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Substituting Viribar®750 for 500N Fitments

A check against Australian Standard AS 3600: 2018 Concrete structures was completed to demonstrate that standard 500 MPa fitments can be directly substituted with the equivalent force capacity Viribar®750 fitment.

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This publication is provided to assist engineers and designers with specifying Viribar®750. Users of this information are required to check this information to satisfy themselves of its accuracy and not rely on it without doing so first. Unless required by the law, the company cannot accept responsibility for any loss, damage or consequence resulting from the use of this publication.

This check covers the relevant the Clauses in AS3600 relating to column fitments, specifically Clauses 10.7.2 to 10.7.4 incl. and 14.5.4

Designation	Units	**V8.2**	N10	**V9.8**	N12	**V13**	N16
Diameter	mm	**8.165**	10	**9.798**	12	**13.064**	16
Grade - $f_{sy.f}$	MPa	**750**	500	**750**	500	**750**	500
Area - $A_{b.fit}$	mm^2	**52.4**	78.5	**75.4**	113.1	**134.0**	201.1
Capacity - $A_{b.fit} \times f_{sy.f}$	kN	**39.3**	39.3	**56.5**	56.5	**100.5**	100.5

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

Viribar®750 V8.2, V9.8 and V13 directly substitutes for N10, N12 and N16 respectively

Let $(A_{b.fit})_{500} \times 500 = (A_{b.fit})_{750} \times 750$ denote the general case

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AS 3600: 2018

Cl.10.7.2 Functions of fitments

- Satisfy Clause 10.7.3 to confine concrete
- Satisfy Clause 10.7.4 to provide lateral restraint of longitudinal bars against buckling
- Satisfy Section 14 – Earthquake action in moment resisting frames

Cl.10.7.3 Confinement to the core

Cl.10.7.3.1 *General requirements*

(a) *for columns where* $f_c \leq 50$ *MPa* – deemed to satisfy if Cl 10.7.4 is satisfied

(b) (i) *for columns where* $f_c > 50$ *MPa* – need to check Cl 10.7.3.2; 10.7.3.3 & 10.7.3.4

(ii) Does not impact on dia., impacts on spacing relative to dimensions only

REFERENCE	CALCULATION

Cl.10.7.3.2 *Calculation of core confinement by rational calculation*

Use simplified calculation in Cl 10.7.3.3

Cl.10.7.3.3 *Calculation of core confinement by simplified calculation*

Eq. 10.7.3.3(1) - $f_{r.eff} = k_e f_r$

Determine f_r using equation 10.7.3.3(2)

Determine k_e using equation 10.7.3.3(3)

Eq. 10.7.3.3(2) - $$f_r = \frac{\sum_{i=1}^{m} A_{b.fit} f_{sy} \sin\theta}{d_s s} \quad \textbf{Where } f_{sy} \leq 800MPa$$

Since $(A_{b.fit})_{500} \times 500 = (A_{b.fit})_{750} \times 750$**;**

And sin θ, ds and s are unchanged,

Then - $(f_r)_{500} = (f_r)_{750}$

(a) *For rectangular sections*

Eq. 10.7.3.3(3) - $$k_e = \left(1 - \frac{nw^2}{6A_c}\right)\left(1 - \frac{s}{2b_c}\right)\left(1 - \frac{s}{2d_c}\right)$$

No terms dependant on fitment strength $f_{sy.f}$ or fitment area $A_{b.fit}$

(b) *For circular sections*

Eq. 10.7.3.3(4) - $$k_e = \left(1 - \frac{s}{2d_s}\right)^2$$

No terms dependant on fitment strength $f_{sy.f}$ or fitment area $A_{b.fit}$

Alternatively, for rectangular or circular columns the effective confining pressure can be calculated using:

Eq. 10.7.3.3(5) - $f_{r.eff} = 0.5 k_e \rho f_{sy.f}$

Where $$\rho = \frac{A_{b.fit} \times \textit{total perim. of fitments crossing the section}}{A_c \times s}$$

Substituting into **Eq 10.7.3.3(5)** –

$$f_{r.eff} = 0.5k_e \frac{A_{b.fit} \times \textit{total perim. of fitments crossing the section} \times f_{sy.f}}{A_c \times s}$$

Re-arranging

$$f_{r.eff} = 0.5k_e \frac{(A_{b.fit} \times f_{sy.f}) \times \textit{total perim .of fitments crossing the section}}{A_c \times s}$$

Now, $(A_{b.fit})_{500}$ x 500 = $(A_{b.fit})_{750}$ x 750;

fitment perimeter and spacing is the same as is the column area A_c

$\therefore (f_{r.eff})_{500} = (f_{r.eff})_{750}$

Ie. If the design capacity of the Viribar®750 fitment equals the design capacity of the 500 MPa fitment, then the effective confining pressure is the same.

Cl.10.7.3.4 *Deemed to conform core confinement*

(a) *For rectangular sections:*

Eq. 10.7.3.4(1) – **Min Fitment spacing** $\leq \frac{15nA_{b.fit}f_{sy.f}}{f'_c\sqrt{A_c}}$

(b) *For circular sections:*

Eq. 10.7.3.4(2) – **Min Fitment spacing** $\leq \frac{100A_{b.fit}f_{sy.f}}{d_s f'_c}$

Now, $(A_{b.fit})_{500}$ x 500 = $(A_{b.fit})_{750}$ x 750

And n, number of fitments; f'_c; A_c, area of column and d_s, overall dimension of fitments do not change

$\therefore$ (Min fitment spacing)$_{500}$ = (Min fitment spacing)$_{750}$

Cl.10.7.4 **Restraint of longitudinal reinforcement**

Cl.10.7.4.1 *General requirements*

No impact from fitment strength $f_{sy.f}$ or fitment area $A_{b.fit}$

Cl.10.7.4.2 *Lateral restraint*

No impact from fitment strength $f_{sy.f}$ or fitment area $A_{b.fit}$

Cl.10.7.4.3 *Diameter and spacing of fitments and helices*

(a) Minimum bar diameter of fitment and helices to conforms to **Table10.7.4.3**

T. 10.7.4.3 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.

Longitudinal bar diameter (mm)	Minimum bar diameter of **500 MPa** fitment and helix (mm)	Minimum bar diameter of **Viribar®750** fitment and helix (mm)
Single bars up to 20	6	**4.8**
Single bars 24 to 28	10	**8.2**
Single bars 32 to 36	12	**9.8**
Single bars ≥ 40	16	**13.1**
Bundled Bars	12	**9.8**

(b) Maximum Spacing of fitments shall not exceed

(i) D_c and $15d_b$ for single bars

(ii) $0.5D_c$ and $7.5D_b$ for bundled bars

(i) and (ii) are independent of fitment strength $f_{sy.f}$ or fitment area $A_{b.fit}$

(iii) If Lu ≤ 5D - Need to check Section 14.5

REFERENCE	CALCULATION

(c) Location of first or last fitment - independent of fitment strength $f_{sy.f}$ or fitment area $A_{b.fit}$

Cl.10.7.4.4 *Detailing of fitments and helices*

Independent of fitment strength $f_{sy.f}$ or fitment area $A_{b.fit}$

Cl.14.5.4 **Columns**

Only need to check this clause if the column is part of a seismic resisting frame

The spacing of fitments shall not be greater than

(a) 8 times the diameter of the smallest longitudinal bar enclosed

(b) $24\sqrt{f_{sy.f}/500}$ times the diameter of the fitment bar

(c) One-half of the smallest cross-sectional dimension of the column

(d) 300 mm

Only (b) is affected by the fitment strength $f_{sy.f}$ or fitment diameter $d_{b.fi}$.

The table below shows there is no change in the fitment spacing for the equivalent Viribar®750 fitment when the formula in (b) is applied.

Clause 14.5.4 (b) – Maximum fitment spacing for column in a seismic resisting frame

500 MPa Fitments Diameter (mm)	Maximum Spacing (mm)	Viribar®750 Fitments Diameter (mm)	Maximum Spacing (mm)
10	240	8.165	240
12	288	9.798	288
16	384	13.06	384

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