Construction Systems

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Product Engineering Laboratory

Reid™ Product Engineering Laboratory
All testing has been performed by independent IANZ accredited testing laboratories. See below for details.

Reinforcement Technical Assessment

RTA-22/0014
of 19/12/2022

This Technical Assessment meets the testing requirements stipulated in clauses 8.7.5.2, 8.9.1.3, 8.6.11 of NZS 3101:2006 A3

Trade name of the construction product	ReidBar™ Steel Components: Couplers
Product family to which the construction product belongs	ReidBar™ Reinforcement System used in concrete structures sizes RB12, RBA16, RB20, RB25 & RB32
Manufacturer	Reid Construction Systems 1 Ramset Drive Chirnside Park Victoria 3116 Australia
Manufacturing plant	Reid Construction Systems
This Technical Assessment contains:	14 pages & 10 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 & NZTA Bridge Manual 3rd Edition A4	Tests performed by WSP Opus Research Reference reports: 5-24E97.00/A2-01, 5-24E97.00/C1-01, 5-24E97.00 Phase E, 15-524D57.00, 15-524D03.00, 14-524C90.00, 13-524C60.00, 1-L0140.38 Tests performed by X-Ray Laboratories Ltd Reference reports: 11966,7380, 9606A1
This Assessment replaces:	RTA-19/0001 of 23/04/2020

1. Technical description of the product

ReidBar™ Steel Couplers are used as part of the ReidBar™ Mechanical Splicing System.

All ReidBar™ components in this report are Steel elements and the ReidBar reinforcing steel is Grade 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 reinforcement mechanical splicing system is used in compliance with the specifications and conditions given in Annex B.

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) NZTA Bridge Manual 3rd ed. A4: Cl 4.2.1 (f) (i)	See Annex C1
High Cycle fatigue NZS 3101:2006 A3: Cl 8.7.5.2 (c), 8.9.1.3 (b) NZTA Bridge Manual 3rd ed. A4: Cl 4.2.1 (f) (i)	See Annex C2
Alternating Large Strains NZS 3101:2006 A3: Cl 8.9.1.3 (a) NZTA Bridge Manual 3rd ed. A4: Cl 4.2.1 (f) (i)	See Annex C3
Ultimate Tensile Strength NZS 3101:2006 A3: Cl 8.6.11.1 & 8.6.11.2 NZTA Bridge Manual 3rd ed. A4: Cl 4.2.1 (f) (i)	See Annex C4
Mode of Failure NZS 3101:2006 A3: Cl 8.6.11.1, 8.6.11.2, 8.6.11.3 NZTA Bridge Manual 3rd ed. A4: Cl 4.2.1 (f) (i)	See Annex C5
Resistance to Brittle Fracture NZS 3101:2006 A3: Cl 8.6.11.4 NZTA Bridge Manual 3rd ed. A4: Cl 4.2.1 (f) (iv)	See Annex C6

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 & Cl 4.2.1 (f) (i) NZTA BM 3rd Edition A4

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.

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, is used to determine the maximum allowable elongation over the coupler length.

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 High Cycle fatigue – Cl 8.9.1.3 (b) NZS 3101:2006 A3 & Cl 4.2.1 (f) (i) NZTA BM 3rd Edition A4

ISO 15835-2:2009 §5.5 requires the test piece be subjected to an axial tensile force, which varies cyclically according to a sinusoidal wave-form of constant frequency in the elastic range.

Test and performance requirements:
• The mechanical splices shall sustain a fatigue loading of at least 2 megacycles.
• The frequency shall be between 1Hz and 200Hz.
• The stress range shall be 60MPa.
• The upper stress shall be 0.6 of the specified characteristic (or nominal) yield strength value of the reinforcing bar, $R_{eH,spec}$.

The test pieces shall comply with the performance requirements of ISO 15835-1 §5.4 without any failure.

The test was carried out under force control and the frequency of the load cycles was set at 20 Hz for all the samples.

3.2.3 Alternating tension and compression test of large strains – Cl 8.9.1.3 (a) NZS 3101:2006 A3 & Cl 4.2.1 (f) (i) - NZTA Bridge Manual 3rd Edition A4

For testing the performance of mechanical splices, ISO 15835-2:2009 §5.6.2 specifies the following loading programme:

• From zero strain up to twice the yield strain (strain at nominal yield strength) in tension followed by downloading to a strain corresponding to half of the stress of the nominal yield strength value of the reinforcing bar ($0.5R_{eH,spec}$) in compression, alternating 4 times.

• Thereafter, from zero strain up to five times the yield strain in tension, followed by downloading to a strain corresponding to the stress $0.5R_{eH,spec}$ in compression, alternating four times, followed by tensioning the test piece to failure.

Performance requirements are:

• Tensile strength: at least $R_{m,spec}$, or $R_{eH,spec} \times (R_m / R_{eH})_{spec}$

• Residual elongation: $u4 \leq 0.3$ mm, $u8 \leq 0.6$ mm

Where $R_{m,spec}$ is the nominal tensile strength value of the reinforcing bar, $R_{eH,spec}$ is the nominal yield strength value of the reinforcing bar, and (R_m / R_{eH})spec is the specified tensile/yield strength ratio of the reinforcing bar.

The strain/stress rates were set according to ISO 6892-1:2009 Metallic materials – Tensile testing – Part1: Method of test at ambient temperature.

For the Steel Couplers, in accordance with ISO 15835-2, the gauge length (L_c) should be equal to the coupler length plus eight times the diameter.

3.2.4 Ultimate Tensile Strength – Cl 8.6.11.1 & 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, and mechanical couplers, at clause 8.7.5.2 (a), are required to be capable of developing the Upper Bound Breaking Strength.

Specifically heat treated ReidBars are connected to the fittings to be tested against this requirement. The thermal treatment allows the bar to develop a tensile strength above the minimum 750MPa required for the test.

3.2.5 Mode of Failure – Cl 8.6.11.1 & 8.6.11.3 NZS 3101:2006 A3

This particular test is often paired with other tests, like the 0.7fy 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.

3.2.6 Resistance to Brittle Fracture – Cl 8.6.11.4 NZS 3101:2006 A3 & Cl 4.2.1 (f) (iv) NZTA Bridge Manual 3rd Edition A4

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.

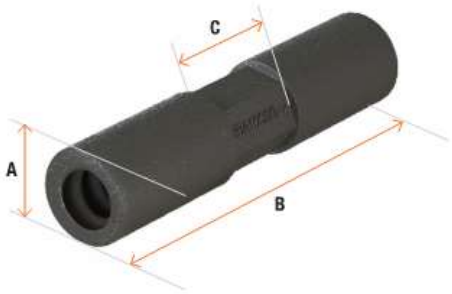
The NZTA Bridge Manual, at Clause 4.2.1 (f) (iv), provides more guidance on how to demonstrate resistance to brittle fracture through testing.

In accordance with AS 1544.2, a Charpy V-notched impact resistance equal to or greater than 27 Jules shall be achieved when standard 10mmx10mm test pieces are tested at 0°C. Test pieces of smaller cross section, as listed in AS/NZS 3678 Table 9, may be used when standard 10mmx10mm is impractical. For these smaller test pieces, the acceptance criteria shall correspond to the L0 impact designation given in Table 9 of AS/NZS 3678. An equivalent energy value is also provided, utilizing the equivalent energy factors from Table 2.6.5.5 (A) of AS 1210.

4 **Material Safety Data Sheet**

Refer to SDS ChemAlert SDS Date: 26 Apr 2022 Version No:1 (EPCON C8) for Safety Data Sheet according to New Zealand HSNO requirements.

ReidBar™ Steel Couplers
RB12CS, RBA16CS, RB20CS, RB25CS, RB32CS

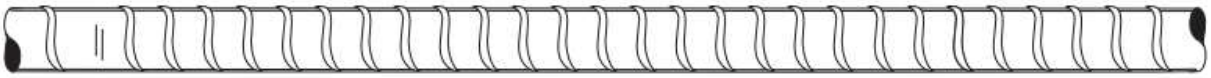


Part No.	Description	Body Diameter (A) (mm)	Length (B) (mm)	Hex A/F (C) (mm)	Min Threaded Depth (mm)
RB12CS	12mm ReidBar Steel Coupler	32	130	26	50
RBA16CS	16mm ReidBar Steel Coupler	32	136	26	54
RB20CS	20mm ReidBar Steel Coupler	35	148	32	60
RB25CS	25mm ReidBar Steel Coupler	42	193	38	80
RB32CS	32mm ReidBar Steel Coupler	60	242	52	102

NOTE: Hot dip galvanised finish also applicable

ReidBar™ Reinforcing bar RB12, RBA16, RB20, RB25, RB32

Seismic® 500E Micro Alloyed Reidbar™



Commercial reinforcing (E Class - Seismic) bar to AS/NZS 4671:2019

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

Mechanical connections subject to:

- Seismic, Static and quasi-static load.

Base materials

- Non-cracked and cracked concrete for reinforcing bars RB12 to RB32.
- Reinforced or unreinforced normal weight concrete for use in construction in accordance with NZS 3101:2006 A3 and NZTA Bridge Manual 3rd Edition A4.

Design:

- The Mechanical Spliced Connections are designed in accordance with the "Standards New Zealand NZS 3101:2006 A3 – Concrete Structures Standard" and the NZTA Bridge Manual 3rd Edition A4 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 transferred over the spliced connection. The position of the anchor or connection is indicated on the design drawings.

Installation:

- Reinforcement installation carried out in accordance with ReidBar connection installation procedures (including the application of EPCON C8 thread filler in the ReidBar 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	

Installation instructions

Steps

ReidBar Steel Coupler Installation Guidelines below:

Ensure the appropriate PPE is worn when working with Ramset Epcon C8 XTREM.
Refer to www.ramset.co.nz for Epcon C8 XTREM MSDS Sheet.

ReidBar™ Steel Coupler	**Annex B 2**
Intended use Installation procedure	

Table C1: Elongation at 0.7fy: Cl 8.7.5.2 (b) NZS 3101:2006 A3
Cl 4.2.1 (f) (i) - NZTA Bridge Manual 3rd Edition A4

Sample	Part No.	Lg Gauge length [mm]	Lc Coupler length [mm]	No. (of Sampl. Tested)	ε_{350} Non-spliced ReidBar strain at $0.7f_y$	$0.7\ f_y$	Criteria assessed over Lc (coupler length)		Test report reference(s)
							Aver. displ. (over coupl. Length)	Allw. max. displ. (over coupl. length)	
					[mm/m]	[kN]	[mm]	[mm]	
ReidBar Steel Couplers									
12mm Steel Coupler	RB12CS	226	130	5	2.12	39.55	0.09	0.55	WSP-Opus 5-24E97.00/C1-01
16mm Steel Coupler	RBA16CSG	264	136	5	2.07	70.35	0.15	0.56	WSP-Opus 5-24E97.00/A2-01
20mm Steel Coupler	RB20CSG	308	148	5	1.86	109.9	0.20	0.55	WSP-Opus 5-24E97.00/A2-01
25mm Steel Coupler	RB25CSG	393	193	5	1.77	171.85	0.28	0.68	WSP-Opus 5-24E97.00/A2-01
32mm Steel Coupler	RB32CSG	498	242	5	2.04	281.4	0.29	0.99	WSP-Opus 5-24E97.00/A2-01

Table C2: High Cycle Fatigue: Cl 8.7.5.2 (c) & 8.9.1.3 (b) - NZS 3101:2006 A3
Cl 4.2.1 (f) (i) - NZTA Bridge Manual 3rd Edition A4

Sample	Part No.	No. (of Samples Tested)	In accordance with ISO 15835-1 & ISO 15835-2						Test report reference(s)
			Freq.	No. of cycles	Nomin. Yield Str. f_y	Cycle upper stress	Cycle lower stress	Result	
			[Hz]	`	[kN]	[kN]	[kN]		
ReidBar Steel Couplers									
16mm Steel Coupler	RBA16CSG	3	20	2,000,000	100.6	60.36	48.3	Pass	WSP-Opus 15-524D57.00 15-524D03.00
20mm Steel Coupler	RB20CSG	1	20	2,000,000	157.0	94.2	75.4	Pass	WSP-Opus 15-524D03.00
25mm Steel Coupler	RB25CSG	2	20	2,000,000	245.5	147.3	117.8	Pass	WSP-Opus 15-524D57.00 15-524D03.00
32mm Steel Coupler	RB32CSG	3	20	2,000,000	402.0	241.2	193.0	Pass	WSP-Opus 15-524D57.00 15-524D03.00

Table C3: Large Strains: Cl 8.9.1.3 (a) - NZS 3101:2006 A3
Cl 4.2.1 (f) (i) - NZTA Bridge Manual 3rd Edition A4

Sample	Part No.	No. (of Samples Tested)	Criteria assessed						Test report reference(s)
			ISO $u_4 \leq 0.3$mm [mm]		ISO $u_8 \leq 0.6$mm [mm]		UTS ≥575MPa [MPa]		
			$u_{4(min)}$	$u_{4(max)}$	$u_{8(min)}$	$u_{8(max)}$	$UTS_{(min)}$	$UTS_{(max)}$	
ReidBar Steel Couplers									
12mm Steel Coupler	RB12CS	3	-0.08	-0.01	-0.01	0.07	639.8	642.5	WSP-Opus 5-24E97.00/C1-01
16mm Steel Coupler	RBA16CSG	3	0.02	0.03	0.06	0.09	645	670	WSP-Opus 15-524D57.00 & 14-524C90.00
20mm Steel Coupler	RB20CSG	3	0.01	0.03	0.13	0.15	657.2	660.1	WSP 5-24E97.00 Phase E
25mm Steel Coupler	RB25CSG	2	0.09	0.10	0.22	0.22	670	705	WSP-Opus 13-524C60.00
32mm Steel Coupler	RB32CSG	3	0.02	0.17	0.21	0.34	680.3	681.9	WSP 5-24E97.00 Phase E

Table C4: Ultimate Tensile Strength – Cl 8.6.11.1 & 8.6.11.2 NZS 3101:2006 A3
Cl 4.2.1 (f) (i) - NZTA Bridge Manual 3rd Edition A4

Sample	Part No.	No. (of Samples Tested)	Criteria assessed			Test report reference(s)
			UTS ≥750MPa [MPa]		Mode of Failure	
			$UTS_{(min)}$	$UTS_{(max)}$		
ReidBar Steel Couplers						
12mm Steel Coupler	RB12CS	5	895.6	937.2	5 hardened ReidBar break	WSP-Opus 5-24E97.00/C1-01
16mm Steel Coupler	RBA16CSG	4	1015	1149	4 hardened ReidBar break	WSP-Opus 1-L0140.38 & ITW Test Rep. V3.8
20mm Steel Coupler	RB20CSG	5	828.7	937.9	5 hardened ReidBar break	WSP 5-24E97.00 Phase E
25mm Steel Coupler	RB25CSG	5	951	1035	2 hardened ReidBar break 3 Coupler split	ITW Test Rep. V3.8
32mm Steel Coupler	RB32CSG	5	782.7	931.1	5 hardened ReidBar pull out	WSP 5-24E97.00 Phase E

Table C5: Mode of Failure – Cl 8.6.11.1, 8.6.11.2, 8.6.11.3 NZS 3101:2006 A3
Cl 4.2.1 (f) (i) NZTA Bridge Manual 3rd Edition A4

Sample	Part No.	No. (of Samples Tested)	Criteria assessed			Test report reference(s)
			UTS [MPa]		Mode of Failure	
			$UTS_{(min)}$	$UTS_{(max)}$		
ReidBar Steel Couplers						
12mm Steel Coupler	RB12CS	3	639.8	642.5	3 ReidBar ductile failure clear of coupler	WSP-Opus 5-24E97.00/C1-01
16mm Steel Coupler	RBA16CSG	5	645	672	5 ReidBar ductile failure clear of coupler	WSP-Opus 1-L0140.38 WSP-Opus 15-524D57.00 WSP-Opus 14-524C90.00
20mm Steel Coupler	RB20CSG	3	657.2	660.1	3 ReidBar ductile failure clear of coupler	WSP 5-24E97.00 Phase E
25mm Steel Coupler	RB25CSG	2	670	705	2 ReidBar ductile failure clear of coupler	WSP-Opus 13-524C60.00
32mm Steel Coupler	RB32CSG	3	680.3	681.9	3 ReidBar ductile failure clear of coupler	WSP 5-24E97.00 Phase E

Table C6: Resistance to brittle fracture – Cl 8.6.11.4 NZS 3101:2006 A3
Cl 4.2.1 (f) (iv) NZTA Bridge Manual 3rd Edition A4

Sample	Part No.	No. (of Samples Tested)	Criteria assessed		Test report reference(s)
			Energy Absorbed at 0°C (Average) [J]	Comments	
ReidBar Steel Couplers					
12mm Steel Coupler	RB12CS	3	14* (40J equiv.)	2.5x10 samples, equivalent energy on a standard 10x10 sample in brackets	X-Ray Lab 11966
16mm Steel Coupler	RBA16CSG	3	105	10x10 samples (from billet)	X-Ray Lab 7380
32mm Steel Coupler	RB32CSG	3	103	10x10 samples	X-Ray Lab 9606A1

* Sub-size sample, value in brackets reports the equivalent energy on a standard 10mmx10mm sample.