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Building Columns

Technical Manual

Contents

Introduction

This manual contains technical guidelines for the design and application of Rocla® Building Columns including;

- Column Types, details and dimensional tolerances.
- Column Properties and Design Information including;
    - Axial Load/Bending Moment Interaction Strength Diagrams
    - Fire Resistance Levels
    - Durability
    - Design example
- Connection design options for the base, top and intermediate locations.
- Details for installation of free-standing columns.
- Handling & Installation guidelines.

Applications

Rocla® Building Columns are suitable for single level or multi-storey construction in industrial, commercial and residential applications.

They can be used as stand-alone structural columns or as permanent formwork, either self-supporting or traditionally fixed.

Description

Rocla® Building Columns are manufactured from high strength (65 MPa min.) spun reinforced concrete. The column manufacturing process provides numerous benefits over traditional forming methods, including;

- Connection components that are built in to provide fast, efficient installation & continuity of construction.
- High strength columns have a smaller footprint that frees up letable space.
- A smooth off steel form finish.
- The hollow column is typically 30% lighter than solid columns.
- The hollow column can carry services internally.
- A range of standard diameters and strength options.
- Fire Resistance Levels to 4 hours.
- Excellent durability. The standard range is generally suitable for Exposure Classifications up to B2 in AS3600.
- Single piece lengths up to 24 metres are possible. Long column lengths speed up multi floor construction.
- Tapered columns also available.
- Factory controlled quality manufacture.

For further information contact Rocla Building Products on 1800 257 311 and www.buildingproducts.rocla.com.au

Materials & Manufacture

Rocla® Building Columns are manufactured from high strength, spun concrete of 65 MPa minimum strength. Reinforcement comprises of wire & bar to AS/NZS 4671 and OneSteel proprietary reinforcement.

Rocla® Columns are designed & manufactured using technology and experience gained from many years of spun concrete component supply.

Standard Column Types

Table 1 shows the standard range of Column Types and associated details. **Standard Columns** are described by a numeric designation, e.g. 400/120/2 where 400 represents the external diameter, 120 the Fire Resistance Period (120 minutes) and 2 the Strength Rating.

Standard Diameters are 260, 300, 350, 400, 450 & 585mm. 810 and 1140mm diameter columns are also available. In addition to parallel face columns, tapered columns (with an outer diameter taper of 15mm per metre length) can also be supplied.

The **Strength Rating** specifies the column strength. Strength rating 1 is the lowest strength. Column properties and axial load / bending moment interaction strength diagrams for each Strength Rating are provided in this manual.

Column Size

'Column Size' describes the combination of column length and column Type. e.g. column size 8.5/400/120/2 describes a column 8.5m long, with attributes of a 400/120/2 Type column.

Single-piece columns up to 24m are possible but maximum lengths are generally less, limited by factors such as transport, lifting capacity and free-standing heights.

Fire Resistance

Rocla® Building Columns encompass Fire Resistance Periods of 60, 90, 120 & 240 minutes.

The Fire Resistance Period (FRP) for Rocla® Building Columns is determined by reference to Clause 5.6.3.3 of the Concrete Structures Code AS3600-2001. The FRP for each column Type is shown in Table 1.

Durability

Rocla® Building Columns have excellent durability characteristics and are suitable in Exposure Classifications A1, A2, B1 and B2 (except for 260/60) in accordance with Section 4 of the Concrete Structures Code AS3600-2001.

Internal column surfaces, including 260/60 columns, can be exposed to 'interior or exterior environments', Exposure Classifications A1, A2 and B1.

In applications close to marine or severe industrial environments, contact Rocla Building Products for assistance.

For further information contact Rocla Building Products on 1800 257 311 and www.buildingproducts.rocla.com.au

Column Types & Details

Table 1: Standard Rocla® Building Column Types & Details

Column Type	Column Diameter (mm)	Fire Resistance FRP (mins)	Strength Rating	External Cover (mm)	Minimum Wall Thickness (mm)	Mass (kg/m)
260/60/1	260	60	1	15	55	100
260/60/2	260	60	2	15	55	100
260/90/1	260	90	1	30	70	120
260/90/2	260	90	2	30	70	120
300/90/1	300	90	1	20	60	130
300/90/2	300	90	2	20	60	130
300/120/1	300	120	1	40	80	160
300/120/2	300	120	2	40	80	160
350/90/1	350	90	1	20	60	150
350/90/2	350	90	2	20	60	160
350/90/3	350	90	3	20	60	170
350/120/1	350	120	1	35	80	190
350/120/2	350	120	2	35	80	200
350/120/3	350	120	3	35	80	200
400/120/1	400	120	1	30	70	210
400/120/2	400	120	2	30	70	220
400/120/3	400	120	3	30	90	280
450/120/1	450	120	1	30	70	240
450/120/2	450	120	2	30	70	250
450/120/3	450	120	3	30	90	320
585/120/1	585	120	1	30	75	340
585/120/2	585	120	2	30	75	350
585/120/3	585	120	3	30	75	360
585/240/1	585	240	1	55	100	440
585/240/2	585	240	2	55	100	450
585/240/3	585	240	3	55	120	530
585/240/4	585	240	4	55	120	540

Tolerances	
Overall Length	
- Critical	+/-5mm
- Non-Critical	+/-20mm
Outer Diameter	+/-5mm
Wall Thickness	-0/+ no limit
Internal Core Diameter	Varies
Cover to reinforcement	
- External	+5/-0mm
- Internal	-0/+ 50% limit
Straightness	3mm/m
End Squareness	
- Critical	+/-3mm
- Non-Critical	+/-6mm
Accessory Location	
Longitudinally	
- Critical	+/-2mm
- Non-Critical	+/-10mm
Radially	
- Critical	+/-2mm
- Non-Critical	+/-5mm
PCD Fittings	
- Critical	+/-2mm
- Non-Critical	+/-3mm
Mass	+10/-5 %

Notes:

- Minimum internal cover is 15mm.
- To ensure minimum wall thicknesses are achieved, actual walls are typically 0 to 15% thicker than the values shown due to overfill allowances.
- Although the internal diameter is approximately circular, the manufacturing (spinning) process extracts material which reduces and causes variations to the internal diameter. This spun-off material is considered to be non-structural.
- The masses shown include over-fill allowances. Also, these masses may vary depending on fittings and block-outs.
- Unless noted otherwise, 'non-critical' tolerances apply to dimensions, fittings and accessories.

Design Overview

Rocla® Building Columns comply with the rules and conventions of AS3600-2001.

Loadings should, as a minimum, be in accordance with relevant Australian Standards, in particular AS1170, AS3600 and AS3610.

To facilitate member strength design, axial load / bending moment strength interaction diagrams are provided for each column Type on pages 7 -11.

Column slenderness effects, if any, must be considered. Refer to AS3600 Section 10.4. The example shown here illustrates the effect of slenderness on column Type. Also the effects of block-outs and fittings must be addressed.

It is also necessary to consider the effects of handling, lifting and installation. Recommendations for these design aspects are provided on pages 17 - 20.

Strength Interaction Diagrams

Rocla® Building Columns have considerable axial load / bending moment interaction strength due to the combination of high concrete strength and efficient use of reinforcement.

The axial load / bending moment interaction strength diagrams associated with the standard range of Rocla Columns are shown on pages 7 - 11.

The strength interaction diagrams are based on;

- Outer diameter = external diameter.
- Internal diameter = nominal column diameter – (2 x minimum wall thickness). Refer to Table 1.
- Concrete strength f'c = 65 MPa.
- Longitudinal reinforcement is prescribed by the column Strength Rating. The quantity of reinforcement complies with AS3600 Section 10.7.1 except some Types exceed 0.04 x Ag.
- Circumferential reinforcement can be of a variable amount. The minimum circumferential reinforcement is 5.55mm diameter hard drawn wire at a pitch of 160mm.
- External cover to circumferential reinforcement is shown in Table 1.
- Axial load / bending moment strength interaction calculations comply with AS3600 Section 10.6.

Design Certification

The information contained in this manual has been checked & certified by consulting engineers Cardno MBK (NSW) Pty Ltd.

Design example : braced column

A braced column with an effective length = 6.5m has critical design loadings;

Dead Load = 150 kN, Live Load = 300 kN.
N* = 630 kN, M* = 100 kNm.
M1* / M2* = -0.8

A 400mm dia column with a FRP = 120 is considered.

To establish what Strength Rating is required:

From Interaction Diagram 7, a Strength Rating 1 column may be structurally adequate. But, we need to determine whether the column is 'short' or 'slender'.

From Table 2, r (radius of gyration) = 119.

Le / r = 6500 / 119 = 55 > 25 therefore the column is 'slender' [AS3600-2001 Clause 10.3.1 (a)].

Calculate the magnified moment due to slenderness effects:

db = km / (1-N*/Nc)
Nc = NF / [(Le)^2 x (1 + Bd)]
Bd = 1.2 x 150 / (1.2 x 150 + 1.5 x 300) = 0.29

By Table 2, NF = 77 x 10^3 for 400/120/1 columns.

Nc = 77 x 10^3 / [6.5^2 x (1 + 0.29)] = 1410 kN.
km = 0.6 – 0.4 x (-0.8) = 0.92
db = 0.92 / (1-630 / 1410) = 1.66

Therefore the magnified design moment

= 1.66 x 100 = 166 kNm.

Interaction Diagram 7 indicates for N* = 630 kN and db.M* of 166 kNm that a Strength Rating = 2 would be required.

Table 2: Standard Rocla® Building Column Properties										
Column Type	Sectional Area Ag (mm²)	Stiffness EI x 10^12 (Nmm²)	Radius of Gyration (mm)	NFx10³ (kNm²)	Bending Strength Muo (kNm)	Bending Strength Mub (kNm)	Axial Strength Nuo (kN)	Axial Strength Nub (kN)	Design Shear Strength (kN)	Inter-action Diagram
260/60/1	35420	10	75	16	33	74	2160	700	40	1
260/60/2	35420	11	75	19	71	88	2750	600	45	1
260/90/1	41780	10	72	15	47	109	2760	870	45	2
260/90/2	41780	11	72	18	84	127	2960	820	55	2
300/90/1	45250	17	87	27	47	109	2760	870	50	3
300/90/2	45250	17	87	32	84	127	2960	820	55	3
300/120/1	55300	18	83	26	46	112	3280	950	55	4
300/120/2	55300	18	83	29	78	125	3510	850	65	4
350/90/1	54680	28	105	46	57	155	3250	1100	55	5
350/90/2	54680	30	105	52	105	177	3480	1050	60	5
350/90/3	54680	31	105	62	159	207	3790	1000	70	5
350/120/1	67870	32	100	48	56	170	3980	1280	60	6
350/120/2	67870	33	100	53	101	188	4210	1200	70	6
350/120/3	67870	34	100	60	149	213	4510	1100	80	6
400/120/1	72590	49	119	77	86	232	4310	1450	65	7
400/120/2	72590	53	119	99	219	297	4930	1300	85	7
400/120/3	80440	60	117	129	326	396	6910	1200	110	7
450/120/1	83580	73	137	116	99	305	4920	1750	70	8
450/120/2	83580	79	137	145	262	381	5540	1600	90	8
450/120/3	101810	93	131	190	398	509	7690	1600	120	8
585/120/1	120190	189	182	298	196	589	7100	2550	115	9
585/120/2	120190	196	182	343	374	677	7560	2450	130	9
585/120/3	120190	203	182	385	529	757	8020	2400	140	9
585/240/1	152390	224	175	363	363	751	9340	2950	145	10
585/240/2	152390	230	175	395	510	819	9800	2800	160	10
585/240/3	175330	256	170	472	686	988	12210	2900	190	10
585/240/4	175330	263	170	511	829	1067	13020	2750	200	10

Notes:

Strength parameters are as defined in AS3600-2001. Mub and Nub are calculated at ku=0.55.

The gross cross-sectional area values (Ag) are based on minimum wall thicknesses. Actual areas are generally higher due to concrete over-fill.

Stiffness (EI) values are based on gross concrete sections.

The radius of gyration (r) values are based on minimum wall thicknesses.

(NF) values are a constant for each column and apply to the buckling load Nc calculation, AS3600-2001 Clause 10.4.4.

$Nc = NF / [(Le)^2 \times (1+Bd)]$.

Where: $NF = (3.142)^2 \times 182 \times do \times Ø \times Mub$ with units: Nc (kN); do (m); Mub (kNm); Le (m).

Shear strength calculations in accordance with AS3600-2001.

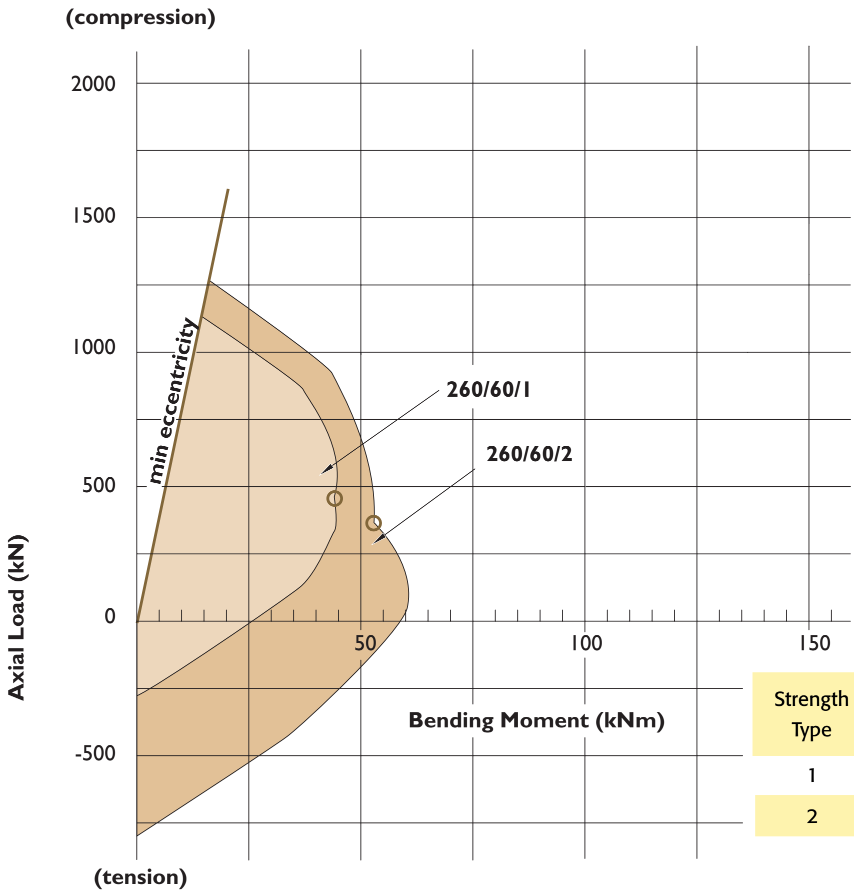
Design shear strengths = Ø.Vu, where Ø = 0.7.

For design shear values shown, N* (design axial load) = 0.

Where columns include sectional area reductions, e.g. block-outs the design shear strength value may be reduced by the following factor x (1-(sum of void areas) / (column sectional area)).

Where column penetrations have been made good by suitable grout or concrete, the full design shear strength may be used or, at the discretion of the design engineer, include a reduction factor due to the restoration process.

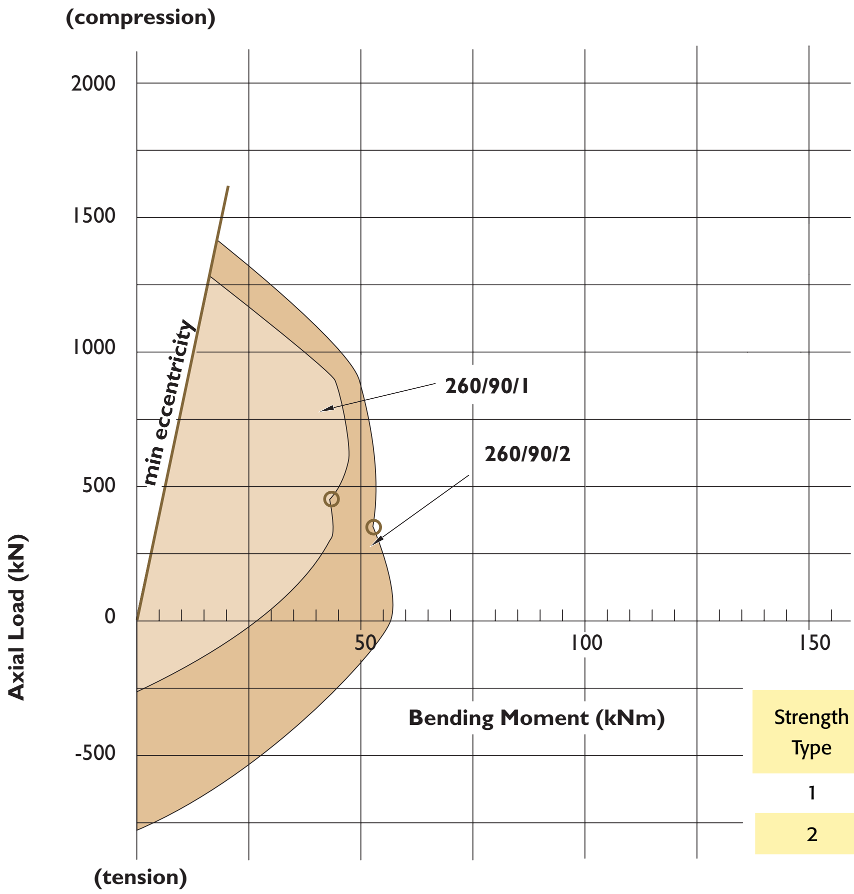
Diagram 1: Rocla® Building Columns - 260 dia. FRP 60 mins



Ultimate design strengths
(∅ factored)
○ $k_u = 0.55$
Type 1
Type 2

Strength Type	∅Nuo kN	∅Muo kNm	∅Nub kN	∅Mub kNm
1	1300	26	420	44
2	1440	60	360	53

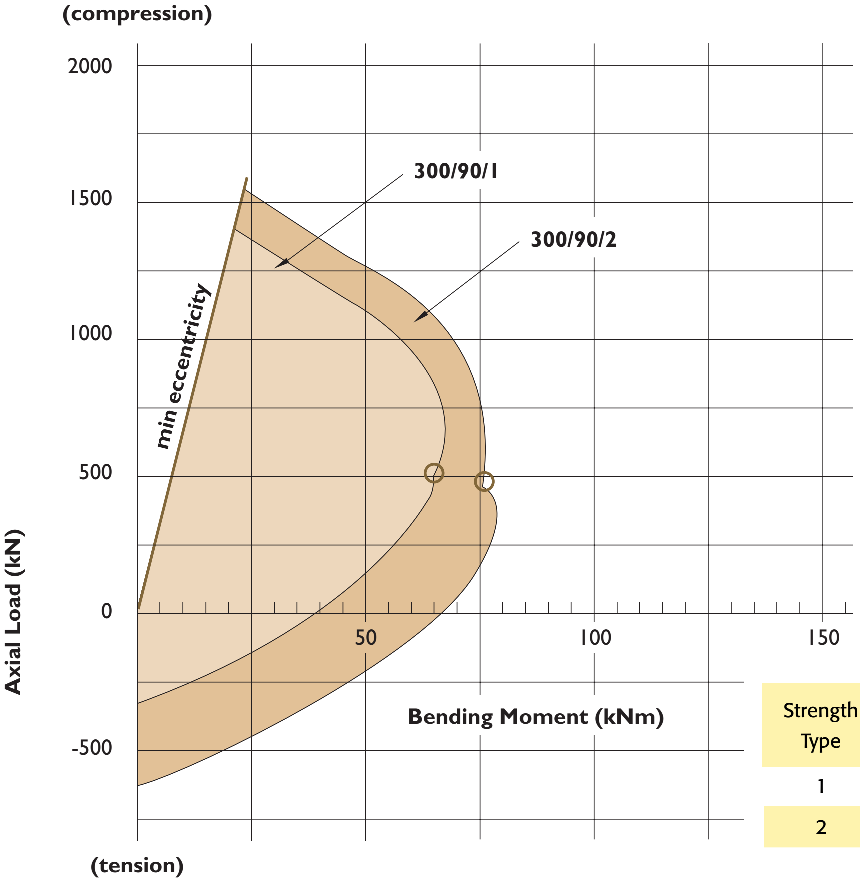
Diagram 2: Rocla® Building Columns - 260 dia. FRP 90 mins



Ultimate design strengths
(∅ factored)
○ $k_u = 0.55$
Type 1
Type 2

Strength Type	∅Nuo kN	∅Muo kNm	∅Nub kN	∅Mub kNm
1	1500	26	430	44
2	1650	57	360	53

Diagram 3: Rocla® Building Columns - 300 dia. FRP 90 mins



Ultimate design strengths

(∅ factored)

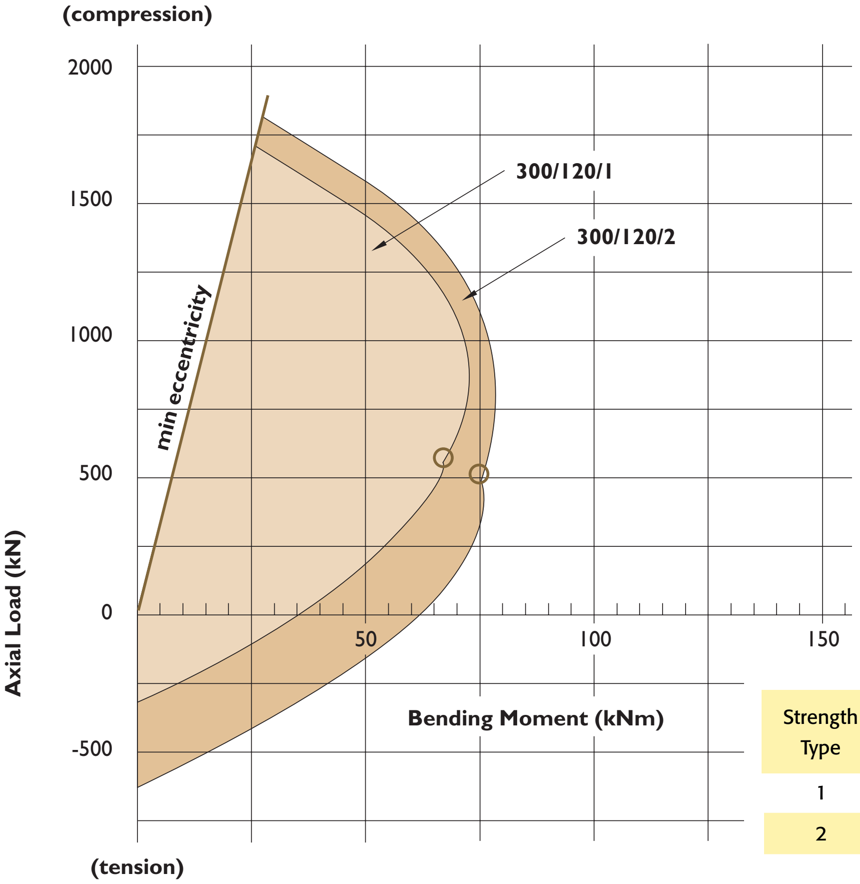
o $k_u = 0.55$

Type 1

Type 2

Strength Type	∅ Nuo kN	∅ Muo kNm	∅ Nub kN	∅ Mub kNm
1	1650	38	520	65
2	1770	67	490	76

Diagram 4: Rocla® Building Columns - 300 dia. FRP 120 mins



Ultimate design strengths

(∅ factored)

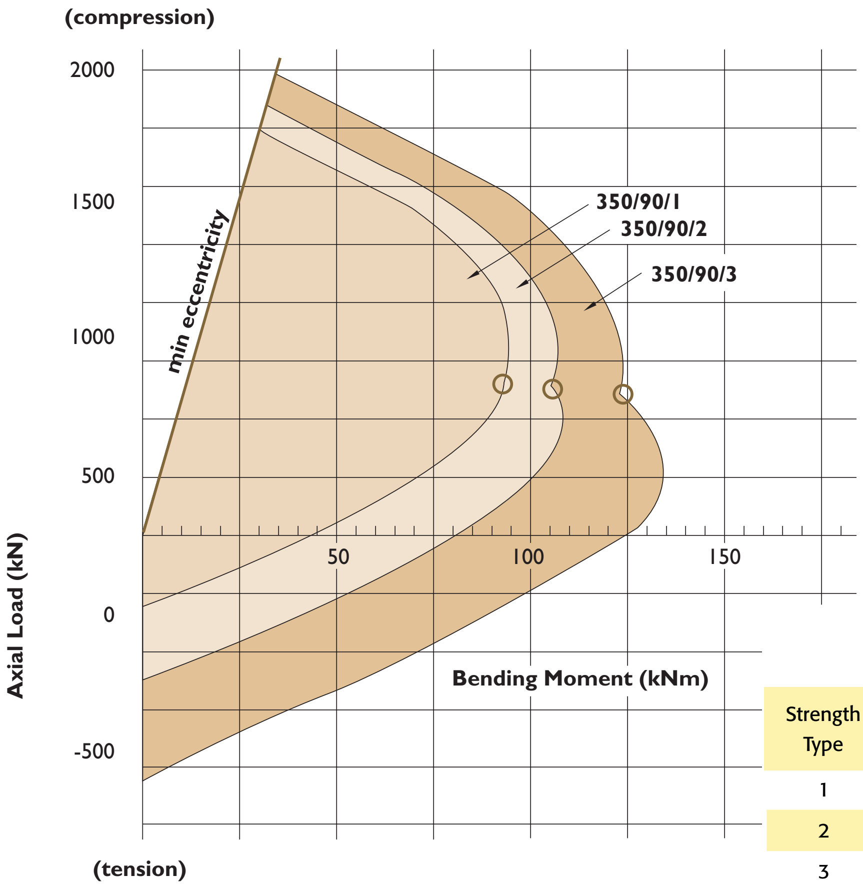
o $k_u = 0.55$

Type 1

Type 2

Strength Type	∅ Nuo kN	∅ Muo kNm	∅ Nub kN	∅ Mub kNm
1	1970	37	570	67
2	2110	62	510	75

Diagram 5: Rocla® Building Columns - 350 dia. FRP 90 mins



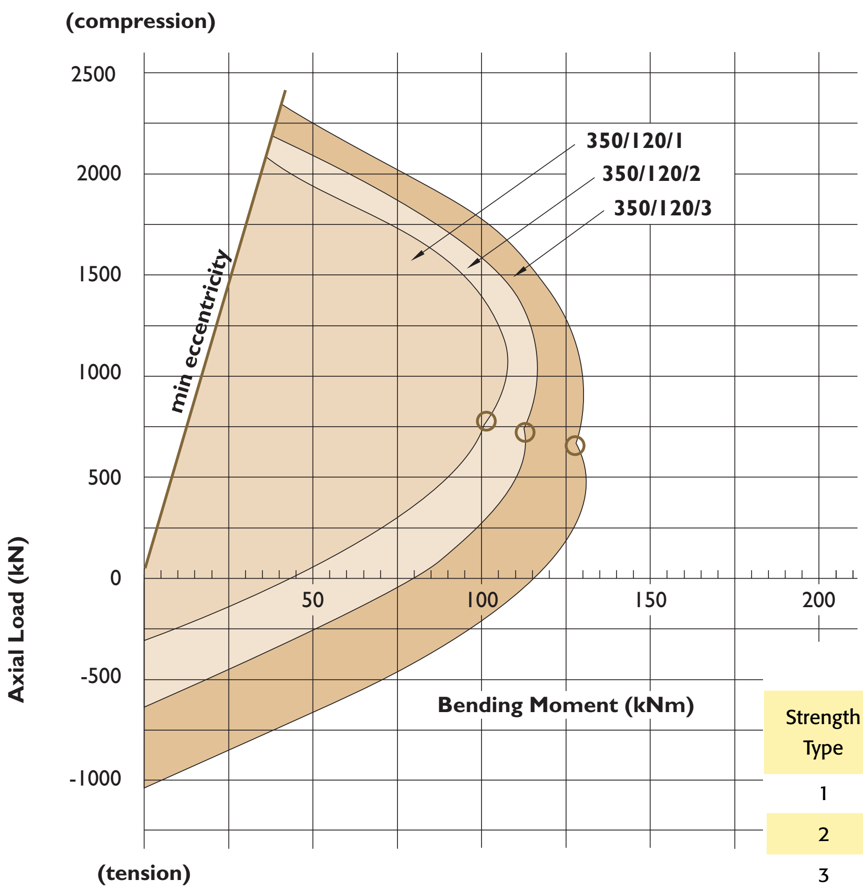
Ultimate design strengths

(∅ factored)

- o $k_u = 0.55$
- Type 1
- Type 2
- Type 3

Strength Type	∅ Nuo kN	∅ Muo kNm	∅ Nub kN	∅ Mub kNm
1	1950	46	660	93
2	2090	84	630	105
3	2270	125	600	125

Diagram 6: Rocla® Building Columns - 350 dia. FRP 120 mins



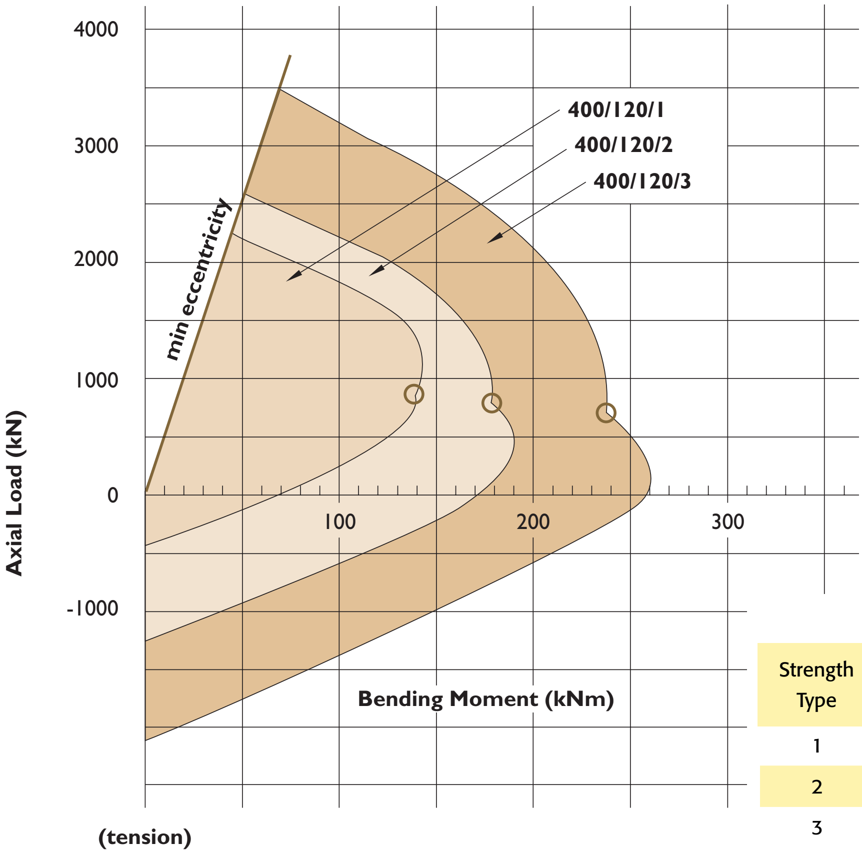
Ultimate design strengths

(∅ factored)

- o $k_u = 0.55$
- Type 1
- Type 2
- Type 3

Strength Type	∅ Nuo kN	∅ Muo kNm	∅ Nub kN	∅ Mub kNm
1	2390	45	770	100
2	2520	81	720	110
3	2710	120	660	125

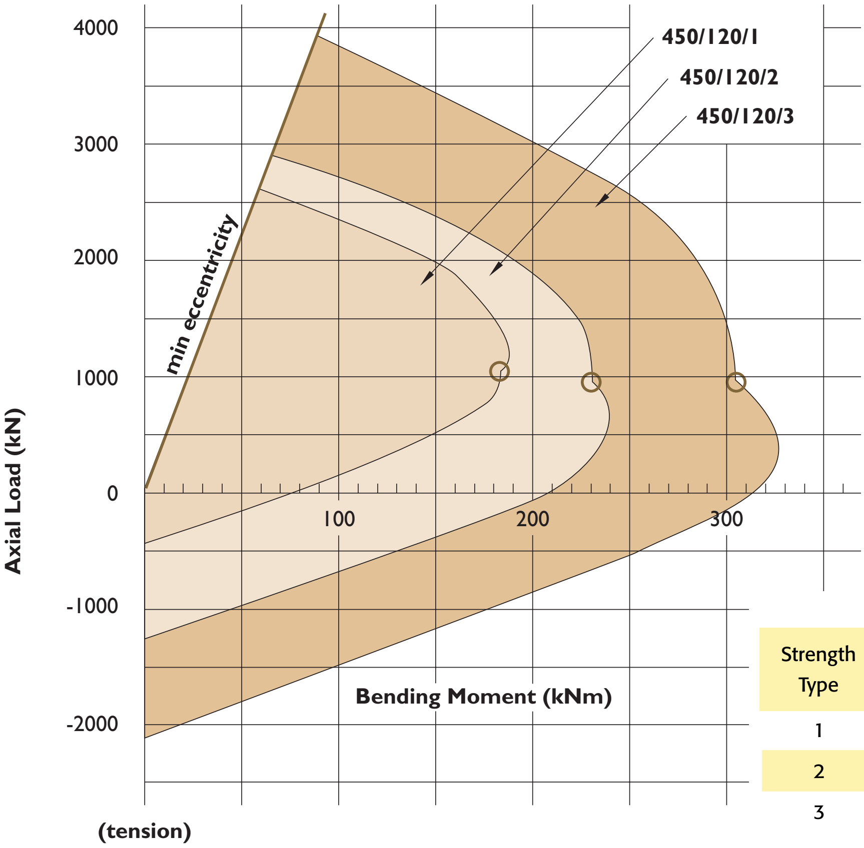
Diagram 7: Rocla® Building Columns - 400 dia. FRP 120 mins



Ultimate design strengths
(∅ factored)
o $k_u = 0.55$
Type 1
Type 2
Type 3

Strength Type	∅Nuo kN	∅Muo kNm	∅Nub kN	∅Mub kNm
1	2590	69	870	140
2	2960	175	780	180
3	4140	260	720	235

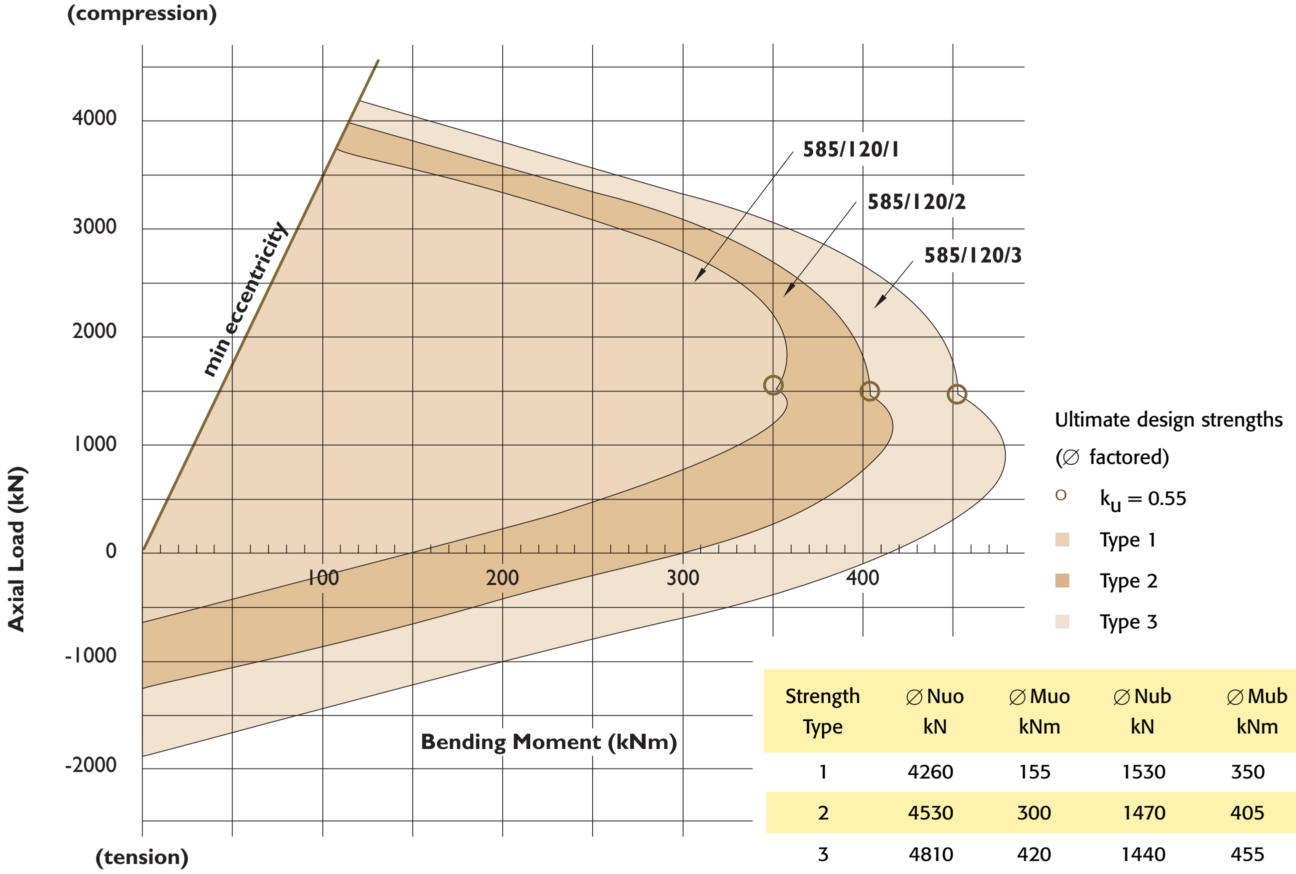
Diagram 8: Rocla® Building Columns - 450 dia. FRP 120 mins



Ultimate design strengths
(∅ factored)
o $k_u = 0.55$
Type 1
Type 2
Type 3

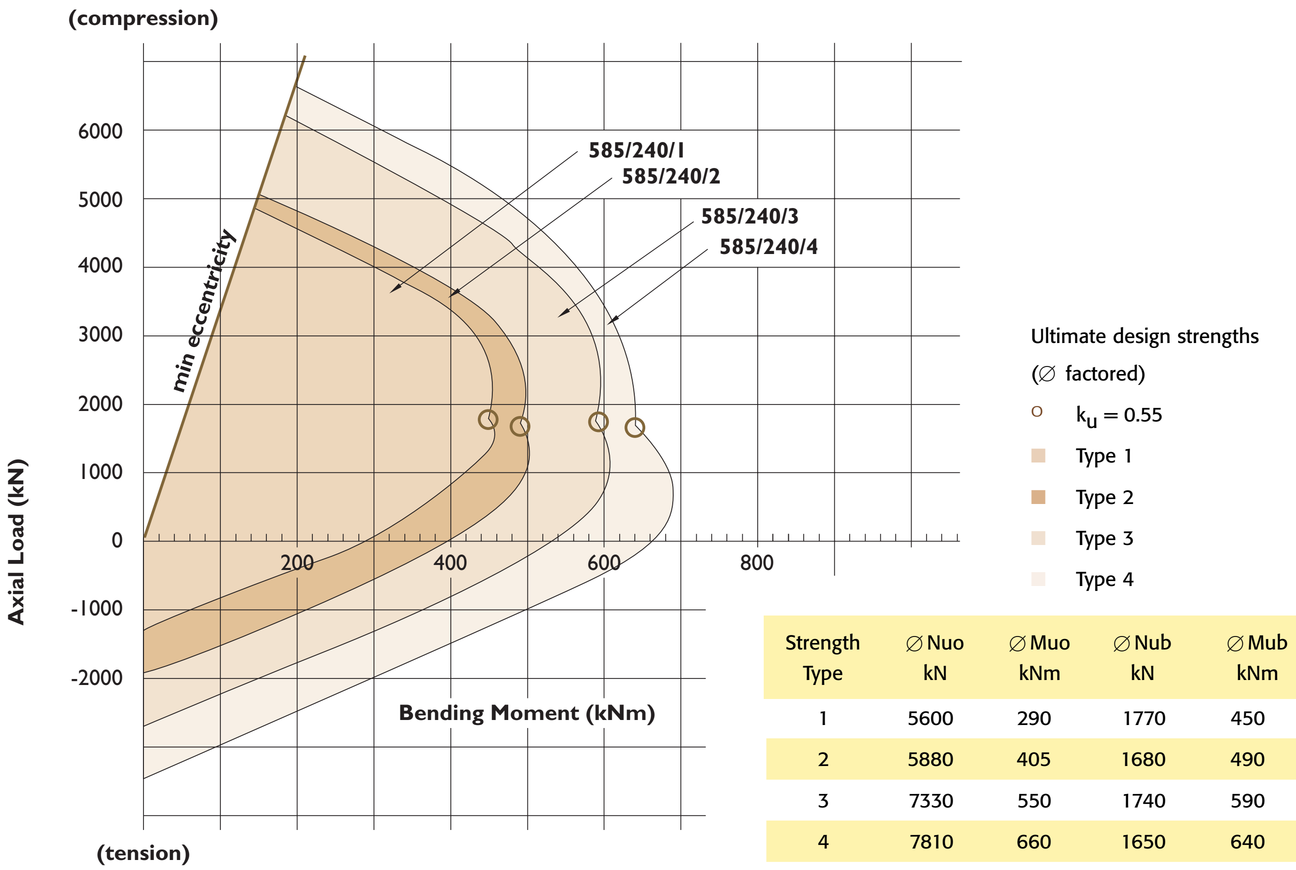
Strength Type	∅Nuo kN	∅Muo kNm	∅Nub kN	∅Mub kNm
1	2950	79	1050	180
2	3320	210	960	230
3	4610	315	960	305

Diagram 9: Rocla® Building Columns - 585 dia. FRP 120 mins



Strength Type	∅Nuo kN	∅Muo kNm	∅Nub kN	∅Mub kNm
1	4260	155	1530	350
2	4530	300	1470	405
3	4810	420	1440	455

Diagram 10: Rocla® Building Columns - 585 dia. FRP 240 mins



Strength Type	∅Nuo kN	∅Muo kNm	∅Nub kN	∅Mub kNm
1	5600	290	1770	450
2	5880	405	1680	490
3	7330	550	1740	590
4	7810	660	1650	640

Connection Design

Rocla® Building Columns can be connected to other structural members such as footings, beams and slabs. The following pages outline various options for base, top and intermediate column connections.

Connections and associated components must be designed for all loads and action effects encountered during both construction and in-service. Connections must also be compatible. e.g. the footing hold-down bolts need to match the barrel connectors at the base of the column.

Base Connection

Rocla® Building Columns can be connected to structural members at the bottom end of the column (the base) in various ways.

The base connecting member may be the footing for a foundation, a slab, or a beam at any level in the structure. For convenience here after referred to as the footing.

Free-standing (unbraced) columns can be achieved by bolting 'barrel connectors', located at the base of the column, to hold-down bolts protruding from the footing. This connection provides the column with immediate over-turning capacity, allowing the column to be immediately self-supporting and thus avoid temporary bracing.

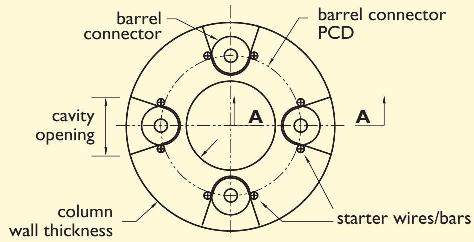
Table 3 nominates the maximum allowable unbraced column heights based on four equi-spaced hold-down bolt/barrel connector combinations under a maximum wind condition. Other possible loadings, such as accidental impact during construction, should be considered by the engineer.

The 'with grout' unbraced heights and base design strength values in Tables 3 & 4 are based on a grout strenth of 32MPa. Intermediate unbraced heights and base strength values between zero grout strength (the without grout values) and 32MPa grout strength (the 'with grout' values) maybe linearly interpolated.

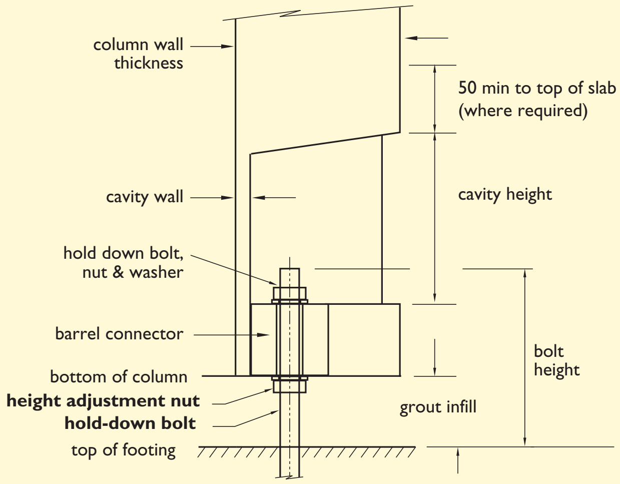
The spacing of barrel connectors (and the corresponding hold down bolts) for the various column Types is provided in Table 5.

To give the column base greater bending strength, the number of barrel connectors can be increased in some cases. For 450 and 585mm diameter columns, higher strength barrel connectors are also available. Refer to Rocla Building Products for further information.

Another method to fix the base of the column is to use internal starter bars. The column is positioned over the starter bars and then filled with concrete to the top of the starter bars. This method requires the column to be temporarily propped until the concrete infill cures. Also, a combination of 'barrel connectors' and starter bars may be an efficient combination when higher base strengths are required.



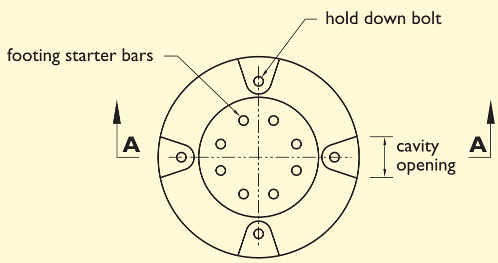
Section through Column Base



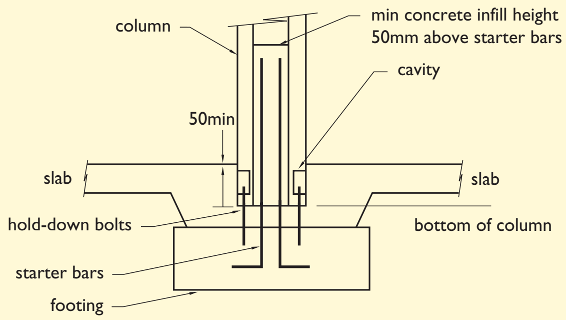
Section A-A

Barrel	Bolt Height (mm)	Grout Infill (mm)	Cavity Height (mm)
M16	150	25 min / 60 max	100
M24	190	30 min / 60 max	110

Barrel Connector Detail



Section at Column Base



Section A-A

Combined Starter Bar/ Barrel Connector Option

Table 3: Maximum Unbraced Column Heights (m)								
Dia.	Without Grout				With Grout			
mm	M16 Bolt Grade		M24 Bolt Grade		M16 Bolt Grade		M24 Bolt Grade	
	4.6	**8.8**	**4.6**	**8.8**	**4.6**	**8.8**	**4.6**	**8.8**
260	5.0	8.5	7.0	8.5	8.5	8.5	8.5	8.5
300	5.0	8.5	7.0	8.5	8.5	8.5	8.5	8.5
350	5.5	9.0	8.0	9.5	9.0	9.5	9.5	9.5
400	5.5	9.5	8.5	10.0	9.0	10.0	10.0	10.0
450	5.5	9.5	8.5	11.0	9.5	11.0	11.0	11.0
585	5.5	9.5	8.5	12.5	9.5	12.5	12.5	12.5

Notes:

Maximum unbraced Column Height Calculations based on:

1. 4-barrel connectors and corresponding hold down bolts as nominated.
2. The barrel connector bending strengths at base of column as shown in Table 4 and PCD as per in Table 5.
3. Wind load calculations to AS1170.2, assume basic wind speed=38m/s, Region A, Terrain Category 2, Mt=Mi=Ms=1.
4. Co-efficient of drag on column taken as 0.9.
5. Load combination used to determine maximum unbraced column height is 1.5 x W + 1.1 x G.
6. 32 MPa minimum grout strength.
7. M24 barrel connectors not suitable with 260/90/1, 2 columns.
8. Grade 4.6 bolts to AS 1111 and Grade 8.8 bolts to AS 1252.

Table 4: Design Bending Strengths (kNm) at base of column								
Dia.	Without Grout				With Grout			
mm	M16 barrels Bolt Grade		M24 barrels Bolt Grade		M16 barrels Bolt Grade		M24 barrels Bolt Grade	
	4.6	**8.8**	**4.6**	**8.8**	**4.6**	**8.8**	**4.6**	**8.8**
260	4.3	12	9	24	12	24	22	34
300	4.1	11	8.4	23	14	30	27	32
350	5.6	15	11	32	17	38	34	62
400	7.1	19	15	43	20	47	41	92
450	8.4	23	18	51	24	56	48	112
585	10	28	22	62	32	80	68	156

Notes:

- 'Design bending strengths øMu' are based on 4-barrel connectors and corresponding hold-down bolts. PCD's as per Table 5.
- 'With grout' values based on f'c = 32MPa grout.
- M24 barrel connectors not available with 260/90mm diameter columns.

Table 5: Barrel Connector PCD/Hole Centres (mm)				
Column Type	M16		M24	
	PCD	Hole Centres	PCD	Hole Centres
260/60/1,2	180	127	166	117
260/90/1,2	146	103	N/P	N/P
300/90/1,2	214	151	201	142
300/120/1,2	171	121	155	110
350/90/1,2,3	267	189	257	182
350/120/1,2,3	233	165	219	155
400/120/1,2,3	296	209	289	204
450/120/1,2,3	348	246	342	242
585/120/1,2,3	480	339	472	334
585/240/1,2,3	430	304	420	297

Base Infill

The space between the column base and the top of the member with the hold-down bolts must be filled with a low shrinkage, cementitious grout for compressive load transfer. This is best achieved by drilling or puncturing a small hole in the interior wall of a barrel cavity. The diameter of the grout infill at the top of footing must be at least (column diameter + 4 x infill gap). 'With grout' unbraced column heights based on 32MPa grout strength.

Barrel Grouting

Barrel cavities must also be filled with grout or concrete to protect the barrel starter bars from corrosion. This can be readily achieved when a slab is poured around the column, finishing the slab 50mm (min) above the top of the barrel cavities.

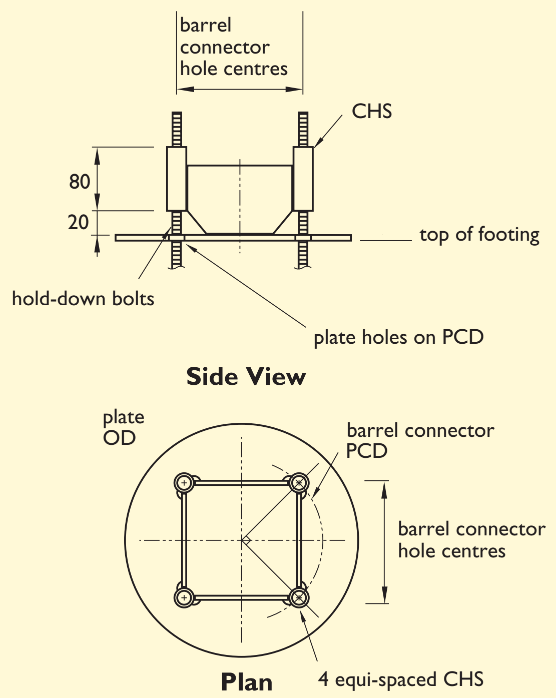
Where the barrel cavities are above the finished floor level, break through all diametrically opposed barrel connector cavity walls and place N12 bars across full column diameter. Wrap a flexible form around the column base and pour grout through inlet tubes in the column.

For maximum protection of the starter bars, paint the barrel cavity interiors with a concrete bonding agent prior to filling.

Where fire ratings must be maintained, refer to Rocla Building Products for details.

Hold-down Bolts

Hold-down bolts must be accurately cast into the footing. The top of the footing must be flat and horizontal with solid concrete, free of laitance. The protruding bolt heights should be 150mm for M16 bolts and 190mm for M24 bolts. The nominated range of allowable 'base infill gap' is dependent upon these heights.' To assist in the accurate positioning of hold-down bolts, reusable setout templates are recommended. A typical detail is shown below.

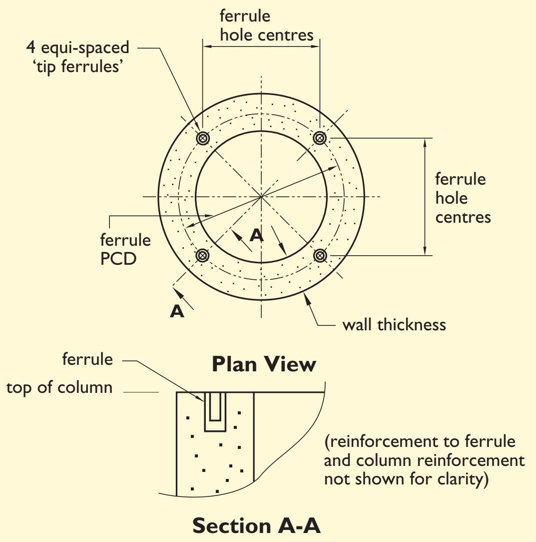


Hold-down Bolt Template

Top of Column Connections

Connections to other structural members at the top end of Rocla® Building Columns can typically be achieved by using tip-ferrules, starter bars, hole formers or side-ferrules, or a combination of these methods.

Tip-ferrule assemblies are cast into the top end of the column for lifting and / or connection of structural members such as rafters. Two or four equi-spaced tip ferrules on the PCD / hole centres shown in Table 6 can be supplied. Design bending strengths (Ø Mu) for columns using M16 and M24 tip-ferrules are also shown in Table 6.



Tip Ferrule Diagram

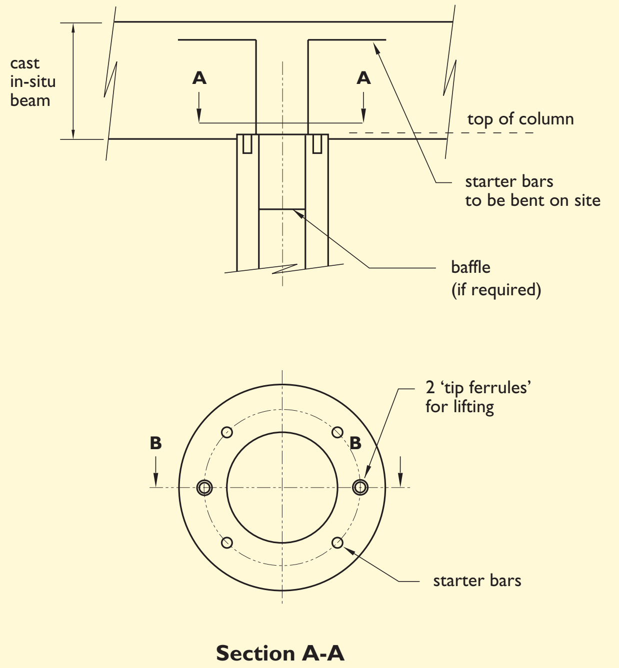
Table 6: Tip ferrule PCD's (mm) and Design Bending Strengths (kNm) at top of column						
Column Type	PCD (mm)	Hole Centres (mm)	Ø.Mu (kN.m) M16 Bolt Grade		Ø.Mu (kN.m) M24 Bolt Grade	
			4.6	8.8	4.6	8.8
260/60	190	134	13	30	25	55
260/90	159	112	13	29	25	58
300/90	222	157	16	37	32	70
300/120	181	128	16	36	32	64
350/90	273	193	19	45	39	88
350/120	238	168	19	45	40	85
400/120	304	215	22	54	47	105
450/120	355	251	26	64	54	124
585/120	481	340	36	88	75	177
585/240	431	305	36	88	75	176

Notes:

Design bending strength ØMu values at the top end of the column are based on:

1. 4-ferrules / bolts and associated PCD's as shown in table.
2. Connected member assumed to be able to transmit forces to achieve 'strain compatibility'.
3. Grade 4.6 bolts to AS 1111 & Grade 8.8 bolts to AS 1252.

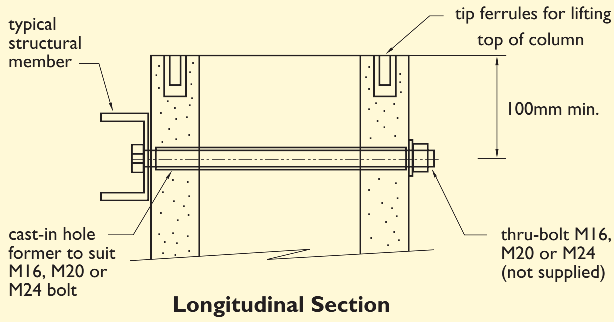
Starter bars can be used in cast-insitu applications. Where Rocla® Building Columns are supplied with starter bars, the bars are supplied straight for transport and need to be bent on site, if required. The typical configuration of a column with starter bars and tip-ferrules for lifting is shown below. *Refer to the installation section of this manual for end-lifting of columns using eyebolts and tip- ferrules.*



Starter Bars (with tip ferrules)

Hole Formers

Hole formers can be cast through the column near the end of a column (the minimum end distance depends upon the bolt size and application) to facilitate the bolting-on of structural sections, as shown in the detail below. Standard hole formers suit M16, M20 & M24 bolts.



Hole former (with tip ferrules)

Intermediate Column Connections

Intermediate connection to Rocla® Building Columns can typically be achieved via 'block-outs', 'fin plates', 'side-ferrules' or 'hole formers'. These options are described as follows. For fully developed connection details as well as other options refer to Rocla Building Products.

Block-out Connections

Rocla® Building Columns can be manufactured with 'in-line' or 'cross' type block-outs. These block-outs provide a void or penetration in the column enabling beams, precast, cast-insitu or steel, to be connected. The final strength of the completed connection is dependent upon the type of beam-column connection. Column integrity can be maintained by grout / concrete filling, using steel-framed openings or by using a 'thick wall' column option.

'In-line' block-outs are a pair of diametrically opposite blockouts that provide an in-line penetration though the column to accommodate a narrow steel or concrete beam.

'Cross' block-outs are four, right angle penetrations that facilitate two-way, cast-insitu beam connection. In this case, the strength of the column can be reinstated, partially or fully, when the column core is concrete-filled.

Refer to Table 7 for maximum column block-out widths.

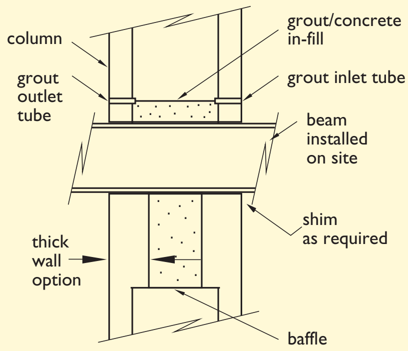
Table 7: Rocla® Building Columns - Maximum Block-Out Widths (mm).

Column Type	Wall Thickness (mm)	Max Opening Width (mm)
260/60/all	55	100
260/90/all	70	85
300/90/all	60	120
300/120/all	80	100
350/90/all	60	160
350/120/all	80	140
400/120/1,2	70	190
400/120/3	90	160
450/120/1,2	70	220
450/120/3	90	190
585/120/all	75	250
585/240/1,2	100	250
585/240/3,4	120	250

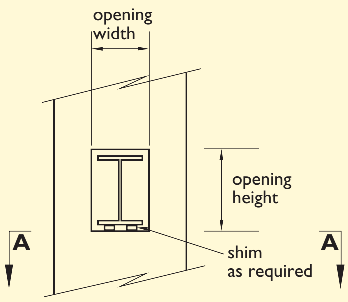
- Maximum opening height = 2 x maximum opening width.

'Thick wall' Column Options

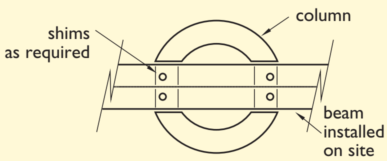
'Thick wall' column options avoid the need to reinstate the strength lost due to the penetration. The nominated column strength is maintained by using a thicker wall and additional reinforcement. The availability of this option is design dependent.



Section through column



Elevation



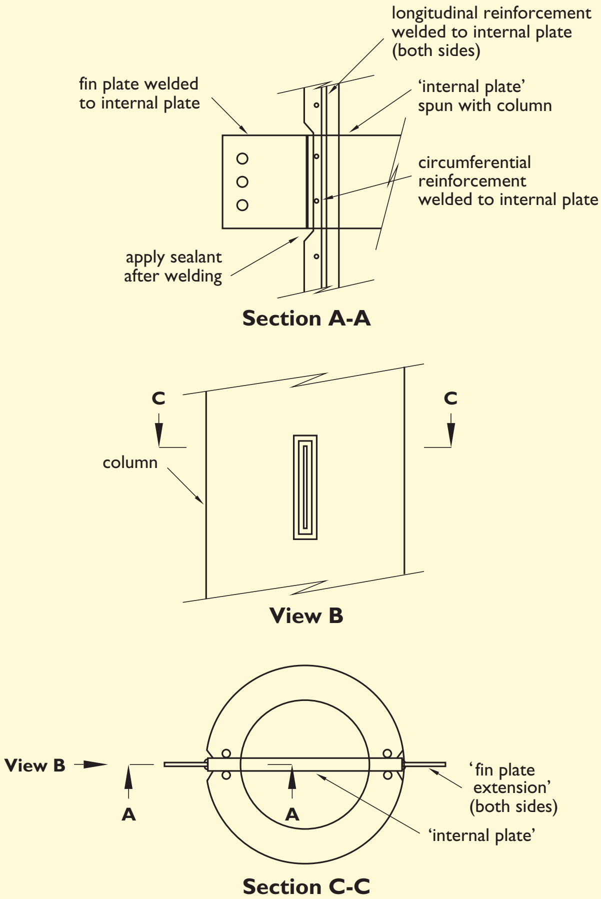
Section A-A

Thick wall Column

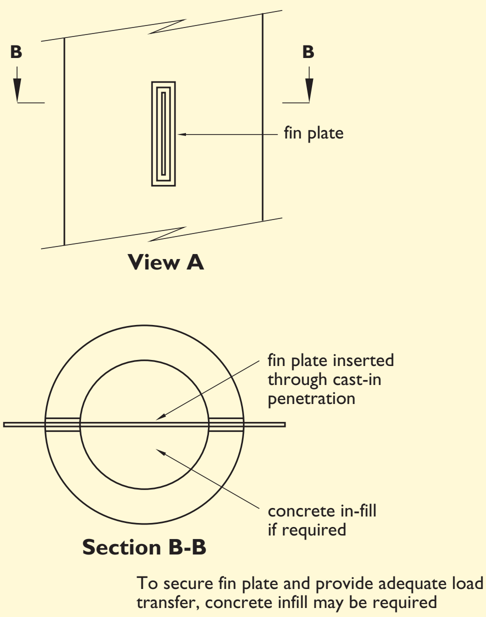
Fin Plate Connection

Steel sections can be connected to columns by the following fin plate options:

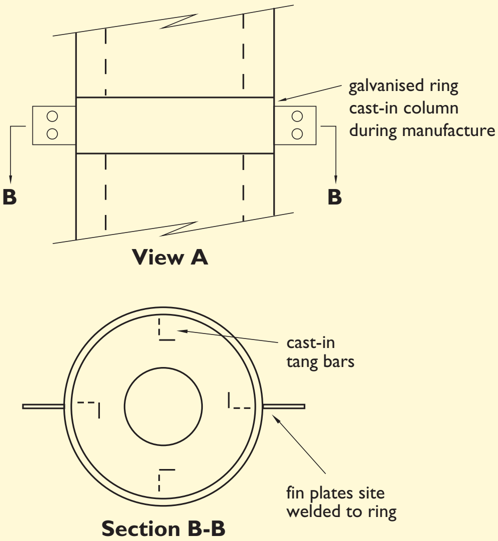
- 'Internal plates'. At the nominated position an internal plate can be cast into the column so that fin plates can be welded to these later, either in the factory or on site.
- 'Fin plate penetrations'. Penetrations that allow fin plates to be inserted through the column on site can be cast into the column. In this case, to secure the fin plates and provide adequate load transfer, a concrete infill within the column core maybe required (this infill maybe local, not necessarily the full column length.)
- 'Steel Ring'. A steel ring can be cast into the column so that fin plates can be site-welded, at the desired position and orientation.



Option 1: Internal Plate for welding fin plates



Option 2: Fin Plate penetration

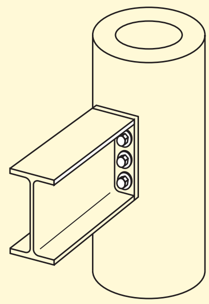


Option 3: Cast-in Steel Ring for Site welding fin plates

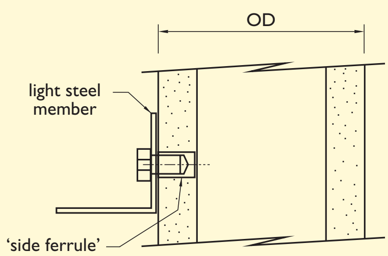
Bolted Connections

Steel sections can be bolted to a column via bolts passing through hole-formers, as described previously, or side-ferrules that are cast into the sides of a column.

M16 side-ferrules, which suit M16 bolts is the standard size ferrule. The design pull-out strength for an M16 side ferrule is 18kN.



Option 4: Hole former/thru-bolts



Side Ferrule Detail

Option 5: Side Ferrule Connection

Installation

This section provides the minimum requirements for the installation of Rocla® Building Columns. The design and site engineers for a project should nominate additional requirements when deemed necessary.

Delivery & Unloading

Delivery to site is generally provided by Rocla Building Products as agreed with the installer / builder. The receiver will ensure timely and safe unloading of columns from trucks.

The columns must be lifted from the truck horizontally at two points located approximately 0.2 x column length from each end and away from any void in the column. Use nylon slings or similar so as to not mark or damage the column surface. If the columns are moved around on site prior to installation, follow the same procedure described here.

Site Storage

Where columns are stored on site, they are to be placed on a flat area and on suitable timber supports off the ground. Use only two support points per column. These support points must be located between 0.2 to 0.25 x column length from each end and away from any void (eg block-out) in the column.

Chock each column at the support points to ensure that each column is safely secured. Do not stack columns unless properly designed stillages are used.

Footing Preparation

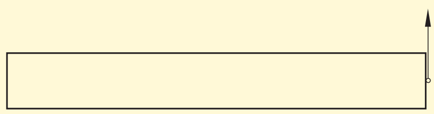
The top of footings must be solid concrete, clean & free of laitance. Ensure that concrete footings have achieved sufficient strength, and if applicable, hold-down bolts have developed the required pullout strength before placing columns. Hold-down bolts should be cleaned and the levelling / height adjustment nuts fitted to the correct height.

Lifting Columns

Single-point lifting of Rocla® Building Columns is the most practical way to lift, position and secure a column into place. Table 9 nominates maximum column lengths and masses associated with the following lifting options. Typically, a column would be lifted at the top of the column (end-lift using eyebolts) or at the upper block-out, for columns with block-outs. These block-outs can be either 'in-line' or 'cross' types. The following diagrams indicate the single-point lift positions for these two cases. For other lifting arrangements and longer lengths, refer to Rocla Building Products.

Lifting Columns without Block-Outs

COLUMNS WITHOUT BLOCK-OUTS, Must be end lifted



Lifting Columns with Block-Outs

These columns can be end-lifted or lifted at the upper block-out provided that this upper block-out is between 0.2 x L and 0.4 x L from the top of the column.

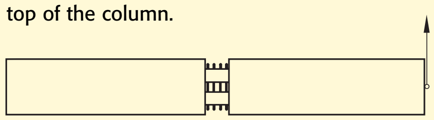


Table 9: Column Lift Length & Mass Limits

Column Type	Max. Lift Length (m)	Column Mass (t)
260/60/1	7.0	0.7
260/60/2	9.0	0.9
260/90/1	6.0	0.7
260/90/2	8.0	1.0
300/90/1	7.0	0.9
300/90/2	9.0	1.3
300/120/1	6.0	1.0
300/120/2	8.0	1.3
350/90/1	6.0	1.0
350/90/2	9.5	1.5
350/90/3	11.0	1.9
350/120/1	6.0	1.1
350/120/2	8.0	1.6
350/120/3	10.0	2.0
400/120/1	7.0	1.5
400/120/2	11.0	2.4
400/120/3	12.5	3.5
450/120/1	7.0	1.7
450/120/2	12.0	3.0
450/120/3	12.5	4.1
585/120/1	8.5	2.9
585/120/2	12.0	4.2
585/120/3	14.0	5.0
585/240/1	10.0	4.4
585/240/2	12.0	5.4
585/240/3	12.5	6.6
585/240/4	14.0	7.7

Notes:

Mass refers to the column length indicated.

Lifting is to be within '0.4x column length' of the top of the column.

Block-outs are assumed to be located within 0.4xL from the ends of the column. For a centrally located block-out, reduce the nominated column length by 20% and only use 'end-lifting'.

Block-outs are assumed to reduce the intact bending strength by no more than 35%.

Lifting considerations include an impact factor of 1.5.

No consideration has been given to lifting equipment capacity.

End Lifting

Columns with a SWL of 5 tonne or less can be 'end lifted' using two ferrules (one each side) at top end of column. Eyebolts, as nominated in Table 10, are to be used with these ferrules. Each eyebolt should be fully screwed into the ferrule until finger tight, then undone sufficiently to allow for rope alignment.

For columns greater than 5 tonne mass, contact Rocla Building Products for lifting details.

Table 10: Maximum Column Mass for End Lifting

Standard Collared Eyebolt Size	Safe Lifting Mass (kg)	Rocla Plated Eyebolt Size	Safe Lifting Mass (kg)
M16	800	M16	1600
M24	2500	M24	5000

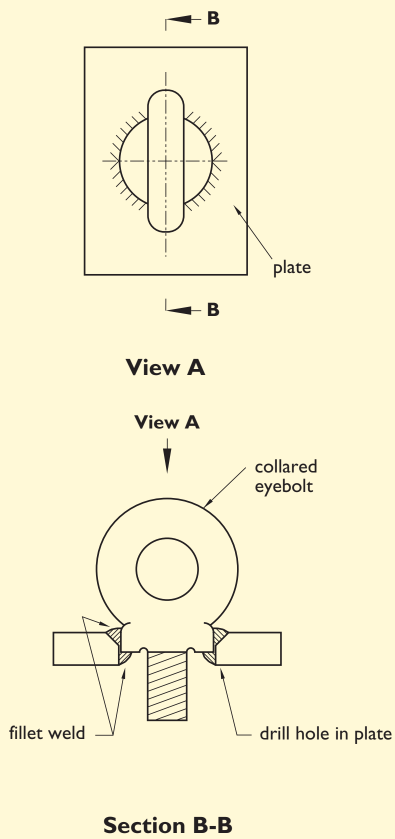
Notes:

The 'Safe Lifting Mass' is the lifting mass that can be safely raised from horizontal to vertical using the nominated eyebolts and instructions detailed in this manual.

The 'Lifting Mass' includes the column mass, lifting equipment, fittings and the mass of any attached items.

Standard eyebolts are to AS2317.

'Plated eyebolts' can be purchased from Rocla Building Products.

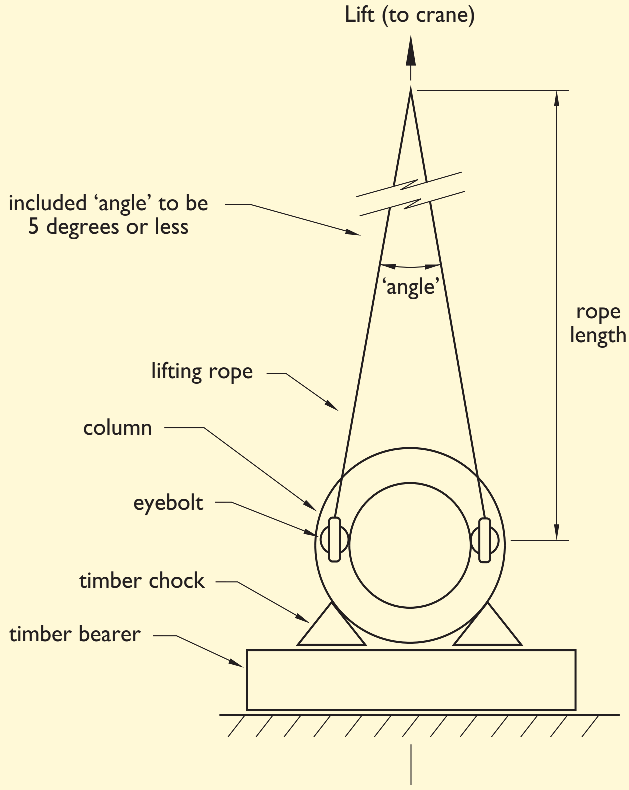


Typical Plated Eyebolt

Table 11: Minimum Rope Lengths for End Lifting

Diameter (mm)	Minimum Rope Length (m)
260	2.2
300	2.7
350	3.2
400	3.5
450	4.2
585	5.5

The minimum length lifting ropes, to ensure a maximum included rope angle of 5°, are shown in Table 11. Refer to the end-lifting diagram for typical lifting arrangement. Alternatively, a lifting beam may be used to avoid the requirements for rope length and angle.



Lifting Arrangement from Column End

Lifting at Block-Out

Columns with one or more block-outs may be lifted from the upper block-out (only) provided that the upper block-out is within 0.4xL from the top of the column.

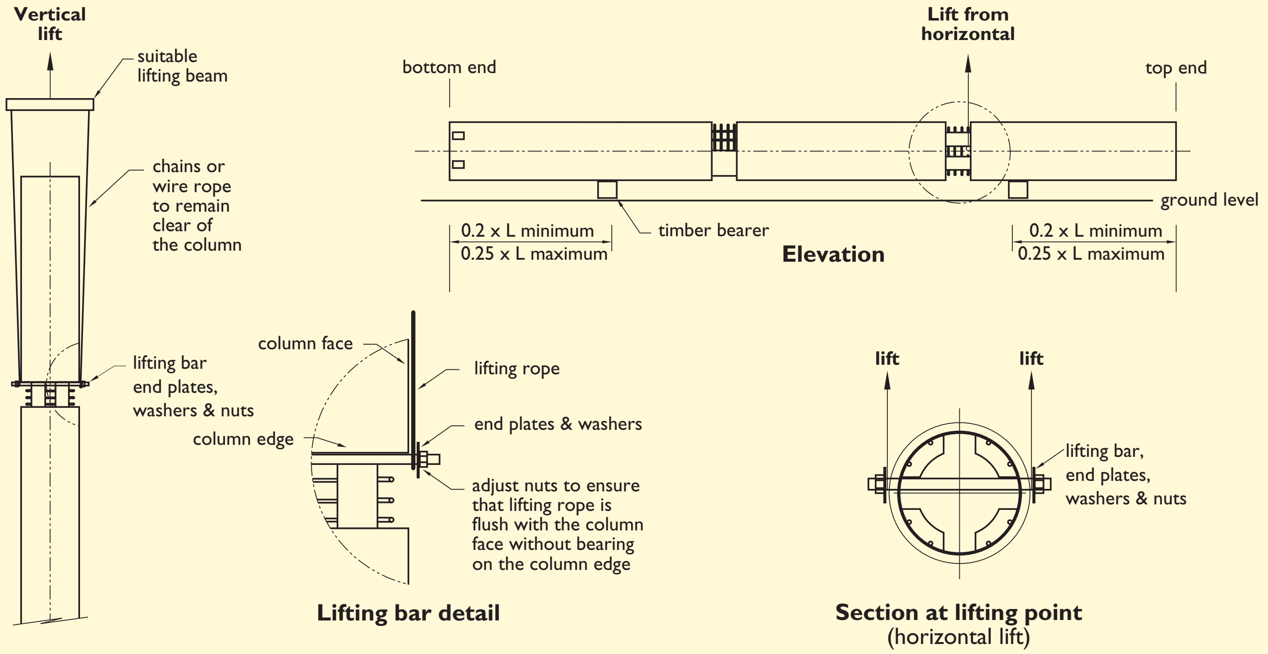
Lifting from a block-out requires the use of a lifting bar with threaded ends, end plates, washers and locking nuts, chains or wire ropes and a suitable lifting beam.

The lifting beam must be of sufficient capacity and the distance between rope/chain attachment points on the lifting beam must exceed the column diameter. Refer to the block-out lifting arrangement diagram.

The safe lifting masses for various lifting bar diameters are shown in Table 12.

The end plates or washers are to be sized to ensure that the lifting chains or ropes are not able to slip off the ends of the lifting bar.

Note: *Some bedding of the lifting bar locally into the concrete can be expected.*



Block-Out Lifting Arrangement

Table 12: Lifting Bar Options	
Lifting Bar Diameter (mm)	**Safe Lifting Mass (t)**
60	2.7
80	6.0
100	10.0

Notes:

1. The 'Safe Lifting Mass' is the lifting mass that can be safely raised from horizontal to vertical using instructions detailed in this manual.
2. The 'Lifting Mass' includes the column mass, lifting equipment, fittings and the mass of any attached items.
3. Refer to diagram for lifting arrangement.
4. Lifting bar material Grade 300 round bar to AS3679.1.
5. Lifting bar thread is permitted in shear plane.
6. Maximum distance from column surface to centre of lifting rope assumed to be 30mm.
7. 'Safe lifting mass' calculations assume a FoS = 1.5 and Ø = 2.2 in accordance with AS1418.1 1994.

Column Placement

Ensure that the correct column is selected for each location. Clean the thread of the hold-down bolts (where applicable) and fit leveling / height adjustment nuts to the required height. Ensure that each column is orientated in the required direction, particularly if column block-outs and fittings are non-symmetric or handed.

Once the column is located, secure immediately by the relevant bolting or propping. Do not remove the lifting chains/ropes until all of the column adjustments have been made and the column is secure.

Infilling Column Base & Cavities

Refer to page 13 for details.

Fixing to Columns

Attachment of partitions, ductwork, etc to columns may be made in the same manner as for reinforced columns. Ensure that the applied loads, associated action affects and durability issues are addressed by the design engineer.

Column Cutting

Do not drill or cut holes into the columns unless approved by the design engineer.

Column Repairs

In the event of minor surface chipping, use structural grade epoxies such as Hilti CA125 or Megapoxy P1 to repair. Follow the manufacturer's instructions.