Diameter pitch combinations	
Nominal diameter D (mm)	Thread pitch P (mm)
10	1.5
12	1.75
14	2.0
16	2.0
20	2.5
22	2.5
24	3.0
27	3.0
30	3.5
36	4.0
42	4.5

Note: Local availability of metric sizes should be checked.

Figure 4.15.2 *Metric fastener thread data*

Nominal bolt size, inches D	Threads per inch n
1/2	13
5/8	11
3/4	10
7/8	9
1	8
1 1/8	7
1 1/4	7
1 3/8	6
1 1/2	6

Note: Dimensions according to ANSI B18.2.1
Thread dimensions according to ANSI B1.1

Figure 4.15.3 *Imperial fastener thread data*

4.15.2 Anchor Rods

The following equations are used to determine anchor rod diameters.

The factored tensile resistance [6] shall be taken as:

$T_r = \phi_{ar} A_n F_u$

$\phi_{ar} = 0.67$

A_n = the tensile stress area of the rods

$= \frac{\pi}{4}(D - 0.938P)^2$ for metric rod

$= \frac{\pi}{4}(D - \frac{0.974}{n})^2$ for imperial rod

P = the pitch of thread, mm (Fig. 4.15.2)

n = number of threads per inch (Fig. 4.15.3)

D = diameter of the rod

A list of commonly used anchor rod materials are found in Figure 4.15.4.

The factored shear resistance [6] shall be determined by:

$V_r = 0.60\phi_{ar} A_b F_u$

When the rod threads are intercepted by the shear plane, the factored shear resistance shall be taken as 70% of V_r.

An anchor rod required to develop resistance to both tension and shear shall be proportioned [6] so that:

$$\left(\frac{V_f}{V_r}\right)^2 + \left(\frac{T_f}{T_r}\right)^2 \leq 1$$

is the portion of the total shear per rod transmitted by bearing of the anchor rods on the concrete.

Specification		f_y (MPa)	F_u (MPa)
CSA G30.18 – M1992 (R2002)			
	400 R	400	620
	400 W	400	620
CSA G40.21-04			
	300 W	300	450
	350 W	350	450
	380 W	380	480
	400 W	400	520
	480 W	480	590
	550 W	550	620
ASTM F155-04			
	36	248	400
	55(1)	371	517
	105(2)	724	862

(1)Weldable grade 55 must be specified.
(2)Grade 105 is not weldable.

Figure 4.15.4 *Anchor rod materials*

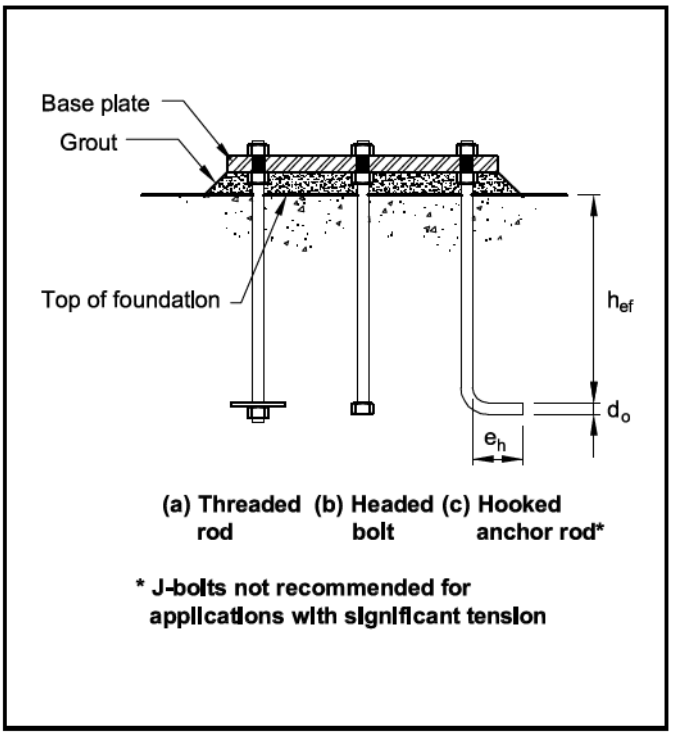


Figure 4.15.5 *Typical anchor rods*

An anchor rod, required to develop resistance to both tension and bending, shall be proportioned to meet the requirement of S16 Clause 13.9(a). The tensile and moment resistance, T_r and M_r, shall be based on the properties of the cross section at the critical section:

$$\frac{T_f}{T_r}+\frac{M_f}{M_r}\le 1.0$$

When the rods are near a free edge, the buckling of the rods before grouting must be considered.

Confinement reinforcement, as shown in Figure 4.15.1, should be provided. A minimum of 4-10M ties at 75mm spacing is recommended.

Anchor rods must be fully developed in the concrete per A23.3 Clause 15.9.3.2. The methods shown in Section 4.11 can be used to determine rod capacity governed by concrete failure.

The pullout capacity can be increased using hooks, nuts or plates as shown in Figure 4.15.5. The bottom of anchor rods should be a minimum of 100mm above the bottom of a footing, and above the footing reinforcement.

As Annex D of A23.3 is not mandatory, testing can also be used to confirm pullout strength.

Compression on anchor rods during erection can be substantially reduced by using steel shims to support gravity loads. The required area of the shims can be determined by calculating the bearing resistance of the concrete.

Example 4.17 *Column Connection; Baseplate and Anchor Bolt Design*

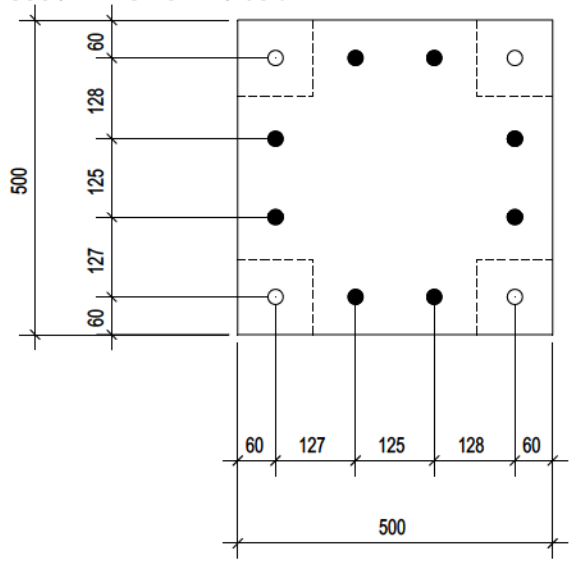
Given:
500 mm square column anchored with threaded rod anchor bolts. The column is assumed pinned at the base; no tension requirements other than structural integrity (CSA A23.3 16.5.2.4)

$f'_{c\ (column)}$ = 35 MPa
$f_{y\ (baseplate)}$ = 300 MPa

Problem:
Determine anchor bolts size and baseplate size.

Solution:
Anchor bolts: structural integrity

$T_r \geq 1.4\ Ag = 1.4\ (500 \times 500) / 1000$
$= 350$ kN
$350 / 4 = 87.5$ kN / bolt



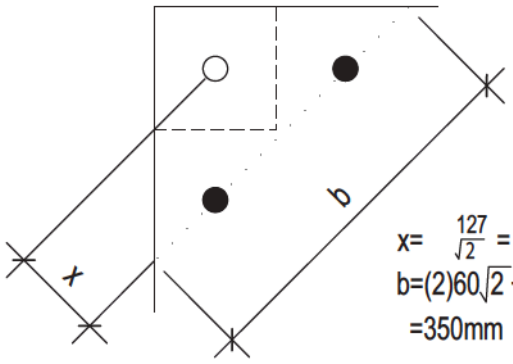
Try 24 mm ASTM A36 bolts

$T_r = \phi_{ar} A_n F_u$
$= 0.67\ [\pi/4\ (24 - 0.938x3)^2]\ 400 / 1000$
$= 94.5$ kN > 87.5 OK

Check anchor pullout strength in footing.

Baseplate:

Check one bolt in tension:



$x = \frac{127}{\sqrt{2}} = 90$mm
$b = (2)60\sqrt{2} + 127\sqrt{2}$
$= 350$mm

$t = \sqrt{(T_f 4x / \phi sfyb)}$
$= \sqrt{[(87.5 \times 10^3 \times 4 \times 90)/(0.9 \times 300 \times 350)]}$
$= 18.25$ mm

Use plate 500 x 500 x 19 mm

Check plate anchors into precast column.

4.16 WELDING

4.16.1 Welding of Steel Plates

The welding of steel plates is governed by CSA Standard S16. Typically precast connections are welded using fillet welds. See Figure 4.16.1 for capacities. See CISC [6] for more information.

4.16.2 Welding of Reinforcing Bars

Welding of reinforcement is a practical method of developing force transfer in many connections. Typical reinforcing bar welds are shown in Figure 4.16.2.

The welding of reinforcing bars is governed by W186.