



# SENSE 600<sup>®</sup> Column Fitments



Column fitments produced from SENSE 600<sup>®</sup> reinforcing bar offer the following benefits:

- ↳ a more sustainable solution
- ↳ CodeMark certification for easy substitution
- ↳ lighter and easier to handle

SENSE 600<sup>®</sup> is the future of sustainable steel. It means lower Scope 3 emissions without reinventing your processes. SENSE 600<sup>®</sup> is InfraBuild Steel's new range of 600 MPa grade, Class N (600N) bars produced in diameters with equivalent load capacity to its 500 MPa range of bars.

Column fitments produced from SENSE 600<sup>®</sup> bars with its higher strength and smaller diameter compared with 500 MPa bars is a more sustainable option with savings of up to 16.7 per cent in raw materials. Furthermore, the 100 per cent electric arc furnace steel making route, which uses only scrap steel for feed, results in up to a 39 per cent reduction in embodied carbon when used in place of our equivalent load capacity 500 MPa bar.

We make it easy – you can use your existing software for future designs, or our substitution table which is part of the SENSE 600<sup>®</sup> CodeMark certification. The CodeMark means that SENSE 600<sup>®</sup> column fitments can be substituted for 500 MPa fitments and will comply with the National Construction Code (NCC), if the 500 MPa fitments complied, without any calculation. No additional design work is required by the engineer.

Table 1 provides the SENSE 600<sup>®</sup> fitment substitution sizes for existing 500 MPa column fitments.

Table 1: Equivalent Capacity SENSE 600 <sup>®</sup> Column Fitments			
Designed 500 MPa fitment	Alternative SENSE 600 <sup>®</sup> fitment		Capacity (kN)
Designation	Designation	Diameter (mm)	
N12	S11	11.0	56.5
N16	S15	14.6	101
N20	S18	18.3	157

This technical note provides a summary of the Performance Solution presented to the Australian Buildings Code Board certifiers, Global-Mark. The Performance Solution demonstrates how the existing 500N fitments can be substituted to utilise the benefits offered by the higher strength SENSE 600® fitments and still meet the requirements of AS 3600: *Concrete structures*.

Fitments in columns, sometimes also referred to as ligatures or column ties, are to provide confinement of the concrete and to restrain the longitudinal bars from buckling.

AS 3600 : 2018, Clauses 10.7.3 and 10.7.4 indicate that if the confining pressure and the restraint to the longitudinal bars provided by the fitments are not changed, then spacing requirements of the fitments are also not changed. Therefore one diameter fitment can be substituted by another diameter fitment provided they have the same or higher capacity which is given by the product of the area of the fitment ( $A_{b,fit}$ ) and the grade ( $f_{sy,f}$ ) of the fitment.

For example, in Table 1 above:

For a 500N, 12 mm fitment, the capacity is:

$$\frac{(\pi \times 12^2)}{4} \times 500 \times 10^{-3} = 56.5 \text{ kN}$$

For a 600N, 11.0 mm fitment, the capacity is:

$$\frac{(\pi \times 11^2)}{4} \times 600 \times 10^{-3} = 57.0 \text{ kN}$$

Therefore, the 500 MPa 12 mm diameter fitment can be replaced by a SENSE 600® 11.0 mm diameter fitment with the same spacing because it has the same or higher capacity of 57.0 kN.

A full set of calculations to AS 3600 is presented in Appendix A.

### Complementary Publications

SENSE 600® – CodeMark Certificate of Conformity – Columns

# Appendix A

A check of Australian Standard AS 3600: 2018 *Concrete structures* was completed and is detailed on the following pages to demonstrate that standard 500 MPa fitments can be directly substituted with the equivalent load capacity SENSE 600® fitment.

This check covers the relevant the Clauses in AS 3600 relating to column fitments, specifically Clauses 10.7.2 to 10.7.4 incl. and 14.5.4.

Designation	Units	S11	N12	S15	N16	S18	N20
Diameter	mm	11.0	12.0	14.6	16.0	18.3	20.0
Grade - $f_{sy,f}$	MPa	600	500	600	500	600	500
Area - $A_{b,fit}$	mm <sup>2</sup>	94.3	113	168	201	262	314
Capacity - $A_{b,fit} \times f_{sy,f}$	kN	56.5	57	101	101	157	157

Check to show using the data from the table above that:

SENSE 600® S11, S15 and S18 directly substitutes for N12, N16 and N20 respectively.

Let  $(A_{b,fit})_{500} \times 500 = (A_{b,fit})_{600} \times 600$  denote the general case

---

REFERENCE	CALCULATION
AS 3600: 2018	
CI.10.7.2	<p><b>Functions of fitments</b></p> <ul style="list-style-type: none"> <li>• Satisfy Clause 10.7.3 to confine concrete</li> <li>• Satisfy Clause 10.7.4 to provide lateral restraint of longitudinal bars against buckling</li> <li>• Satisfy Section 14 – Earthquake action in moment resisting frames</li> </ul>
CI.10.7.3	<p><b>Confinement to the core</b></p>
CI.10.7.3.1	<p>General requirements</p> <p>(a) for columns where <math>f'_c \leq 50</math> MPa – deemed to satisfy if CI 10.7.4 is satisfied</p> <p>(b) (i) for columns where <math>f'_c &gt; 50</math> MPa – need to check CI 10.7.3.2; 10.7.3.3 and 10.7.3.4</p> <p>(ii) Does not impact on diameter, impacts on spacing relative to dimensions only.</p>

REFERENCE	CALCULATION
CI.10.7.3.2	<p>Calculation of core confinement by rational calculation</p> <p>Use simplified calculation in CI 10.7.3.3</p>
CI.10.7.3.3	Calculation of core confinement by simplified calculation
Eq. 10.7.3.3(1)	$f_{r,eff} = k_e f_r$ <p>Determine <math>f_r</math> using equation 10.7.3.3(2)</p> <p>Determine <math>f_e</math> using equation 10.7.3.3(3)</p>
Eq. 10.7.3.3(2)	$f_r = \frac{\sum_{i=1}^m A_{b,fit} f_{sy} \sin \theta}{d_s s}$ Where $f_{sy} \leq 800\text{MPa}$ <p>Since <math>(A_{b,fit})_{500 \times 500} = (A_{b,fit})_{600 \times 600}</math>;</p> <p>And <math>\sin \theta</math>, <math>d_s</math> and <math>s</math> are unchanged,</p> <p>Then <math>(f_r)_{500} = (f_r)_{600}</math></p> <p>(a) For rectangular sections</p>
Eq. 10.7.3.3(3)	$k_e = \left(1 - \frac{nw^2}{6A_c}\right) \left(1 - \frac{s}{2b_c}\right) \left(1 - \frac{s}{2d_c}\right)$ <p>No terms dependant on fitment strength <math>f_{sy,f}</math> or fitment area <math>A_{b,fit}</math></p> <p>(b) For circular sections</p>
Eq. 10.7.3.3(4)	$k_e = \left(1 - \frac{s}{2d_s}\right)^2$ <p>No terms dependant on fitment strength <math>f_{sy,f}</math> or fitment area <math>A_{b,fit}</math></p> <p>Alternatively, for rectangular or circular columns the effective confining pressure can be calculated using:</p>
Eq. 10.7.3.3(5)	$f_{r,eff} = 0.5k_e \rho f_{sy,f}$ <p>Where <math>\rho = \frac{A_{b,fit} \times \text{total perim. of fitments crossing the section}}{A_c \times s}</math></p>

REFERENCE	CALCULATION
	<p>Substituting into Eq 10.7.3.3(5) –</p> $f_{\text{reff}} = 0.5k_e \frac{A_{\text{b.fit}} \times \text{total perim. of fitments crossing the section} \times f_{\text{syf}}}{A_c \times s}$ <p>Re-arranging</p> $f_{\text{reff}} = 0.5k_e \frac{(A_{\text{b.fit}} \times f_{\text{syf}}) \times \text{total perim. of fitments crossing the section} \times f_{\text{syf}}}{A_c \times s}$ <p>Now, <math>(A_{\text{b.fit}})_{500} \times 500 = (A_{\text{b.fit}})_{600} \times 600</math>;  fitment perimeter and spacing is the same as is the column area <math>A_c</math>  therefore <math>(f_{\text{r.eff}})_{500} = (f_{\text{r.eff}})_{600}</math>  ie. If the design capacity of the SENSE 600® fitment equals the design capacity of the 500 MPa fitment, then the effective confining pressure is the same.</p>
CI.10.7.3.4	Deemed to conform core confinement (a) For rectangular sections:
Eq. 10.7.3.4(1)	Min fitment spacing $\leq \frac{15nA_{\text{b.fit}}f_{\text{sy.f}}}{f'_c\sqrt{A_c}}$ (b) For circular sections:
Eq. 10.7.3.4(2)	Min fitment spacing $\leq \frac{100A_{\text{b.fit}}f_{\text{sy.f}}}{d_s f'_c}$ Now, $(A_{\text{b.fit}})_{500} \times 500 = (A_{\text{b.fit}})_{600} \times 600$ And n, number of fitments; $f'_c$ ; $A_c$ , area of column and $d_s$ , overall dimension of fitments do not change. Therefore $(\text{Min fitment spacing})_{500} = (\text{Min fitment spacing})_{600}$

REFERENCE	CALCULATION																		
<b>CI.10.7.4</b>	<b>Restraint of longitudinal reinforcement</b>																		
<b>CI.10.7.4.1</b>	General requirements No impact from fitment strength $f_{sy,f}$ or fitment area $A_{b,fit}$																		
<b>CI.10.7.4.2</b>	Lateral restraint No impact from fitment strength $f_{sy,f}$ or fitment area $A_{b,fit}$																		
<b>CI.10.7.4.3</b>	Diameter and spacing of fitments and helices (a) Minimum bar diameter of fitment and helices to conform to Table 10.7.4.3																		
<b>T.10.7.4.3</b>	NOTE – allows the minimum diameter of fitments to be reduced by a factor of $\sqrt{500/f_{sy,f}}$ This is applied and tabulated below.																		
	<table border="1"> <thead> <tr> <th>Longitudinal bar diameter (mm)</th> <th>Minimum bar diameter of 500 MPa fitment and helix (mm)</th> <th>Minimum bar diameter of SENSE 600® fitment and helix (mm)</th> </tr> </thead> <tbody> <tr> <td>Single bars up to 20</td> <td>6</td> <td>N/A</td> </tr> <tr> <td>Single bars 24 to 28</td> <td>10</td> <td>N/A</td> </tr> <tr> <td>Single bars 32 to 36</td> <td>12</td> <td>11.0</td> </tr> <tr> <td>Single bars <math>\geq 40</math></td> <td>16</td> <td>14.6</td> </tr> <tr> <td>Bundled Bars</td> <td>12</td> <td>11.0</td> </tr> </tbody> </table>	Longitudinal bar diameter (mm)	Minimum bar diameter of 500 MPa fitment and helix (mm)	Minimum bar diameter of SENSE 600® fitment and helix (mm)	Single bars up to 20	6	N/A	Single bars 24 to 28	10	N/A	Single bars 32 to 36	12	11.0	Single bars $\geq 40$	16	14.6	Bundled Bars	12	11.0
Longitudinal bar diameter (mm)	Minimum bar diameter of 500 MPa fitment and helix (mm)	Minimum bar diameter of SENSE 600® fitment and helix (mm)																	
Single bars up to 20	6	N/A																	
Single bars 24 to 28	10	N/A																	
Single bars 32 to 36	12	11.0																	
Single bars $\geq 40$	16	14.6																	
Bundled Bars	12	11.0																	
	(b) Maximum spacing of fitments shall not exceed <ul style="list-style-type: none"> <li>(i) <math>D_c</math> and <math>15d_b</math> for single bars</li> <li>(ii) <math>0.5D_c</math> and <math>7.5D_b</math> for bundled bars</li> <li>(i) and (ii) are independent of fitment strength <math>f_{sy,f}</math> or fitment area <math>A_{b,fit}</math></li> <li>(iii) Need to check Section 14.5</li> </ul>																		
	(c) Location of first or last fitment – independent of fitment strength $f_{sy,f}$ or fitment area $A_{b,fit}$																		
<b>CI.10.7.4.4</b>	Detailing of fitments and helices Independent of fitment strength $f_{sy,f}$ or fitment area $A_{b,fit}$																		

REFERENCE	CALCULATION																								
CI.14.5.4	<p><b>Columns</b></p> <p><b>Only need to check this clause if the column is part of a seismic resisting frame</b></p> <p>The spacing of fitments shall not be greater than</p> <p>(a) Eight times the diameter of the smallest longitudinal bar enclosed</p> <p>(b) <math>24\sqrt{(f_{sy,f}/500)}</math> times the diameter of the fitment bar</p> <p>(c) One-half of the smallest cross-sectional dimension of the column</p> <p>(d) 300 mm</p> <p>Only (b) is affected by the fitment strength <math>f_{sy,f}</math> or fitment diameter <math>d_{b,f}</math>.</p> <p>The table below shows there is no change in the fitment spacing for the equivalent SENSE 600® fitment when the formula in (b) is applied.</p> <table border="1"> <thead> <tr> <th colspan="4">Clause 14.5.4 (b) – Maximum fitment spacing for column in a seismic resisting frame</th> </tr> <tr> <th>500 MPa Fitments Diameter (mm)</th> <th>Maximum Spacing (mm)</th> <th>SENSE 600® Fitments Diameter (mm)</th> <th>Maximum Spacing (mm)</th> </tr> </thead> <tbody> <tr> <td>10</td> <td>240</td> <td>N/A</td> <td>N/A</td> </tr> <tr> <td>12</td> <td>288</td> <td>11.0</td> <td>288</td> </tr> <tr> <td>16</td> <td>384</td> <td>14.6</td> <td>384</td> </tr> <tr> <td>20</td> <td>480</td> <td>18.3</td> <td>480</td> </tr> </tbody> </table>	Clause 14.5.4 (b) – Maximum fitment spacing for column in a seismic resisting frame				500 MPa Fitments Diameter (mm)	Maximum Spacing (mm)	SENSE 600® Fitments Diameter (mm)	Maximum Spacing (mm)	10	240	N/A	N/A	12	288	11.0	288	16	384	14.6	384	20	480	18.3	480
Clause 14.5.4 (b) – Maximum fitment spacing for column in a seismic resisting frame																									
500 MPa Fitments Diameter (mm)	Maximum Spacing (mm)	SENSE 600® Fitments Diameter (mm)	Maximum Spacing (mm)																						
10	240	N/A	N/A																						
12	288	11.0	288																						
16	384	14.6	384																						
20	480	18.3	480																						

**Disclaimer:**

THIS DOCUMENT PROVIDES GENERAL GUIDANCE ONLY – SEEK PROFESSIONAL ADVICE

The information provided in this document is general guidance only. You should seek professional advice before relying on any of the information in this document. To the extent permitted by law, InfraBuild, the authors, publishers and editors expressly disclaim any liability for personal injury, death, or loss or damage directly or indirectly resulting from relying on this document. InfraBuild reserves the right to change specifications and availability of the products at any time.

Copyright © 2024, InfraBuild Australia Pty Ltd ABN 91 631 112 457. All rights reserved. This document (in full or part) must not be reproduced, copied, modified, adapted, translated, republished, uploaded or posted to any website or other online platform, publicly displayed, distributed for commercial purposes, or electronically transmitted or communicated in any way, without the express prior written permission of the copy-right owner.

**Document: T04 V0.2**





---

**It just makes  
SENSE**