Technical Manual

Duraspun® Concrete Piles

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Rocla Duraspun® concrete piles are manufactured from high-density concrete, either reinforced or pre-stressed.
The centrifugal spinning process produces concrete of high strength and durability.

The annular cross-section makes Duraspun® concrete piles lighter and more economical than cast concrete piles of equivalent bending strength. The efficient mass-to-strength ratio allows longer lengths, which can eliminate the need for jointing.

Duraspun® concrete piles can be used in all standard driving conditions. After driving, the hollow section allows internal inspection to assess structural integrity.

Duraspun® Concrete Piles

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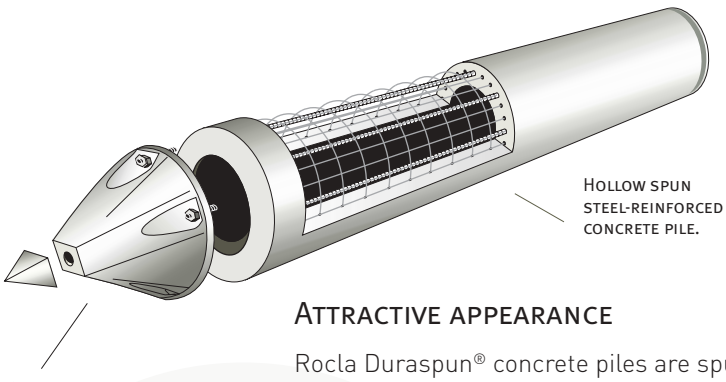


Hollow spun steel-reinforced concrete pile.

Optional bolt-on toe and cast iron tip.

Attractive appearance

Rocla Duraspun® concrete piles are spun in accurately dimensioned steel moulds. This allows designers to take full advantage of the economies of extended pile/pier construction requiring both strength and aesthetics. The circular section allows rotation without affecting alignment or appearance.

Quality

All Rocla pile plants maintain a certified quality management system based on the requirements of the ISO9001 Standard (Licence No. QEC177). Rocla's objective is to provide customers with products and services of consistent and uniform quality that are suitable for their intended purpose and conform to relevant specifications, codes and contractual requirements.

Pile types

Duraspun® concrete piles are available in three main diameters – 400, 450 and 585mm – and are designed to suit both driven and potted applications. Various strength types and lengths are available as well as other diameters for specialist applications (e.g., 350mm and 810mm)

Duraspun® concrete piles are designated by diameter, installation method, strength type and length.

Example: A pile designation of **450/D/2-12.5** refers to a pile of 450mm diameter, with driving pile features, Type 2 strength and a length of 12.5m.

Diameter = pile outside diameter

Installation method = potted or driven

Strength type = strength of pile as characterised by interaction strength (see interaction diagrams)

Length = pile length (in 0.5m increments)

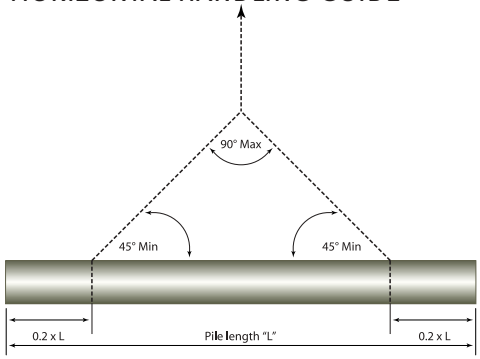
Handling

Duraspun® concrete piles should be handled in accordance with the following guidelines. For more details see the Rocla Poles and Piles Handling and Installation Guide.

When a pile is stored it should be supported by two timber bearers. These support bearers should be level and located approximately (0.2 x pile length) from each end. Always use suitable chocks to prevent the piles from rolling. Piles should not be stacked in more than three levels, and the upper bearers must be vertically above the lower bearers.

When a pile is lifted or moved in a horizontal position, spreader chains or a lifting beam must be used. The chains must be located approximately (0.2 x pile length) from each end of the pile and the horizontal angle between the chain and the pile should be no less than 45°.

Horizontal handling guide



Installation

Driving

In general, the standards used for driving solid cast concrete piles also apply to Duraspun® concrete piles. The high strength-to-weight ratio of Rocla Duraspun® concrete piles makes them easy to drive and allows a wide choice of rig and hammer sizes. A cylindrical helmet is not necessary, although this can help during set-up and alignment. Suitable packing material is required between the pile head and the driving helmet. The hammer must be located centrally over the pile head.

All Duraspun® driving piles are supplied with a steel headband and optional driving toe.

Driven piles can be lifted into the driving position by chains wrapped around and choked off against the pile immediately below the lifting point (approximately 0.3 x pile length from the head). A shear bar is then inserted through the cast-in lifting tube. The chains gripping the pile support the pile mass, while the bar through the lifting tube prevents the chains from slipping off the pile.

Piles used as supports for the Rocla M-Lock® bridge system must be driven to within a small tolerance to allow connection to the precast headstocks. In this application, the lifting tube can be placed at the standard lifting point 600mm from the head of the pile. This allows the pile to be lowered vertically within a fine tolerance (see Pile Handling Guidelines for details).

Potting

Potted piles are generally placed into a hole and socketed into rock to a depth of about 2 metres (depending on the rock strength and the applied loads on the pile). The diameter of the hole must be sufficient to allow accurate placement of the pile and leave adequate space for the backfill. The length of the pile is predetermined to suit the nominated embedment depth. The pile must not be shortened by cutting the toe end, as this may remove critical shear reinforcement.

Any loose material must be removed from the bottom of the hole before the pile is placed and concreted. "Toe holes" are generally provided in the pile near the toe end to allow the backfill concrete to flow into the bottom of the pile. It is recommended that the inside of the pile be filled with concrete to at least 500mm above the bottom of the pile.

The foundation strength relies on the bond between the augered hole and the concrete backfill, as well as the bond between the concrete backfill and the pile. The pile outer surface can be factory roughened or scabbled over the required rock-socket length to enhance this bond. The standard potted pile has a lifting tube located 600mm from the head of the pile to facilitate accurate placement. Refer to Lifting Bar Specifications for details.

Duraspun® concrete pile being driven with hydraulic drop hammer.

Duraspun® concrete pile being potted into pre-drilled hole.

General design notes

Piles must have a design strength greater than the design loads. Bending moment/axial load (interaction) diagrams are provided in this manual to ensure the specified piles have adequate bending moment and axial strength. The Pile Shear Strength table lists the shear strength values for different types of piles at particular locations in the pile. Shear strength is particularly important in the rock-socket section of potted piles.

Options and accessories

Depending on the application, a number of options and accessories can be specified by the pile designer.

Potted piles requiring uplift capacity can be roughened or scabbled externally to achieve a good bond with the surrounding concrete. Internal scabbling is provided to ensure that infill concrete (specified to enhance the crushing capacity) adequately bonds with the inside of the pile. Potted bridge piles may also require "headbars" at the top of the pile for connection to bridge headstocks.

Driven piles are normally specified with a driving toe and headband. However, piles can be driven without a toe. The hollow pile fills with soil and creates an immovable plug that provides full toe-end resistance. The headband is designed to confine the concrete at the head of the pile during driving to minimise spalling. Connection to a bridge headstock is generally achieved using a prefabricated steel reinforcement cage accommodated within the hollow area of the concrete pile.

Summary of Pile Features		
Typical Features	Application	
	Potted	Driven
Headband	No	Yes
Protruding Headbars	Yes	No
Lifting Tube @ LPL	Yes	Yes
Precast Driving Toe	No	Yes
Toe Holes	Yes	No
Scabbled Inner Base	Yes	No
Scabbled Outer Base	Yes	No
Scabbled Inner Top	No	No

External scabbling of pile

Steel headband

Internal scabbling of pile

Solid pile driving toe

Cast iron driving toe

Prefabricated steel reinforcement cage for headstock connection

Headbars embedded in pile

LIFTING BAR SPECIFICATIONS		
Pile Diameter	**Bar Length** (mm)	**Bar Mass** (kg)
400mm	550	7.0
450mm	600	7.5
585mm	735	9.0

NOTES.

Standard lifting bar is 42mm diameter grade 300 which provides a safe working load of 8.0 tonne.

Lifting bar must not have thread in plane of shear, i.e. thread is not to extend to lifting chains or slings.

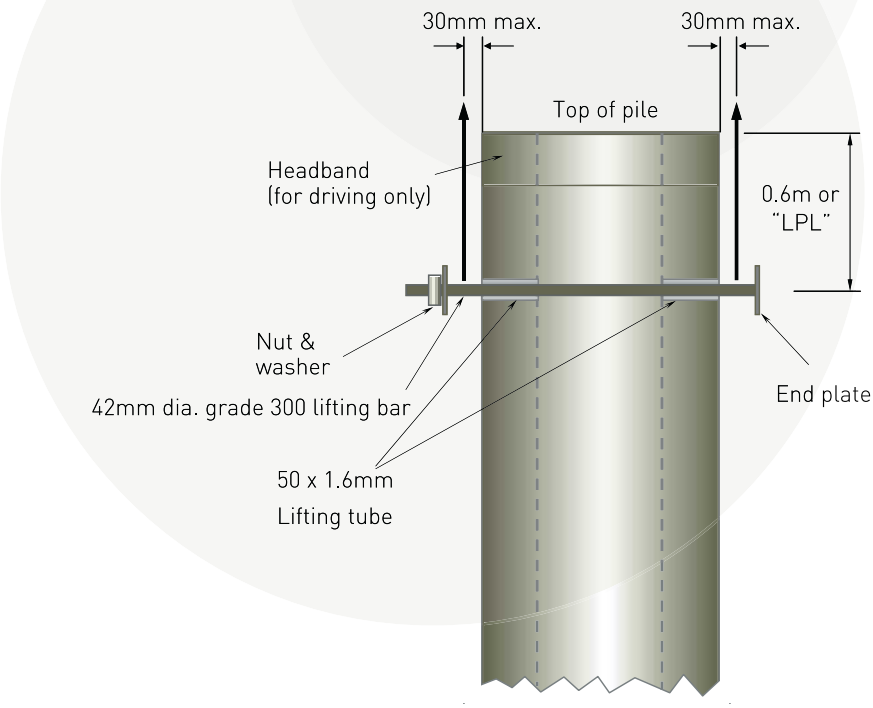
Lifting bar calculations assume the following: Single-point vertical lift of pile via chains or slings connected to lifting bar. Lifting bar passes through pile, within embedded lifting tube. Lifting chains or slings are attached to each end of bar. Maximum distance from pile surface to centre of lifting chain or sling = 30mm. Pile is lifted in slow and careful manner.

PILE HANDLING GUIDELINES

The lifting calculations assume the pile is lifted from a horizontal position, where it was supported by bearers on the ground. The pile is single-point lifted at LPL with the toe (butt end) bearing on the ground until the toe is lifted clear of the ground. These calculations apply to single-piece piles of uniform strength only. Jointed piles have not been considered. Moments induced by lifting are from pile mass only. No other attachments have been considered.

Calculations assume negative moment at lifting point and positive moment between lifting point and butt end reaction. Impact factor = 1.5.

The standard lifting point for all piles is 0.6m from the pile head. However, it may be necessary to lift the pile at the optional lifting point (0.3 x pile length) from the head for longer piles.



PILE SHEAR STRENGTH & STIFFNESS NOTES.

* Maximum internal diameter. Wall thickness may be greater than quoted.
** Design shear strength = phi x Vu.
Vu = Shear strength of pile based on Rocla in-house design. The shear strength values LLDS and LMS apply only to potted piles. For driven piles, the ULDS value applies over the entire length of the pile.
LMS = Length of maximum shear
ULDS = Upper level design shear strength. Applies over the upper portion of the pile, or L – LMS (where L = length of pile).
LLDS = Lower level design shear strength. Applies over the bottom length of maximum shear (LMS) of a pile.
If the pile length is less than LMS + 3m, the LLDS value will be valid for the full length of the pile.
The shear reinforcement extends 1.0m beyond the length LMS to ensure that the shear load acts within the strengthened area (allows for a pile diameter beyond the support point).

PILE SHEAR STRENGTH & STIFFNESS

Pile Type Diameter		Mass (kg/m)	Wall Thickness (mm)	Outside Diameter (mm)	Internal Diameter (mm)*	Shear Strength **			Stiffness (EI) (N.mm² x 10¹²)
						ULDS (kN)	LLDS (kN)	LMS (m)	
400mm	1	200	70	400	260	130	185	1.5	45
	2	205	70	400	260	130	185	1.5	45
	3	240	90	400	220	150	200	1.5	50
	4	220	75	400	250	135	190	2.0	50
	5	255	90	400	220	150	200	2.0	50
	6	290	100	400	200	160	210	2.5	55
450mm	1	230	70	450	310	155	210	1.5	70
	2	240	70	450	310	155	210	1.5	70
	3	280	90	450	270	180	240	1.5	75
	4	245	70	450	310	155	210	2.0	80
	5	260	75	450	300	160	220	2.5	75
	6	300	90	450	270	180	240	3.0	85
	7	345	100	450	250	190	250	3.5	95
585mm	1	315	70	585	445	220	300	1.5	170
	2	325	70	585	445	220	300	2.0	175
	3	340	70	585	445	220	300	3.0	180
	4	380	80	585	425	240	320	3.5	200
	5	390	80	585	425	240	320	4.0	205
	6	435	90	585	405	250	340	4.0	225
	7	450	90	585	405	250	340	4.5	235
	8	480	95	585	395	260	350	5.0	250

PILE LENGTH NOTES.

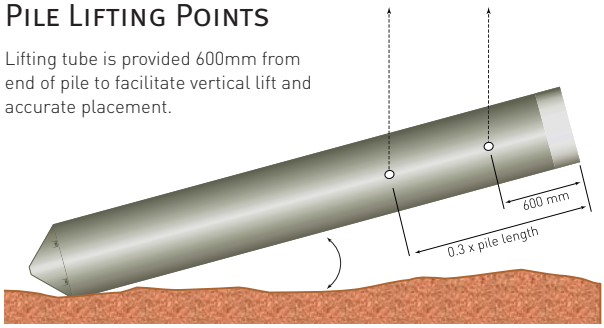
* LPL = Lifting point location (distance from pile head to lifting point). LPL = 0.6m facilitates a vertical lift and allows accurate placement.
** The lifting tube location (LPL) must be (0.3 x pile length) when the pile length exceeds the LPL = 0.6m pile limits shown in the table.

MAXIMUM PILE LENGTH FOR SINGLE POINT LIFT

Pile Type Diameter		Mass (kg/m)	Max. Pile Length (m) LPL = 0.6m*	Max. Pile Length (m) LPL = L x 03**
400mm	1	200	10.0	16.0
	2	205	12.5	20.0
	3	240	9.0	15.0
	4	220	14.0	23.0
	5	255	15.0	24.0
	6	290	16.0	24.0
450mm	1	230	10.0	16.0
	2	240	13.5	22.0
	3	280	10.5	17.0
	4	245	15.5	24.0
	5	260	17.0	24.0
	6	300	17.5	24.0
	7	345	18.0	24.0
585mm	1	315	12.0	19.5
	2	325	16.0	24.0
	3	340	18.5	24.0
	4	380	20.0	24.0
	5	390	22.0	24.0
	6	435	21.0	24.0
	7	450	22.5	24.0
	8	480	23.5	24.0

PILE LIFTING POINTS

Lifting tube is provided 600mm from end of pile to facilitate vertical lift and accurate placement.



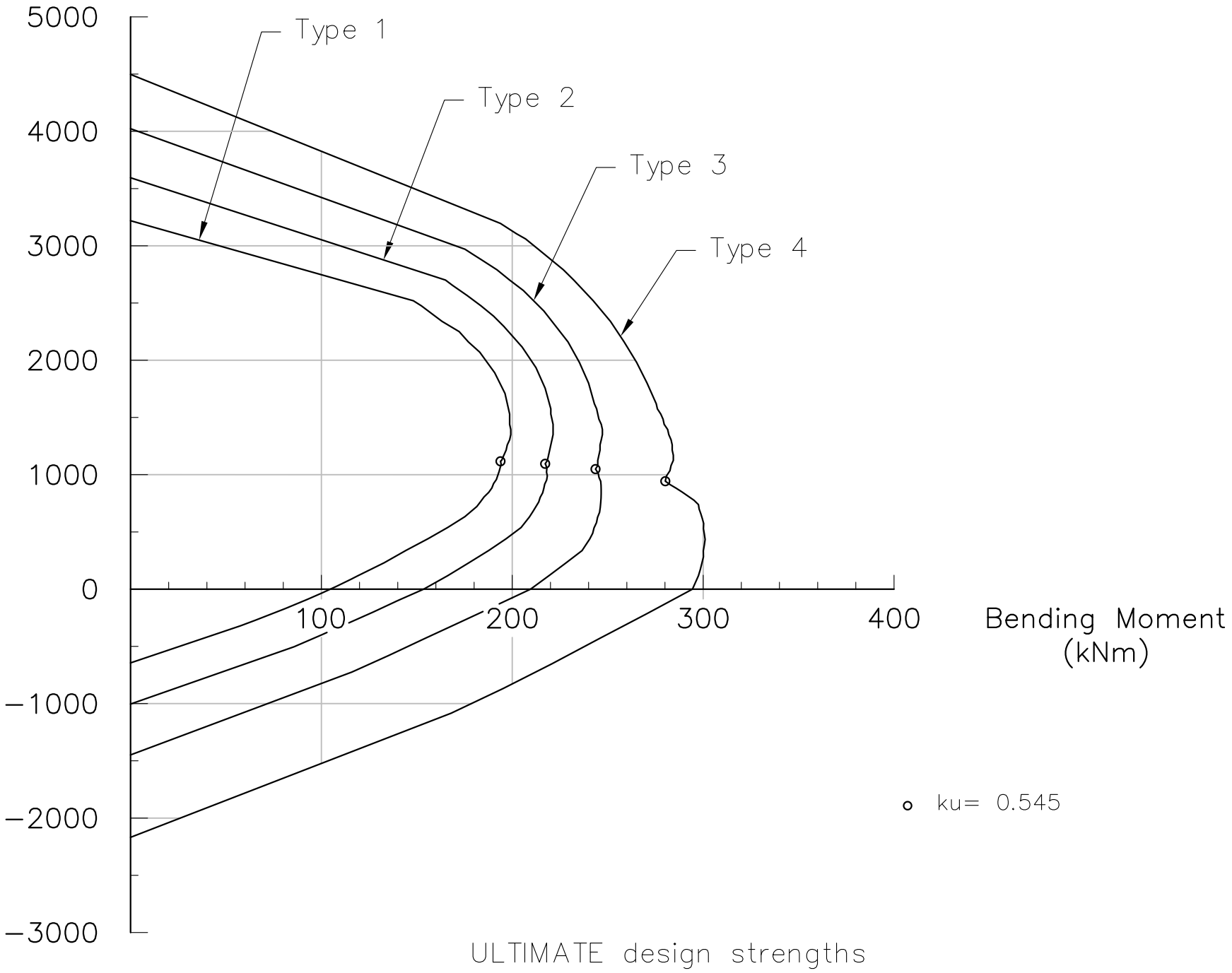
These strength interaction diagrams are based on AS5100.5–2017 and apply to Rocla hollow spun reinforced concrete Foundation Piles.

Pile outer diameter = 400 mm Spun concrete strength f'c = 80 MPa, min.

External cover to reinforcement = 25mm, min.

Pile wall thickness & reinf varies with Strength Type (see Sheet 2).

Strength Type	phi.Nuo kN	phi.Muo kNm	phi.Nub kN	phi.Mub kNm
1	3220	105	1115	194
2	3595	154	1095	217
3	4025	210	1050	244
4	4495	294	945	280



All dimensions in mm unless otherwise stated.

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A	SDJ	CC	Original Issue	10/12/20

APP	PJC	DATE	10/12/20
CKD	CC	DATE	10/12/20
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DRN	SDJ	DATE	10/12/20

400 dia Standard Foundation Pile Strength Interaction Diagrams AS5100.5–2017

REF	94374, 95010
JOB No.	20102801
SCALE	NTS
	P 96064 A
SHEET 1 OF 2	REV

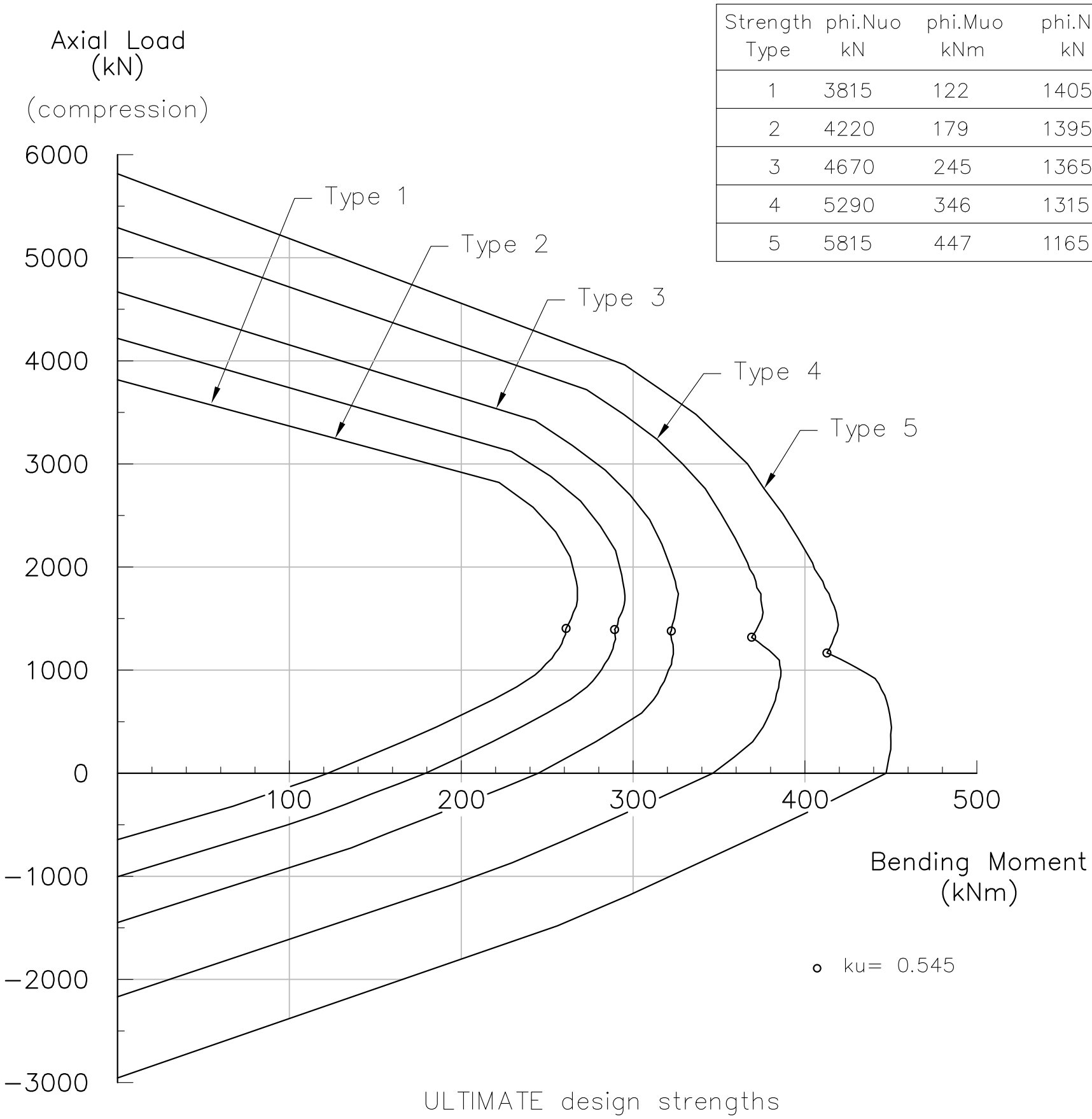
These strength interaction diagrams are based on AS5100.5–2017 and apply to Rocla hollow spun reinforced concrete Foundation Piles.

Pile outer diameter = 450 mm Spun concrete strength f'c = 80 MPa, min.

External cover to reinforcement = 25mm, min.

Pile wall thickness & reinf varies with Strength Type (see Sheet 2).

Strength Type	phi.Nuo kN	phi.Muo kNm	phi.Nub kN	phi.Mub kNm
1	3815	122	1405	261
2	4220	179	1395	289
3	4670	245	1365	322
4	5290	346	1315	369
5	5815	447	1165	413



All dimensions in mm unless otherwise stated.

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APP	PJC	DATE	10/12/20
CKD	CC	DATE	10/12/20
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DRN	SDJ	DATE	10/12/20

450 dia Standard Foundation Pile Strength Interaction Diagrams AS5100.5–2017

REF	94373, 95010
JOB No.	20102801
SCALE	NTS
	P 96063 A
SHEET 1 OF 2	REV

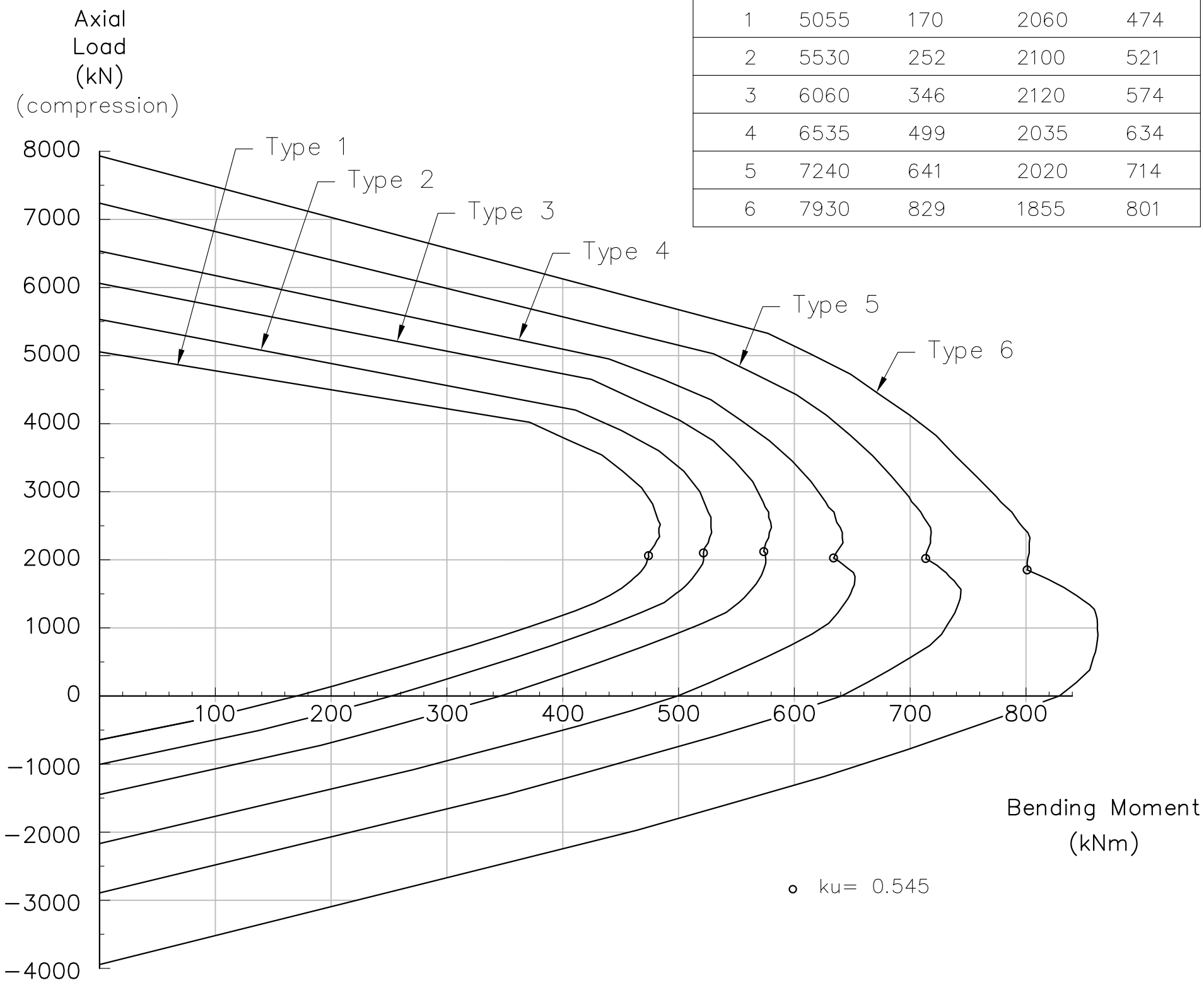
These strength interaction diagrams are based on AS5100.5–2017 and apply to Rocla hollow spun reinforced concrete Foundation Piles.

Pile outer diameter = 585 mm Spun concrete strength f'c = 80 MPa, min.

External cover to reinforcement = 25mm, min.

Pile wall thickness & reinf varies with Strength Type (see Sheet 2).

Strength Type	phi.Nuo kN	phi.Muo kNm	phi.Nub kN	phi.Mub kNm
1	5055	170	2060	474
2	5530	252	2100	521
3	6060	346	2120	574
4	6535	499	2035	634
5	7240	641	2020	714
6	7930	829	1855	801



ULTIMATE design strengths
(phi factored)

All dimensions in mm unless otherwise stated.

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APP	PJC	DATE	10/12/20
CKD	CC	DATE	10/12/20
DES	SDJ	DATE	10/12/20
DRN	SDJ	DATE	10/12/20

585 dia
Standard Foundation Pile
Strength Interaction Diagrams
AS5100.5–2017

REF	94151, 95016
JOB No.	20102801
SCALE	NTS
	P 96053 A
SHEET 1 OF 2	REV

Rocla Pile Driving Energy

For ‘drop-hammer’ driven piles, the hammer mass multiplied by the drop height is the ‘delivered energy’ or ‘driving energy’. As there are energy losses in the driving process, the energy transferred to the pile is less than the delivered energy. Mathematically:

‘delivered energy’ = ‘loss factor’ x ‘driving energy’

The ‘loss factor’ is dependent upon the type of driving rig, the type and thickness of packing and other factors controlled by the pile driving operator. A good loss factor is typically in the range 0.8 to 0.7.

For standard 350 diameter or larger Rocla spun concrete piles:

The ‘maximum recommended driving energy’ is 4 tonne.m for piles driven with a 5 tonne hammer (800mm nominal drop height).

The ‘maximum recommended driving energy’ is 5 tonne.m for piles driven with a 7 tonne hammer (700mm nominal drop height).

Notes:

The above MRDE values are based on piles having a minimum spun concrete compressive strength = 65 MPa. If piles have not developed this strength at the time of driving, adopt the following MRDE values:

For a 5 tonne hammer:				For a 7 tonne hammer:			
Concrete strength (MPa)	65	50	40	Concrete strength (MPa)	65	50	40
MRDE (adopt) (tonne.m)	4.0	3.1	2.5	MRDE (adopt) (tonne.m)	5.0	3.8	3.1

If pile concrete compressive strength is unknown, contact Rocla for advice.
Do not drive piles with a compressive strength under 40MPa.

Maximum driving energy should only be applicable when piles are reaching ‘practical refusal’ or near the required ‘set’.

The hammer mass should be similar to the pile mass.
A heavier hammer provides better driving.
Shorter drop-heights are less likely to damage the pile.

Refer to Rocla drawing 91958 Sheets c1 and a2 for recommended helmet and packing requirements when driving Rocla spun Foundation piles.

February 2017

DRIVING REQUIREMENTS FOR ROCLA FOUNDATION PILES

Rocla produce hollow spun concrete piles. Refer to 'Duraspun Concrete Piles' Technical Manual for handling and installation information.

Diagram 1 shows a typical steel helmet and packing arrangement used to drive spun concrete piles. The actual arrangement used is the choice and responsibility of the piling contractor.

The force from driving needs to be passed uniformly into the pile. The 'drive plate' must be sufficiently stiff to transmit the driving force from the hammer uniformly into the walls of the annular pile. Uneven or excessive local stresses may crack and/or spall the pile concrete.

The hammer and drive cap diameter should be similar in outer diameter to the pile to help achieve an even pile loading. The drive cap may comprise of steel or a suitable plastic.

If the packing material consists of plyboard, then 3No 25mm thick plyboards should be used: 1No hardwood beneath 2No softwood boards. These plyboards must be replaced regularly to avoid damage to the pile head. Accurate cutting of plyboards (plyboard diam = pile diam – 10mm) helps prevent local pile head damage and deliver a uniform force to the pile.

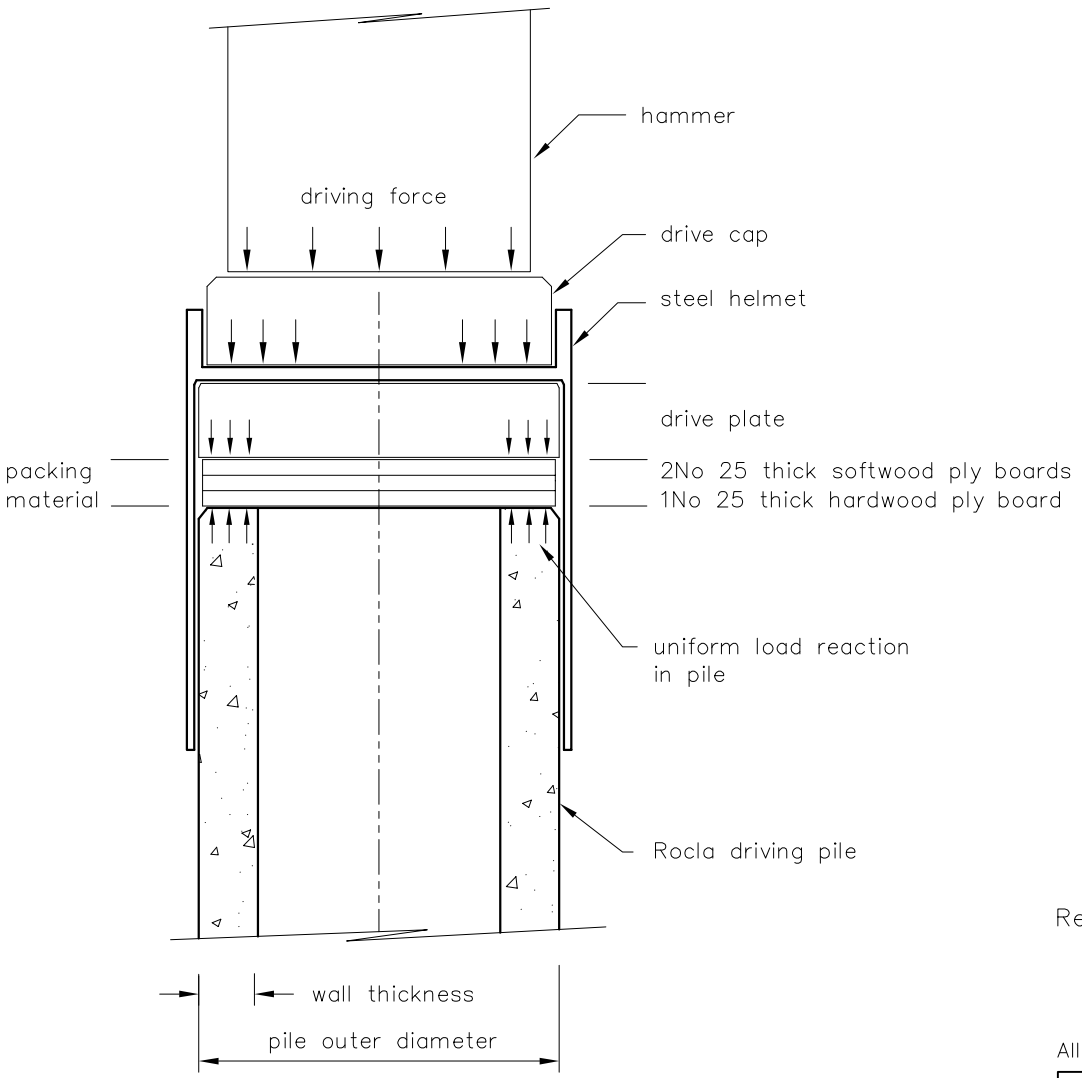

Diagram 1

Typical helmet and packing arrangement for Rocla spun driving piles

Refer to Sheet 2 for piles with joint studs at the pile head

All dimensions in mm unless otherwise stated.

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REV	DRN	CKD	DESCRIPTION	DATE
C	JG	CC	Notes changed and Sheet 2 added	01/10/12
B	CC	CC	Note Changes	15/07/08
A	CC	CC	Original Issue	15/07/08

APP	PJC	DATE	15/07/08
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DES	CC	DATE	15/07/08
DRN	CC	DATE	15/07/08

Pile Driving Helmet
& Packing Requirements
Rocla Spun Foundation Piles

REF	
JOB No.	
SCALE	NTS
	P 91958 C
SHEET	1 OF 2 REV

For further information on Rocla Duraspun® power, lighting, communication and CCTV poles, or foundation and marine piles or building columns, contact Rocla at :

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