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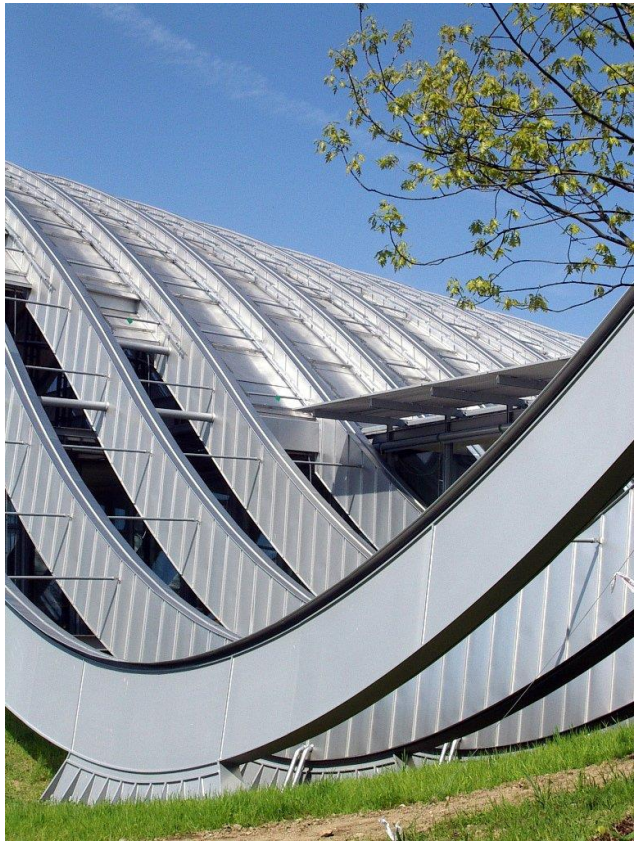
Queensland IPWEA INSTITUTE OF PUBLIC WORKS ENGINEERING AUSTRALASIA

HOW TO REDUCE THE RISK OF STRUCTURAL STEELWORK FAILING IN YOUR PROJECTS



AUSTRALIAN STEEL INSTITUTE

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Outline:

- Introduction
- Problems to be addressed
- Case Study
- Australian Standards AS 4100, AS/NZS 5131
- Construction Categories
- De-specification and Product Substitution
- The National Structural Steelwork Compliance Scheme (NSSCS)
- ASI Awareness

Introduction

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About the Australian Steel Institute

The Australian Steel Institute (ASI) is the nation's peak body representing the entire steel supply chain, from the primary producers through to end users in building and construction, resources, heavy engineering and manufacturing.

A not for profit, member-based organisation, the ASI's activities extend to; advocacy and support, steel excellence, standards and compliance, training, events and publications. The ASI provides marketing and technical leadership to promote Australian-made and fabricated steel as the preferred material to the building, construction, resources, and manufacturing industries, as well as policy advocacy to government.

	Membership representation			
Product supply chain:	Steel mills	Distributors	Roll formers	Fabricators
Services:	Galvanizers	Paint Coating	Support services	Detailers
Professional:	Builders	Engineers	Specifiers	Educators

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Introduction

- Our WTO obligations open the door to international trade
- But… who polices that door, and how and when?
- It has worked for Australian sourced product because we have a legal system.
- Legal measures are not easy internationally…

A very simple question that goes to **your** duty of care:

How can a structure be safe when the veracity of the steel and steelwork in that structure cannot be established?

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Problems to address to mitigate risk

The problems we see in the market:

1. Some overseas steel falsely represented as being produced to full compliance with Australian Standards.
2. Deliberate fraud.
3. Lack of definition of responsibilities for critically evaluating compliance and approving product.
4. Engineers infrequently contracted for site or product surveillance.
5. Lack of transparency with NCP problems – most are hushed up.
6. A lack of understanding of how to assess compliance correctly

Problems to address to mitigate risk

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FRAUD

’Silastic’ welds

Water-filled members

MATERIALS

Pressure vessel cracking

Material cracking

Bolt failures

Poor galvanising

WORKMANSHIP

Poor welding

Poor workmanship

Poor painting

Weld cracking

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Case Study – Steel Truss

Non-compliant imported steel fabrication for a steel truss supporting a glass sound barrier

Project: A glass acoustic noise barrier alongside a Sydney roadway, comprising a 62m span triangular tubular truss fabricated from up to 250 mm square steel hollow sections.

Details of the failure: This project was put out to tender, and the winning tender (lowest price) was based on imported fabricated steelwork from Vietnam. The resulting imported fabricated steelwork illustrated significant defects with the truss defecting on installation.

Case Study – Steel Truss

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Issues determined:

- Steel was well below the specified yield strength. Independently measured by a NATA certified laboratory at 338 MPa versus the 450 MPa specified.
- Lower capacity fillet welds used instead of the specified full penetration butt welds.
- The welded joints indicated weld cracking. Chord members displayed cracking in the steel.
- The workmanship of the tube and fabricated structure was non-compliant to Australian Standards.
- Many of the tubular members were below the design wall thickness i.e., lower capacity sections were utilised.
- The cross chords were filled with water, presumably to increase component weight to that specified for shipping purposes (suspected fraud).
- The protective coating was non-compliant. It was independently verified by a NACE certified coating inspector that the top urethane coat was missing, and signs of rusting were evident.

Poor paint finish

Wall thickness below specification

Under-cut (concave) weld below required thickness

Case Study – Steel Truss

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Outcome:

- Significant repairs made onsite, including reinforcing the areas where cracking occurred in the junction between cross beams and main truss beams and welding reinforcing tubing alongside sections of the cross beams that had split.
- Truss still failed in service and the fabricator responsible for importation of the truss structure went into insolvency.
- Project was rebuilt by an Australian fabricator to largely the same design but with compliant materials and workmanship.
- Initial cost difference between local and imported fabricated steel was approximately $100,000. The rectification and rebuild costs were approximately $810,000.
- Unfortunately, the ultimate responsibility was passed onto the engineer by the builder and the overall cost including legal fees was borne by the engineer's Professional Indemnity Insurance.

Fillet welded connection instead of butt weld

Australian Standards AS 4100, AS/NZS 5131

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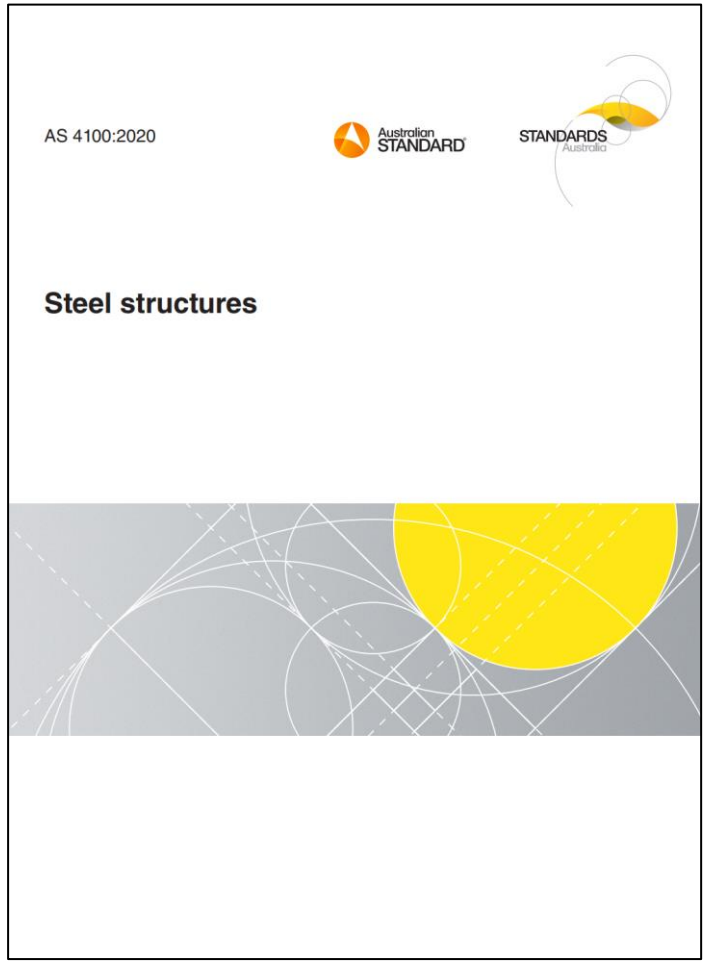
Changes in Australian Standards to address non-compliant structural steelwork

AS 4100:2020:

- Sets out minimum requirements for design of steel structures according to the limit states design concept
- Recent revision (August 2020) referenced AS/NZS 5131 for fabrication and erection
- Makes reference to four ‘Construction Categories’ CC1, CC2, CC3 and CC4
- Provides guidance on assessment of the Construction Category in Appendix L



Australian Standards AS 4100, AS/NZS 5131

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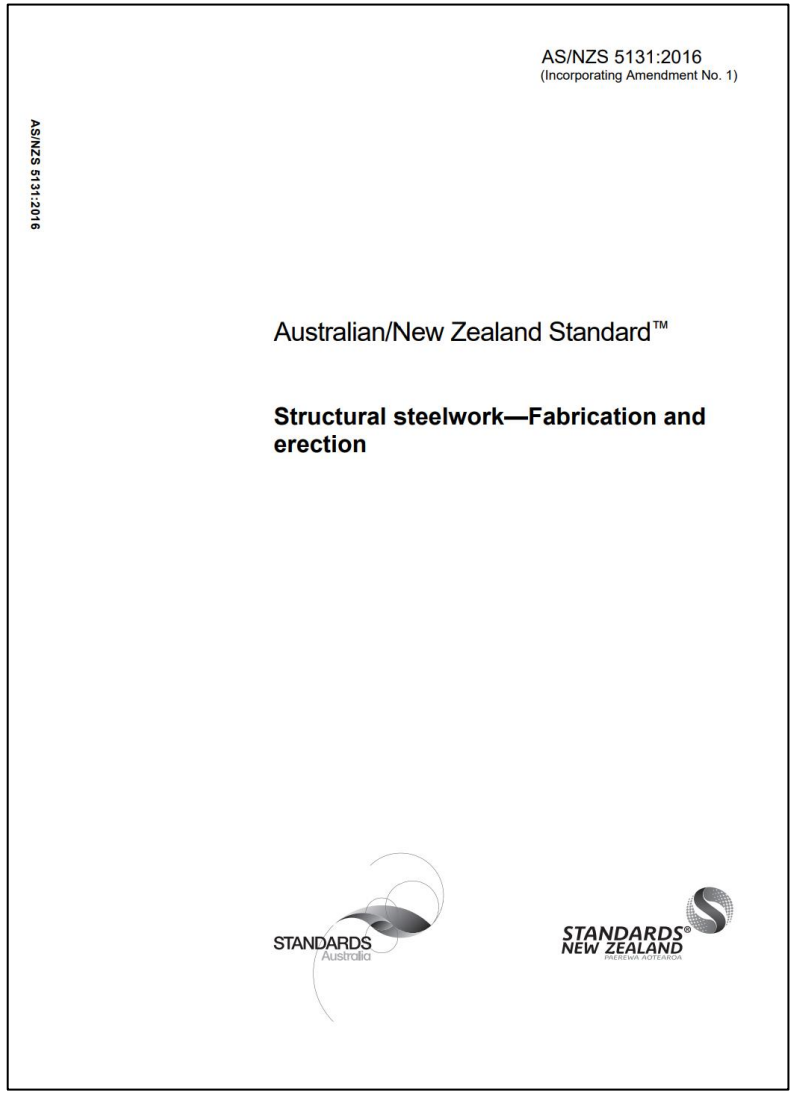
AS/NZS 5131:2020:

- Sets out minimum requirements for fabrication and erection of structural steelwork.
- Published in 2016, with 2020 revision.
- Makes reference to four ‘Construction Categories’ CC1, CC2, CC3 and CC4, with increasing requirements for management of quality.
- Provides guidance on assessment of the Construction Category in Appendix C, identical to that in AS 4100.



Australian Standards AS 4100, AS/NZS 5131 and the NCC

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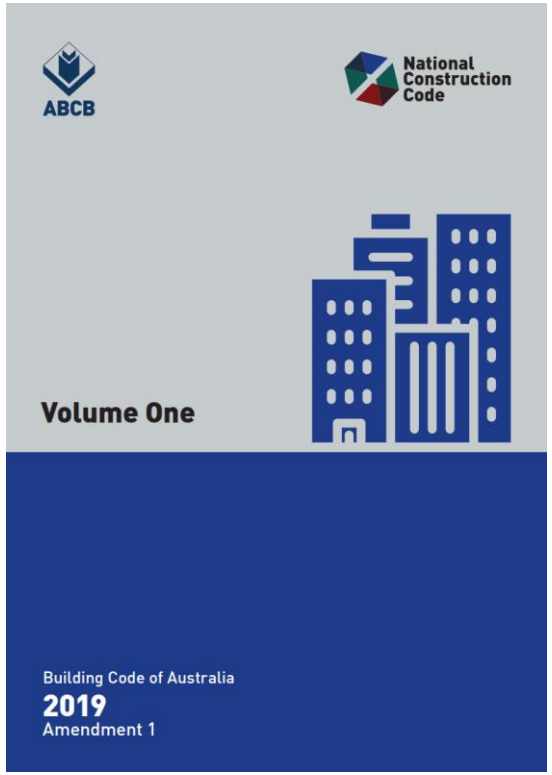

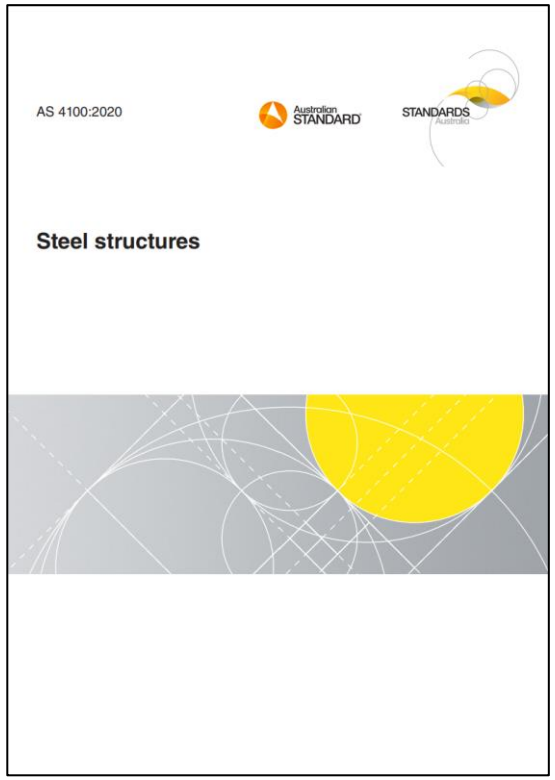

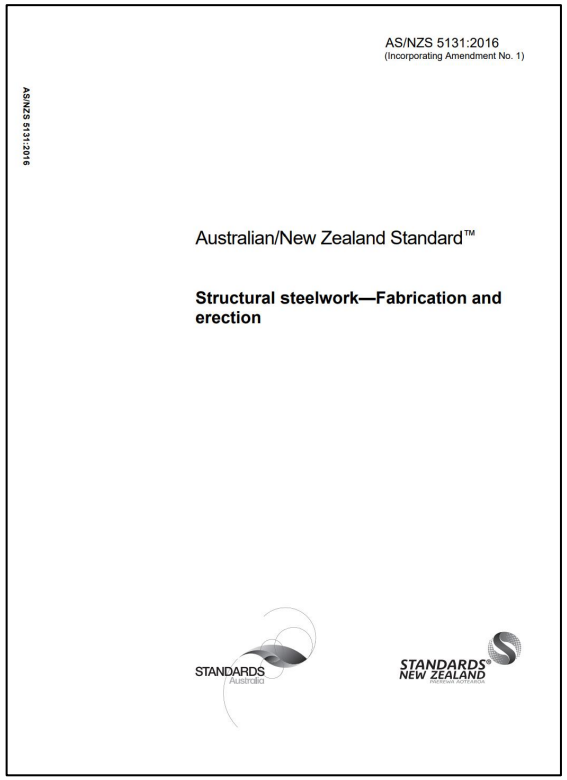

National Construction Code

Next update 2022

References

AS 4100:2020

Revision published 21/8/2020

AS 4100 (2020 revision)

References

AS/NZS 5131 Amd. 1

Amendment published 21/8/2020

AS/NZS 5131 Amendment 1

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Construction Categories

Importance Level		1		2		3		4	
Service Category		**SC1**	**SC2**	**SC1**	**SC2**	**SC1**	**SC2**	**SC1**	**SC2**
Fabrication Category	**FC1**	CC1	CC3	CC2	CC3	CC2/CC3(1)	CC3	CC3	CC3
	FC2	CC2	CC3	CC2	CC3	CC3	CC3	CC3	CC4

Note 1: The assessment of CC2 or CC3 for this designation marked should be based on engineering judgement and the relative simplicity of fabrication and erection of the structure.

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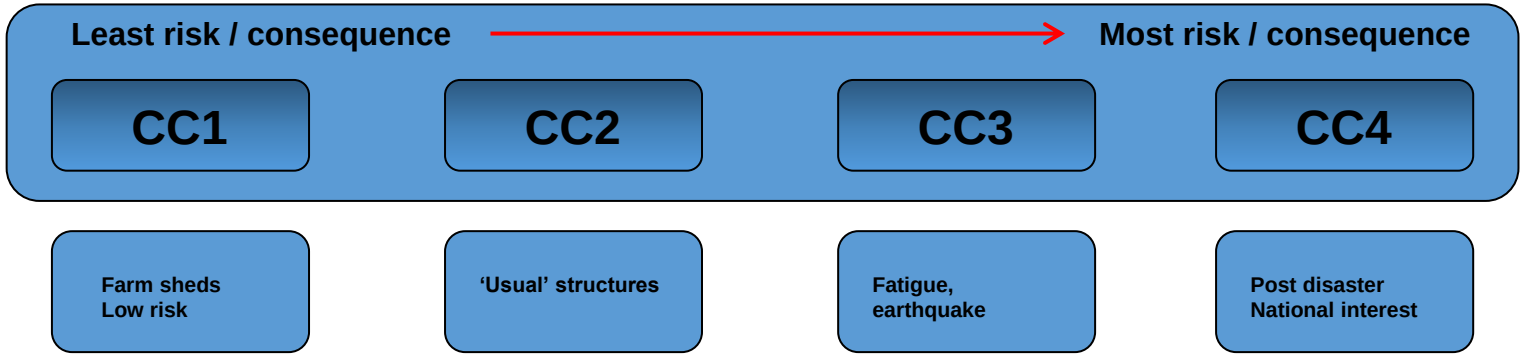
Construction Categories

A risk-based fit-for-purpose classification:



- The engineer assigns a 'Construction Category'
- The engineer adjusts his specification

For engineers, this de-risks the process and makes life easier!

Construction Categories

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Construction Category	Example structure types[1]
CC1	• Farm sheds; greenhouses; fences; gates; small signs
CC2	• Low- to medium-rise buildings (industrial buildings, residential buildings, offices, residential apartments and retail) • Single and two level school buildings and structures
CC3	• Large structures (e.g. high-rise buildings) • Large stadia • Road and rail bridges • Post-disaster buildings (e.g. hospitals)
CC4	• Structures with extreme consequences of structural failure

Notes:

The structure types shown are indicative only. The assessment of the construction category is the responsibility of the engineer based on the guidance provided in AS 4100 and AS/NZS 5131. The 'Building importance level' from the NCC is one factor in the assessment of the construction category.

Construction Categories (CC) and example structure types

De-specification and Product Substitution

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Particular Concerns with some imported fabricated 3 plate beams (welded beams)

- top and bottom flanges out of alignment and of different widths.
- pitted steel visible in flanges.
- inadequate welding of beams to end plates.
- suspected fillet welds used where full penetration butt welds are specified/required.
- unnecessary welded joints in the length of beams which increases the risk of failure due to a larger amount of potentially faulty welding.
- lack of documentation/information on welders' qualifications and competence.
- incorrect/inadequate material test certificates provided for the steel plates leading to a lack of knowledge of the chemical composition and strength of the steel plates.
- no material test certificates provided for some of the steel plates causing a lack of traceability of the steel.
- the overseas fabricator only providing test results for a sample of the steel used rather than the full batch testing results including statistical test data in line with what is required by Australian Standard AS 4100.

De-specification and Product Substitution

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Applicable Australian Standards for imported fabricated 3 plate beams (welded beams)

- If a welded beam is manufactured to **AS/NZS 3679.2** then:
  - The manufacturer has process controls in place to ensure compliance.
  - Certificates will contain the information required by the Standard.

- Alternatively, if a bespoke welded beam is fabricated, then:
  - The welded beam, and in particular the welds, must be designed.
  - The applicable fabrication Standard is **AS/NZS 5131.**
  - The materials, cutting, holing, coping and welding must conform to **AS/NZS 5131.**

- Fabricated beams made from multiple plates present issues with ascertaining compliance of the steel.

De-specification and Product Substitution

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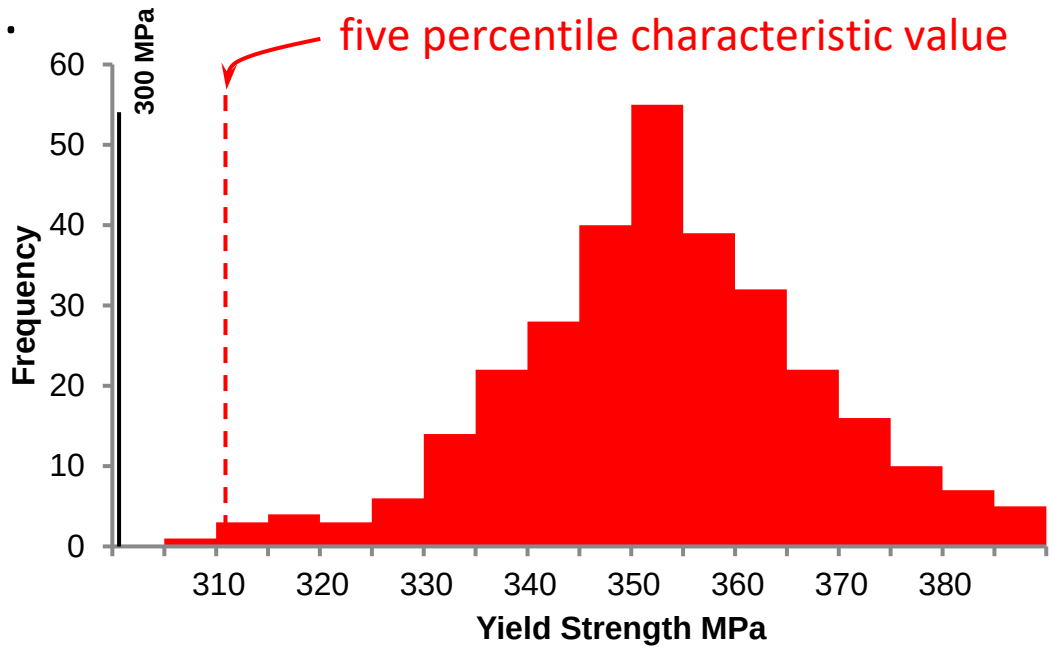
Standards Context - Basis for design resistance ϕR_u:

- The NCC (clause BP1.2) requires that "The structural resistance of materials and forms of construction must be determined using five percentile characteristic material properties…"
- Manufacturers target long term quality (LTQ) values to ensure the design assumptions in the calibration exercise remain valid.
- Manufacturers operate 'initial type testing' (ITT) and 'Factory production control' (FPC) to ensure LTQ is maintained.
- On the graph shown, at least 95% of the results exceed the design grade of 300 Mpa.



Yield strength histogram based on manufacturer production testing – 300 Grade steel

De-specification and Product Substitution

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It follows that:

- A single batch test (mill certificate) only affords a snapshot of manufacturer's production at a point in time.
- A batch test does not give an indication of LTQ levels.

Therefore:

- A single batch test (mill certificate) CANNOT be used to regrade steel
  - It is NOT a five percentile value!
- A single tensile coupon test CANNOT be used to determine the steel design grade
  - It is NOT a five percentile value!
- If the five percentile material properties are required to be assessed, sufficient tests must be performed to form a statistical basis.

The verification protocol presented subsequently provides a statistical basis for assessment of specific material properties when required.

De-specification and Product Substitution – NCC context

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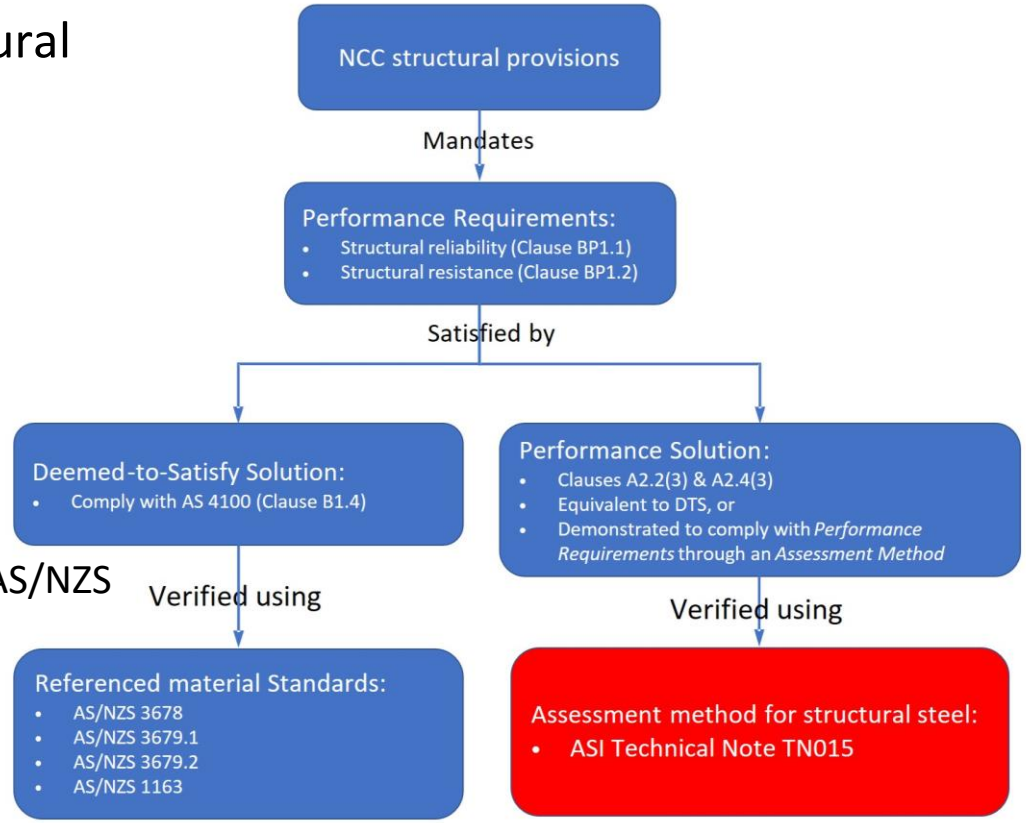
NCC Context - in respect of structural provisions (including structural steelwork):

1. Performance requirements are defined in:
   - Clause BP1.1 for structural reliability
   - Clause BP1.2 for structural resistance
2. Deemed-to-satisfy solution for structural resistance:
   - Clause B1.0 references clause B1.4
   - Clause B1.4 -> For steel structures, AS 4100 is the DTS solution
   - AS 4100 references AS/NZS 3678, AS/NZS 3679.1, AS/NZS 3679.2 and AS/NZS 1163 for structural steel sections, plates and tubes
3. Performance solution for structural resistance:
   - Clause B1.0 references clauses A2.2(3) and A2.2(4)
   - At least equivalent to DTS, or
   - Demonstrated to comply with all relevant *Performance Requirements* through an *Assessment Method – ASI Tech Note 015*



Structural steel that cannot be demonstrated to have been manufactured to the requirements of the Australian Standards called up in AS 4100 cannot be a deemed-to-satisfy solution. It must be treated as a *Performance Solution* and must be demonstrated to comply to all relevant *Performance Requirements* through an *Assessment Method*.

The ‘cost’ dimensions of non-compliance

1. The cost of rework to repair or replace non-compliant product.
2. The cost to human life due to failure of faulty materials or products.
3. The cost to enact increased maintenance regimes over the lifetime of the structure.
4. A reduction in lifetime of the structure.
5. Cost to your reputation.

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The National Structural Steelwork Compliance Scheme (NSSCS)

Responsible fabricated steelwork procurement – a supply chain solution

Workplace Health and Safety (WHS) provides context to responsibilities:

- All parties in the supply chain are prescribed a 'duty of care' in WHS Regulation
- Codes of Practice provide implementation guidance:
  - 'Managing the risks of plant in the workplace'
  - '**Safe design of structures**'
  - 'Construction work'

Model Codes of Practice may be freely downloaded from: https://www.safeworkaustralia.gov.au/construction

Answers from WHS(Qld) can be viewed on the ASI website at https://www.steel.org.au/ASI/media/Australian-Steel-Institute/PDFs/WHSQ-answers-to-questions-ASI-Brisbane-seminar-26-Nov-2012.pdf

The WHS Act/Regulations and/or Codes of Practice outline specific duties for:

- **Clients** (a person conducting a business or undertaking who commissions a design or construction work or a construction project).
- The **principal contractor.**
- The **manufacturer** (including of a product or a structure). This includes steel manufacturers and also fabricators.
- The **importer** (including of material or a structure). This includes importers of steel material and also of fabricated steel structures.
- The **supplier** (including of material or a structure). This includes distributors of steel material and components.
- The **constructor** (of the steel structure). This includes steelwork erectors and other contractors associated with site installation.

National Structural Steelwork Compliance Scheme (NSSCS)

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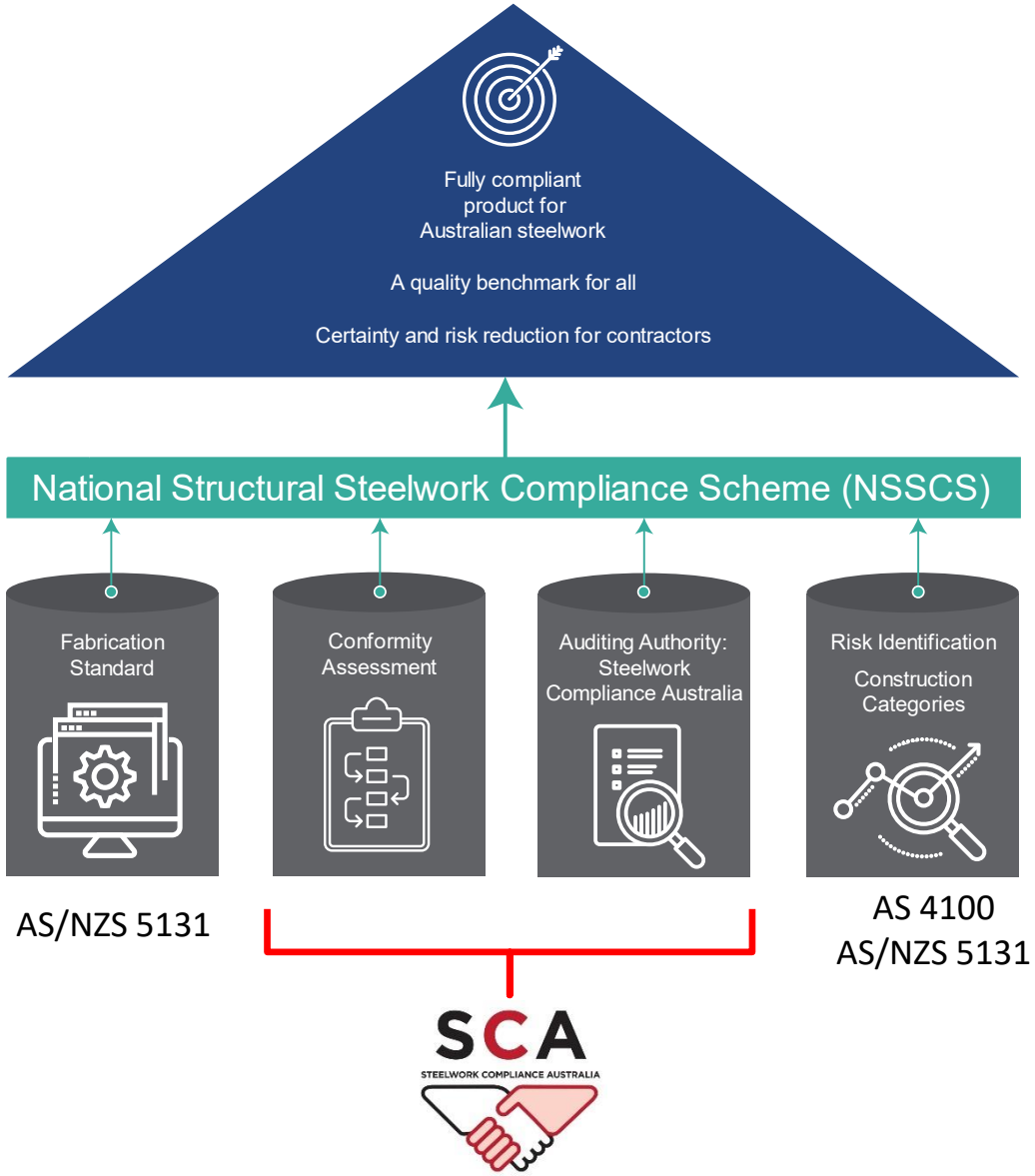
A Compliance Scheme for Australia

Four pillars:

1. Fabrication Standard (AS/NZS 5131).
2. Risk identification – engineers obtain CC from AS 4100 & AS/NZS 5131.
3. Conformity assessment (SCA).
4. Auditing & certification (SCA).

Outcomes:

- Truly independent certification.
- Rationalisation and cost effectiveness.
- Fit-for-purpose (risk levels).
- Open scheme (local or overseas located fabricators can be certified).
- Streamlines project sign-off by RPEQ Engineer.
- <u>Amounts to a 'National technical prequalification scheme'.</u>



National Structural Steelwork Compliance Scheme (NSSCS)

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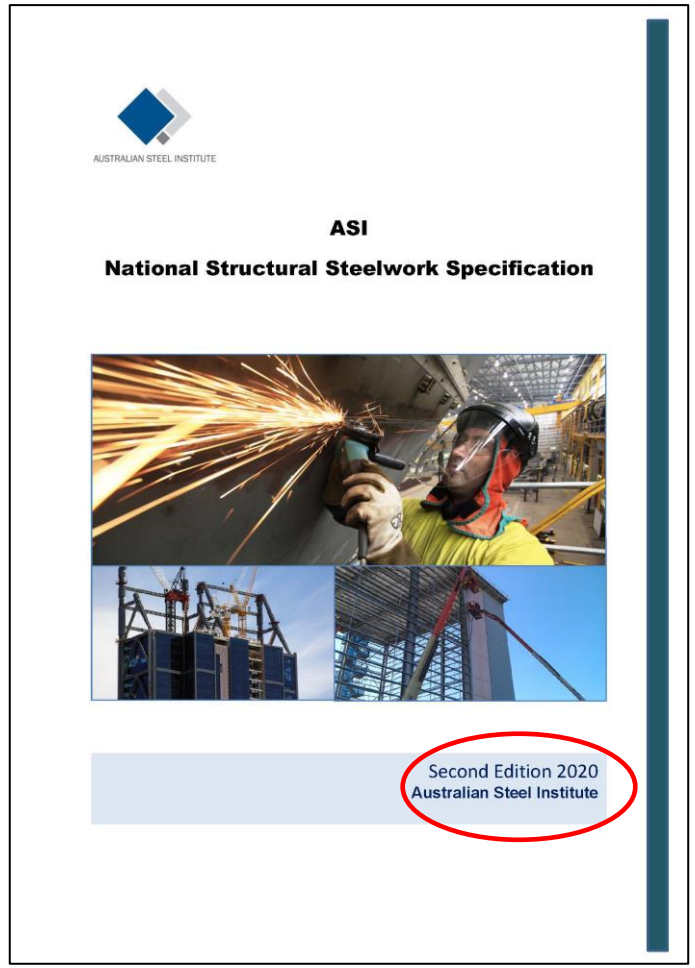
Implementation Tools to embed AS/NZS 5131 into projects:

- ASI has created the 'National Structural Steelwork Specification'.
- 'Standard Drawing Notes' (SDN) are also available.
- The NSSS and SDN are a free download from the ASI website.



Available for free download from ASI website:
https://www.steel.org.au/focus-areas/quality-and-compliance/national-structural-steelwork-specification/

National Structural Steelwork Compliance Scheme (NSSCS)

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Summary - Why we need 3rd party fabricator certification.

- Because non-compliant construction products are circulating in the market.
- Because our Regulation is not adequately policed.
- Because we are now sourcing globally and insist on the cheapest product without adequate regard to quality.
- Because acceptable quality defined by our Standards needs to be properly checked, which is not easy for most stakeholders. Construction product compliance is complicated! Current safeguards such as NCBP (Qld) chain of responsibility legislation is reactive not proactive.
- Because procurers need help to properly assess quality and ensure their 'Duty of care' under WHS Regulation.
- Because engineers are asked to 'certify' and they are generally not properly equipped.

For all these reasons, Compliance = Certification in today's market.
ASI has developed the NSSCS to provide the market a solution.

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National Structural Steelwork Compliance Scheme (NSSCS)

Steelwork Compliance Australia (SCA)

- Commenced in late 2014
- Audit fees are paid by steel fabricators
- Currently (Oct, 2020) over 100 steel fabricators certified (23 in Qld)
- Queensland Govt is working with stakeholders to investigate the adoption of the certification scheme
- SA Government has mandated SCA 3rd party certification
- NSW Procurement has mandated AS/NZS 5131 and is developing an approach to 3rd party certification – supporting SCA to become JAS ANZ accredited

SCA
STEELWORK COMPLIANCE AUSTRALIA

SCA was established by ASI to independently audit fabricators via the NSSCS to AS/NZS 5131.

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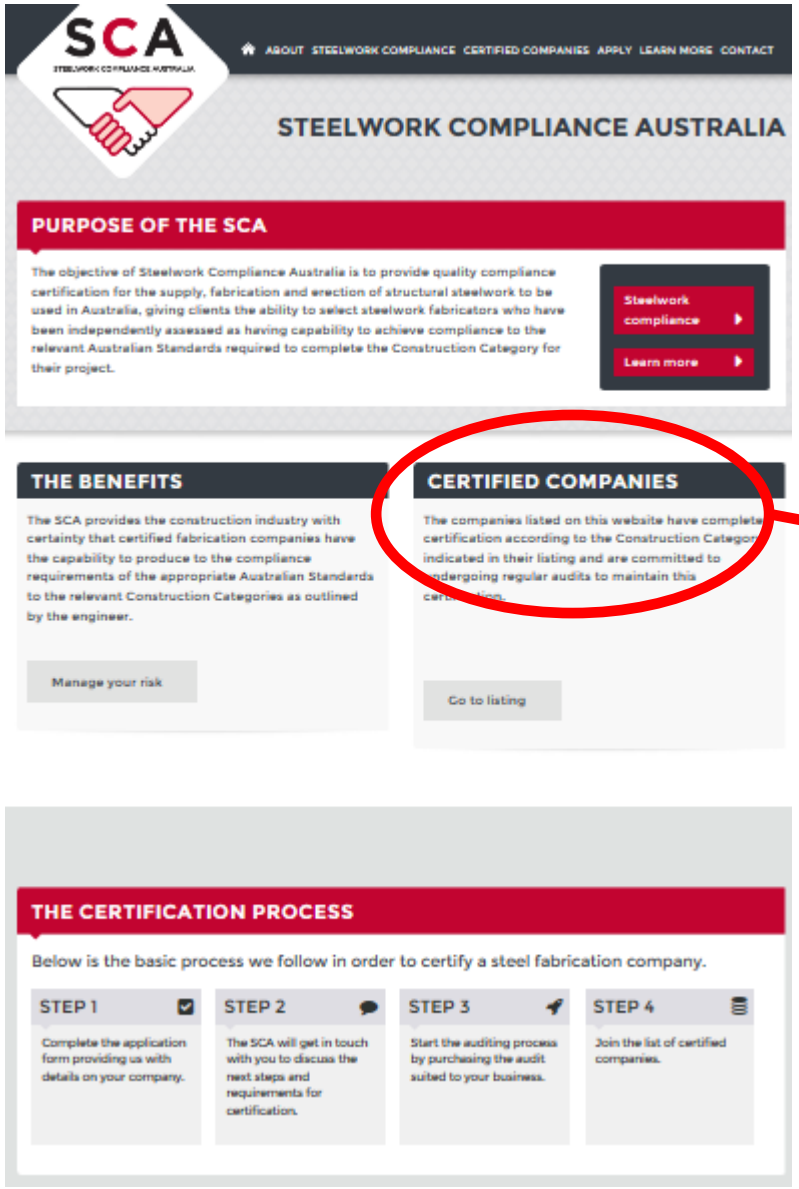
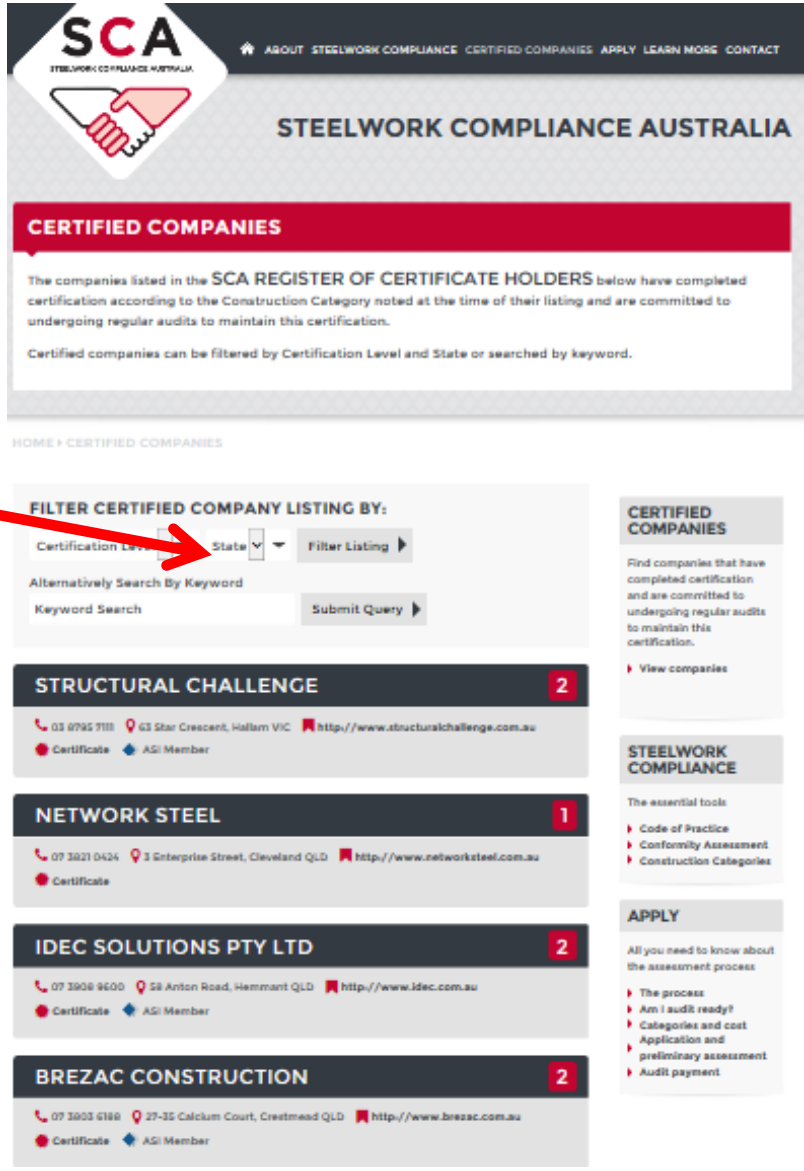
National Structural Steelwork Compliance Scheme (NSSCS)

How to find a certified Fabricator

SCA
STEELWORK COMPLIANCE AUSTRALIA

http://www.scacompliance.com.au/





National Structural Steelwork Compliance Scheme (NSSCS)

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ASI is calling on Govt authorities to require SCA 3rd party Fabricator certification as a pre-qualification at the tender stage.

The South Australian Government has successfully mandated this level of certification for projects funded by the South Australian Government since 2017.

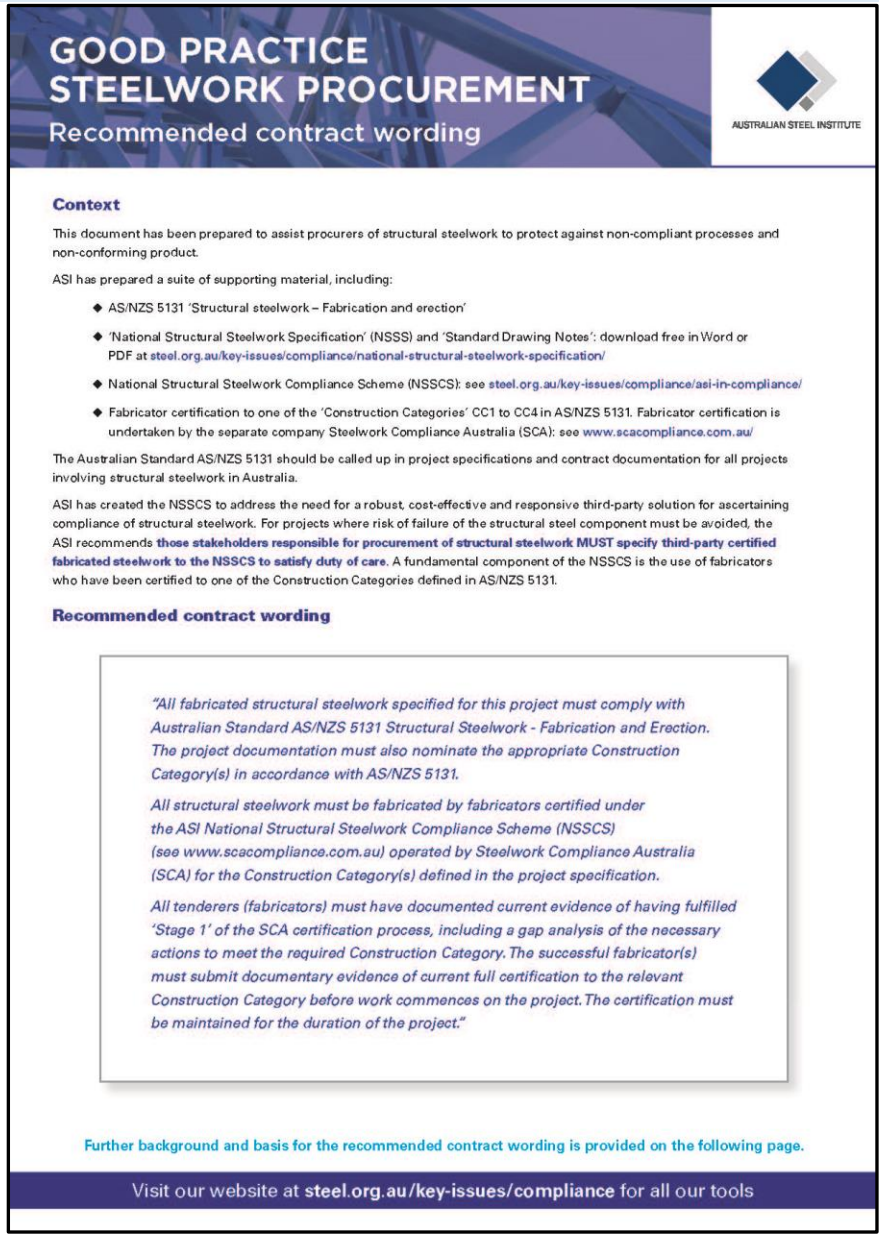
Recommended Contract Wording

"All fabricated structural steelwork specified for this project must comply with Australian Standard AS/NZS 5131 Structural Steelwork - Fabrication and Erection. The project documentation must also nominate the appropriate Construction Category(s) in accordance with AS/NZS 5131.

All structural steelwork must be fabricated by fabricators certified under the ASI National Structural Steelwork Compliance Scheme (NSSCS) (see www.scacompliance.com.au) operated by Steelwork Compliance Australia (SCA) for the Construction Category(s) defined in the project specification.

All tenderers (fabricators) must have documented current evidence of having fulfilled 'Stage 1' of the SCA certification process, including a gap analysis of the necessary actions to meet the required Construction Category. The successful fabricator(s) must submit documentary evidence of current full certification to the relevant Construction Category before work commences on the project. The certification must be maintained for the duration of the project."

https://www.steel.org.au/focus-areas/quality-and-compliance/nsscs-for-clients-and-government/



GOOD PRACTICE STEELWORK PROCUREMENT

Recommended contract wording

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Context

This document has been prepared to assist procurers of structural steelwork to protect against non-compliant processes and non-conforming product.

ASI has prepared a suite of supporting material, including:

- AS/NZS 5131 'Structural steelwork – Fabrication and erection'
- 'National Structural Steelwork Specification' (NSSS) and 'Standard Drawing Notes': download free in Word or PDF at steel.org.au/key-issues/compliance/national-structural-steelwork-specification/
- National Structural Steelwork Compliance Scheme (NSSCS): see steel.org.au/key-issues/compliance/asi-in-compliance/
- Fabricator certification to one of the 'Construction Categories' CC1 to CC4 in AS/NZS 5131. Fabricator certification is undertaken by the separate company Steelwork Compliance Australia (SCA): see www.scacompliance.com.au/

The Australian Standard AS/NZS 5131 should be called up in project specifications and contract documentation for all projects involving structural steelwork in Australia.

ASI has created the NSSCS to address the need for a robust, cost-effective and responsive third-party solution for ascertaining compliance of structural steelwork. For projects where risk of failure of the structural steel component must be avoided, the ASI recommends **those stakeholders responsible for procurement of structural steelwork MUST specify third-party certified fabricated steelwork to the NSSCS to satisfy duty of care.** A fundamental component of the NSSCS is the use of fabricators who have been certified to one of the Construction Categories defined in AS/NZS 5131.

Recommended contract wording

"All fabricated structural steelwork specified for this project must comply with Australian Standard AS/NZS 5131 Structural Steelwork - Fabrication and Erection. The project documentation must also nominate the appropriate Construction Category(s) in accordance with AS/NZS 5131.

All structural steelwork must be fabricated by fabricators certified under the ASI National Structural Steelwork Compliance Scheme (NSSCS) (see www.scacompliance.com.au) operated by Steelwork Compliance Australia (SCA) for the Construction Category(s) defined in the project specification.

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Further background and basis for the recommended contract wording is provided on the following page.

Visit our website at **steel.org.au/key-issues/compliance** for all our tools

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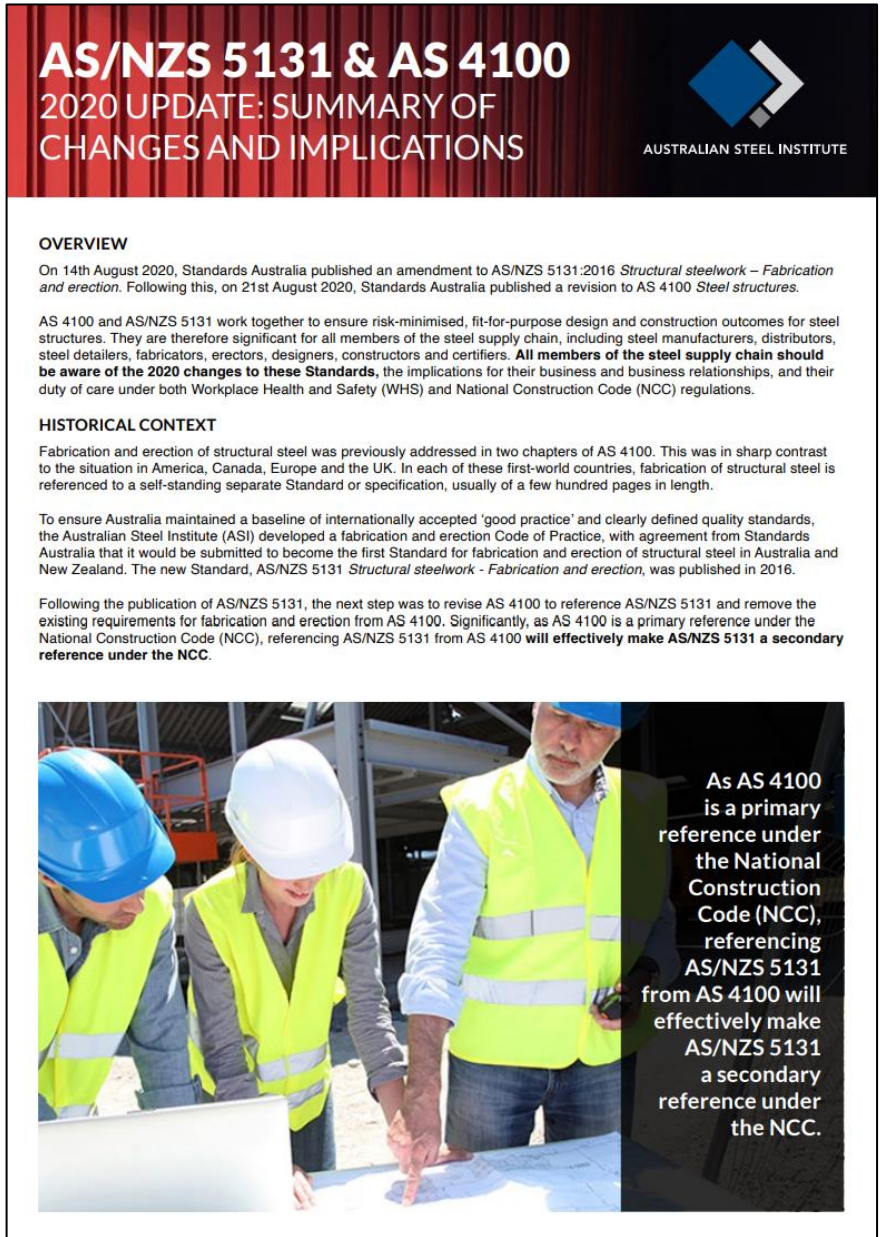
ASI Awareness

- **ASI website landing page**: see https://www.steel.org.au/focus-areas/steel-and-design/standards-and-design/key-standards-updates/
- **Tech Note TN014**: Structural steelwork certification in Australia
- **Tech Note TN015**: Ascertaining compliance of structural steel. Download for free from: ASI - Technical Notes (steel.org.au)
- **Updates:** of various Tech Notes and our NSSS and SDN
- **Planning series of 'Guidance Notes':** intended for various members of supply chain



AS/NZS 5131 & AS 4100
2020 UPDATE: SUMMARY OF CHANGES AND IMPLICATIONS

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OVERVIEW

On 14th August 2020, Standards Australia published an amendment to AS/NZS 5131:2016 *Structural steelwork – Fabrication and erection*. Following this, on 21st August 2020, Standards Australia published a revision to AS 4100 *Steel structures*.

AS 4100 and AS/NZS 5131 work together to ensure risk-minimised, fit-for-purpose design and construction outcomes for steel structures. They are therefore significant for all members of the steel supply chain, including steel manufacturers, distributors, steel detailers, fabricators, erectors, designers, constructors and certifiers. **All members of the steel supply chain should be aware of the 2020 changes to these Standards,** the implications for their business and business relationships, and their duty of care under both Workplace Health and Safety (WHS) and National Construction Code (NCC) regulations.

HISTORICAL CONTEXT

Fabrication and erection of structural steel was previously addressed in two chapters of AS 4100. This was in sharp contrast to the situation in America, Canada, Europe and the UK. In each of these first-world countries, fabrication of structural steel is referenced to a self-standing separate Standard or specification, usually of a few hundred pages in length.

To ensure Australia maintained a baseline of internationally accepted 'good practice' and clearly defined quality standards, the Australian Steel Institute (ASI) developed a fabrication and erection Code of Practice, with agreement from Standards Australia that it would be submitted to become the first Standard for fabrication and erection of structural steel in Australia and New Zealand. The new Standard, AS/NZS 5131 *Structural steelwork - Fabrication and erection*, was published in 2016.

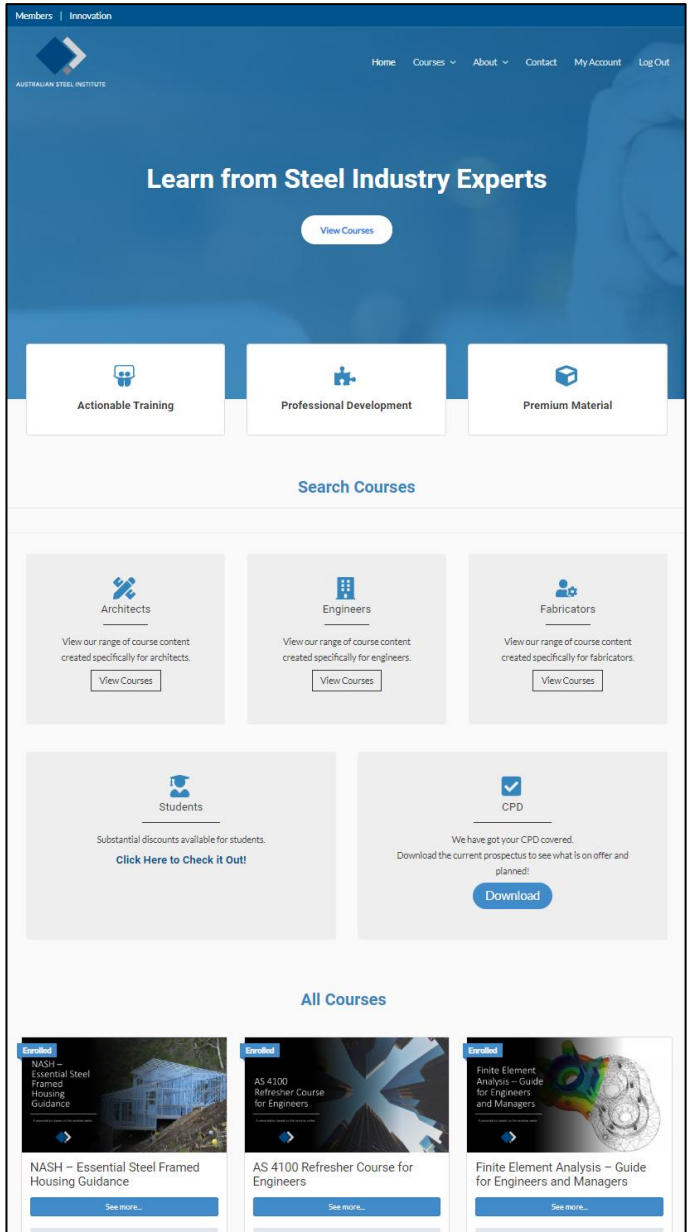
Following the publication of AS/NZS 5131, the next step was to revise AS 4100 to reference AS/NZS 5131 and remove the existing requirements for fabrication and erection from AS 4100. Significantly, as AS 4100 is a primary reference under the National Construction Code (NCC), referencing AS/NZS 5131 from AS 4100 **will effectively make AS/NZS 5131 a secondary reference under the NCC**.

ASI Awareness

Australian Steel Institute

Visit the eLearning Portal at:
https://learn.steel.org.au/

- Structural Steelwork Compliance – Tools to minimise risk. *Free 1.5 hour eLearning course.*
- More than 30 other courses currently available, with new courses added regularly



Thank you!

Email me: johng@steel.org.au