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5–8 September 2021 • Virtual Conference

Smart & Innovative Concrete from Disruption

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Don't Break the Reo Quality Chain

Scott Munter – Executive Director (Presenter)
Eric Lume – National Engineer
Steel Reinforcement Institute of Australia (SRIA)

Scott Munter

Eric Lume

SRIA

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What is the REO Quality Chain?

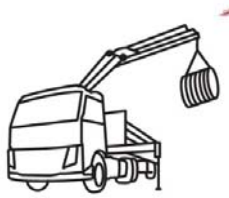
Seamless chain of events from manufacture, processing and site practices to deliver an NCC compliant solution that guarantees the quality and reduces the risk to the client.

JAS-ANZ accredited third party Processor Certificate guarantees quality and traceability through the supply chain.

SRIA Members meet these requirements.

Poor Site Practices can result in non-conforming reinforcement

REO quality and traceability chain



STEEL MILL
A JAS-ANZ accredited **3rd Party Mill Certificate** Certifies the **stock bar and rod** conforms to AS/NZS 4671.

Step 1

PROCESSOR
A JAS-ANZ accredited **3rd Party Processor Certificate** certifies the **processed bar and welded mesh** conforms to AS/NZS 4671, And complies with AS 3600 and AS 5100.5.

Step 2

BUILDER
Provides a JAS-ANZ accredited **3rd Party Processor Certificate** (ACRS or equivalent) to the **Engineer** and **Building Certifier** to guarantee REO quality.

Step 3

CLIENT
Confident the structure is **safe and robust, and meets the NCC.**

Step 4

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What are the Minimum Quality Requirements?

AS/NZS 4671 (2019) Steel for the reinforcement of concrete

- Mechanical, physical and chemical properties.
- Frequency of testing
- Weldability of conforming steel
- Demonstrating product conformity

AS 3600 (2018) Concrete structures

- Properties, bending, tolerances & site practices

AS 5100.5 (2017) Bridge design, Part 5: Concrete

AS/NZS 1554.3 (2014) Structural steel welding,
Part 3: Welding of reinforcing steel

- Correct welding procedures

Importance of conformity

Brittle fracture

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Manufacturing Reinforcement – Step 1 Steel Mill

Ensure reinforcement complies with AS/NZS 4671

- Steel Composition – Carbon Equivalence Value (*CEV*)
- Mechanical Properties

Property		500L	500N	600N	750N	Type of specified value
Nominal Diameter (mm)		5 to 12	10 to 40	10 to 40	10 to 40	-
Yield Stress (MPa)	$R_{ek.L}$ $R_{ek.U}$	≥ 500 ≤ 750	≥ 500 ≤ 650	≥ 600 ≤ 750	≥ 750 ≤ 900	C_{vL}: P = 0.95 C_{vU}: P = 0.05
Ratio	(R_m/R_e)k.L	≥ 1.03	≥ 1.08	≥ 1.08	≥ 1.04	C_{vL}: P = 0.90
Uniform Elongation (%)	$A_{gt.k.L}$	≥ 1.5	≥ 5.0	≥ 5.0	≥ 4.0	C_{vL}: P = 0.90

- Geometric Properties – diameter, cross-sectional area, mass and straightness
- Surface Geometry – geometry and spacing or ribs
- Quality of Finished Bar – free of defects that affect end use

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Processing Reinforcement – Step 2 Processor

Scheduling, cutting and bending manufactured reinforcement (coils & straight bars) to the required shape

Steel processor defined in AS/NZS 4671

Processing can alter the mechanical properties of certified mill feed

Certification essential to ensure processed reinforcement also conforms to the Standards

Off-coil machine

Bench bending machine

Bars bent in brake press

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Prefabrication of Reinforcement

Reduces congestion on site and speeds up construction and improves quality control (with 3D modelling)

Ideal for complex reinforcement cages

Welding (& wire tying) typically used to secure bars

Consider stability of cages and lifting points

Prefabricated vertical element & 3D model

Prefabricated beam cage for Chatswood Railway Station

Prefabricated footing cage for Sydney Light Rail

Braced column cage

Vertical infrastructure element

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Welding of Steel Reinforcement

AS/NZS 1554.3 (2014) – Covers correct welding procedures for reinforcing steels including:

- Locational welds (tack welds)
- Non-loadbearing welded joints

Recommend welding carried out in a processor facility

- site welding typically poor quality & lacks the prequalification processes

Manual welding of reinforcement cage in SRIA processor facility

Prefabrication of reinforcement cage using machine welding

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Role of Certification

Verify conformance

Third party

SRIA members use ACRS

ACRS Certification for Reo

- AS/NZS 4671
- Based on UK CARES

Risks with non-conforming reinforcement

Example of Mill Certificate

- Covers manufacturing
- **Step 1 of Reo Quality Chain**

VALID TO 31 DEC 2021

Australasian Certification Authority for Reinforcing and Structural Steels Ltd

ACRS PRODUCT CERTIFICATION

CERTIFICATE OF PRODUCT PERFORMANCE
Manufactured Product

Certificate Number: 31102

InfraBuild

INFRABUILD STEEL
LAVERTON, VIC, AUSTRALIA

has satisfied the Authority that it complies with the rules of the ACRS Product Certification Scheme, and the relevant ACRS Quality and Operations Assessment Procedures. Where appropriate, and as listed below, it has further satisfied the Authority that it manufactures and/or supplies products that conform with the standards listed below, and is entitled to use the ACRS mark in relation to the products listed on this certificate.

SCOPE OF CERTIFICATION

Reinforcing Bar Manufactured in straight lengths to AS/NZS 4671: 2019

Products listed on this Manufactured Product certificate may be relied upon as having the benefit of ACRS Product Scheme certification after any subsequent processing only if cut, or bent, or welded by an ACRS certified processor. For Approval of processed reinforcing bar, refer to the bar processor's ACRS Fabricated Product certificate.

Full details of the products for which certification has been achieved should be viewed at: www.steelcertification.com

By authority of ACRS Board: Phillip Sanders, Executive Director

Valid until: 31 December 2021

First certified: November 2003

JAS-ANZ

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Products manufactured :

AS/NZS 4671 Grade 500N Ribbed Bar

Bar	
	12, 16 mm ✓
	20, 24, 28 mm ✓
	32, 36, 40, 50 mm ✓

AS/NZS 4671 Grade 500E Microalloyed Ribbed Bar

Bar	
	12, 16 mm ✓
	20, 25 mm ✓
	32, 40 mm ✓

AS/NZS 4671 Grade D250N Ribbed Bar

Bar	
	12 mm ✓

Bar Markings

D250N and D500N Straight Bar

Laverton Bar Mill mark

Grade 500E Microalloyed Bar

Laverton Bar Mill mark

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Straight Bar Manufactured to AS/NZS 4671:2001
Manufactured Bars listed on the ACRS Certificate, only remain ACRS Certified if cut, or bent, or welded by an ACRS certified processor.

For Approval of processed reinforcing bar, refer to the bar processor's ACRS Fabricated Product certificate.

VALID TO 31 DEC 2021

Australasian Certification Authority for Reinforcing and Structural Steels Ltd

ACRS PRODUCT CERTIFICATION

CERTIFICATE OF PRODUCT PERFORMANCE
Manufactured Product

Products assessed by ACRS to AS/NZS 4671:2019

To be read in conjunction with Certificate Number: 31102

InfraBuild

INFRABUILD STEEL
LAVERTON, VIC, AUSTRALIA

has satisfied the Authority that it complies with the relevant ACRS Quality and Operations Assessment Procedures. Where appropriate, and as listed below, it manufactures products as indicated by "✓" below and is entitled to use the ACRS mark with these products.

Products manufactured :

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Role of Certification

ACRS Processor Certificate

Certifies processed bar and welded mesh conforms to:

- AS/NZS 4671
- AS 3600
- AS 5100.5
- NZS 3109

Step 2 of Reo Quality Chain

VALID TO 31 DEC 2021

Australasian Certification Authority for Reinforcing and Structural Steels Ltd

ACRS PRODUCT CERTIFICATION

CERTIFICATE OF PRODUCT PERFORMANCE
Fabricated Product

Certificate Number: 811021

AUSREO

AUSREO
WETHERILL PARK, NSW, AUSTRALIA

has satisfied the Authority that it complies with the rules of the ACRS Product Certification Scheme, and the relevant ACRS Quality and Operations Assessment Procedures. Where appropriate, and as listed below, it has further satisfied the Authority that it manufactures and/or supplies products that conform with the standards listed below, and is entitled to use the ACRS mark in relation to the products listed on this certificate.

Scope of Certification

Processing and distribution of carbon steel bars, welded mesh.

a) Processing and distribution of carbon steel bars and welded mesh in accordance with AS/NZS 4671:2001, and either AS 3600:2018 Concrete structures and AS 5100.5:2017 Bridge design – Concrete "material and construction requirements for reinforcing steel", or the "Reinforcement" clauses of NZS 3109 Concrete Construction.

Processed steel reinforcing materials may only be relied upon as having the benefit of ACRS Product Scheme certification when manufactured by ACRS certified mills. Please refer to the manufacturer's ACRS certificates for details.

Full details of the products for which certification has been achieved should be viewed at: www.steelcertification.com

By authority of ACRS Board: Philip Sanders, Executive Director

Valid until: 31 December 2021

First certified: November 2008

JAS-ANZ

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Carbon steel bars and welded mesh are in accordance with AS/NZS 4671 (2001 or 2019) and reinforcement clauses in:

- *AS 3600 (2018) Concrete structures*
- *AS 5100.5 Bridge design – Concrete*
- *NZS 3109 Concrete Construction*

Processed steel reinforcing materials may only be relied upon as having the benefit of ACRS Product Scheme certification when Manufactured by ACRS certified mills.

AS/NZS 4671 Grade 500L Mesh

Square Mesh	SL62	✓
	SL72	✓
	SL81	✓
	SL82	✓
	SL92	✓
	SL102	✓
Rectangular Mesh	RL718	✓
	RL818	✓
	RL918	✓

Products Certified

VALID TO 31 DEC 2021

Australasian Certification Authority for Reinforcing and Structural Steels Ltd

ACRS PRODUCT CERTIFICATION

CERTIFICATE OF PRODUCT PERFORMANCE
Fabricated Product

Products assessed by ACRS to AS/NZS 4671:2001

To be read in conjunction with Certificate Number: 81102

AUSREO

AUSREO
WETHERILL PARK, NSW, AUSTRALIA

has satisfied the Authority that it complies with the relevant ACRS Quality and Operations Assessment Procedures. Where appropriate, and as listed below, it manufactures products as indicated by "✓" below and is entitled to use the ACRS mark with these products.

Products manufactured :

JAS-ANZ

Note: ACRS Processor Certificate only available if reinforcement supplied by ACRS Certified Mill

Importance of JAS-ANZ Accreditation

Joint Accreditation System of Australia and New Zealand (JAS-ANZ)

Government appointed body

Does not certify or inspect organisations, but accredits the bodies such as ACRS that do

Certifiers and inspectors must meet minimum assessment criteria

Provides assurance that certifiers and inspectors are:

- Independent
- Competent to perform their duties

Internationally recognised assessment

Using a third party JAS-ANZ accredited body such as ACRS

- Assures clients that assessment is truly independent, and
- Certificate can be relied on as evidence of conformity

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Site Practices and Quality – Surface Condition of Reinforcement

Step 3 of Reo Quality Chain

Ensure no loose or flaking rust on surface of bar

Indicates loss of steel section (or mass) which may affect performance

Limits on mass provided in Table 7.5 (A) of AS/NZS 4671

If outside these limits, then non-conforming

Refer also SRIA Technical Note 1

Surface corrosion on bars
Acceptable

Loose and flaking rust on mesh
Unacceptable

N20 Bar

SL72 Bar

Loose and flaking rust on bars
Unacceptable

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Site Practices and Quality – Site Bending of Reinforcement

Step 3 of Reo Quality Chain

Often carried out incorrectly

Correct procedures covered in Clause 17.2.3 of AS 3600

Site rebending now covered by Clause 17.2.3.2 of AS 3600 (2018) due to poor site practices

Overheating to facilitate bending a common problem and will be dealt with shortly

Use of pipes for leverage no longer allowed in AS 3600 due to a lack of control on site

Bent starter bars

Starter bars backed over by truck on site

Using heat to bend bars

Using pipe to bend bars

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Site Practices and Quality – Site Bending of Reinforcement

Step 3 of Reo Quality Chain

Site bending should be carried out using suitable tools

Manual benders only up to 16 mm dia. bars due to pin dia. & difficulty with larger bars

Ensure electric benders are suitable for bar size being bent – 5 bar dia. pin required

Recommend that bars be correctly bent off site by a processor wherever possible

Incorrect bending will result in a non-conforming bar and potential performance issues

Manual bar bender
Max. 16 mm

Electric bar bender
Max. 20 mm (100 dia. Pin)

Bending tool with various
pin diameters available

Electric bar bender
No pin? Compliance?

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Site Practices and Quality – Heating & Cutting of Reinforcement

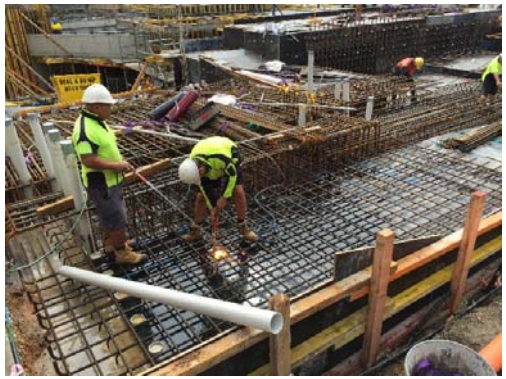
Step 3 of Reo Quality Chain

Hot bending temperature requirements are covered in Clause 17.2.3.1(b) of AS 3600

Temperature should not exceed 600^{o}C

If more than 450^{o}C, yield stress to be taken as 250 MPa and design assessment required

From the temperature colour chart, if any redness is visible, assume 250 MPa yield stress



Uncontrolled site cutting bars for services

Oxy damage to bars

Bending bars

Colour	C
Faint Red	600
Dark Red	700
Cherry Red	800
Dull Orange	900
Orange	950
Lemon Yellow	1000
Yellow	1050
Bright Yellow	1100
White	1200
Glowing White	1300

Temperature colour chart for steel

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Site Practices and Quality – Support of Reinforcement

Step 3 of Reo Quality Chain

Use of bar chairs now covered by Clause 17.2.5 of AS 3600 referencing AS/NZS 2425

Engineers must specify load carrying capacity and spacing of chairs for loads

Spacing of bar chairs should be 600 mm to 800 mm maximum as covered in NCC

Walking in or pulling up reinforcement should not be allowed

For slab-on-ground work, ensure adequate base to support bar chairs

(a) Deformation of mesh under truck

(b) Cracking from placement in (a)

(c) Mesh bent and incorrectly located

(d) Driveway with no bar chairs

Site Practices and Quality – Support of Reinforcement

Step 3 of Reo Quality Chain

Bar chairs to comply with AS/NZS 2425 Bar chairs in concrete – Product requirements

Use appropriate type of bar chair for application

Includes 4 load capacities – 60, 120, 200 and >300 kg

For concrete bar chairs, specify chloride permeability for durability of cover concrete

- Very low, low, moderate or high classifications included

Note: Hurdles typically specified by scheduler

Types of bar chairs

Plastic

Plastic tipped wire

Concrete

Processor fabricated hurdles

Site Practices and Quality – Impact of Reinforcement

Step 3 of Reo Quality Chain

Clause 17.2.3.1 of AS 3600:

- Bars can be bent cold or hot
- If bent cold, bend around conforming pin with uniform motion to:
  "Avoid impact loading of the bar and mechanical damage to the bar surface"
- *"Bars shall not be bent using impact, such as with hammers"*

Damage due to impact can cast doubt on reinforcement quality which may not be the reality

Fracture due to hammer impact (flattened ribs)

Bending cold is possible if done correctly

Site Practices and Quality – Services Planning

Step 3 of Reo Quality Chain

Reinforcement detailing must allow for services

Cutting and bending reinforcement on site to fit services may be impossible

Coring holes through reinforcement afterwards needs careful design assessment

No provision allowed for required service

Reinforcement detailed for services with designated block out

Site Practices and Quality – Site Welding

Step 3 of Reo Quality Chain

Site welding practices can affect performance of reinforcement

Numerous enquiries relating to weld quality received

Welding must conform to AS/NZS 1554.3 ideally in processor facility

Avoid site welding wherever possible

Weld Australia is an excellent resource for information

Good Quality
Factory welding

Good Quality
Factory welding

Poor Quality welding
porosity

Poor Quality welding
unsuitable tack

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Conclusions & Recommendations

Quality chain includes:

- Manufacture – Mill 'controlled' (**Step 1**)
- Processing – Processor 'controlled' (**Step 2**)
- Welding and various site practices – Builder, Engineer & Certifier 'controlled' (**Step 3**)
- Each stage can affect the properties of the quality certified reinforcement

Obtain a JAS-ANZ accredited third party **Processor** Certificate to guarantee quality supply

- All SRIA members must meet these strict eligibility requirements to obtain SRIA membership to guarantee quality of supplied reo and deliver market confidence

To reduce the risk of non-conforming steel reinforcement on your project:

- Don't Break the Reo Quality Chain ie SRIA Processors mitigate your supply risk but

Ensure poor site practices do not result in non-conforming reinforcement

- delivers client confidence the structure is safe, robust & meets NCC (**Step 4**)

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Thank You

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