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ramsetreid™ Concrete Structures Laboratory
All testing has been performed by independent testing laboratories and PEL. See below for details.

Reinforcement Technical Assessment

RTA-21/0011 of 21/05/2021

This Technical Assessment meets the testing requirements stipulated in clauses 8.7.5.2 (b) & 8.9.1.3 (a) of NZS 3101:2006 A3	
Trade name of the construction product	ReidBar™ Ductile Cast-Iron Components – Threaded Inserts
Product family to which the construction product belongs	ReidBar™ Reinforcement System used in concrete structures sizes RB12, RBA16, RB20
Manufacturer	ramsetreid 1 Ramset Drive Chirnside Park Victoria 3116 Australia
Manufacturing plant	ramsetreid
This Technical Assessment contains	13 pages & 9 Annexes which form an integral part of this assessment.
This Technical Assessment for NZS3101 is in accordance with the requirements stipulated in NZS 3101:2006 A3.	Reference reports: WSP Opus Research: • 5-24E97.00/A1-01, Melbourne Testing Services: • MTS-18-1019-A, B & C Ramsetreid Product Engineering Laboratory: • TRR 53

1. Technical description of the product

ReidBar™ Ductile Cast-Iron Threaded Inserts are used as part of the ReidBar™ Mechanical Anchorage System.

All ReidBar™ components in this report are Ductile Cast-iron elements and the ReidBar reinforcing steel is Gr 500E (Seismic) produced in accordance with AS/NZS 4671:2019.

The illustration and the description of the product are given in Annex A1 and A2.

2. Specification of intended use

The performances given in Section 3 are only valid if the anchor Reinforcement System is used in compliance with the specifications and conditions given in Annex B1. Furthermore, references given in Annex B2 are provided to compliment the performances given in Section 3.

3. Performance of the product and references to the methods used for its assessment

3.1 Performance Requirement of Mechanical Connections

Criteria	Performance
Elongation at $0.7f_y$ NZS 3101:2006 A3: Cl 8.7.5.2 (b)	See Annex C1
Alternating Large Strains NZS 3101:2006 A3: Cl 8.9.1.3 (a)	See Annex C2
Anchorage & Ultimate Tensile Strength NZS 3101:2006 A3: Cl 8.6.11.1 & Cl 8.6.11.2	See Annex C3
Mode of Failure NZS 3101:2006 A3: CL 8.6.11.1, 8.6.11.2, 8.6.11.3	See Annex C4
Resistance to Brittle Fracture NZS 3101:2006 A3: Cl 8.6.11.4	See Annex C5

3.2 Testing Methodology of Mechanical Connections

3.2.1 Elongation at $0.7f_y$ – Cl 8.7.5.2 (b) NZS 3101:2006 A3

The bars and connectors were loaded into the test machine and loaded in tension up to 0.7 times the nominal yield load at a rate of 300 kN/min. Once at $0.7f_y$, the bars were held at $0.7f_y$, for 20 seconds before being returned to zero load. The displacement was measured using dual gauges over a fixed gauge length throughout the test with the displacement and load recorded at a rate of approximately 100 Hz.

The gauge length of the steel couplers was determined in accordance with ISO 15835-2:2009 *Steels for the reinforcement of concrete – Test methods*, the gauge length has been taken as the length of the coupler plus eight times the diameter of the bar. ISO 15385-2 describes test methods applicable to couplers for mechanical splices of the two steel reinforcing bars. Threaded Inserts are joined to only one bar. Therefore, it has been considered the gauge length (L_g) for the Threaded Inserts should be equal to the length of the fitting plus four times the bar diameter.

In order to determine the maximum elongation allowable, as per clause 8.7.5.2 (b) of NZS 3101, two samples of non-spliced ReidBar of the same size and from the same batches have been tested for reference. A tensile load, corresponding to a stress level of 350MPa ($0.7f_y$), has been applied on the reference bars and the corresponding strain measured. The average value (ε_{350}), between the two measurements, times two and times the length of the coupler or the length of the gauge, is used to determine the maximum allowable elongation over the coupler length or the gauge length respectively.

ε_{350} is also used to determine the elongation over the coupler length, from the measured elongation over the gauge length, by discounting the elastic elongation of the bars outside the coupler.

3.2.2 Alternating tension and compression test of large strains – Cl 8.9.1.3 (a) NZS 3101:2006 A3

From the load of $0.7f_y$, the bars began the low-cycle testing as defined in ISO 15835-2 Clause 5.6.2. From a load of $0.7f_y$ in tension, the bars were further loaded to twice the nominal yield strain with the load then reversed and the sample loaded to half the nominal yield load in compression. The cycle was completed by loading in tension back up to twice the nominal yield strain. This cycle was repeated four times. Subsequently the bar was loaded in tension to five times the nominal yield strain and another four cycles performed between five times the nominal yield strain and half the nominal yield load in compression.

The residual elongations, u_4 and u_8, as detailed in ISO 15835, are measured from plots of the force against displacement over the gauge length on the last cycle at two and five times the nominal yield strain.

From the end of the final loop, at five times the nominal yield strain, the displacement gauges were removed, and the samples were loaded through to failure in tension with the Ultimate Tensile Strength (UTS) and Mode of Failure (MOF) recorded.

3.2.3 Anchorage in Concrete: Cl 8.6.11.1 & Cl 8.6.11.2 - NZS 3101:2006 A3

NZS 3101 A3, at Clause 8.6.11.2, defines the Upper Bound Breaking Strength of the reinforcing bar as 1.25 times the Upper Characteristic Yield Strength of the bar. For ReidBar, being 500E grade, this corresponds to 750MPa. Mechanical anchorages, at Clause 8.6.11.1, are required to be capable of developing the Upper Bound Breaking Strength.

Specifically heat treated ReidBars are connected to the threaded inserts through a fabricated load applicator to be tested to this requirement. Calibrated linear deflection transducers can be affixed to the fabricated load applicator to measure the displacement of the test bars. The thermal treatment allows the bar to develop a tensile strength above the minimum 750MPa required for the test.

Testing was conducted for anchorage in a concrete test slab with the use of a test frame consisting of two (2) large concrete blocks and a structural beam crosshead spanning the blocks. A second structural steel beam was fixed across the width of the test slab at the specified cantilever distance.

The hydraulic jacking system and calibrated load measuring device was placed onto the steel crosshead and secured to the load applicator. The force was progressively applied to the pair of connections simultaneously until the target load was achieved. The test force was then to be held and the concrete slab inspected for signs of cracking or other obvious visible evidence of failure.

Upon achieving the nominated test force, the load was to be increased until failure occurred within the test bars or concrete panel. A total of upto six test were to be conducted for each test case. Test force and resultant deflection were autographically recorded throughout the test and the test items were monitored for signs of cracking, spalling or other evidence of failure. The Characteristic capacities were derived using the tested values based on statistical method to provide a 5% fractile at a 90% confidence level using a normal distribution and average values.

3.2.4 *Mode of Failure*: *Cl 8.6.11.1 & Cl 8.6.11.2 - NZS 3101:2006 A3*

This particular test is often paired with other tests, like the $0.7f_y$ or the ISO 15835 for large strains, to become the conclusive part of those tests. Once the main test is finished, the test sample is pulled to failure and the Mode of Failure is recorded.

3.2.5 *Resistance to Brittle Fracture*: *Cl 8.6.11.4 NZS 3101:2006 A3*

As per Clause 8.6.11.4 of NZS 3101 A3, mechanical couplers and anchorages shall be proven, by an appropriate test method, to possess resistance to brittle fracture at the service temperatures at which they are intended for use. However, there is no indication on what an appropriate test method would be, particularly considering that ReidBar connections are made of Spheroidal Graphite Iron Grade 600/3.

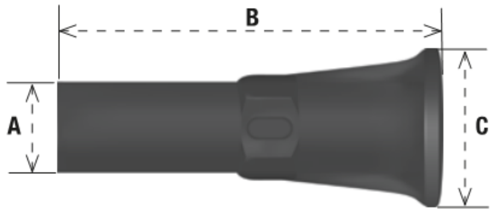
In 2018 another ReidBar product, ReidBrace™, was the subject of an extensive testing program at the University of Auckland. The constituent material of ReidBrace, DCI Grade 600/3, is exactly the same of the ReidBar Connections. One of the key steps of the test program was to determine the behavior of the components at temperatures below 0°C. This was accomplished by freezing the components at different temperatures between 0°C and -10°C and applying a load with an actuator at a rate of 10mm/s until failure, to simulate rapid tensile loading during earthquake.

4 **Material Safety Data Sheet**

Refer to the following ChemAlert documents for Safety Data Sheet according to New Zealand HSNO requirements:

- 10 Apr 2018 Version No:1 (EPCON C8)

ReidBar™ Ductile Cast-Iron Threaded Inserts
RB12TI, RBA16TI, RB20TI



Part No.	Description	(A) Body Diameter (mm)	(B) Length (mm)	(C) Foot Diameter (mm)	Thread Depth (mm)
RB12TI	12mm ReidBar Threaded Insert	22	99	38	55
RBA16TI	16mm ReidBar Threaded Insert	30	118	50	50
RB20TI	20mm ReidBar Threaded Insert	35	149	64	64

NOTE: Hot dip galvanised finish also applicable

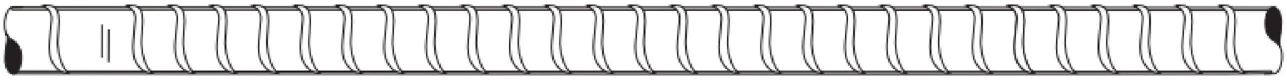
ReidBar™ Starter Bar Fitment Thread Filler
EPCON™ C8 Xtrem™

Description	Cartridge Size	Part No.
EPCON™ C8 Xtrem™	450ml	C8-450

ReidBar™ Ductile Cast-Iron Threaded Inserts	**Annex A 1**
Product description Mechanical anchorages	

ReidBar™ Reinforcing bar RB12, RBA16, RB20

Seismic® 500E Micro Alloyed Reidbar™



Commercial reinforcing (E Class - Seismic) bar to AS/NZS 4671:2001

Product Characteristics	Value
Lower Characteristic yield strength $R_{ek.L}$ (MPa)	≥ 500
Upper Characteristic yield strength $R_{ek.U}$ (MPa)	≤ 600
Characteristic Minimum Ultimate to Yield ratio – R_m/R_e	≥ 1.15
Characteristic Maximum Ultimate to Yield ratio - R_m/R_e	≤ 1.40

ReidBar™ Reinforcing Steel	Annex A 2
Product description Reinforcing Bars	

Specifications of intended use

Anchorages subject to:

- Seismic, Static and quasi-static load.

Base materials

- Non-cracked and cracked concrete for reinforcing bars RB12, RBA16 & RB20.
- Reinforced or unreinforced normal weight concrete for use in construction in accordance with NZS 3101:2006 A3 .

Design:

- The Mechanical anchorages or Mechanical Spliced Connections are designed in accordance with the Standards New Zealand NZS 3101:2006 A3 – Concrete Structures Standard" under the responsibility of an engineer experienced in structural design and concrete work.
- Verifiable calculation notes and drawings are prepared taking into account the loads to be anchored or spliced connection. The position of the anchor or connection is indicated on the design drawings.
- The ReidBar Threaded Inserts are to be used with ReidBar Starter Bars of a development length designed in accordance with NZS 3101:2006 (A3) Clause 8.6.

Installation:

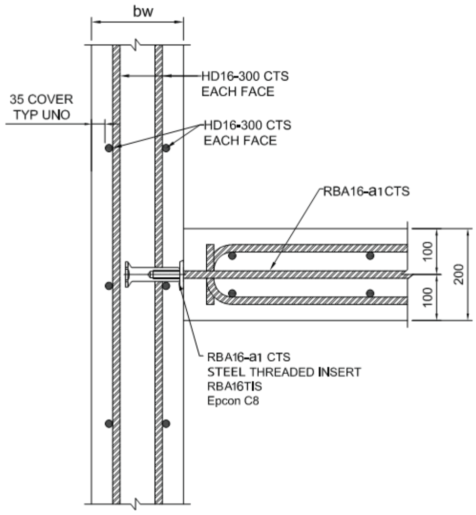
- Reinforcement installation carried out in accordance with ReidBar connection installation procedures (including the application of EPCON C8 thread filler in the starter bar fitment) by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site.

ReidBar™ Components	**Annex B 1**
Intended use Specifications	

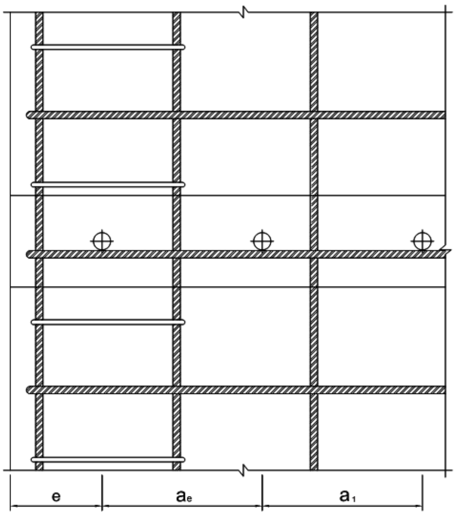
Typical Threaded Insert Reference Detail

A. Suspended Floors (Typical Detail)

Side View

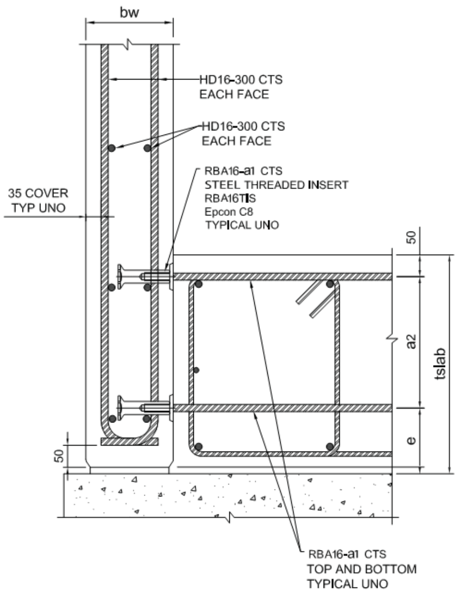


Front View

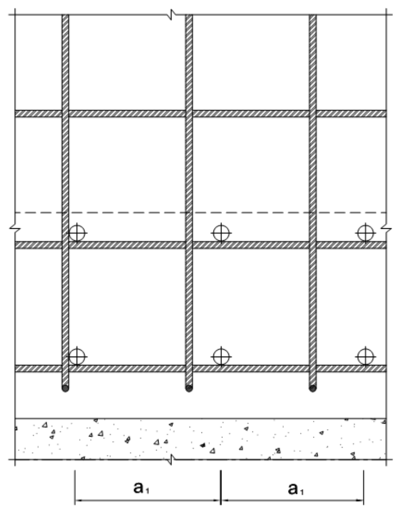


B. Cantilevered Connection (Typical Detail)

Side View



Front View



ReidBar™ Ductile Cast-Iron Threaded Insert	**Annex B 2**
Intended use Installation procedure	

Table C1: Elongation at 0.7fy: Cl 8.7.5.2 (b) NZS 3101:2006 A3

Sample	Part No.	L_g Gauge length [mm]	L_c Insert length [mm]	No. (of Sample. Tested)	ε_{350} Non-spliced ReidBar strain at $0.7f_y$	$0.7\ f_y$	Criteria assessed over L_g (gauge length)		Test report reference(s)
							Aver. displ. (over coupler length)	Allw. max. displ. (over coupler length)	
					[mm/m]	[kN]	[mm]	[mm]	
ReidBar Ductile Cast-iron Threaded Inserts									
12mm DCI Threaded Inserts	RB12TI	148	100	3	2.12	39.55	0.12	0.42	WSP-Opus Phase 1 5-24E97.00/A1-01
16mm DCI Threaded Inserts	RBA16TI	182	118	3	2.04	70.35	0.17	0.49	WSP-Opus Phase 1 5-24E97.00/A1-01
20mm DCI Threaded Inserts	RB20TI	229	148	3	1.86	109.9	0.25	0.55	WSP-Opus Phase 1 5-24E97.00/A1-01

ReidBar Reinforcing Bar System

Performances: Elongation at 0.7 fy
According to NZS3101:2006 A3 & AS/NZS 4671

Annex C 1

Table C2: Large Strains: Cl 8.9.1.3 (a) - NZS 3101:2006 A3

Sample	Part No.	No. (of Samples Tested)	Criteria assessed						Test report reference(s)
			ISO $u_4 \le 0.3$mm [mm]		ISO $u_8 \le 0.6$mm [mm]		UTS ≥ 575MPa [MPa]		
			$u_{4(min)}$	$u_{4(max)}$	$u_{8(min)}$	$u_{8(max)}$	$UTS_{(min)}$	$UTS_{(max)}$	
ReidBar Ductile Cast-iron Threaded Inserts									
12mm DCI Threaded Inserts	RB12TI	3	-0.06	0.04	-0.03	0.09	641.1	643.5	WSP-Opus Phase A1 5-24E97.00/A1-01
16mm DCI Threaded Inserts	RBA16TI	3	0.03	0.07	0.08	0.14	657.7	659.5	WSP-Opus Phase A1 5-24E97.00/A1-01
20mm DCI Threaded Inserts	RB20TI	3	0.02	0.05	0.09	0.16	655.1	660.9	WSP-Opus Phase A1 5-24E97.00/A1-01

Note:

1. Components are tested in accordance with ISO 15835.1:2009, Table A.1, requiring three samples tested for the smallest, medium and largest sizes of components.

ReidBar Reinforcing Bar System

Performances: Large Strains
According to NZS3101:2006 A3 & AS/NZS 4671

Annex C 2

Table C3: Characteristic values of resistance Anchorage: Cl 8.6.11.1 & Cl 8.6.11.2 - NZS 3101:2006 A3

Characteristic Ultimate Steel Tensile Capacity $N_{us} = f_{sy}$					
ReidBar Size			**RB12**	**RBA16**	**RB20**
ReidBar Grade 500E	N_{us}	[kN]	56.5	100.5	157.0
Capacity Reduction Factor	ϕ_s	[-]	0.75		

Concrete Cone Failure in Non-Cracked Concrete f'c = 40 MPa														
RBar Size	**Part Number**	**Installat'n details**	**Eff've depth h_{ef} (mm)**	**Min Edge Dist., e (mm)**	**Min.[3] Conc. thick b_w (mm)**	**Cap. Red'n Fctr, ϕ_c**	**Characteristic Ultimate Tensile Capacity Concrete Cone Failure Tension, N_{uc} (kN) per anchor[2)] Anchor Spacing, a_1 [mm]**							
							150	**200**	**250**	**300**	**350**	**400**	**450**	**500**
12	RB12TI	8mm thick Nailing Plate & EPCON C8	104	150	150	0.65	39.1	52.1	65.1	79.1[1)]	83.7[1)]	83.7[1)]	83.7[1)]	83.7[1)]
16	RBA16TI		121	180	200		43.2	57.6	72.0	86.4	113.1[1)]	113.1[1)]	113.1[1)]	113.1[1)]
20	RB20TI		151	240	200		48.6	64.8	81.0	97.2	113.3	129.5	145.7	146.7

Concrete Cone Failure in Cracked Concrete f'c = 40 MPa														
Rbar Size	**Part Number**	**Installation accessories**	**Eff've depth h_{ef} (mm)**	**Min Edge Dist., e (mm)**	**Min.[3] Conc. thick b_w (mm)**	**Cap. Red'n Fctr, ϕ_c**	**Characteristic Ultimate Tensile Capacity Concrete Cone Failure Tension, N_{uc} (kN) per anchor[2)] Anchor Spacing, a_1 [mm]**							
							150	**200**	**250**	**300**	**350**	**400**	**450**	**500**
12	RB12TI	8mm thick Nailing Plate & EPCON C8	104	150	150	0.65	31.2	41.7	52.1	63.0[1)]	66.1[1)]	66.1[1)]	66.1[1)]	66.1[1)]
16	RBA16TI		121	180	200		34.6	46.1	57.6	69.1	71.2[1)]	71.2[1)]	71.2[1)]	71.2[1)]
20	RB20TI		151	240	200		38.9	51.8	64.8	77.7	90.7	103.6	116.6	117.4

Threaded Inserts used alone as anchorage in Non-Cracked Concrete f'c = 40 MPa								
Rbar Size	**Part Number**	**Installation accessories**	**Eff've depth h_{ef} (mm)**	**Min Edge Dist., e (mm)**	**Min.[3] Conc. thick b_w (mm)**	**Cap. Red'n Fctr, ϕ_c**	**Gr500E ReidBar $1.5xf_{sy}$ (kN) as per NZS3101:2006 (A3) Cl 8.6.11.2**	**Characteristic Ultimate Tensile Capacity Single Anchor Capacity without damage to concrete Tension, N_{ur} (kN) per anchor[2)]**
12	RB12TI	8mm thick Nailing Plate & EPCON C8	104	160	150	0.65	84.7	84.7[1)]
16	RBA16TI	42mm deep rebate & EPCON C8	155	240	200		150.8	150.8[1)]
20	RB20TI	67mm deep rebate & EPCON C8	210	315	250		235.5	235.5

[1)] Capacity data has been validated through testing at ramsetreid facility, independently witnessed by Melbourne Testing Services, a NATA accredited laboratory. ***Test Report Reference MTS-18-1019-A, B & C.***
Data also validated for performance equivalency of DCI vs STEEL components at ramsetreid Product Engineering Laboratory. ***Test Report Reference TRR 53.***
[2)] Capacity data is derived by calculation in accordance with ***NZS3101:2006 (A3) Section 17***
[3)] All capacity data is based on minimum concrete thickness listed in table. For capacity data based on other concrete thicknesses, please calculate in accordance with ***NZS3101:2006 (A3) Section 17***

Table C4: Mode of Failure – Cl 8.6.11.1, 8.6.11.2, 8.6.11.3 NZS 3101:2006 A

Sample	Part No.	No. (of Samples Tested)	Criteria assessed			Test report reference(s)
			UTS [MPa]		Mode of Failure	
			$UTS_{(min)}$	$UTS_{(max)}$		
ReidBar Threaded Inserts						
12mm Threaded Inserts	RB12TI	3	641.1	643.5	3 ReidBar ductile failure clear of Component	WSP–Opus Phase A1 5–24E97.00/A1–01
16mm Threaded Inserts	RBA16TI	3	657.7	659.9	3 ReidBar ductile failure clear of Component	WSP–Opus Phase A1 5–24E97.00/A1–01
20mm Threaded Inserts	RB20TI	3	655.1	660.9	3 ReidBar ductile failure clear of Component	WSP–Opus Phase A1 5–24E97.00/A1–01

Table C5: Resistance to brittle fracture – Cl 8.6.11.4 NZS 3101:2006 A3

Samples	Material	Temperature (of Tested Samples) [°C]	Criteria assessed: Minimum Service Temp. [°C]	Criteria assessed: Abstract from 'Summary of Outcomes from ReidBrace Testing at the University of Auckland"	Test report reference (s)
ReidBrace* Components 12,16mm, 20mm, 25mm Total No. of Test samples:28	Spheroidal Graphite Iron Grade 600/3	0° ≤ T ≤ -10°	-5°	"Component failures occasionally occurred when they were tested under impact tensile loading at −10˚ C, however improvement in performance was noted when tested at −5˚ C. It was therefore theorised that the ductile to brittle transition temperature of the product lies between −5˚ C and −10˚ C, and that the service temperature for the design of the ReidBrace System shall be limited to −5˚ C."	Static and Dynamic Testing of ReidBrace™ System [25/05/18 – The University of Auckland] & Summary of Outcomes from ReidBrace Testing at the University of Auckland [30/08/18 – The University of Auckland]

* All tested components are part of the ReidBrace system, which utilizes the same reinforcing bars (ReidBar, grade 500E reinforcement) and the fittings are made of the same material.

ReidBar Reinforcing Bar System

Performances: Resistance to Brittle Fracture
According to NZS3101:2006 A3 & AS/NZS 4671

Annex C5