulus) - symbol generally E.

Moment Redistribution - In design, adjustment of the bending moment diagram at the strength limit state relative to the elastically-calculated design bending moment diagram and the actual distribution of design strength in bending, while maintaining equilibrium with the design loads.

Negative Bending Moment - A bending moment that causes a tensile change in stress on the nearer face of a member, e.g. on the topside of a slab loaded from above.

Negative Moment Region - Area of negative bending moment.

Negative Reinforcement - Main tensile reinforcement in a negative moment region.

Normal-Weight Concrete - AS 3600 : 2009 defines normal-weight concrete as having a saturated surface-dry density in the range 2100 to 2800 kg/m^3. Concrete density is usually assumed to be 2400 kg/m^3.

Perimeter Edge Footing - Edge beam around outside edge of house - may or may not be cast integrally with slab.

Piles - Elements used to support a structure in poor soil/foundation conditions - based on the pile bearing on a good stratum at some distance below the structure to be supported - typically are steel, precast or cast in situ concrete - steel and precast used for long lengths and would be generally end bearing piles onto rock - cast in situ used for shorter length, and combination of end bearing onto a soil plus skin friction on the surrounding soil.

Positive Bending Moment - A bending moment that causes a tensile change in stress on the opposite face of a member. e.g. on the underside of a slab loaded from above.

Positive Reinforcement - Main tensile reinforcement in a positive moment region of a horizontal member of a building.

Post-Tensioned Concrete - Concrete elements where the concrete is poured with hollow ducts containing steel strand or bar subsequently stressed and normally grouted for bond. Extensively used in bridges, and beams and slabs of high-rise buildings. Strand has the ability to be "draped" (held towards the top of a member at the ends and towards the bottom of the member at mid-span) so as to induce an uplift force in the member. Strand is more suitable than bar where long lengths are required.

Precast Concrete - Concrete elements that are cast in the factory or yard and lifted into position on site. Precast prestressed or post-tensioned beams for bridge construction are popular in Australia.
Prestressed Concrete - Generic term for any beam, slab or column containing stressed strands or bars - but normally refers to a concrete element cast around previously placed and stressed strand - just about all prestressed concrete is precast but not vice versa - main examples would be hollowcore planks - strands are stressed in long lengths, concrete poured, cured and set then strands cut - long members cut to required lengths - not to be confused with Post-Tensioned Concrete.
Raft - Usually applied to slabs where the whole area of the slab is considered to act as a "raft" which relies on the underlying ground for support.
Reinforcement Surface Condition - The state of the surface on the exterior of reinforcing bars. Note: hot-rolled bars normally have a thin layer of mill scale on the surface. Rust on the surface of reinforcement is not normally deleterious to the bond developed between the steel and concrete.
Shear Reinforcement - The reinforcement which caters for vertical or transverse shear forces in the member.
Shrinkage - Shortening of concrete due to autogenous shrinkage or drying shrinkage, which may be restrained in the direction of embedded steel, e.g. rebar, or by adjacent members or supports.
Slump - Simple on-site measure of consistency (and possibly workability) of concrete in the as-mixed fluid state - involves a standard test using a metal cone.
Slipform - Form of construction used for building service cores, towers, etc - involves formwork moving continuously as concrete and reinforcement are placed.
Spacing of Reinforcement - The distance between adjacent reinforcing bars, normally measured centre-to-centre.
Stack Cast - Flat slabs which are cast alternately, one on top of the other.
Starter Bars - Short reinforcing bars which are cast in or screwed into inserts at a joint to provide continuity of bending and shear strength across the joint.
Stiffness - Under flexural conditions, it is a function of EI/L - modulus of elasticity (normally of the concrete) (E) times effective second moment of area (I) of the composite uncracked and cracked sections divided by the length or span (L) of the element.
Stirrups - Same as ligatures. Generally provided in a beam as shear and torsional reinforcement (determined from engineering design) and hold t he main bars in position. Superseded by the general term "fitments" in AS3600 : 2009.

Strain - Ratio of elongation to original length. There are no units to strain.
Strain Localisation - Uneven distribution of tensile strain in longitudinal steel reinforcement at flexural cracks due to bond transfer.
Strength - Used synonymously with capacity in Australian Standards, and can relate to axial force, shear force, bending moment, torsion, etc.
Stress - Local internal pressure that can arise due to action effects, restraint, etc. Units MPa or kPa.
Strip Footing - Beam around the perimeter of a house, generally supporting a continuous line of masonry - generally not connected to the floor slab.
TEMPCORE® (TC) - Quenched and self-tempered straight length Grade 500 reinforcing bar.
Tensile Development Length - A term in AS 3600 referring to the length of embedment of a straight reinforcing bar into concrete required to develop the yield stress of the reinforcement in axial tension. Related to bond stress (or strength).
Tensile Strength - The maximum or ultimate tensile stress that can develop in a reinforcing bar, at which necking is initiated and fracture ensues.
Ties - Used in columns for various purposes including to prevent main bars from buckling at ultimate load should the cover spall - generally more closely spaced than stirrups in beams. See AS 3600 : 2009 for new rules concerning core-confinement for concrete >50 MPa and also new type of internal fitment with one leg. Superseded by the general term "fitments" in AS3600 : 2009.

Tilt Up - Process of casting flat wall panels on the concrete floor on site and then lifting and securing in place using a mobile crane.
Torsion - Twisting of a building element (beam, slab, etc.) requiring additional reinforcement such as closed fitments in beams or additional corner bars in slabs.
Ultimate Strength Design - Design using the ultimate strength of materials to calculate the design strength of critical cross-sections or regions of concrete members which must exceed the ultimate design action effects.
Uniform Strain or Elongation - Axial strain of steel bar up to the point where the stress/strain curve starts to turn down (at the point of maximum load) - symbolised as A_{gt} or ε_u and expressed as %.
Yield Strength - Alternative term for Yield Stress used in AS 3600.
Yield Stress - Stress at which steel yields, the definition of which depends on the shape of the stress-strain curve. In design, a lower characteristic value is used to define the strength grade of the steel.
Young's Modulus - Slope of elastic portion of stress/strain curve (same as Modulus of Elasticity) - Symbol generally E for steel or concrete.

Imperial to Metric Units Conversion Table

Unit	Imperial	Metric Conversion
Angle	1 degree	0.0175 radian
Area	1 acre	0.405 ha
	1 yd^2	0.836 m^2
	1 ft^2	0.0929 m^2
Force	1 lbf	4.448 N
	1 tonf	9.964 kN
Fuel Consumption	1 mpg	0.354 km/L
Length	1 mile	1.609 km
	1 yd	0.914 m
	1 ft	0.305 m
	1 in	25.4 mm
Mass	1 ton (long)	1.016 t
	1 lbm	0.4536 kg
	1 oz	28.35 g

Note: For US gallon reduce value by 16.74%.

Unit	Imperial	Metric Conversion
Moment	1 lb.ft	1.356 N.m
Power	1 hp	0.746 kW
	1 Btu/h	0.293 W
Pressure	1 lbf/in^2	6.895 kPa
Temperature	°F	5/9 x(°F -32) °C
Speed	1 ft/s	0.305 m/s
	1 mile/h	1.609 km/h
	1 knot	1.852 km/h
Volume	1 yd^3	0.765 m^3
	1 ft^3	0.0283 m^3
	1 gal	4.546 litre
	1 in^3	16.387 mL
Volume Flow Rate	1 ft^3/s	0.0283 m^3/s
	1 ft^3/min	0.472 m^3/s

Mass Densities of Materials

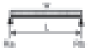
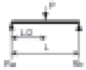
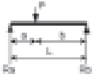
Material	kg/m³
Aluminium	2700
Brass	8400-8600
Cast Iron	7000-7400
Clay dry	1480
Clay wet	1660
Concrete	2400
Copper	8900
Earth dry	1280
Earth wet	1760
Glass	2400-2800

Metric Conversion	kg/m³
Granite	2600
Gravel mixed grading	1930
Ice	900
Lead	11370
Mercury	13570
Rockfill 75% rock, 25% earth	1960
Rockfill 50% rock, 25% earth	1720
Rockfill 25% rock, 75% earth	1570
Rubber	960-1300
Sand dry	1420

Metric Conversion	kg/m³
Sand damp	1690
Sand wet	1840
Sandstone	1510
Shale	1250
Steel	7850
Top Soil	950
Water fresh	1000
Water salt	1030
Wood soft	480
Wood hard	800

Note: Figures for soils can vary greatly depending on moisture content, particle size and compaction. Figures provided are averages.

Basic Support Reaction, Bending Moment & Deflection Formulae

Load Case	Reaction at Support		Maximum Moment	Maximum Deflection
	R_a	R_b		
	$\frac{wL}{2}$	$\frac{wL}{2}$	$\frac{wL^2}{8}$	$\frac{5wL^4}{384\ EI}$
	$\frac{P}{2}$	$\frac{P}{2}$	$\frac{PL}{4}$	$\frac{PL^3}{48\ EI}$
	$\frac{Pb}{L}$	$\frac{Pa}{L}$	$\frac{Pab}{L}$	$\frac{PL^3}{27\ EI}\ \frac{a}{L}\ \sqrt{3\left(1-\left(\frac{a}{L}\right)^2\right)^3}$ which applies for $\frac{a}{L} \leq 0.5$
	wa	-	$\frac{wa^2}{2}$	$\frac{wa^4}{8\ EI}\left(1+\frac{4b}{3a}\right)$
	P	-	Pa	$\frac{Pa^3}{3\ EI}\left(1+\frac{3b}{2a}\right)$

w = load per unit length. I = second moment of area for whole width of member.
Effect of self weight of member to be considered separately to load case shown.

Steel Reinforcement Standards & Relevant Concrete Construction Standards

Relevant Concrete Construction Standards: Commercial, Civil, Industrial

- AS/NZS 4671 : 2001 Steel reinforcing materials
- AS 3600 : 2001 Concrete structures
- AS 3600 : 2009 Concrete structures
- AS 5100.5 : 2004 Bridge design: Concrete
- AS/NZS 1170 : 2002 Structural design actions
- AS 2327.1 : 2003 Composite structures, Part: 1 Simply supported beams
- AS 1554.3 : 2008 Part 3: Welding of reinforcing steels
- AS 1100-Part 501 : 2002 - Technical drawing - Structural engineering drawing

Relevant Concrete Construction Standards: Residential Housing Slabs, Concrete Pavements, Swimming Pools, Driveways, Patios, House Extensions, Footpaths etc

- AS/NZS 4671 : 2001 Steel reinforcing materials
- AS 3727 : 1993 Guide to residential pavements
- AS 2870 : 2011 Residential slabs and footings - Construction
- AS 2783 : 1992 Use of reinforced concrete for small swimming pools

Relevant Concrete Construction Standards

Relevant Concrete Construction Standards: Commercial, Civil, Industrial

AS/NZS 4671 : 2001 Steel reinforcing materials

- Specification of Steel bars, wire and mesh for use in reinforced concrete structures that have been designed in accordance with AS 3600 : 2001 or AS 3600 : 2009
- Amendment 1: 2003 refers to latest ISO Standards, etc.
- 250 & 500 MPa, Class N & L reinforcing bar and mesh.

AS 3600 : 2009 Concrete structures

- Design and detailing of concrete structures and elements, with or without steel reinforcement or prestressing tendons, based on the principles of structural engineering mechanics
- Previous version referenced in BCA published in 2001, i.e. AS 3600 : 2001 not expected to be withdrawn until July 2012
- References AS/NZS 4671
- Amendment 2, 2004 provided modified rules for the design of Class L steel in floors
- AS 3600 : 2009 published December 2009: Amendment 1, 2010 contains mainly typographical corrections.

AS 5100.5 : 2004 Bridge design: Concrete

- Minimum requirements for the design and construction of concrete bridges and associated structures including members that contain reinforcing steel and tendons, or both
- Although AS 5100.5 closely follows the design rules of AS 3600. There are some differences in regard to the detailing of reinforcing steel in concrete elements. Recent developments in AS 3600 : 2009 have yet to be considered.

Relevant Residential Concrete Construction Standards

AS/NZS 1170 : 2002 Structural design actions

Part 1: Permanent, imposed and other actions (Loading code)

- Specifies permanent, imposed, static liquid pressure, ground water, rainwater ponding and earth pressure actions to be used in the limit state design of structures and parts of structures
- Ref AS/NZS 1170 - Loading Standards
- Amendments 1 & 4 - April 2005

AS 2327.1 : 2003 - Composite structures

Part 1: Simply supported beams

- Sets out minimum requirements for the design, detailing and construction of simply supported composite beams composed of a steel beam and a concrete slab interconnected with shear connectors, including applications where the slab incorporates profiled steel sheeting.
- The main changes are related to the design of shear connectors, stud location, distinction between open and closed rib profiles, 500 MPa longitudinal shear reinforcement and some new reference material.

AS 1554.3 : 2008 Part 3: Welding of reinforcing steels

- The welding of reinforcing steel used in concrete structures that are designed and constructed in accordance with AS 3600
- Reference: AS/NZS 4671

AS 1100-Part 501 : 2002 - Technical drawing - Structural engineering drawing

- This Standard references AS/NZS 4671 : 2001 and thus covers the use of 500 MPa reinforcing bar and mesh.

Relevant Concrete Construction Standards: Residential Housing Slabs, Concrete Pavements, Pools, Driveways, Patios, House Extensions, Footpaths, etc

AS/NZS 4671 : 2001 Steel reinforcing materials

- Specification of steel bars, wire and mesh for use in reinforced concrete structures that have been designed in accordance with AS 3600 : 2001 or AS 3600 : 2009
- 250 & 500 MPa. Class N & L reinforcing bar and mesh
- Supersedes AS 1302, 1303 & 1304. Amendment - 1 June 2003

AS 3727 : 1993 Guide to residential pavements

- Guidelines for the selection and construction of pavements associated with residential buildings consisting of single houses or multiple dwellings in medium density housing development
- Recommends mesh sizes for concrete slabs, depending on the service requirements
- Loading categories - foot traffic, light and medium vehicles, as well as joint spacing

AS 2870 : 2011 Residential slabs and footings - Construction

- This standard covers slab on ground for housing
- Classification of a site and the design and construction of a footing system for a single dwelling house, townhouse or the like which may be detached or separated by a party wall or common wall, but not situated vertically above or below another dwelling
- Treats Class N and L reinforcing steels as fully equivalent to each other as main or secondary reinforcement
- Previous version referenced in BCA published in 2001, i.e. AS 2870 : 1996

AS 2783 : 1992 Use of reinforced concrete for small swimming pools

- Structural design and construction of reinforced concrete pools
- References AS 3600 & AS 3735 - Concrete structures for retaining liquids

Compliance to Concrete Construction Standards

Does reinforcing bar and mesh comply with Australian Standards?

- Commercial buildings, bridges, civil structures, house slabs, patios, extensions, driveways, footpaths, etc, must be built with steel reinforcement with the correct chemical and mechanical properties.
- Not all rebar and reomesh meets Australian Standards. Materials are sourced widely in Australia and from overseas, and manufactured to varying standards, so you need to check and be sure of what you are getting or specifying.
- There are potentially serious consequences of using non-compliant materials. For example: serviceability (excessive cracking or deflections due to poor bond); ultimate (reduced strength and safety due to low yield stress or inadequate ductility).
- Australian Standards require steel reinforcement to have the necessary chemical and mechanical properties, strength and level of ductility appropriate to the engineering design assumptions on which they are based.
- The Building Code of Australia (BCA) references Australian Standards. ACRS certified steel reinforcing materials comply with the relevant Australian Standards and therefore the BCA.

OneSteel Reinforcing REOMESH® & REBAR are ACRS accredited

ACRS – The Australian Certification Authority for Reinforcing Steels

- ACRS is an independent third party assessment body which checks Reinforcement for compliance to AS/NZS 4671 Steel Reinforcing Materials
- It tests both the steel supplied by the steel mills in Australia & overseas to Australian reinforcing mesh manufacturers, and the finished REBAR and REOMESH® products delivered to builders and concreters
- ACRS certification independently confirms the Standards compliance of the materials you buy
- Ask for proof that the reinforcing mesh you are supplied complies with AS/NZS4671 Steel Reinforcing Materials
- The easiest way to check this is ask to see your supplier's ACRS certificate.

Full details of ACRS can be found at acrs.net.au

ACRS

INDEPENDENT THIRD PARTY CERTIFICATION OF REINFORCING STEELS COMPLIANCE TO AUSTRALIAN STANDARDS

Steel Reinforcement Institute of Australia (SRIA) Technical Notes

OneSteel Reinforcing is proud to be a member of the SRIA. The following Technical Notes are available for download from the SRIA website.

Technical Note 1: Surface Condition of Steel Reinforcement

Technical Note 2: Substitution of N12 Rebar in AS 2870 Residential Slabs & Footings

Technical Note 3: Restrictions on the Use of Wire Bar Chairs

Technical Note 4: Fabrication and Site Handling of Reinforcing Bars

Technical Note 5: Guidelines for Economical Assembly of Reinforcement

Technical Note 6: Design to AS 3600 : 2001 of Suspended Concrete Floors Reinforced with Class L Mesh

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