REINFORCING SOLUTIONS

REIDBAR™ DESIGN GUIDE

2015 EDITION

reid™

REINFORCING • PRECAST • TILT-UP

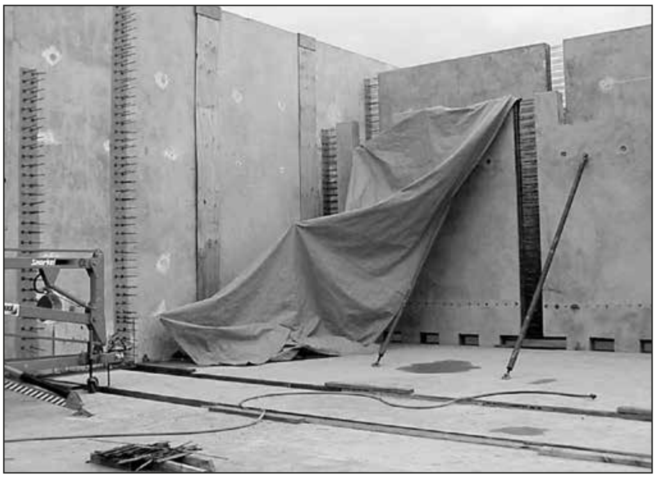
CONTENTS

ReidBar™ Systems are revolutionising construction

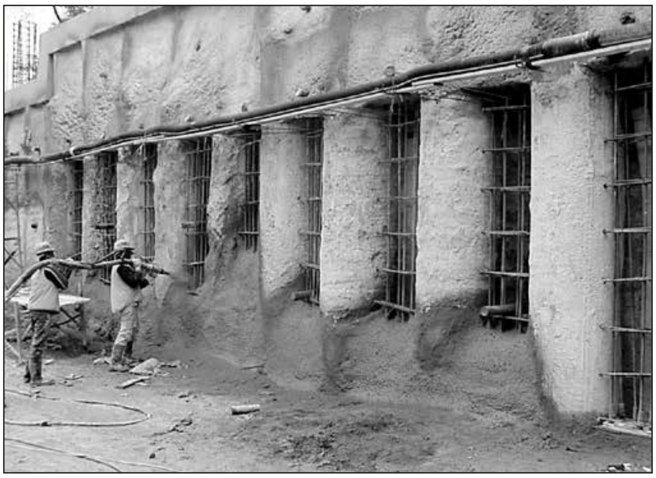
ReidBar™ is a reinforcing bar that can be cut at any point along its length and screwed into one of a number of threaded components. This unique feature enables an entirely new approach to reinforcement placing and fixing.

ReidBar™ threaded reinforcing provides simple solutions for construction problems, reducing both labour and material costs.

Using ReidBar™ grouters and couplers each floor of this building took only three days to construct. This grouting method provides continuity in reinforcement.



RB12 threaded inserts anchoring starter bars at a new water treatment facility.



RB25 couplers providing anchorage for wall steel between columns.

Structural connections using RB32 couplers in bridge construction.

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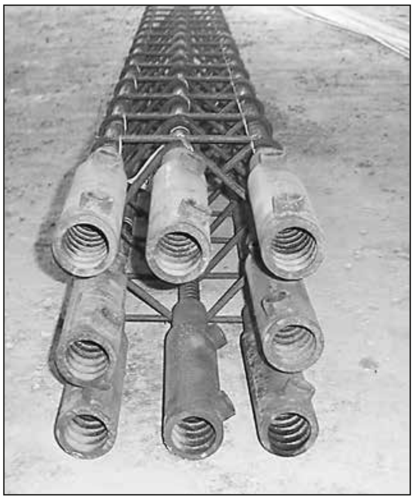
APPLICATION EXAMPLES

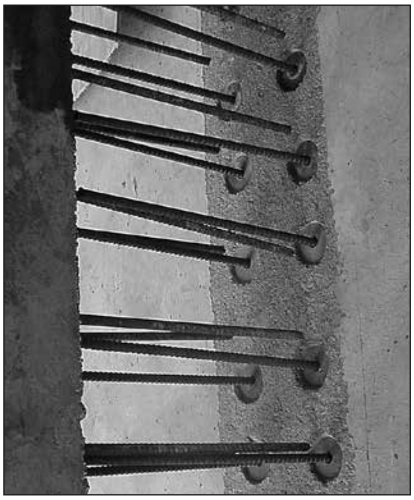
More detail on ReidBar™ components can be found on product specific technical datasheets available from Reid™. They can also be downloaded from www.reid.com.au.

Reinforcing



ReidBar™ Grouters

A grouted method of providing a continuous connection for ReidBar™ in precast panels and structural elements.



ReidBar™ Inserts

A screw-in method of connecting starter bars for stronger structural connections between panels.

Cathodic Protection & Earthing

ReidBar™ can be used for grounding of lightning strikes and cathodic protection from stray electric currents.

Couplers

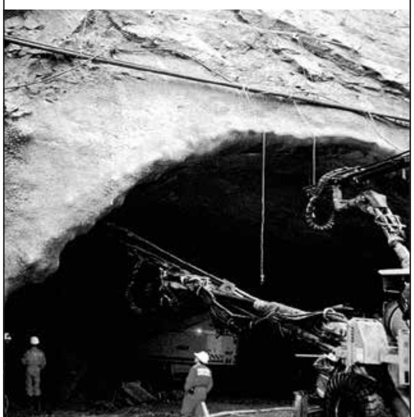
A threaded method of providing continuity in reinforcement.

Bridge Strengthening Retrofit

Rock & Soil Support

Soil Nails/Anchors

Used to provide soil stabilisation in earthwork construction.



Rockbolts – Mining

Used for rock stabilisation in mining and civil construction.

Fastening

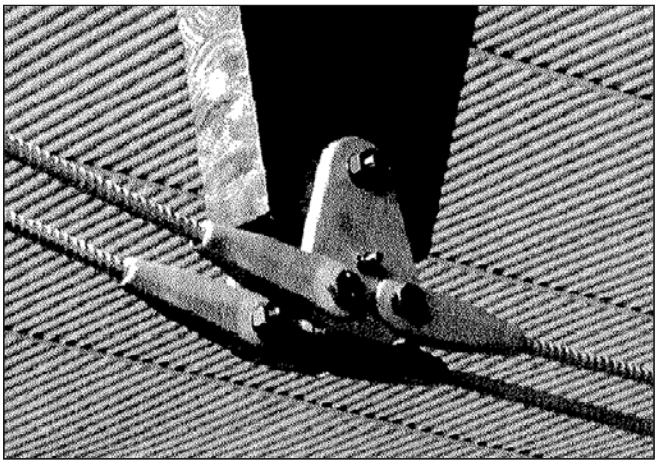
Hold Down Bolts

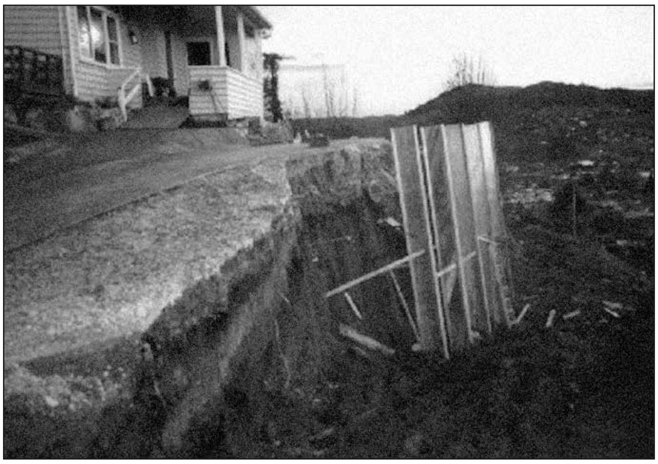
Fastening of structural elements using the ReidBar™ threaded nut systems.

Bracing

Can be used to provide bracing and stabilising of any structure. Ideal retrofit to improve the performance of existing structures.

Bracing

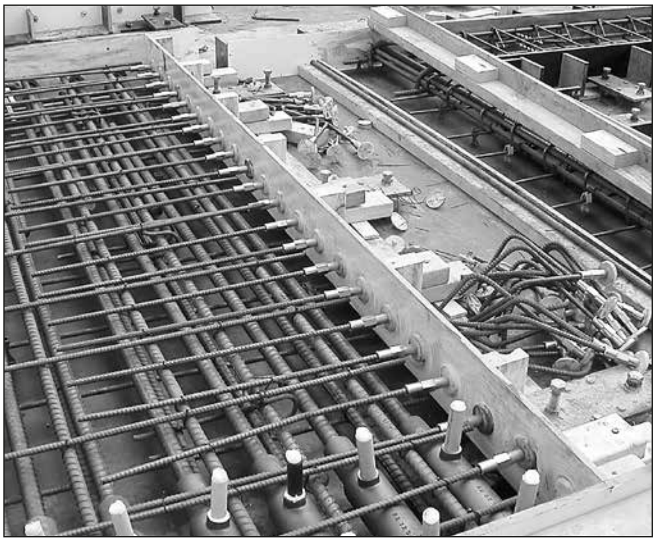




Tie backs for retaining walls

3.1 Features and Benefits

- A continuously threaded, hot rolled, Grade 500 reinforcing bar that can be cut along its length, then simply joined end to end by a coupler. This unique feature enables an entirely new approach to reinforcement placing and fixing.
- Improved structural integrity. Ductility can be guaranteed at all column/beam/slab joints.
- Ultimate strength development is possible with short embedment depths.
- Suitable for very thin concrete sections, such as wall panels.
- Provides simple solutions for construction problems, reducing both labour and material costs.
- Increases productivity on site.
- Full range of threaded fittings for joining, anchoring and terminating.
- Simplifies the detailing and fixing of rebar.
- Economical to splice the bar without specialised splicing equipment.
- Reduces bar congestion problems; laps, cogs, eliminated in heavily reinforced areas.
- Eliminates cast-in starter bars to simplify transport and handling.
- Easy to provide anchorage for starter bars for in-situ concrete pours.
- Eliminates the need to drill holes in formwork and shutters for starter bars.
- Offcuts have many other uses and the ability to join shorter lengths reduces wastage.



“Bridge to Nowhere” - precast bridge can be bolted together with virtually no ‘on site’ concrete.

Retaining walls constructed from the top down.

3.2 ReidBar™ Specifications and Sizes

Bar Diameter (mm)	Grade	Nom Thread Pitch (mm)	Characteristic Values				Mass (kg/m)	Nom Area (mm²)	Min Hole Dia. to Pass Bar (mm)	Part No
			Min Yield Stress (MPa)	Min Yield Strength (kN)	Min Ultimate Strength (kN)	Min Shear (.62 min ult)				
12	500E	8	500	56.5	61.0	37.8	0.91	113	15	RB12
16	500N	9	500	100.6	108.5	67.3	1.62	201	20	RBA16
20	500N	10	500	157.0	169.6	105.2	2.53	314	24	RBA20
25	500N	12.9	500	245.5	265.1	164.4	3.95	491	29	RB25
32	500N	16.4	500	402.0	434.2	269.2	6.47	804	38	RB32

AS/NZS4671:2001 defines the characteristic value as that value which has a 95% probability that it will not be lower than 95% of the minimum listed value, and not be higher than 105% above the upper listed value.

Note: In the table above and subsequent tables Char Min = Characteristic Minimum, Char Max = Characteristic Maximum.

For applicable capacity reduction factors, please refer to AS3600: 2009

Youngs modulus (E) is nominally 200GPa.

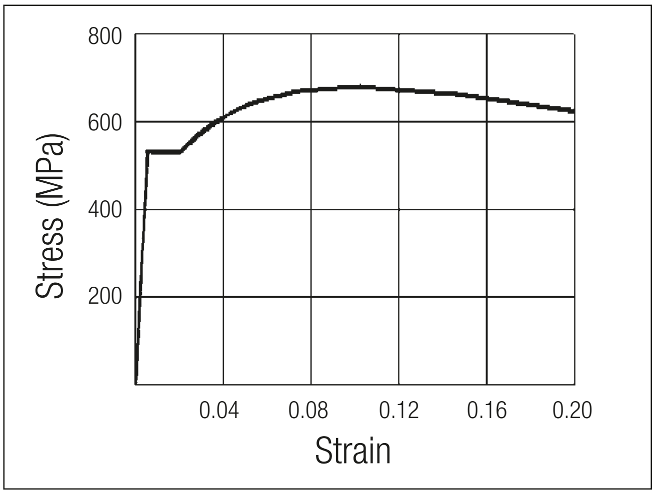
ReidBar™ is manufactured in both New Zealand and Australia and satisfies the requirements of the standard for "Steel Reinforcing Materials, AS/NZS4671:2001". The bars are hot rolled with the deformations forming a continuous right hand thread.

RB12 ReidBar™ is manufactured in New Zealand and is micro alloyed, 500E grade. RBA16 to RB32 ReidBar™ is manufactured in Australia using the TEMPCORE process.

Reidbar™ is a part of a proprietary system using a range of fittings to simplify reinforcement detailing.

With the exception of formwork fittings and the 32mm ReidBrace™ system, all Reidbar™ system fittings develop the breaking strength of Reidbar™. This is defined as 1.08 x 500MPa = 540MPa in the Reidbar™.

Typical Characteristics



3.3 Anchoring in Concrete

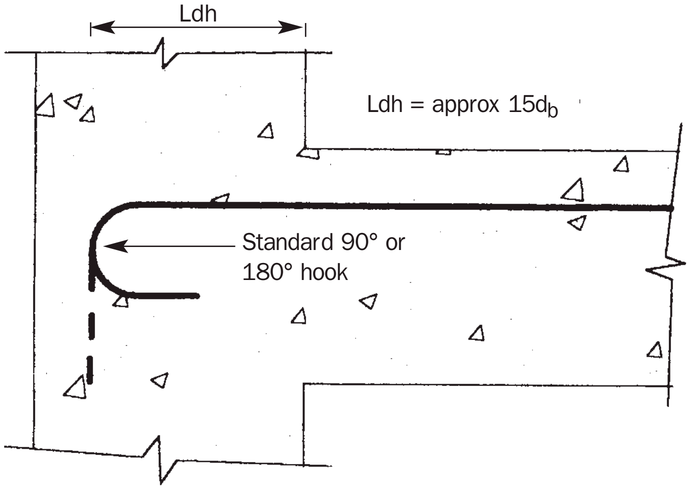
ReidBar™ Inserts overcome the under strength and slip deflection problems caused by using bent bars or hooked bars. Concrete design codes specify that a minimum length from the back of the bend to the critical surface is to be $\mathbf{L_{dh}}$ in order to be fully effective as flexural reinforcement.

As designers and constructors become more familiar with the use of tilt-up and precast methods normal conservatism can be pushed to the limit. This is especially true with the current trend towards increasingly slimmer wall panels where the provision of an effective base anchorage for cantilever action is still required. Although bent bars are still widely used for this function it is not always possible to meet code requirements for minimum anchorage length in thin panels.

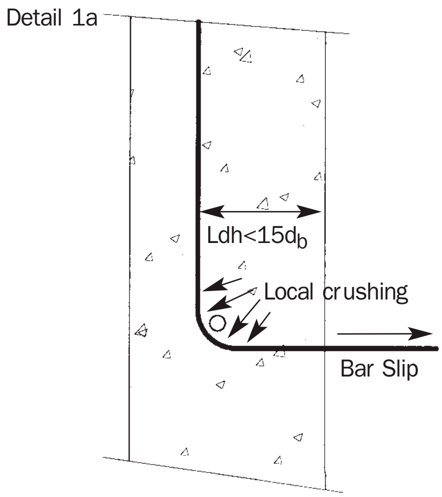
Hooked or bent Grade 500 rebars require an embedment depth of $\mathbf{L_{dh}}$ if they are to meet concrete design standards and are to be fully effective as flexural reinforcement.

This is often not possible in thin structural panels.

Also refer AS3600:2009, Clause 8.1.10 for minimum detailing requirements of flexural reinforcement and tendons.



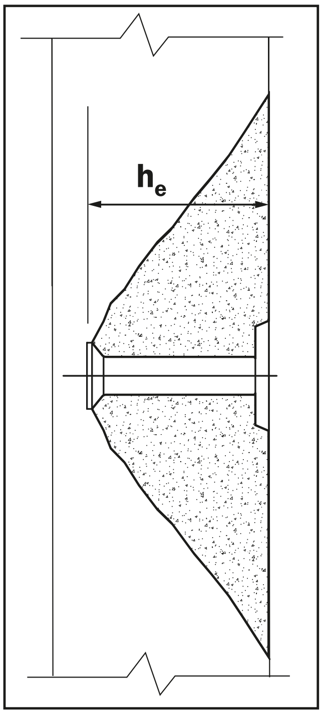
Standard 90° or 180° hook



Common starter detail in a thin panel where embedment lengths may not meet code requirements.

Research at New Zealand University of Auckland by Maureen Ma in 1999 into Methods of Joining Precast Concrete components to form Structural Walls highlighted the performance of Reid™ Inserts compared to that of conventional hooked bar construction. Apart from requiring significantly less embedment to develop the full capacity of the reinforcing bar, ReidBar™ Inserts effectively remove the issue of localised concrete crushing.

Threaded Insert effective depth h_e.



3.3 Anchoring in Concrete *(continued)*

Predicted Performance of ReidBar™ Inserts used in connections such as:

- Wall / Floor
- Core Wall / Shear Wall Joints
- Core Wall / Stair Landings
- Slab / Slab

Insert	Embedment, mm (inc 8mm nailing plate)	Insert Ultimate Steel Tensile Capacity N_{us} (kN)	Ultimate Concrete Capacity, N_{uc} (kN)			ReidBar™ Mechanical Properties		
			32MPa	40MPa	50MPa	Min Yield F_{sy} (kN)	Min Ultimate F_{su} (kN)	Min Shear V_{su} (kN)
RB12TI	108	>61	107	124	144	56.5	61.0	37.8
RBA16TI	126	>109	157	182	211	100.6	108.5	67.3
RBA20TI	156	>170	234	272	315	157.0	169.6	105.2
RB25TI	199	>266	379	440	510	245.5	265.1	164.4
RB32TI	218	>435	469	544	632	402.0	434.2	269.2

(All values derived through extensive testing of Reidbar™ inserts and like products in unreinforced concrete)
For applicable capacity reduction factors, please refer to AS3600: 2009

Depth, Edge Distance Effects

The design strength of the concrete anchoring system is dependent on many factors. The four most critical are:

1. The compressive strength of the concrete.

2. The depth of the anchor.

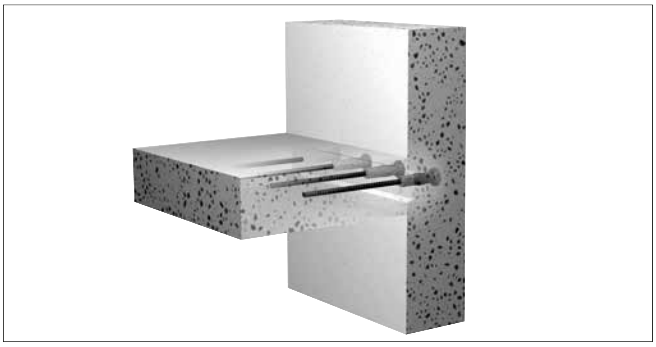
ReidBar™ Inserts are developed to provide sufficient embedment to develop the Min. ultimate steel tensile capacity of the bar in 32MPa concrete.

3. Minimum edge distances

The designer shall take into account edge distances. Refer to Appendix A for a detailed process to calculate Isolated Direct Tension and Shear Capacity.

4. Spacing effects (end/internal of a row)

The designer shall take into account spacing effects. Refer to Appendix A for a detailed process to calculate Isolated Direct Tension and Shear Capacity.



For capacity reduction factors and ReidBar™ performance information on moment connections, please refer the application to your local Reid™ engineer.

ReidBar™ Inserts installed in the ReidBox rebate former

For further information on the ReidBar™ system for Slab to Wall connections, please refer to:

Patrick, M / Wheeler, A / Gonzales, A / Marsden, W

Innovative Testing Procedures for a High-Performance, Pre-formed Mechanical Connection System between Concrete Slabs and Walls, Proceedings Concrete 05, Concrete Institute of Australia, 2005

3.4 Starter Bar Systems

ReidBar™ starter bar systems have been developed to provide full strength and positive connections between precast concrete panels, floor slabs and insitu suspended floors. The system comprises ReidBar™ Threaded Inserts, ReidBar™ Starter Bars, specially designed Placement Chairs, Nailing Plates and Antenna Caps.

Whatever the method used, ReidBar™ starter bar systems offer strength, stability, price effectiveness and ease of operation that you just don't get with standard NBar starter bars.

Features:

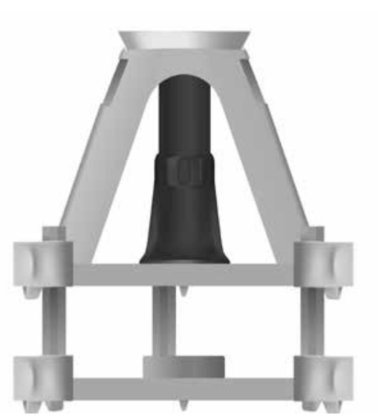
- Available in all diameters – off the shelf.
- Thread diameter is true to size – not a N20 bar turned down to a M16 thread.
- Coarse thread on the bar resists damage and minimises foreign materials blocking the threads of the cast-in ReidBar™ insert.
- Coarse thread results in speed of application when screwing the Insert and starter together.
- System components are purpose designed and offer speed of set up and installation either in the precast yard or on site.
- Non standard lengths are easily catered for as starter bars are cut from standard 6 or 12 metre lengths of threaded reinforcing bar.

Comparison Table

ReidBar™ Starter Bars vs N-bar Starter Bars

Bar Size	Grade MPa	Metric Thread	Nominal Area (mm²)	f_{sy} (kN)	Limit state strength ø f_{sy} (kN)
N12	500	M10	58	21.8	17.4
RB12	**500**	**RB12**	**113.1**	**56.5**	**45.2**
N16	500	M12	84.3	31.6	25.3
RBA16	**500**	**RB16**	**201**	**100.5**	**80.4**
N20	500	M16	157	58.9	47.1
RBA20	**500**	**RB20**	**314**	**157.1**	**125.7**
N24	500	M20	245	91.9	73.5
RB25	**500**	**RB25**	**491**	**245.5**	**196.4**

System Components



Placement Chair
(Suits 125mm to 200mm panels)

Antenna Cap

ReidBar™ Insert

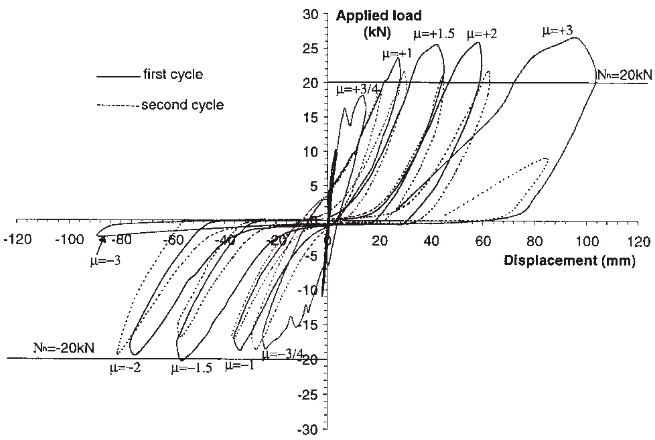
Nailing Plate

Starter Bar

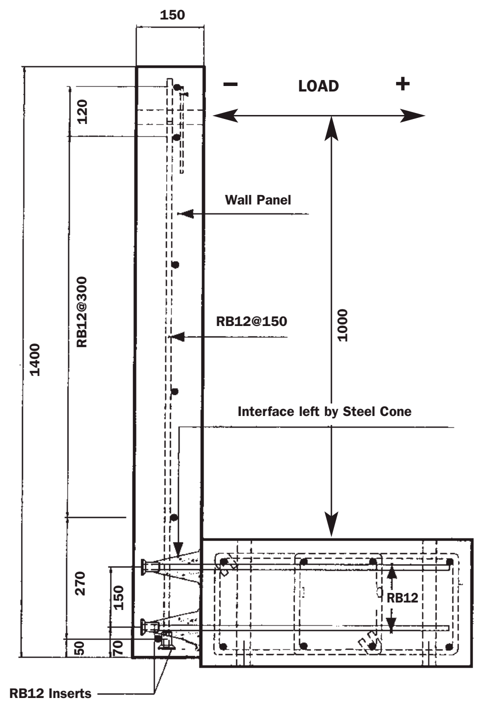
3.5 Performance Comparisons

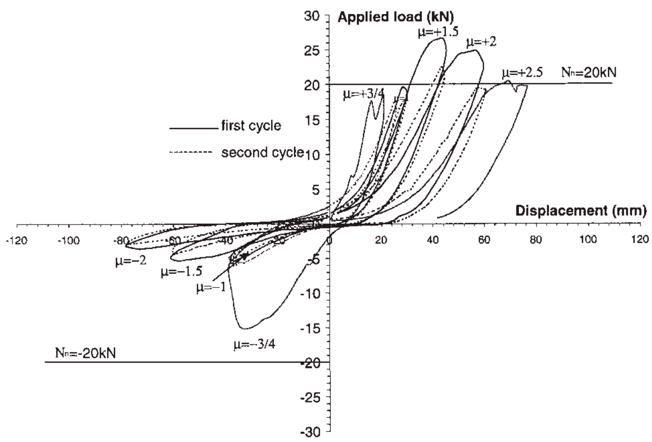
Compare the performance of a ReidBar™ Anchorage

Tests carried out on like products out at Auckland University show that a cantilevered wall connection using ReidBar™ anchored with ReidBar™ Inserts will significantly out perform the common hooked bar detail in thin panels.

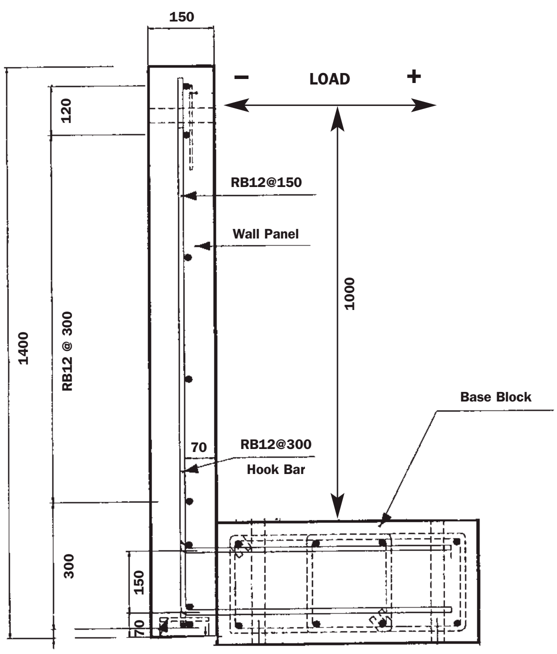


Applied Load vs Displacement at the Load Point
RB12 INSERTS



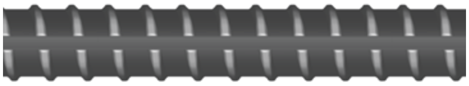


Applied Load vs Displacement at the Load Point
RB12 BENT STARTERS



3.6 ReidBar™ Components

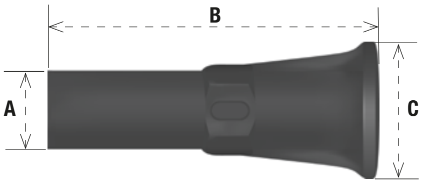
ReidBar™ Starters



Pre-cut bar connections for fast full strength reinforcing.
Grade 500N bar to AS4671:2001

Bar Type	Length (mm)	Min Yield (kN)	Part No
RB12	540	56.5	RB12SB
RBA16	660	100.6	RBA16SB
RBA20	850	157.0	RBA20SB
RB25	1150	245.5	RB25SB
RB32	1450	402.0	RB32SB

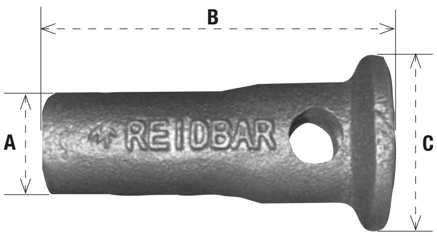
ReidBar™ Insert



Suits	Char. Strength (kN)	(A) Body Dia. (mm)	(B) Length (mm)	(C) Foot Dia. (mm)	Threaded Depth (mm)	Part No
RB12	>61	22	100	38	53	RB12TI
RBA16	>109	30	118	50	47	RBA16TI
RBA20	>170	35	148	64	60	RBA20TI
RB25	>266	43	191	80	78	RB25TI
RB32	>435	55	210	101	102	RB32TI

Also available galvanised.

ReidBar™ Rebate Inserts™



Designed to be used in thin walled panels and panels with rebates, where standard ReidBar™ Inserts will not fit.

Includes a cross hole to suit N12 bar.

Suits	Char. Strength (kN)	(A) Body Dia. (mm)	(B) Length (mm)	(C) Foot Dia. (mm)	Threaded Depth (mm)	Cross Hole Dia. (mm)	Part No
RB12	>61	22	78	39	53	14.5	RB12RI
RBA16	>109	30	96	51	47	14.5	RBA16RI

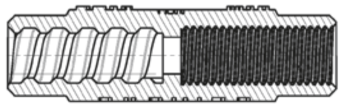
Note: Designed to be used with minimum 25mm rebate to achieve similar performance as Reidbar™ Insert. Refer to part number RB12TI and RBA16TI.

ReidBar™ Coupler

Suits	Char. Strength (kN)	Length (mm)	Hex A/F (mm)	Hex A/C (mm)	Body OD (mm)	Thread Depth (mm)	Part No
RB12	>61	90	25	29	22	43	RB12C
RBA16	>109	102	30	34	30	47	RBA16C
RBA20	>170	129	36	42	33	55	RBA20C
RB25	>266	180	45	52	43	87	RB25C
RB32	>435	210	57	66	55	102	RB32C

Also available galvanised.

ReidBar™ To Metric Coupler™



Suits	Char. Strength (kN)	Length (mm)	Hex A/F (mm)	Hex A/C (mm)	Thread Length (mm)	Part No
RB12 / M16	>61	90	25	29	40	RB12M16C
RBA16 / M20	>109	102	30	34	45	RBA16M20C
RBA20 / M24	>170	119	38	43	45	RBA20M24CG*

Also available galvanised. *RBA20M24CG only available galvanised.

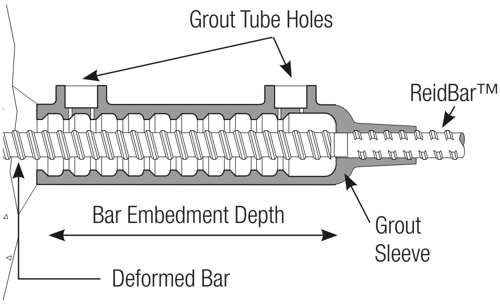
ReidBar™ Nut

Suits	Char. Strength (kN)	Length (mm)	Hex A/F (mm)	Hex A/C (mm)	Part No
RB12	>61	40	25	25	RB12N
RBA16	>109	45	30	34	RBA16N
RBA20	>170	45	36	42	RBA20N*
RB25	>266	65	46	53	RB25N
RB32	>435	82	55	63.5	RB32N

Also available galvanised.

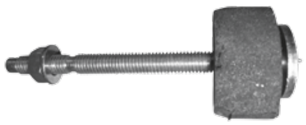
3.6 ReidBar™ Components *(continued)*

ReidBar™ Grouter



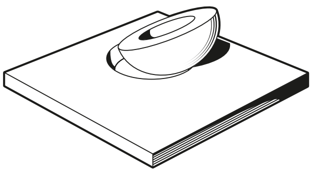
Suits	Overall Length (mm)	Thread Depth (mm)	Body ID (mm)	Body OD (mm)	Non Grout Vol (ml)	Bar Embedment Min (mm)	Bar Embedment Max (mm)	Grout Hole Dia. (mm)	Part No
RB12	200	45	28-40	58-46	200	110	150	21	RB12GS
RBA16	240	47	32	50	200	140	190	21	RBA16GS
RBA20	290	55	40	60	350	174	224	21	RBA20GS
RB25	360	78	48	70	550	234	274	21	RB25GS
RB32	445	109	55	75	746	280	320	26	RB32GS

ReidBar™ Grouter Setting Hardware



Suits	Thread Length (mm)	Thread Diameter	Rubber Plug OD (mm)	Part No
RB12	80	M8	48 - 36	RB12GSSET
RB16	80	M8	32 also fits RB32C	RB16GSSET
RB20	80	M8	40	RB20GSSET
RB25	80	M8	48	RB25GSSET
RB32	80	M8	55	RB32GSSET

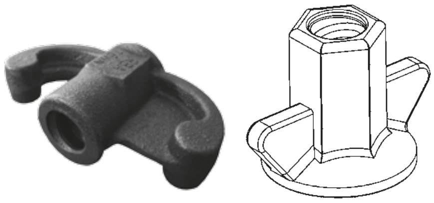
ReidBar™ Domed Base Plates & Spherical Washers



Suits	Description	Dimensions (mm)	Part No
RBA16 / RBA20	Base Plate	100 x 100 x 6.3 x 14 high	BPLATE20100G
	Spherical Washer	50 OD x 24 ID x 18 thick	RBA20SWG
RB25 / RB32	Base Plate	150 x 150 x 10 x 24 high	BPLATE32150G
	Spherical Washer	70 OD x 37 ID x 24 thick	RB32SWG

Available galvanised only.

ReidBar™ Wing Nut



Suits	Hex AF	Height (mm)	Overall Dia. (mm)	Part No
RB12	22	40	58	RB12WN
RBA16	30	51	98	RBA16WN

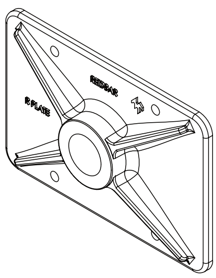
Nail Plate

Suits	Overall Diameter	Indent Thickness (mm)	Part No
RB12	59mm	8	NP12RB
RBA16	59mm	8	NP16RB
RBA20	59mm	8	NP20RB
RB25	59mm	8	NP25RB
RB32	59mm	8	NP32RB

ReidBar™ Insert Chair

Suits Panel Thickness (mm)	Part No
125 - 200	TICHAIR

ReidBar™ Plate (Formwork Accessory)

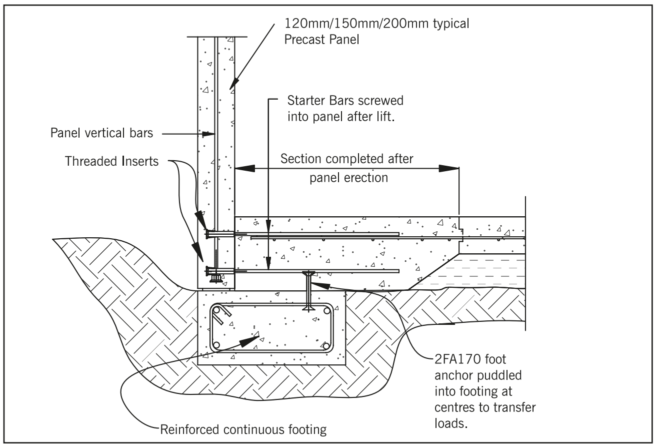


Suits	Dimensions	Part No.
RB12 - RB20	150 x 100 x 6, 24ø hole	RPLATE

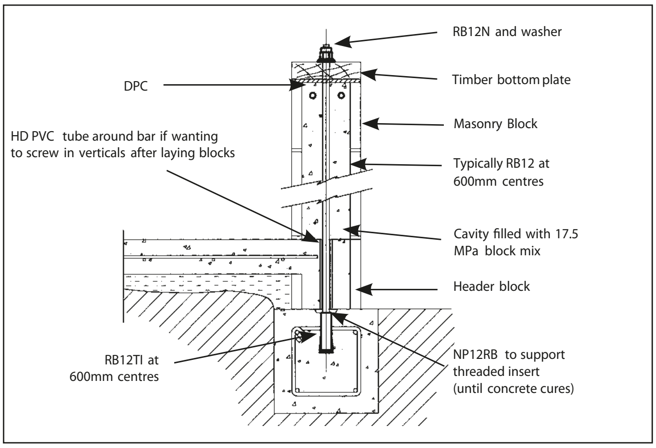
3.7 Typical Construction Details

The typical construction details are examples only. All details should be designed and checked by a suitably qualified engineer to ensure the detail is fit for the purpose it is intended.

Typical cantilevered footing detail

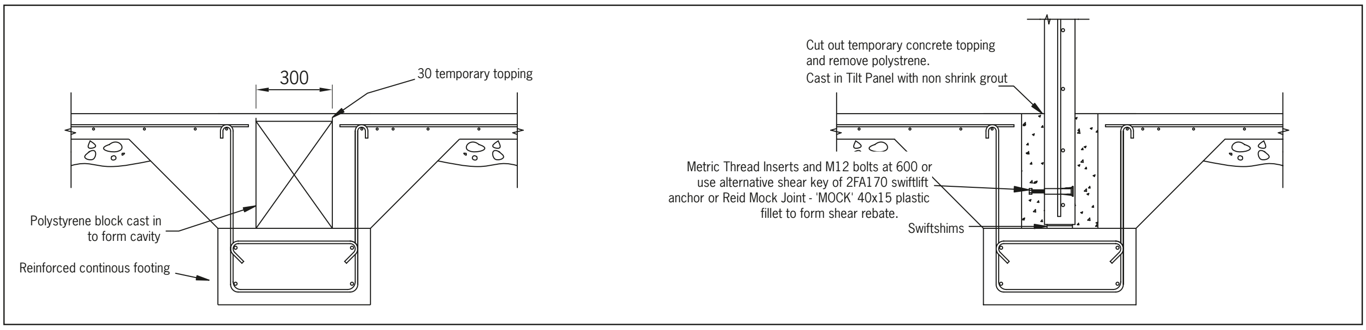


Domestic basement wall - Using masonry construction

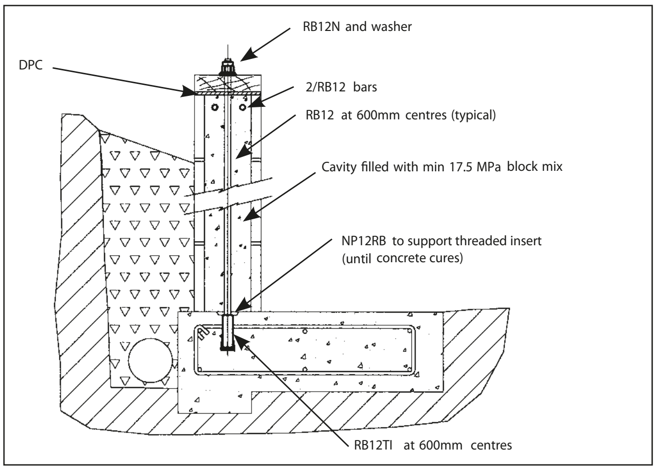


Wall may be dry stacked and post tensioned with ReidBar™. Refer to your Reid™ Engineering Team

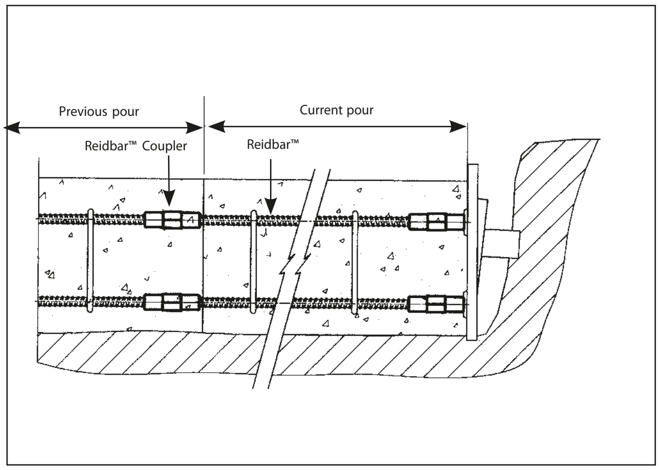
Cantilevered party wall - Footing detail



Common retaining wall footing



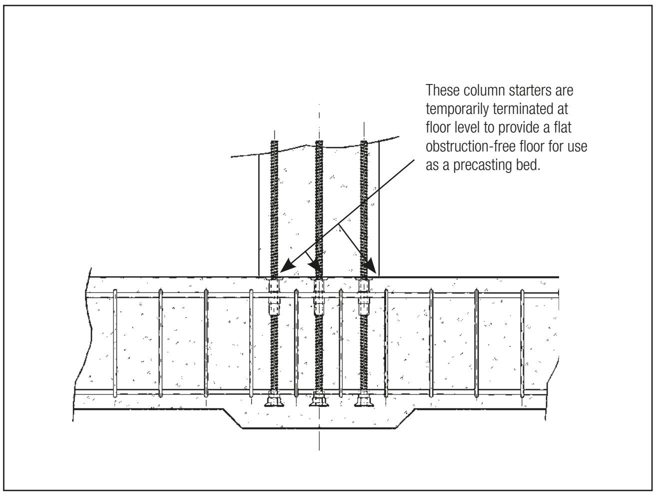
Strip foundation in unstable ground



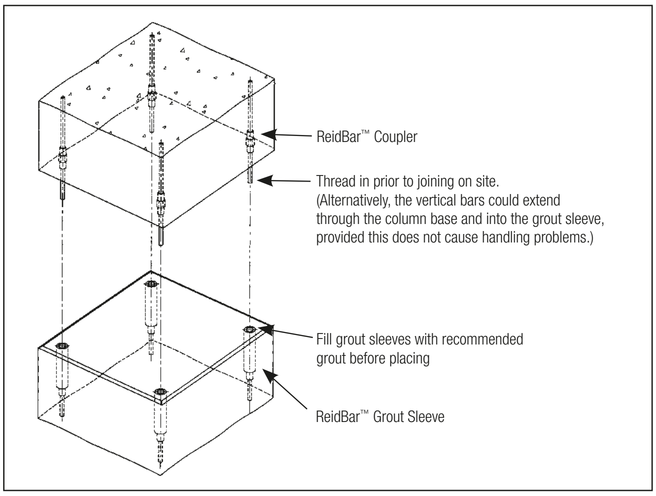
3.7 Typical Construction Details *(continued)*

The typical construction details are examples only. All details should be designed and checked by a suitably qualified engineer to ensure the detail is fit for the purpose it is intended.

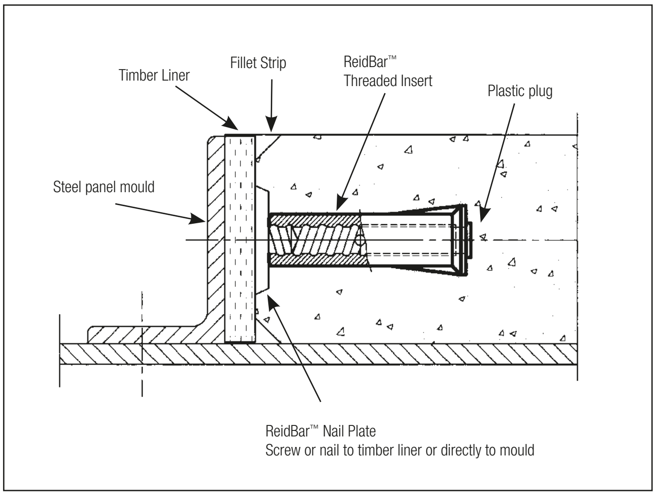
Anchorage for column starters



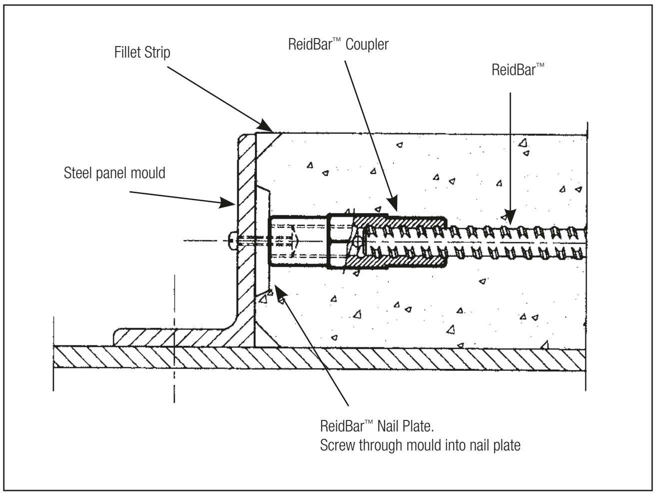
Pre-cast column elements



Threaded insert to edge of precast panel

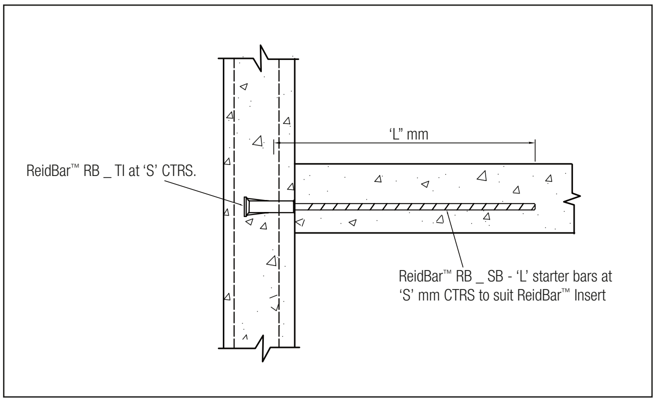


Strip foundation in unstable ground

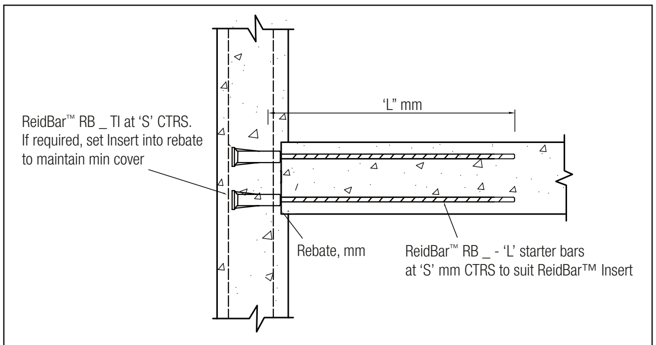


Always ensure that the coupler is firmly screwed onto nail plate.
Nail plates WILL NOT support foot traffic.
Support the bar close to the coupler.

Typical slab to insitu wall detail - Single Row



Typical slab to insitu wall detail - Double Row

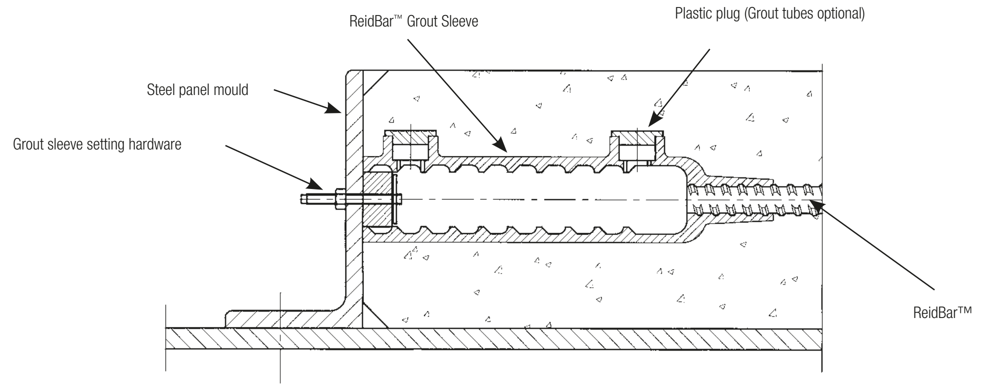


Reid™ offers various rebate solutions to fix and locate Inserts to suit all construction methods. Please contact Reid™ for more information.

3.7 Typical Construction Details *(continued)*

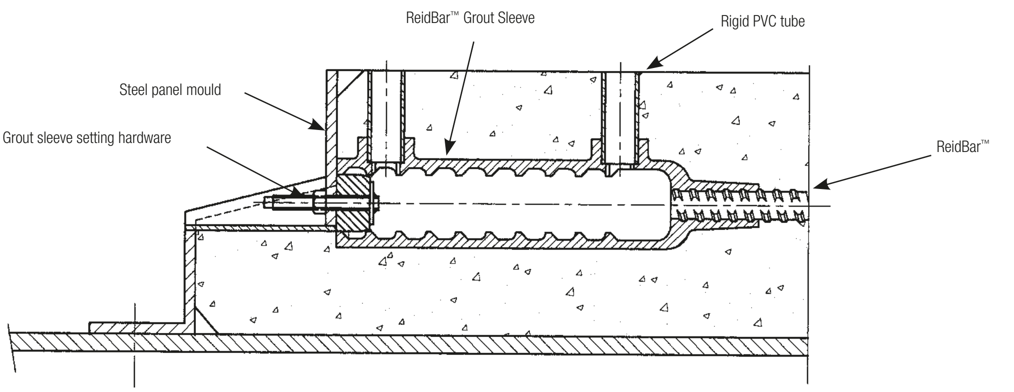
The typical construction details are examples only. All details should be designed and checked by a suitably qualified engineer to ensure the detail is fit for the purpose it is intended.

Grout sleeve to edge of precast panel



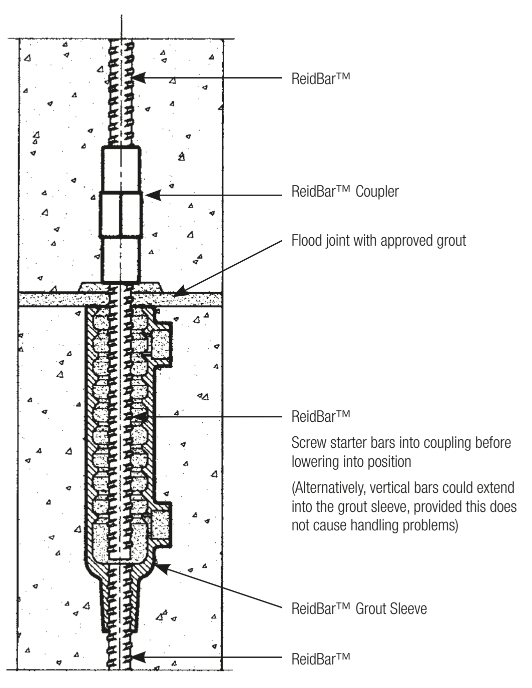
Setting Hardware WILL NOT support foot traffic. Support the bar close to the grout sleeve.

Grout sleeve to edge of rebated precast panel

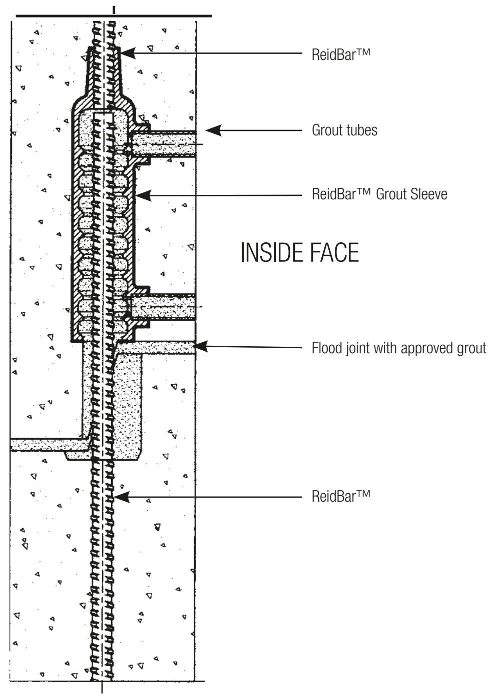


Setting Hardware WILL NOT support foot traffic. Support the bar close to the grout sleeve.

Horizontal structural joint for two precast panels



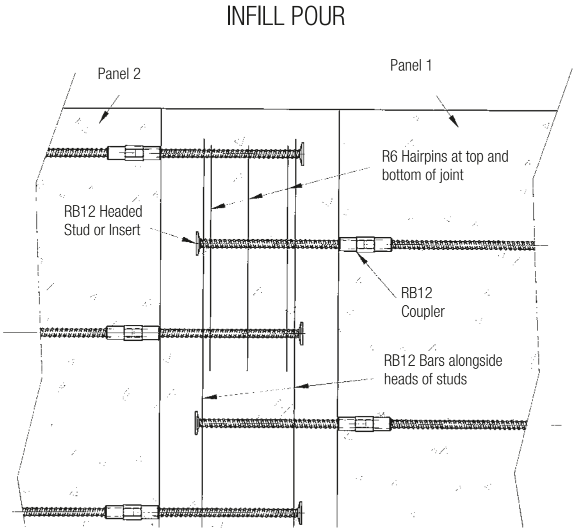
Horizontal structural joint for rebated precast panels



3.7 Typical Construction Details *(continued)*

The typical construction details are examples only. All details should be designed and checked by a suitably qualified engineer to ensure the detail is fit for the purpose it is intended.

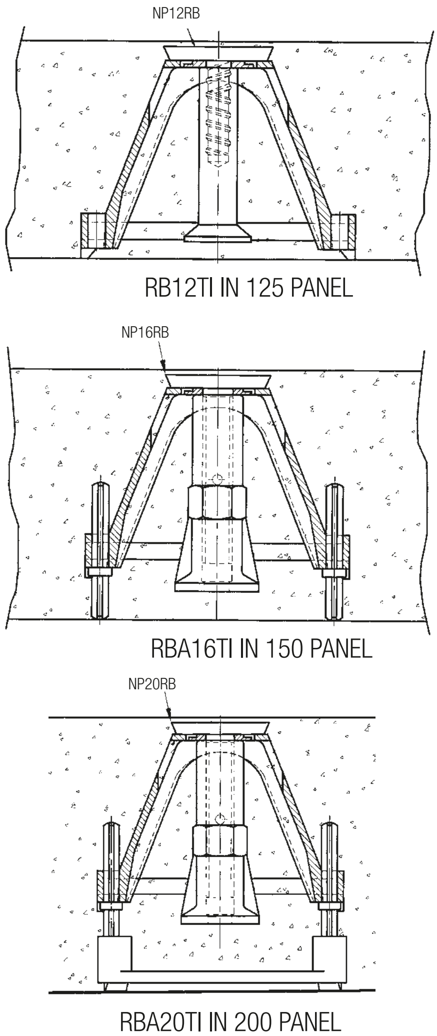
Typical Shear Wall Connection



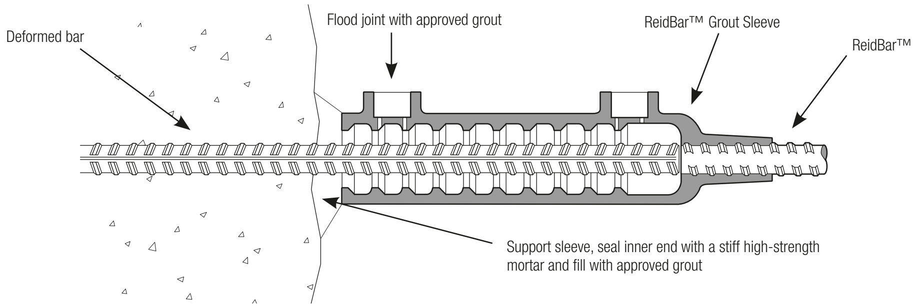
Tests on the arrangement detailed have shown that Reid™ headed studs will transfer the shear stress across a joint better than conventional hairpins of an equivalent steel area.

Small hairpins at the upper and lower ends of the joint add to the confinement and help to control local deformation at ultimate loads.

Threaded Insert to Face of Precast Panel

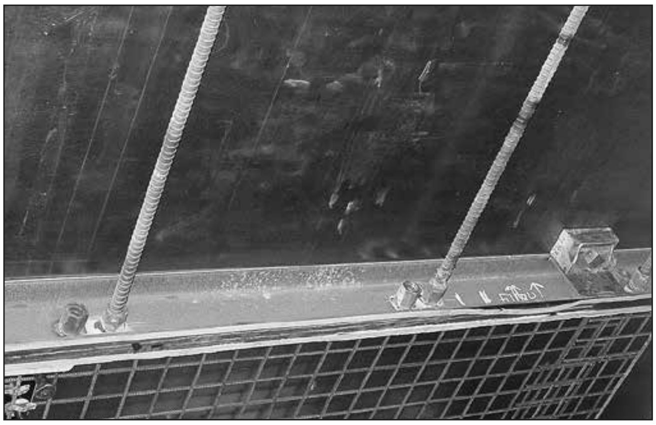


Joining ReidBar™ to Deformed Bar



4.1 Features and Benefits

- ReidBar™ is ductile and can accept tensile loads and shear loads.
- Makes an ideal anchor for jump forms without the risk of unexpected shear failure.
- Robust thread is resistant to damage.
- Can be cut and spliced along its length.
- Reliable mechanical properties.
- Offcuts can be used for formwork and starter bars. Waste is eliminated.
- Simple to install, reusable and recoverable.
- A complete range of fittings available for all applications.
- Simple splicing and installation of anchorage components.
- Standard stock lengths may be stored and cut to suit the application.



4.2 Specifications and Capacity

Capacity for grade 500 ReidBar™ Formwork Systems.

Bar Dia. (mm)	Grade	Char Min Yield Strength (kN)	Char Min Ult Strength (kN)	Capacity Tension Min Ult x 0.6 (kN)	Capacity Shear Min Ult 0.62 x 0.6 (kN)	Part No
12	500E	56.5	61	36	22	RB12
16	500N	100.6	108.5	65	40	RBA16
20	500N	157.0	169.6	102	63	RBA20

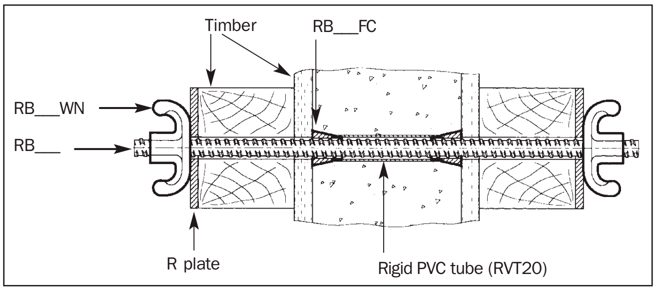
Based on Capacity Reduction Factors in AS3600: 2009, Table 2.2.2 (i)

4.3 Typical Construction Details

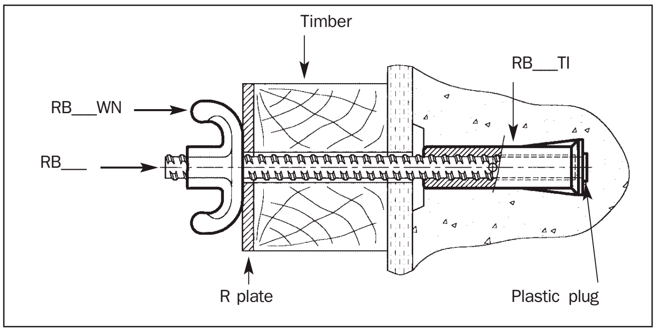
Recoverable form tie rods

The most commonly specified ReidBar™ systems are assembled from ReidBar™ tie rods, wing nuts, removable cones and plastic tube spacers.

Securing formwork with threaded insert



Securing formwork with threaded insert



5 SOIL AND ROCK ANCHORING

5.1 Features and Benefits

- ReidBar™ has closely defined mechanical properties in accordance with AS/NZS 4671: 2001
- Unlike strand tendons the solid anchors have no constructional losses.
- Supplied in the hot rolled condition which is effectively stress-free.
- The high ductility and smooth, relatively flat rate of strain hardening ensures a high margin of safety against tensile/shear overload in the case of transverse movements in the rock or soil.
- Preloading to the full working load ensures that the load transmitted to the anchorage medium (rock or soil) is constant i.e. live loads have minimal transmission to the anchorage medium.
- Rugged thread is resistant to damage.
- Simplicity in applying the prestress with jacks, torque wrenches or air operated tools.
- Recoverable anchors may be removed to simplify later excavations.
- The rigidity of the anchors makes them easy to install especially in overhead applications.
- High shear bond as deformations are designed for shear interlock with concrete or resin.
- Transmits the anchor forces efficiently to the grout body without additional fittings.
- Standard stock lengths may be stored and cut to suit the application.
- Offcut bars may be used for all standard concrete reinforcement applications in the construction site whilst small pieces are ideal for formwork, starter bars or hangers in underground works.
- Can be cut and spliced at any point along its length.

5.2 Specifications and Working Loads

Mechanical properties and working loads for grade 500 ReidBar™.

Bar Diameter (mm)	Grade	Char Yield Stress (MPa)	Char Min Yield Strength (kN)	Char Min Ult Strength (kN)	Char Min Shear .62 min Ult (kN)	Max Tensile Working Load (kN)*	Part No
12	500E	500	56.5	61.0	37.8	39	RB12
16	500N	500	100.6	108.5	67.3	70	RBA16
20	500N	500	157.0	169.6	105.2	109	RBA20
25	500N	500	245.5	265.1	164.4	171	RB25
32	500N	500	402.0	434.2	269.2	281	RB32

For applicable capacity reduction factors, please refer to relevant standard
* Working Load assumes a capacity reduction factor of 0.70

5.3 Anchorage with Cement Grout

Rock Anchors

Rock anchors have traditionally been grouted with cement grouts. The ultimate strength of an anchor in sound competent rock is dependent on many factors. Among the more important of these is the unit bond stress capacity of the rock/grout interface, the unit bond stress capacity of the bar/grout interface, the length of the anchor and the consequences of failure.

The capacity of the cement grout to both bond to and protect the bar as well as to bond with the substrate is largely dependent on the water cement ratio.

“The bond and shear characteristics of a cement grout are also determined largely by the water cement ratio. The ideal water cement ratio lies in the range 0.35 to 0.4 (Hyett et al., 1992). Cement grouts above 0.4 will cure with excessive micro porosity and grouts below 0.35 could be difficult to pump and may be susceptible to void forming and incomplete wetting of the strata.”

Rock/Grout Interface

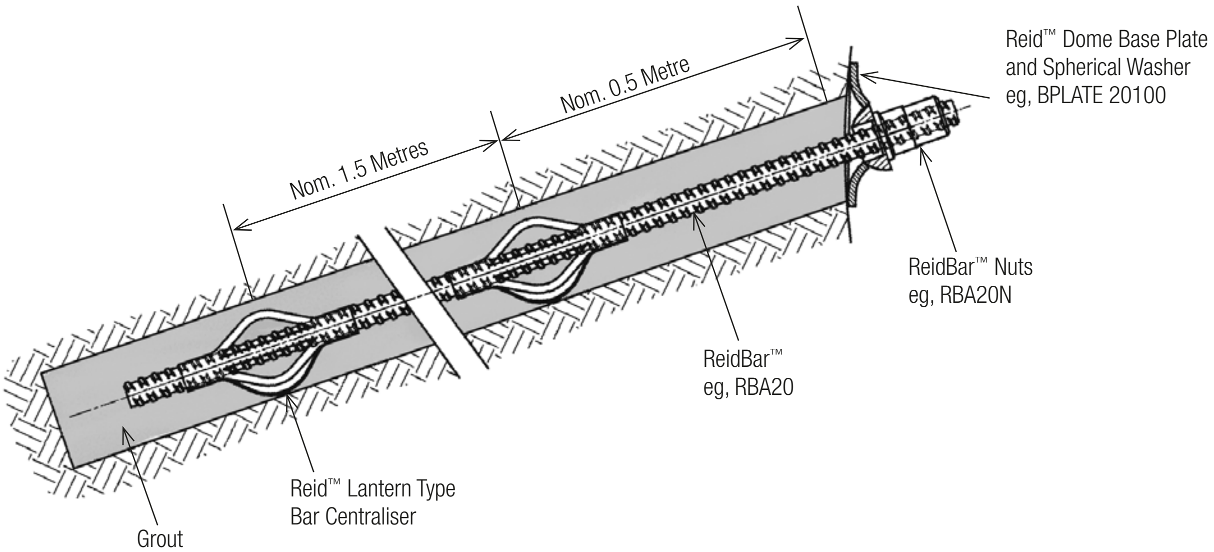
The rock/grout interface is subject to so many vagaries that the choice of a suitable bond stress value is often difficult.

As a general guide the ultimate bond stress for competent rock can be taken as 10% of uniaxial compressive stress (where the uniaxial compressive strength is above 20MPa and the bond stress is limited to a max of 4.2MPa) (after Littlejohn and Bruce 1977).

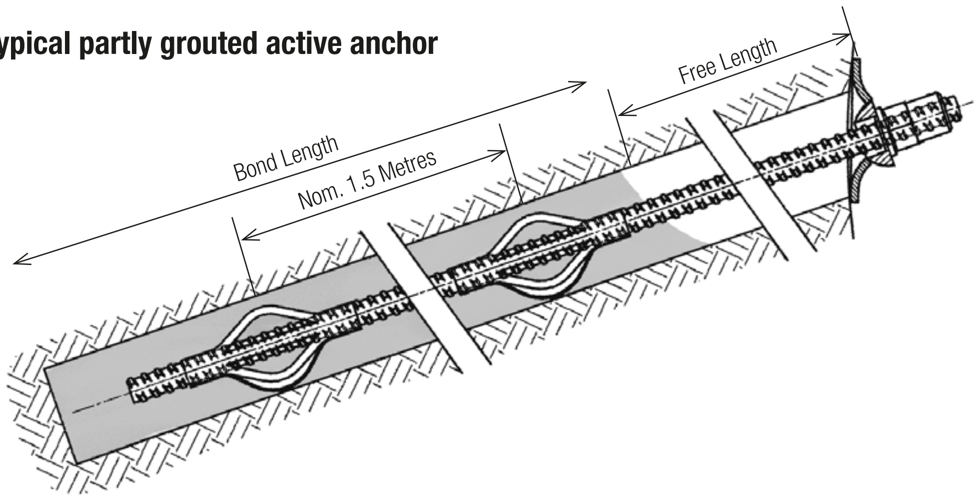
Test bores will give a guide to the initial selection but on site proof load tests are always advisable. The ability of rock to adequately confine the grout column reduces as the anchor length decreases below 1 metre (after Morris and Sharp 1973).

Typical fully grouted passive soil nail

To position bar centrally in drilled holes a Bar Centraliser is used.



Typical partly grouted active anchor



The free length is commonly grouted after the anchor has been stressed. Alternatively the free length can be sleeved during installation and the anchor grouted up to the surface. This effectively removes the bond over the free length allowing it to preload during the subsequent stressing operation.

6.1 ReidBrace™ Bracing and Tie System

The ReidBrace™ System provides an economic solution for bracing structures and tie-back applications.

Typical applications include:

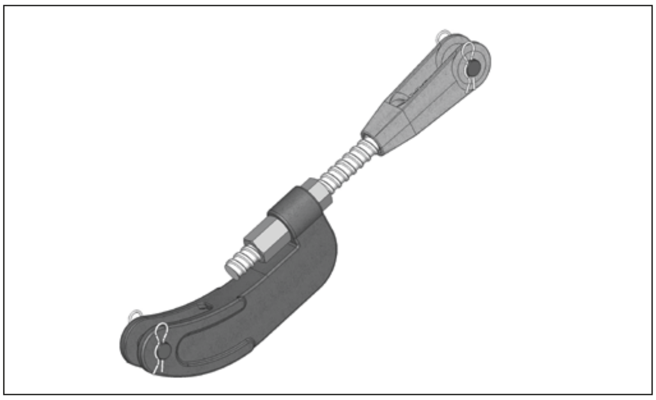
- Wall and roof bracing
- Retro fitted bracing
- Retaining wall tie backs
- Cross ties

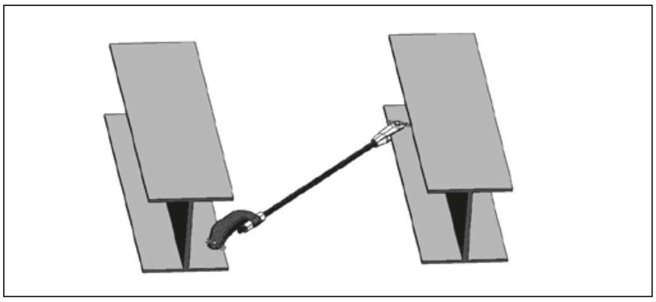
Features & Benefits

- Eliminates expensive threaded rods. ReidBrace™ uses grade 500 ReidBar™ for tendon.
- Eliminates welding and threading. ReidBar™ comes in standard lengths black or galvanised bar and can be joined using standard couplers and locking nuts. (Longer ReidBar™ lengths by order.)
- Over length bar can be cut without dismantling the bracing assembly.
- Substantial cost savings in labour and materials.
- All components sold separately.
- Engineered design, tested and certified to exceed minimum UTS of the 500 Grade ReidBar.™ *
- Clevis End designed to fit over structural steel flanges to provide double shear connection with grade 8.8 steel pin.

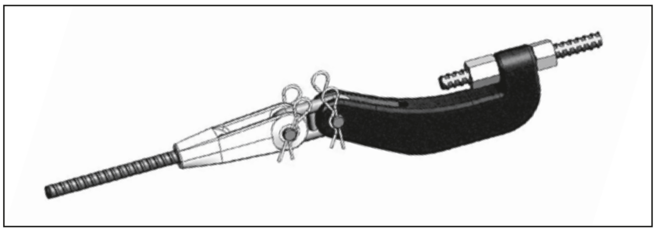
* with exception of the 32mm ReidBrace™ system

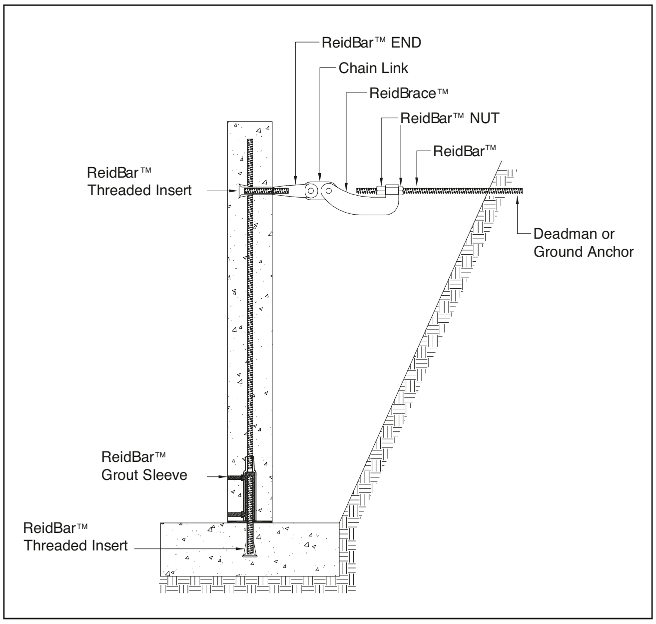
Bracing System





Tie System

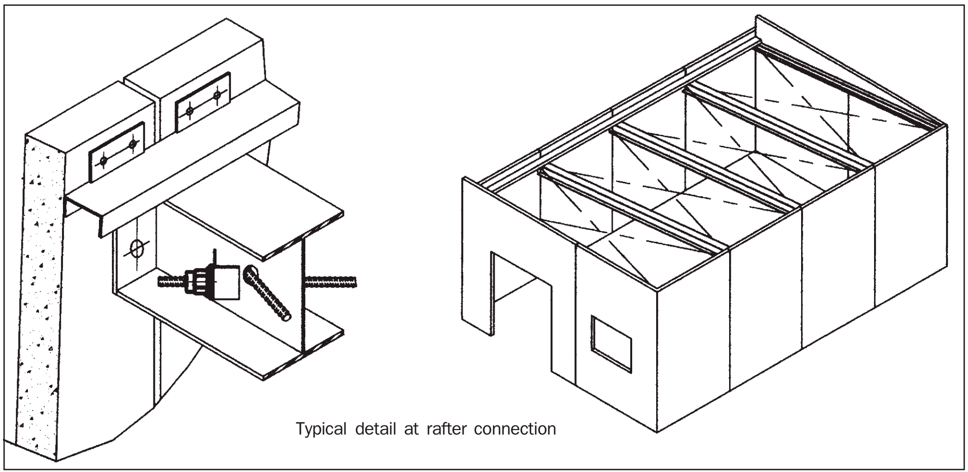


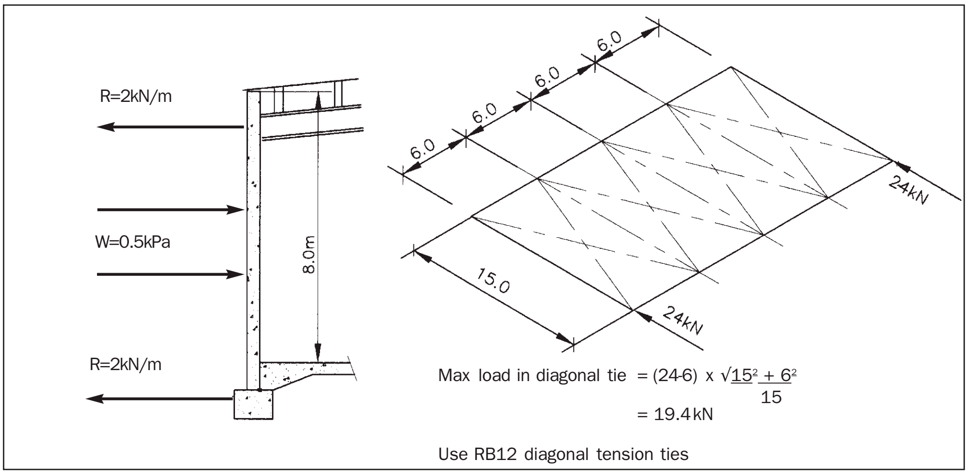


6.2 ReidBar™ for Wind Bracing

ReidBar™ is ideal for use as wind bracing in all types of building construction. Because the bar is threaded along its full length it overcomes the problems of having to prefabricate conventional tie bars and site weld anchorage cleats to close tolerances.

Example:
A tilt-up building wall resists lateral wind/seismic loads by means of a cantilevered footing and an in-plane truss at roof level.





6.3 Tie Down Bars

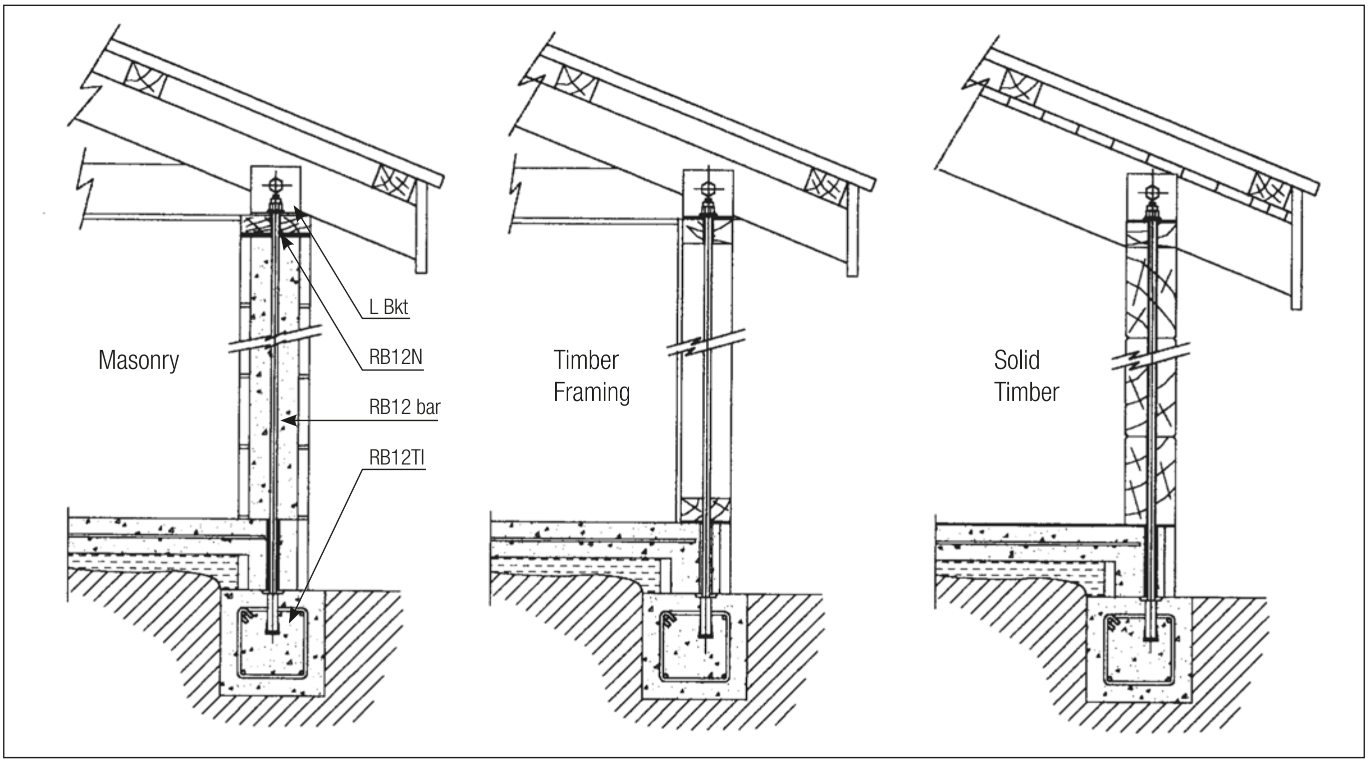
ReidBar™ is ideal for tie-down bars for lightweight masonry, brick, steel framed, timber framed or solid timber structures.

In extreme wind conditions such as Northern Australia or New Zealand Alpine regions, 12mm ReidBar™ (RB12) may be used for cyclone tiedowns for many types of building construction.

Designers can simply and economically provide a continuous tie from the building footing to roof truss that can even be post tensioned to improve the structural performance of the wall unit.

Post tensioning wall ties can provide many advantages:

- Reduces flexural tensile stress in masonry walls.
- Improves stiffness of wall diaphragms.
- Reduces the likelihood of leakage due to shrinkage cracks in concrete or masonry.
- Reduces deflections in structural elements.
- Reduces thermal movement in solid timber construction systems.



6.4 ReidBrace™ System

Size	ReidBrace™	ReidBrace™ End	ReidBar™ Full Nut	ReidBar™
12mm	RBRACE12/16	RBRACE12-END	RB12N	RB12
16mm	RBRACE12/16	RBRACE16-END	RB16N	RB16
20mm	RBRACE20	RBRACE20-END	RB20N	RB20
25mm	RBRACE25/32	RBRACE25-END	RB25N	RB25
32mm	RBRACE25/32	RBRACE32-END	RB32N	RB32

Characteristic Strength Min Ultimate (kN)			
Size	ReidBrace™ System	Min Yield Strength (kN)	Min Ultimate Strength (kN)
12mm	>61	56.5	61.0
16mm	>109	100.6	108.5
20mm	>170	157.0	169.6
25mm	>266	245.5	265.1
32mm	>425	402.0	434.2

For applicable capacity reduction factors, refer to AS3600: 2009

6.5 Notes for Designers

Preload of Brace

When used as a diagonal pair of braces, where one brace is in tension and the other is redundant depending on the load direction, the ReidBar™ brace should be installed with a tension such that deflection of the structure under service load reversal does not remove the preload.

Locking Nuts

It is recommended that a ReidBar™ Nut is used as a locking nut against the RBRACE on the opposite side to the full tensioning nut. This will prevent the possibility of the nut vibrating loose should the preload be lost from the brace.

Crossing of Braces

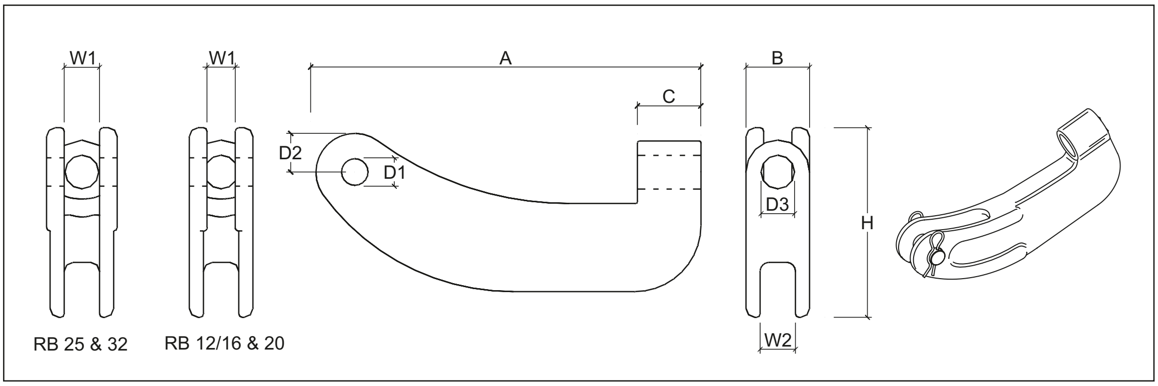
When the braces are working there is the possibility of the braces rubbing together. Noise from this action can be reduced by specifying that a plastic sleeve is wired to one of the braces where they cross and the brace wired together.

Nut Tension

ReidBar™ may be tensioned up to 20% of yield by torquing the ReidBar™ nut on an unlubricated bar. Lubrication of the bar will increase the tension induced in the bar. (Refer to page 35)

6.6 Product Specifications

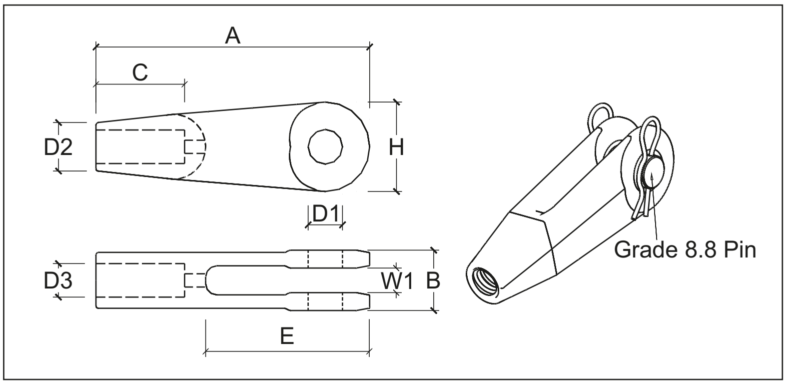
ReidBrace™ (RBRACE)



ReidBrace™

Size	A	B	C	D1	D2	D3	E	H	W1	W2
12/16	276	36	46	17	25	19	-	107	16	20
20	345	45	58	21	32	24	-	134	21	25
25/32	436	68	72	31	44	38	-	170	36	36

ReidBrace™ End (RB-END)

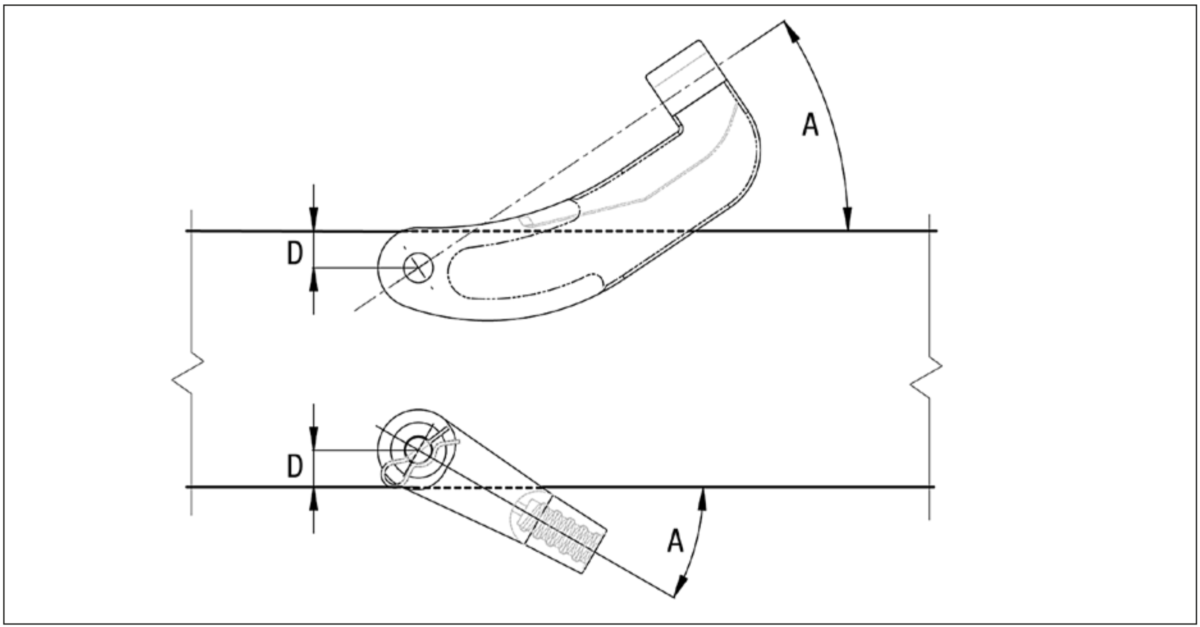


ReidBrace™ End

Size	A	B	C	D1	D2	Pin Ø	E	H	W1	
12	145	32	50	17	-	16	50	40	16	-
16	160	36	55	17	30	16	67	50	16	-
20	195	45	60	21	35	20	88	60	21	-
25	247	50	80	31	43	30	108	80	26	-
32	265	62	85	31	55	30	120	88	32	-

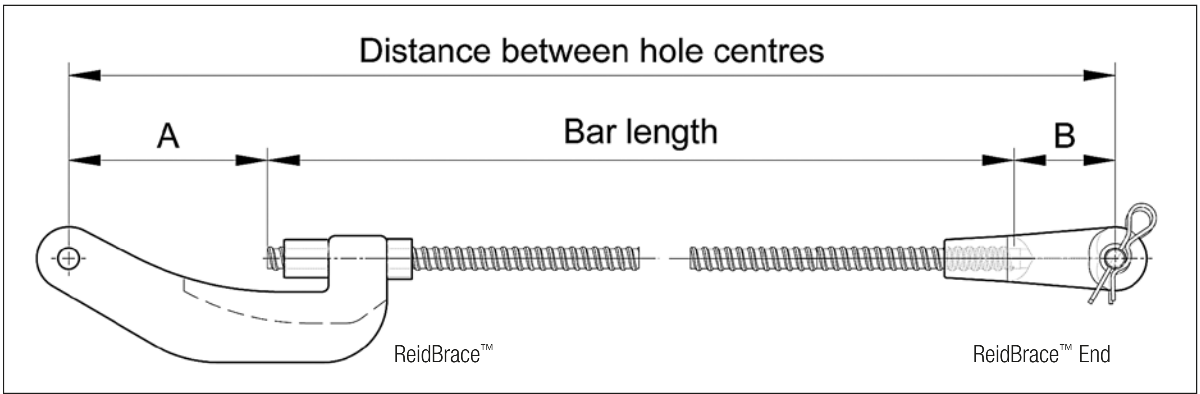
6.6 Product Specifications *(continued)*

Minimum Angle of Bracing to Fixture



Bar size (mm)	D = 1.5x pin diameter in mm				
	D (mm)	Brace	Min angle A°	End	Min angle A°
12	24	Rbrace12/16	30	Rbrace12-end	32
16	24	Rbrace12/16	30	Rbrace16-end	30
20	30	Rbrace20	32	Rbrace20-end	30
25	48	Rbrace25/32	34	Rbrace25-end	32
32	48	Rbrace25/32	34	Rbrace32-end	30

Bar Length for Bracing Application:



ReidBar™ Size	RBrace	A+/-5mm	RBrace-End	B+/-5mm	A+B mm
RB12	RBRACE12/16	135	RBRACE12-END	75	210
RBA16	RBRACE12/16	130	RBRACE16-END	80	210
RB20	RBRACE20	170	RBRACE20-END	105	275
RB25	RBRACE25/32	210	RBRACE25-END	125	335
RB32	RBRACE25/32	200	RBRACE32-END	135	335

7.1 What is it?

Corrosion is a process of restoring natural balance. In steel the iron content is chemically changed to a more stable iron oxide or iron salt.

The corrosion of metals is defined according to ISO8044:1999.

Corrosion is a physiochemical reaction between a metal and its environment which results in changes in the properties of the metal and which may often lead to an impairment of the function of that metal, the environment, or the technical system of which these form a part. The interaction is usually of an electrochemical nature.

In neutral or alkaline environments, dissolved oxygen plays an important role and corrosion only occurs if dissolved oxygen is present in the electrolyte. The most familiar corrosion of this type is the rusting of iron, when exposed to a moist atmosphere or water to form ferric hydroxide, which dries to form ferric oxide.

Rusting requires an environment containing at least 1% each water and oxygen.

The corrosion products of rusting steel bars occupy a volume of three or more times the volume of the steel section consumed. This volume increase will produce sufficient internal stresses to disrupt the surrounding grout or concrete.

Over time corrosion will reduce the effective section of the steel.

There are three broad areas that generally define the type of corrosion. These are uniform or generalised corrosion, localised corrosion and cracking due to either stress corrosion or hydrogen embrittlement.

Ground water with variable pH can create an electrolysis type corrosion cell.

7.2 Corrosion Protection of Grade 500 ReidBar™

ReidBar™ is often used in harsh or corrosive environments and in these areas some form of corrosion protection will need to be considered.

Reducing the effects of corrosion basically require isolating the iron from the environment in which it is to be used. Manufacturers of iron and steel products achieve this by combining the iron with alloys to form a more stable or corrosion resistant material.

For the past 10 years in New Zealand ReidBar™ has been produced as a micro alloyed steel and will have slightly better corrosion resistance than mild steel. The majority of ReidBar™ fittings are cast in Ductile Iron and these will corrode at about 30% of the rate for mild steel.[5] The exception to this is the marine environment where the corrosion rates are similar.

The corrosion products of Ductile Iron are not expansive.

The nature of corrosion is complex and the performance of corrosion protection systems can be extremely variable. The designer needs to thoroughly investigate local conditions before deciding on the protection method.

Common methods of corrosion protection include:

- Applying a corrosion inhibiting medium
- Electro plating
- Hot metal spraying and Hot Dip Galvanising
- Painting and other surface coatings
- Encapsulating in a protective inert barrier

Each of these methods will offer differing degrees of protection. The selection of protection grade is dependant on the application, the application environment, the design life and the consequences of failure.

7.3 Two protection alternatives for ReidBar™ and their likely performance.

Hot Dip Galvanising

ReidBar™ and ReidBar™ fittings are galvanised to meet the requirements of AS/NZS 4680 1999 with the nominal coating mass on ReidBar™ being 600g/m^2. This equates to a surface zinc thickness of approximately 0.10mm (100 microns).

To remove excess zinc, ReidBar™ fittings are spun in a centrifuge after galvanising and the resulting nominal coating thickness will be around 0.04~0.06mm.

Since zinc coatings protect the steel by the sacrificial erosion of itself, the protective life of a metallic zinc coating is roughly proportional to the mass of zinc per unit of surface area. This is regardless of the method of application.

The Galvanizers Association of Australia handbook gives the anticipated life of 600 g/m^2 of hot dipped coating at 50 years in a mild coastal environment and 25 years in a marine environment.

Some environment limitations are noted as follows:

Galvanising will give minimal protection for pH values less than 6.5 to 7.0.

Unprotected galvanised systems should not be used with acid solutions below pH 6.0 or alkaline solutions above pH 12.5

Additional protection is required when galvanised steel is in contact with chemically treated timber.

Cement grouts or concrete provide an environment where the pH is typically 9.5 to 13.5 in which a passive film forms on the steel that protects it from corrosion. However the loss of this protective alkalinity around the steel, or the presence of aggressive ions, notably chloride, in the grout or concrete, can lead to corrosion.

Hot Dip Galvanising will have no significant effect on the development length of reinforcing bars.

Surface Coatings

Surface coatings that are designed to resist corrosion simply enclose the metal component in an impervious barrier to exclude the corrosion causing elements. An effective coating needs toughness to resist abrasion and mechanical damage, proper substrate adhesion to resist corrosion migration at damage sites and be chemically inert.

An extremely effective method of providing this impervious barrier is coating the metal component with fusion bonded epoxy. In this process finely ground, fully cured epoxy powder, is applied to the hot surface of a clean grit blasted metal component. The residual heat of the component melts and fuses the epoxy powder to the component. The cured epoxy coating is flexible, abrasion resistant and almost impossible to remove.

The corrosion protection performance of fusion-bonded epoxy is further enhanced by pre coating the bar or fitting with a zinc rich fusion bonded epoxy.

ReidBar™ and ReidBar™ components can be coated with either fusion-bonded epoxy applied directly to the metal or first coated with the zinc rich fusion bonded epoxy and then over coated with fusion bonded epoxy.

The trade names of the epoxy products used are Black Beauty and Zinc Shield and are produced by Orica Powder Coatings.

Both the epoxy powder and the application and testing procedures meet the requirements of ASTM A775/A775M-97

Epoxy coatings will reduce the effective bonding of reinforcing bars in concrete. For the additional development length required, typically 1.2L_d to 1.5L_d, the designer should refer to the appropriate design literature.

7.4 Measuring the effectiveness of a corrosion protection system

The accurate simulation of actual long term performance on site during testing is virtually impossible. However a series of accelerated corrosion tests have been undertaken to provide a comparison of the relative performance of hot dip galvanising and fusion bonded epoxy.

The tests show that in the accelerated corrosion environment fusion bonded epoxy continues to provide corrosion protection for at least 20 times longer than a hot dipped galvanised surface.

These tests were carried out in a Q-Fog Cyclic Corrosion Tester (salt spray cabinet) in accordance with the test method ASTM B 117[3].

The fusion bonded epoxy top coat was applied over a zinc rich fusion bonded epoxy base coat to give a combined total coating thickness of 270 microns. This coating system provided corrosion protection for at least 10,000 hours.

The hot dipped galvanised surface showed serious distress at 350 hours and was completely destroyed at 500 hours.

The tests showed that the difference in corrosion resistance between the fusion bonded epoxy only coating and the zinc rich plus fusion bonded epoxy coating was only apparent after 5000 hours. At this time small blisters of 0.5mm diameter started showing on the bar surface but still no rusting.

Fusion bonded epoxy's are affected by ultraviolet radiation. Where part of an embedded bar is required to remain exposed some powdering may become evident.

The ultraviolet light in normal sunlight will degrade Fusion Bonded Epoxy coatings at approximately 2 microns per year.

Where Fusion Bonded Epoxy coatings are required to remain exposed to sunlight throughout a long working life then they should be overcoated with a 2 pack polyurethane paint system approximately 60 microns thick.

Due to the coating flexibility straining of up to 75% of the bar yield will not crack the epoxy coating. At these high loads there may be some damage to the coating surfaces within the nut.

References

1. Australian Tunneling Conference, Sydney Australia, August 1997
2. After Fabrication Hot Dip Galvanising, Galvanizing Association of New Zealand
3. Orica Powder Coatings lab report # 0096 of 18 March 2002
4. BS 8081:1989 British Standard Code of Practice for Ground Anchorages
5. A.S.T.M. Atmospheric Corrosion data Table 3.40

FREQUENTLY ASKED QUESTIONS

Q - How far into the Coupler must the bar be threaded?

A - Tests show that to achieve the ultimate strength of the connection the thread engagement must be at least 80% of the maximum thread depth available in the fitting. Correct bar insertion is critical to the performance of the ReidBar™ system and it is recommended that good practice requires the user to mark the bar at half coupler length back from the inserted end so that a visual check is available.

Q - Is tightening torque critical in the performance of ReidBar™ components?

A - Provided the bar is screwed tightly against the centre stop, or fully through the component, whichever is appropriate, the full breaking strength of the bar will be developed. Reid™ recommends using a wrench with a minimum length of 300mm to ensure the bar is fully engaged.

Q - How much slip occurs in the thread of a coupler as it is loaded?

A - Recent tests have shown that up to 0.5mm of slip can occur in each end of the coupler at loads approaching yield. If this is an issue with crack widths at serviceability limit state then slip can be significantly reduced by inducing a preload into the bar/fitting by fully tightening the bar onto the internal stop as detailed in the above Q & A. Serviceability slip of less than 0.1mm is possible by fitting ReidBar™ with Epoxy, such as Ramset Chemset Reo 502 or Epoxy Putty. The effect of slip can be further reduced by staggering alternate couplers. An appropriate stagger distance would be the development length of the bar size being used. It should be noted however that in most cases the ReidBar™ fittings will be used at construction joints which typically have crack widths well above the coupler slip value.

Q - How is the correct preload applied?

A - We have established that a more accurate measure is to run the nut against the coupler by hand then rotate the nut a further fixed amount.

RB12N: 120 degrees after hand tight.

RBA16N: 100 degrees after hand tight.

RBA20N: 70 degrees after hand tight.

RB25N: 60 degrees after hand tight.

RB32N: 30 degrees after hand tight.

Q - How hard is it to apply the preload?

A - In the larger sizes the correct preload requires the use of a very large spanner up to 1.5 metres long with very stiff jaws, otherwise the corners of the nut will be turned and torque will be insufficient. A 48" crescent spanner with a length of pipe is a good tool for this application, however, you will also need a good strong vice bolted to the floor to hold the coupler. If you are applying these sorts of loads to a coupler in a precast element you need have sufficient concrete strength to resist the torque.

Q - What is the best way of cutting ReidBar™ before joining?

A - It is preferable to cut ReidBar™ with an abrasive cut-off wheel or cut-off saw as sheared or cropped ends usually present problems. Poorly maintained equipment will leave a misshaped core diameter and excessive burr on the bar end making more difficult to thread on nuts and couplers.

Q - What end treatment is required before coupling?

A - If difficulty is encountered because of burring or distortion of the end during cutting or shearing then a light dressing with an angle grinder to remove the damage is all that is required.

Q - What type of nuts should I use and when?

A - A1. For most splicing and anchoring applications the primary fittings (couplers, inserts and grout sleeves) may be used without additional nuts.

A2. Nuts are used for all designs where the nut is required to develop the full breaking strength of the bar e.g. terminations for rock bolts, ground anchors, hold down bolts, tensioning applications, etc.

Q - What testing has been done for ReidBar™?

A - During the development of ReidBar™ and like products, extensive tests were conducted by Reid™. These tests include cyclic tension load tests, pullout tests to check embedment anchorage and slip tests. The system's quality is continually monitored by Reid™, along with the steel mills and fitting manufacturers, using accredited testing laboratories in an ongoing program of quality assurance and development while specific research programs continue to be undertaken.

Contact Reid™ for copies of tests concerning specific applications for your project.

Q - Can you bend and rebend ReidBar™?

A - Rebending reinforcing steel is not recommended because steel strain hardens when it is bent and loses some of its ductility, an effect that is usually increased when the steel is rebent. It is important that reinforcing steel used in concrete structures remains ductile, especially when the structure could be subjected to seismic loads. The importance of this has been highlighted by recent failures of concrete structures under seismic loads in California, Kobe and Newcastle. ReidBar™ is highly ductile and can be cold bent and rebent around the minimum former diameters specified in AS/NZS4671:2001 and NZS3402:1989 without fracture (Note Q/A on HD Galvanised Bar). However, while a very common detail uses bent bars as starters for moment connections, the ReidBar™ system can solve structural connection problems often encountered in thin sections or joints without bending the reinforcement.

Q - Can I weld cast ReidBar™ fittings?

A - Although cast SG Iron fittings can be welded using specialised techniques however, it is not a recommended practice because it will degrade the strength and ductility of the fitting and it will no longer meet the performance characteristics stated in this manual. If you have further questions regarding welding contact Reid™ for clarification.

Q - How do ReidBar™ starter bars compare with metric threaded starter bars?

A - There are three issues here:

A1. The minimum core diameter of reinforcing bars does not allow the same diameter metric thread to be cut to a full profile.

A2. The thread cutting process will induce a notch effect at the base of the thread and further reduce the bar strength.

A3. ReidBar™ threaded inserts have an effective depth allowing ductile failure at full bar strength. Metric threaded inserts tend to be shorter.

Q - Can I weld ReidBar™ ?

A - ReidBar™ is produced by the TEMPCORE process. Welding of ReidBar™ shall be carried out in accordance with AS/NZS 1554.3: 2002. The designer must determine the acceptability of bar welding in their design, and should specify the welding process to be adopted, as some types of welded splices can reduce the ductility of the connected bars.

Q - How do I connect one precast concrete element to another using ReidBar™?

A - The best way to join to concrete elements is by casting a ReidBar™ Grout Sleeve into the top of the lower element and a ReidBar™ Coupler into the bottom of the upper element. This eliminates the need for any starter bars protruding from the precast elements that are liable to damage and bending. Immediately prior to final placing a starter bar of the correct length is screwed into the coupler and non-shrink grout is poured into the grout sleeve cup. The two elements are then brought together into the final position, levelled and propped.

Note: This pre-grout method avoids the necessity for casting in grout tubes and the need for a separate grouting operation.

NOTE: TO EFFECTIVELY ANCHOR A GROUT SLEEVE IT REQUIRES A LAP LENGTH OF BAR PROTRUDING FROM AND SCREWED INTO THE THREADED END.

Q - What grout can I use in ReidBar™ grout sleeves?

A - Most general purpose grouts with a 28 day compressive strength exceeding 65MPa can be used. Reid™ Grout Sleeves have been tested with Fosroc Conbextra GP, Sika Grout 212 and MBT 830.

Q - How does a ReidBar™ grout sleeve joint compare with a Drosbach joint?

A - Set Out

Joints formed with corrugated formers such as Drosbach tubes derive their strength from the integrity of the surrounding concrete. As with lapped joints they must be staggered if used in high stress zones. ReidBar™ grout sleeves on the other hand provide full bar strength even in plastic hinge zones.

ReidBar™ Grout Sleeves are simple and easy to use and the reusable setting hardware encourages both quick and accurate placing in boxing and precast forms. The expanding rubber ferrule positively excludes latents from the Grout Sleeve cavity. Grout Sleeves have grout tube holes included in the casting.

On-site

ReidBar™ Grout Sleeves have a short embedment depth, meaning that protruding starter bars are shorter, making on-site installation easier and safer.

Pricing

When all the costs for a completed joint are accounted for, size for size, Grout Sleeves and Drosbachs will be a similar price. While Drosbach tubes have a lower initial cost in practice the smaller grout volume and lower grouting labour costs in a completed joint will compensate for the higher initial cost of the grout sleeve. Since the security of a ReidBar™ Grout Sleeve joint is completely independent of the concrete it is the ideal solution for full strength joints in thin sections.

ReidBar™ Grout Sleeves have been tested with 500 grade bar.

FREQUENTLY ASKED QUESTIONS

Q - What are the minimum cover requirements for ReidBar™ and components?

A - ReidBar™: Code requirements for Reinforcing must be observed. Refer to AS3600 Concrete Structures.

Components:
Because the two main factors to be considered are Fire and Corrosion sufficient protection for the components should be specified by the designer according to the requirements of the application, taking into consideration the relevant codes and the following notes.

Fire:
The temperature of the steel reinforcing is affected by the cover of concrete over the full extent of the embedded bar. The temperature is averaged over the steel by conduction along its length which acts to quickly dissipate any localised temperature variations. A minor reduction in the cover in a very localised area (e.g. at a coupler) would therefore not lead to any significant increase in steel temperature and no increased reduction in strength.

Corrosion:
(1) Those metal ReidBar™ components not made of ductile iron require the same cover as the bar itself unless galvanised or otherwise protected.

(2) ReidBar™ components in sizes larger than RB12 are generally manufactured from specially alloyed high strength ductile iron. Ductile iron corrodes at about 30% of the rate of reinforcing steels and the products of the corrosion are not expansive. Therefore it does not lead to the spalling and flaking problems commonly associated with the corrosion of steels in concrete. Because of this good corrosion resistance cover for Ductile Iron components can be reduced, although it is suggested that cover be maintained to at least 50% of code requirements for reinforcing steel. The exception to the better corrosion resistance of ductile iron is sea water and in that case it is preferable to use the same cover limitation as the bar.

Q - Can I use SG Iron ReidBar™ components for lifting?

A - NO. SG Iron ReidBar™ components are not developed for this purpose and do not comply wit the requirements of AS3850 - 2003 for lifting inserts.

Q - Is the performance of ReidBar™ Inserts affected by traverse cracks in the concrete?

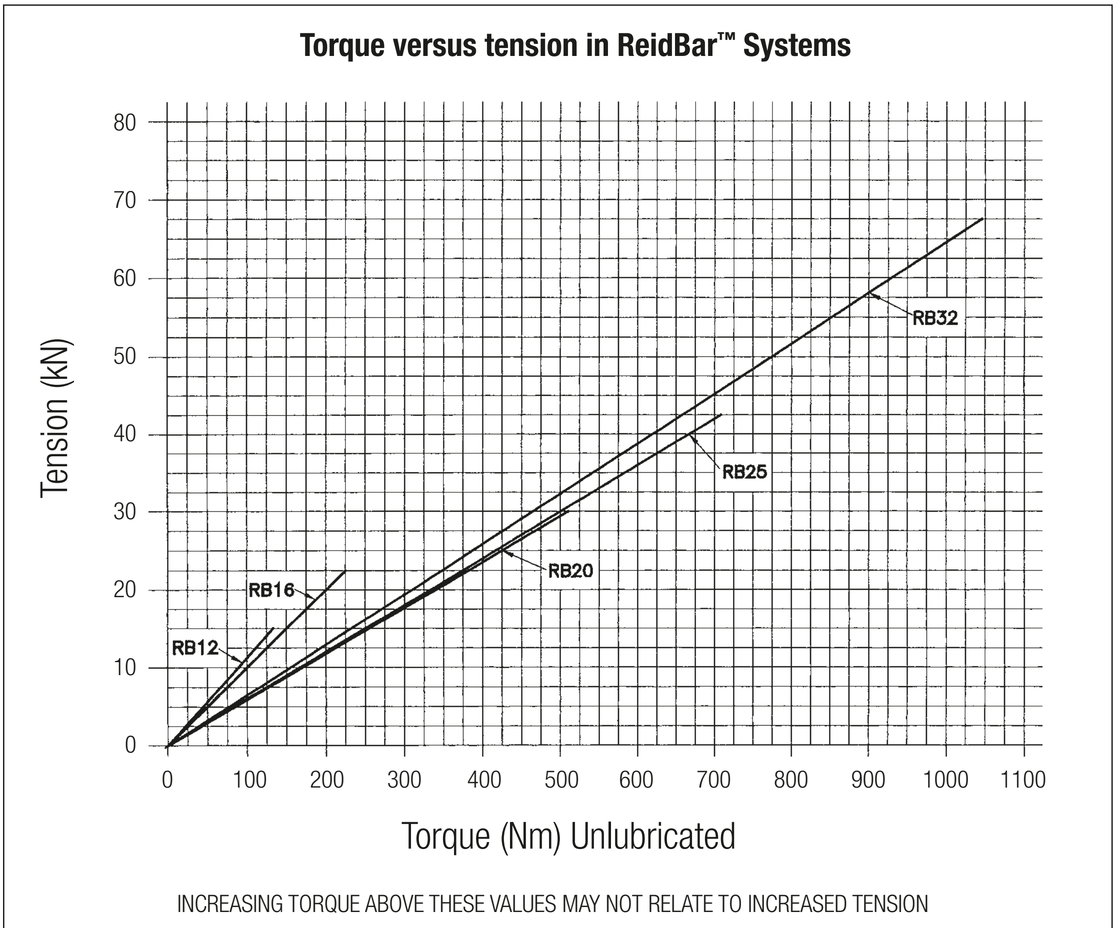
A - Yes. Reid™ recommends that the ultimate capacity of ReidBar™ inserts be reduced by 25% for crack widths of 0.4mm and 30-40% for crack widths of 0.8mm.

DO NOT PLACE THREADED INSERTS IN THE LIKELY BURSTING ZONE OF COVER CONCRETE TO TENSION STEEL.

Q - What is the relationship between torque applied to the nut and tension induced in the bar?

A - The relationship of Torque versus tension in ReidBar™ systems is reasonably linear up to about 25% of the bar yield strength. Refer to the following graph.

Please contact your local Reid Engineer on 1300 780 250 should you have any other questions regarding ReidBar™ design solutions.



Previous university research applicable to the Reid™ approach includes:

Date	Description	Author	Institution
August 93	Tensile capacity of steel connectors with short embedment lengths in concrete	Restrepo-Posada & Park	Canterbury University
Sept 96	Tensile capacity of hooked bar anchorages with short embedment lengths in concrete	Nigel Watts	Canterbury University
Sept 96	Tensile capacity of headed anchors with short embedment lengths in concrete	Barry Magee	Canterbury University
Oct 98	Anchorage plates and mechanical couplers in seismic resistant concrete frames with threaded bar	KL Young	Auckland University
June 2000	Methods of joining precast components to form structural walls	Maureen Ma	Auckland University
2003	Assessing the seismic performance of Reinforcement Coupler System	Anselmo Bai	Auckland University

These papers are held in the corresponding libraries of the Universities.

Future research programs will support investigations into seismic solutions for Beam/Column Joints, Thin Walls, Floor/Wall Joints, Column Bases, Shell Beams.

APPENDIX A: DIRECT TENSION & SHEAR REDUCTION FACTORS

GENERAL NOTATION

a = actual anchor spacing (mm)
a_m = absolute minimum anchor spacing (mm)
e_c = critical edge distance (mm)
e_m = absolute minimum edge distance (mm)
f_{sy} = reinforcing bar steel yield strength (MPa)
X_{nae} = anchor spacing effect, end of a row, tension
X_{nai} = anchor spacing effect, internal to a row, tension
X_{nc} = concrete compressive strength effect, tension
X_{ne} = edge distance effect, tension
X_{va} = anchor spacing effect, concrete edge shear
X_{vc} = concrete compressive strength effect, shear
X_{vd} = load direction effect, concrete edge shear
X_{vn} = multiple anchors effect, concrete edge shear

STRENGTH LIMIT STATE NOTATION

N_{uc} = characteristic ultimate concrete tensile capacity (kN)
N_{ur} = design ultimate tensile capacity (kN)
N_{urc} = design ultimate concrete tensile capacity (kN)
N_{us} = characteristic ultimate steel tensile capacity (kN)
V_{uc} = characteristic ultimate concrete edge shear capacity (kN)
V_{ur} = design ultimate shear capacity (kN)
V_{urc} = design ultimate concrete edge shear capacity (kN)
V_{us} = characteristic ultimate steel shear capacity (kN)
Ø = capacity reduction factor

ISOLATED DIRECT TENSION METHODOLOGY

STEP 1 Select Anchor to be evaluated

CHECK 1 Determine applied loading and check absolute minimum edge and spacing distances of Reidbar™ fittings

Table 3.3.1a – Absolute minimum edge Distance and anchor spacing mm – e_m, a_m

Reidbar™ Insert	RB12TI	RBA16TI	RBA20TI	RB25TI	RB32TI
e_m	40	50	60	75	100
a_m	40	50	60	75	100

STEP 2 Verify concrete tensile capacity per Reidbar™ Insert

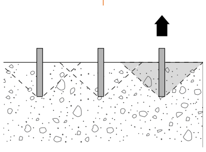
Table 3.3.2a – Reduced Characteristic Ultimate Concrete tensile Capacity – ϕN_{uc}, (kN) $\phi = 0.6$, f'_c = 32MPa, 8mm Nail Plate Embedment

Reidbar™ Insert Type				
RB12TI	RBA16TI	RBA20TI	RB25TI	RB32TI
64.1	93.9	140.5	227.5	281.8

Table 3.3.2b – Concrete Compressive Strength Effect – X_{nc}

f'_c	15	20	25	32	40	50
X_{vc}	0.68	0.79	0.88	1.00	1.12	1.25

Table 3.3.2c – Edge Distance Effect – X_{ne}



Reidbar™ Insert Type	Edge Distance e (mm)											
	50	75	100	125	150	175	200	225	250	275	300	325
RB12TI	0.31	0.47	0.63	0.79	0.94	1.00						
RBA16TI	0.27	0.40	0.54	0.67	0.81	0.94	1.00					
RBA20TI		0.32	0.43	0.53	0.64	0.75	0.85	0.96	1.00			
RB25TI		0.25	0.34	0.42	0.50	0.59	0.67	0.75	0.84	0.92	1.00	
RB32TI			0.32	0.40	0.48	0.56	0.64	0.72	0.80	0.88	0.96	1.00

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Step 2 Continued

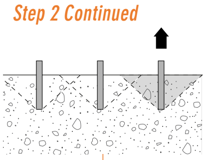


Table 3.3.2d – Spacing Effects end of a row – X_{nae}

Reidbar™ Insert Type	Anchor Spacing a_e (mm)												
	50	75	100	125	150	175	200	250	300	350	400	500	600
RB12TI	0.58	0.62	0.66	0.70	0.74	0.78	0.82	0.90	0.98	1.00			
RBA16TI	0.57	0.60	0.64	0.67	0.71	0.74	0.78	0.84	0.91	0.98	1.00		
RBA20TI	0.56	0.58	0.61	0.64	0.67	0.69	0.72	0.78	0.83	0.89	0.94	1.00	
RB25TI	0.54	0.57	0.59	0.61	0.63	0.65	0.67	0.72	0.76	0.80	0.85	0.93	1.00
RB32TI	0.54	0.56	0.58	0.60	0.62	0.64	0.66	0.70	0.74	0.78	0.83	0.91	0.99

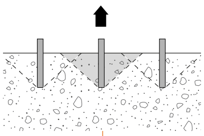


Table 3.3.2e – Spacing Effects internal of a row – X_{nai}

Reidbar™ Insert Type	Anchor Spacing a (mm)											
	100	150	200	250	300	350	400	450	500	550	600	650
RB12TI	0.32	0.48	0.64	0.80	0.96	1.00						
RBA16TI	0.28	0.41	0.55	0.69	0.83	0.96	1.00					
RBA20TI	0.22	0.33	0.44	0.56	0.67	0.78	0.89	1.00				
RB25TI	0.17	0.26	0.35	0.43	0.52	0.61	0.69	0.78	0.87	0.95	1.00	
RB32TI	0.16	0.24	0.33	0.41	0.49	0.57	0.65	0.73	0.81	0.89	0.98	1.00

CHECK 2 Deisgn Reduced Ultimate Concrete tensile capacity. ϕN_{urc}

$\phi N_{urc} = \phi N_{uc} * X_{nc} * X_{ne} * (X_{nae} \text{ or } X_{nai})$

Note: Spacing factors for internal X_{nai} and external X_{nae} may be both applied when > 2 rows are in tension.

STEP 3 Reduced characteristic ultimate steel tensile capacity - ϕN_{us} (kN)

Table 3.3.3a – Verify Tensile Capacity of Reidbar™. ϕN_{us}. $\phi = 0.8$

Reidbar™ size	ϕf_{sy}	ϕF_{us}
RB12	45.2	48.8
RBA16	80.48	86.8
RBA20	125.6	135.68
RB25	196.4	212.08
RB32	321.6	347.36

CHECK 3 Design Reduced Ultimate tensile Capacity. N_{ur} (kN)

$\phi N_{ur} = \min \text{ of } \phi N_{urc} \text{ or } \phi N_{us}$

Check Interaction - $N^* / \phi N_{ur} \leq 1.0$ if not satisfied return to STEP 1

SHEAR CAPACITY METHODOLOGY *Continued*

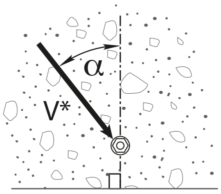
STEP 4 **Verify concrete shear capacity**

Table 3.3.4a – Reduced charateristic ultimate concrete Shear Capacity at 32MPa – ϕV_{uc}, (kN), ϕ = 0.6, $f'c$ = 32MPa

Reidbar™ Insert Type	Insert Edge Distance e (mm)												
	50	75	100	125	150	175	200	225	250	275	300	325	350
RB12TI	4.57	8.40	12.93	18.07	23.75	29.93	36.57	43.64	51.11	58.97	67.19	75.76	84.67
RBA16TI	5.19	9.53	14.67	20.50	26.95	33.96	41.49	49.51	57.98	66.89	76.22	85.94	96.05
RBA20TI		10.44	16.07	22.47	29.53	37.21	45.47	54.25	63.54	73.31	83.53	94.18	105.26
RB25TI		11.69	17.99	25.15	33.06	41.66	50.89	60.73	71.13	82.06	93.50	105.43	117.82
RB32TI			19.74	27.59	36.27	45.71	55.84	66.64	78.04	90.04	102.59	115.68	129.28

Table 3.3.4b – Concrete Compressive Strength Effect – X_{vc}

f'_c	15	20	25	32	40	50
X_{vc}	0.68	0.79	0.88	1.00	1.12	1.25



Load direction effect, conc. edge shear, X_{vd}

Table 3.3.4c – Load Direction Effects, Concrete Edge Shear – X_{vd}

Angle, α	0	10	20	30	40	50	60	70	80	90 – 180
X_{vd}	1.00	1.04	1.16	1.32	1.50	1.66	1.80	1.91	1.98	2.00

Table 3.3.4d – Spacing Reduction Factor for Concrete Shear – X_{va}

Edge Distance e (mm)	Spacing a (mm)								
	100	150	200	250	300	350	400	450	500
50	0.90	1.00							
75	0.77	0.90	1.00						
100	0.70	0.80	0.90	1.00					
125	0.66	0.74	0.82	0.90	0.98	1.00			
150	0.63	0.70	0.77	0.83	0.90	0.97	1.00		
175	0.61	0.67	0.73	0.79	0.84	0.90	0.96	1.00	
200	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00
225	0.59	0.63	0.68	0.72	0.77	0.81	0.86	0.90	0.94
250	0.58	0.62	0.66	0.70	0.74	0.78	0.82	0.86	0.90
275	0.57	0.61	0.65	0.68	0.72	0.75	0.79	0.83	0.86
300	0.57	0.60	0.63	0.67	0.70	0.73	0.77	0.80	0.83
325	0.56	0.59	0.62	0.65	0.68	0.72	0.75	0.78	0.81
350	0.56	0.59	0.61	0.64	0.67	0.70	0.73	0.76	0.79

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Step 4 Continued

Table 3.3.4e – Multiple Anchor Effect – X_{vn}

Number of Anchors - n	Anchor spacing / Edge distance, (a / e)											
	0.20	0.40	0.60	0.80	1.00	1.20	1.40	1.60	1.80	2.00	2.25	2.50
2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3	0.72	0.76	0.80	0.83	0.86	0.88	0.91	0.93	0.95	0.96	0.98	1.00
4	0.57	0.64	0.69	0.74	0.79	0.82	0.86	0.89	0.92	0.94	0.97	1.00
5	0.49	0.57	0.63	0.69	0.74	0.79	0.83	0.87	0.90	0.93	0.97	1.00
6	0.43	0.52	0.59	0.66	0.71	0.77	0.81	0.85	0.89	0.93	0.96	1.00
7	0.39	0.48	0.56	0.63	0.69	0.75	0.80	0.84	0.88	0.92	0.96	1.00
8	0.36	0.46	0.54	0.61	0.68	0.74	0.79	0.84	0.88	0.92	0.96	1.00
9	0.34	0.44	0.52	0.60	0.67	0.73	0.78	0.83	0.87	0.91	0.96	1.00
10	0.32	0.42	0.51	0.59	0.66	0.72	0.77	0.82	0.87	0.91	0.96	1.00
15	0.26	0.37	0.47	0.55	0.63	0.70	0.76	0.81	0.86	0.90	0.95	1.00
20	0.23	0.35	0.45	0.54	0.61	0.68	0.75	0.80	0.85	0.90	0.95	1.00

CHECK 4 Design Reduced Ultimate concrete Edge Shear capacity

$\phi V_{urc} = \phi V_{uc} * X_{vc} * X_{vd} * X_{va} * V_{vn}$

STEP 5

Reduced Characteristic ultimate steel shear capacity

Table 3.3.5a – Verify Unit Reidbar™ Steel Shear Capacity (kN) per insert – ϕV_{us}, $\phi = 0.7$

Reidbar™ size	ϕV_{us}
RB12	26.46
RBA16	47.11
RBA20	73.64
RB25	115.08
RB32	188.44

CHECK 5 Design Reduced Ultimate Shear Capacity – ϕV_{ur} (kN)

$\phi V_{ur} = \min \text{ of } \phi V_{urc} \text{ or } \phi V_{us}$

Check – $V^* / \phi V_{ur} \leq 1.0$ if not satisfied return to STEP 1

STEP 6

Combined loading - Tension Shear Interaction

$N^* / \phi N_{ur} + V^* / \phi V_{ur} \leq 1.2$ if not satisfied return to STEP 1

ReidBar™- Seriously Sensible Steel

ReidBar™ is much more than just a threaded reinforcing bar. It is a complete connection system, proven to offer design flexibility and affordable solutions to almost any concrete construction challenge.

ReidBar™ is Serious

Full bar break connections.

ReidBar™ is Sensible

No loss of cross sectional area across the connection means you can select the bar size you need, not the one the connection system dictates.

ReidBar™ is Steel

Produced using the TEMPCORE™ process, ReidBar™ offers full Grade 500 design strength.

Leading The Industry In Product Innovation

Reid™ has been providing solutions to the concrete construction sector for over 40 years and our knowledge of the industry has enabled us to evolve into a company that is a leader in product innovation and service. Our national engineering team is available to help solve your concrete construction challenges – from concept to completion.

Reid™ - partnering you and your business

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