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IMPLEMENTING TRACEABILITY TO AS/NZS 5131

Synopsis

This Technical Note provides clarification on the performance intent of 'Lot', 'Piece-mark' and 'Piece' traceability as defined in AS/NZS 5131. Guidance is also provided on options available for implementation of these types of traceability.

The Technical Note is specifically intended to provide the steel supply chain in Australia, in particular distributors, processors, fabricators, constructors and specifiers, with clarity on the intent of the Standard and, importantly, a shared understanding on their role in ensuring structural steel and steelwork supplied to the Australian public is traceable to compliant supply and process. This is particularly important in order to demonstrate compliance to the performance intent of the NCC and Australian Standards.

In a broader context than AS/NZS 5131, asset owners, specifiers and procurers are demanding demonstration of traceability of key product attributes throughout the supply chain, in order to demonstrate conformance/compliance to specifications. This Technical Note also provides guidance as to how the steel sector can address those demands.

This Technical Note has been reviewed by a panel of industry stakeholders, as detailed in Appendix A. Their support is gratefully acknowledged.

OUTLINE

1. INTRODUCTION

1.1 Project Context

The procurement, fabrication and erection of structural steelwork for buildings, infrastructure and resource projects involves a supply chain that is as varied as it is long. Contractual relationships and commercial and political pressures all influence the ultimate procurement scenario, which can also change markedly over the period of project delivery. The Regulatory environment is also continually recalibrating, influenced by tensions that exist between our obligations under World Trade Organisation (WTO) requirements for free trade, performance solutions enabling innovation and the most fundamental requirements to ensure our community can expect risk-minimised safe solutions for their workplaces and habitation. Underpinning this, the requirements of Australian Standards for structural steel products, design, fabrication and erection form the technical foundation for fit-for-purpose compliant solutions.

The steel products utilised in a project typically pass through a number of stakeholders in their journey along the supply chain from the steel material manufacturer to the inclusion of the final steel component in the structure on site. The quality and traceability of the steel products utilised in a project is therefore ultimately dependent on a number of parties in the supply chain. If any link in this chain is broken, traceability of the product is lost and the ability to ascertain compliance compromised. Where steel products are sourced internationally the same principles apply, overlaid with the additional requirement to ensure the steel products meet the performance requirements of the NCC and Australian Standards.

Given the complexity and fluidity of supply chains in today's procurement environment, meeting duty of care for stakeholders can be challenging. There is a need to establish a common understanding of the requirements and clearly articulate responsibilities for all parties in the supply chain. This Technical Note establishes a common understanding of the performance intent of the traceability requirements in AS/NZS 5131 to help ensure alignment in expectations along the supply chain and that procurers and ultimately the owner gets compliant fit-for-purpose steelwork in the finished structure.

1.2 Regulatory Context

As with the majority of construction products, structural steel products intended for the Australian marketplace must meet the performance intent of:

a. The National Construction Code (NCC) (Ref. 1) for project types covered under the NCC.
b. The Australian Standards called up in either the contractual documentation (usually the specification) and/or the NCC as applicable to the project type.

This includes both the permanent steelwork and the temporary steelwork required to construct the permanent structure.

Regardless of the type of project, the compliance pathways specified within the NCC provide a robust performance-based approach that should be applied to all project types.

Separate and overarching, the Workplace Health and Safety Act (Ref. 2), Regulations and Codes of Practice provide a basis for ascertaining responsibilities and duty of care for all stakeholders.

The guidance in this Technical Note is predicated on three significant principles:

1. The performance framework established by the NCC.
2. The basic principles of duty of care established under Workplace Health and Safety legislation, and
3. The quality benchmark established by the relevant Australian Standards.

The primary focus of this Technical Note is on establishing demonstrable traceability of structural steel, from the manufacturer through fabrication and into the final erected product. The traceability requirements in AS/NZS 5131 for fabrication of structural steel set the context both upstream and downstream of fabrication and are therefore appropriate as the cornerstone for defining the performance requirements throughout the supply chain.

A benefit of establishing traceability to the final erected product is the ability then, with suitable record keeping, to maintain that traceability to the future end-of-life and recycling, re-use or re-purposing of the steel structure or components. The maintenance and end-of-life phases of the steel structure are not considered in this Tech Note, but equally important to support steel as a material of choice for actioning sustainability outcomes.

1.3 Document Outline and Context

This document discusses the definition and implementation of structural steelwork traceability, framed within the context of the requirements of AS/NZS 5131 and the National Construction Code. It also positions traceability requirements in AS/NZS 5131 within the range of initiatives that are currently underway to develop a workable traceability framework for the construction product supply chain.

In addition to structural steel and steelwork (the fabricated steel) traceability, the traceability requirements for bolts and welds are also discussed.

In order to achieve this aim, the document is divided into the following sections:

- Section 1 (this section) sets the context for the document.
- Section 2 provides a summary of the requirements of the National Construction Code and outlines the distinction between a Performance Solution and a Deemed-to-satisfy Solution before establishing that steel that has not been manufactured to Australian Standards must be considered a Performance Solution and treated accordingly.
- Section 3 examines structural steel product identification and compliance to the requirements of AS/NZS 5131 and the Australian steel product Standards (Refs. 7,8,9,10). Identification and compliance are a necessary starting point for robust product traceability.
- Section 4 examines the specific requirements for traceability in the fabrication process, based on the requirements defined in AS/NZS 5131. Both the type and extent of traceability is related to the particular Construction Category assessed by the engineer based on the requirements in AS 4100.
- Section 5 considers the implementation of ‘Lot’ traceability as defined in AS/NZS 5131
- Section 6 considers the implementation of ‘Piece-mark’ traceability as defined in AS/NZS 5131
- Section 7 considers the implementation of ‘Piece’ traceability as defined in AS/NZS 5131
- Section 8 considers implementation of bolt traceability
- Section 9 considers implementation of welding related traceability

- Section 10 examines stakeholder responsibilities, based on the requirements of AS/NZS 5131 and informed by duty of care under the WHS Act, Regulations and Codes of Practice.
- Section 11 outlines the more general context of construction product traceability and the initiatives currently underway to develop a workable framework

In the most general sense, within a supply chain scenario, traceability is conceptually considered to be actioned through two principle building blocks:

- **Internal traceability:** processes within an actor in the supply chain, sufficient to maintain traceability through the transformation processes (if any) that may be undertaken on the products or services concerned by that actor
- **External traceability:** linkage between the actors in the supply chain, designed to ensure the outputs from one actor maintain traceability into the inputs to the next actor in the supply chain.

This concept is illustrated in Figure 1, configured to illustrate a very simple view of the steel supply chain with the actors involved. A somewhat more refined view of the actual steel supply chain is discussed later in this document.

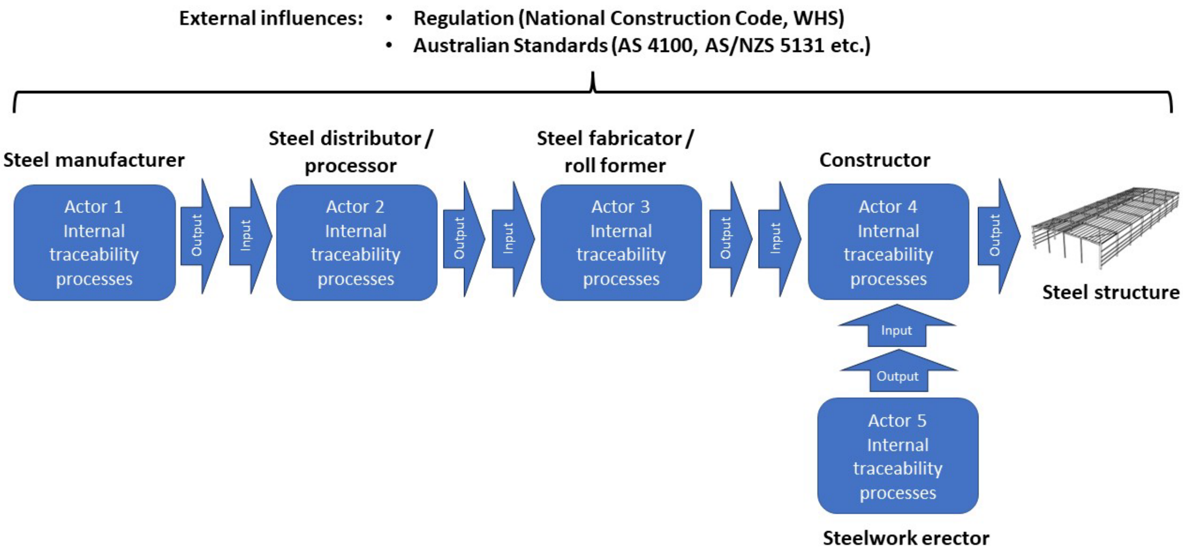

Figure 1 – Generalised traceability within the steel supply chain

Within Figure 1, the primary external influences are also indicated.

Figure 1 may be used as a key into the content of this document, specifically:

- Section 2 discusses the external influence of Regulation, specifically the National Construction Code
- Sections 3 and 4 discuss the requirements of the relevant Australian Standards, in particular AS 4100 and AS/NZS 5131. The Australian Standards define the performance requirements for traceability, both internal to the actors and also the external traceability linkage
- Sections 5 to 9 consider specific aspects of implementation of traceability to the Australian Standards
- Section 10 examines the responsibilities of each of the principle actor types in the steel supply chain, defining in particular the performance requirements for their internal traceability processes and outputs. The inputs to their process are defined by the outputs to the actor they receive product or service from
- Section 11, as noted previously, sets the steel supply chain context within the broader initiatives that are underway on a framework for construction product traceability

It is necessary that each actor understands their role in the process, including requirements for input and output. It is highly desirable that each actor has an understanding of the roles of the other actors, in order to more effectively address issues that may arise during implementation.

1.4 Abbreviations

ABCB	-	Australian Building Codes Board
ACRS	-	Australasian Certification Authority for Reinforcing and Structural Steels
AS	-	Australian Standard
ASI	-	Australian Steel Institute
BIM	-	Building information modelling / Building information management
CAB	-	Conformity Assessment Body
CAD	-	Computer aided drafting
CC	-	Construction category
CompMP	-	Compliance Management Plan
DTS	-	Deemed-to-satisfy
ILAC	-	International Laboratory Accreditation Cooperation
ISO	-	International Standards Organisation
ITP	-	Inspection and test plan
JAS-ANZ	-	Joint Accreditation System of Australia and New Zealand
MDR	-	Manufacturer’s data report
MRA	-	Mutual Recognition Agreement
NCC	-	National Construction Code
NDT	-	Non-destructive testing
NZS	-	New Zealand Standard
QMS	-	Quality Management System
RACI	-	Responsible, Accountable, Consulted, Informed, as in RACI Matrix, a project management tool
SCA	-	Steelwork Compliance Australia
SDoC	-	Supplier Declaration of Conformity
WHS	-	Workplace Health and Safety

1.5 Definitions

The definitions below are provided for clarity. In some cases, industry uses different terms for the same meaning, in which case these terms have been referenced to a common term.

Appropriate authority: means the relevant authority with the statutory responsibility to determine the particular matter (definition from the NCC)

Assembly: a group of pieces (parts, items) connected together, usually by welding, to form a component. Components are bolted together, usually on site but may also be bolted together in the shop

Batch (of structural steel): A group of structural steel product consisting of finished steel of the same yield stress gradation and product form, treated in the same manner and from the same heat (generalised from Refs 6, 7, 8, 9)

Component: Same definition as 'Assembly'

Conformity assessment: demonstration that specified requirements relating to a product, process, system, person or body are fulfilled. The concept of conformity assessment is concerned with the fulfilment of specified requirements, not with the wider concept of conformity. (From AS ISO/IEC 17000 (Ref. 4))

Declaration of Conformity (DoC): the document that is a first-party attestation that the object of conformity (product, process or service) fulfills specified requirements

Deemed-to-satisfy (DTS): a solution that is deemed-to-satisfy the National Construction Code (NCC), usually involving demonstrable compliance with the Standards referenced in the NCC.

Heat (of steel): A product of a ladle of steel melted in one vessel and processed under the same conditions (from Refs 7, 8, 9,10)

Heat number: A unique number assigned to a heat of steel by the manufacturer

Item (of steel): Same definition as 'Piece'

Parent material: the steel plates and sections supplied from the manufacturer and used as input material for the fabrication process

Part: Same definition as 'Piece'

Part material: material that is left over after the components are cut from the parent material. Part material may be used for other fabrication or may be scrapped

Performance solution: a solution that falls outside the definition of DTS in the National Construction Code (NCC) and usually requires demonstration of compliance via the specific protocols outlined in the NCC

Piece (of steel): an individual piece of steel within a fabricated steel component. The piece of steel has one (and only one) mill certificate associated with it.

Procurer/purchaser: Organisation or person who is a recipient from a supplier of a product manufactured to a Standard

Steel Manufacturer: The business operating the steelmaking, hot-rolling process or final processing stage producing the finished steel product

Structural steel: steel products such as I-beams and plate manufactured to a recognised steel product Standard and intended for use in fabricated steel load-carrying structures

Structural steelwork: structural steel that has been fabricated into members, assemblies and components as part of a load-carrying structure

Raw material: same definition as for parent material

Supplier: The distributor, stockist or importer supplying the steel material or components.

Trusted relationship: a relationship between two or more parties that has developed based on a series of interactions whose performance has been judged as successful. The level of trust may be informal or based on metrics to ensure performance is measured and maintained.

Key takeaways:

The primary focus of this Technical Note is guidance on application of traceability specifically to the requirements of AS/NZS 5131. Generally, traceability in the construction product space is becoming increasingly required, as we move towards truly global supply chains and the increasing ability for (potentially inadequately informed) procurers to purchase from markets that are not aligned with our community expectations around risk and quality.

The traceability requirements defined in AS/NZS 5131, whilst specific to structural steel fabrication, are consistent with and complementary to the fundamental performance requirements increasingly necessary for all types of construction products. Identification and compliance are two key aspects of traceability that exist across all these areas. Sustainability, and the need for verifiable steel credentials available for the full life cycle of the building or structure which further drives the necessity for steel material traceability.

ASI are working on several traceability related initiatives for the steel supply chain.

2. THE NATIONAL CONSTRUCTION CODE

The National Construction Code (NCC) (Ref. 1) is a performance-based code and specifies means to achieve compliance to a range of *performance requirements*. The performance requirements outline the minimum necessary standards different buildings or building elements must attain. References to the NCC cited in this Technical Note are specifically to Volume 1, applicable to Class 2 to 9 buildings.

Performance requirements are satisfied by either:

1. A *performance solution*
2. A *deemed-to-satisfy solution (DTS)*
3. A combination of 1 and 2

Performance requirements must be verified using one or a combination of the following *assessment methods*:

- Evidence of suitability in accordance with Part A5 of the NCC
- *Verification method,* as outlined in Clause A2.2(2)(b) of the NCC
- *Expert judgement,* as defined in the NCC
- Comparison with the deemed-to-satisfy provisions of the NCC

The overall NCC verification hierarchy is outlined in Figure 2.

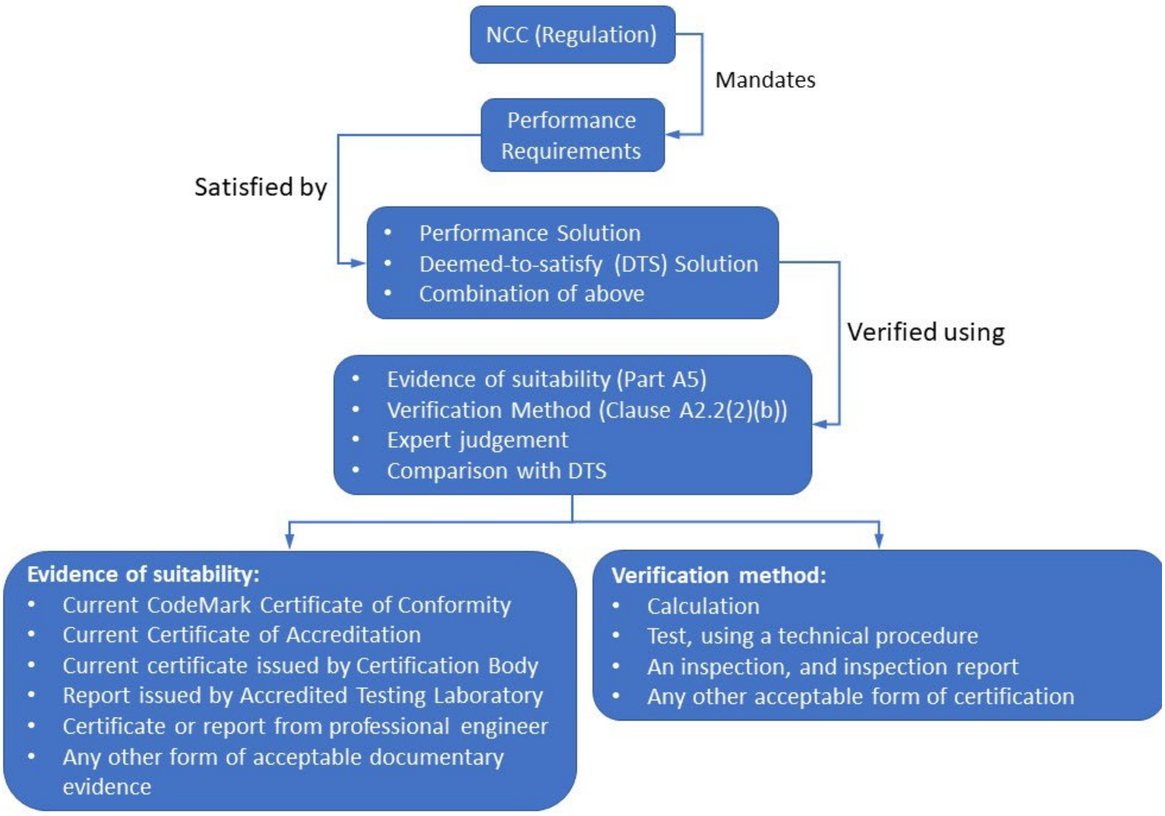

Figure 2 - NCC Verification Hierarchy

Performance requirements must be applied at all levels of the building structure, that is extending from the component level up to the whole building level.

The most common approach to satisfying the performance requirements is via comparison with the deemed-to-satisfy provisions of the NCC, which we explore further below. ASI Tech Note

TN015 (Ref. 3) provides a solution for ascertaining compliance of structural steelwork where a performance solution is required.

In respect of structural provisions (including structural steelwork), the performance requirements are defined in Part B1 and include:

1. Clause BP1.1: Structural reliability
2. Clause BP1.2: Structural resistance

The deemed-to-satisfy (DTS) solution for these performance requirements is outlined in Clause B1.0, which references Clause B1.4 in respect of determination of the structural resistance of materials and forms of construction.

For steel construction, Clause B1.4 states the structural resistance of materials and forms of construction must be determined in accordance with, as appropriate:

- Steel structures: AS 4100 (Ref. 4)
- Cold-formed steel structures: AS/NZS 4600 (Ref. 5)
- Residential and low-rise steel framing: NASH Standard – Residential and Low-Rise Steel Framing Part 1 or Part 2 (Ref. 6)

If a deemed-to-satisfy solution is being adopted, the structural steelwork must meet the requirements of AS 4100, which, in respect of steel materials, calls up the Australian structural steel product standards (Refs 7, 8, 9, 10) and the structural steelwork fabrication and erection Standard AS/NZS 5131 (Ref. 10).

Therefore, to comply with the NCC, <u>the requirements of AS 4100, AS/NZS 5131 and the Australian structural steel product standards must be complied with</u>, unless an alternative performance solution approach is proposed. We will explore the requirements in these Standards subsequently, in particular as regards product identification and traceability.

Key takeaways:

- The National Construction Code (NCC) is performance based
- Utilising Australian design and material Standards is the deemed-to-satisfy approach
- Utilising the common deemed-to-satisfy solution, the requirements of AS 4100, AS/NZS 5131 and our steel product standards must be complied with

3. STRUCTURAL STEEL PRODUCT IDENTIFICATION AND COMPLIANCE

3.1 Context

Fundamentally, traceability is actioned because the procurer wants to be assured that they receive a product that has been identified and is compliant. When the steel product is managed through a supply chain from manufacturer to final placement in the structure, and beyond, unless traceability is specifically implemented, the connection of that final product to the manufacturer will be lost, and with it any opportunity to ascertain compliance. This is also true of the processing (fabrication, coating etc) that the steel product undergoes on its journey along the supply chain.

The starting point for traceability within the context of this Tech Note is a structural steel primary product that is manufactured by a steel mill, whether that mill is located in Australia or internationally. Examples of primary products are structural steel beam, column, channel and angle members, steel strip and plate elements and hollow section members. The inherent steel structural properties of these primary steel products, which define their compliance, are documented via a mechanism of identification linked to test reports or test certificates which state the relevant product properties. This ensures all output from the steel mills can be demonstrably identified as compliant. Ensuring product is correctly identified and credentialed is the starting point for fit-for-purpose traceability of compliant structural steel product.

The three key aspects that need to be addressed at all stages in the supply chain are therefore:

- Product compliance (to Australian Standards and the construction specification)
- Product identification (usually defined by Australian Standards)
- Linkage between compliance and product identification

3.2 Product Compliance

The structural steel product standards listed in Clause 2.2.1 of AS 4100 all contain specific provisions which enable the purchaser or their representative to check whether the product supplied complies with the provisions of the nominated Standard.

The main features of the current editions of these structural steel product Standards are as follows:

(a) In-line marking at the time of manufacture which allows the product to be visually inspected and its provenance checked;

(b) Test certificates or reports provided on behalf of the manufacturer by a laboratory that is a signatory to ILAC (International Laboratory Accreditation Cooperation) through their Mutual Recognition Agreement (MRA) which allows the actual test values for a heat to be compared against the requirements of the relevant Standard. A manufacturer may have its own ILAC accredited laboratory or may employ an independent laboratory.

AS 4100 Clause 2.2.2 ‘Acceptance of steels’ states that “*Test reports or test certificates that conform to the minimum requirements of the appropriate Standard listed in Clause 2.2.1 shall constitute sufficient evidence of conformance of the steel to the Standards listed in Clause 2.2.1’.*

AS/NZS 1163, AS/NZS 3678, AS/NZS 3679.1 and AS/NZS 3679.2 all have specific requirements for information on test certificates, which can be summarised as follows:

- Written in English alphanumeric characters;
- Issued by the steel manufacturer;
- Contain the manufacturers and suppliers and testing authority names;
- Test certificate number and date;
- Product testing specification and grade of steel;
- Product designation and all relevant dimensions;
- Product steel making process;
- Length, bundle or pack or unique identifier to which the certificate applies;
- Heat number (from casting);
- Mechanical properties from tensile tests (all values cited in AS/NZS Standard);
- Whether each measured mechanical property complies with AS/NZS Standard;

- Chemical analysis results and type of analysis undertaken.

Note that test reports or test certificates must be related to a specific heat number which in turn must be able to be related to a specific product.

As regards test certificates for bolts, for the bolt Standards listed in Clause 2.3.1, AS 4100 contains very specific provisions, as follows:

> ‘Test certificates that state that the bolts, nuts and washers conform to all the provisions of the appropriate Standard listed in this Clause shall constitute sufficient evidence of conformance to the appropriate Standard.’

ASI Technical Note TN001 ‘High strength structural bolt assemblies to AS/NZS 1252:2016’ (Ref. 12) discusses quality issues related to bolts, nuts and washers claiming to comply with AS/NZS 1252.1 (Ref. 13) and discusses how compliance with the Standard might be achieved and what a test certificate should contain. The principles are essentially the same as for steel material as listed above.

AS 4100 refers to AS/NZS 5131 for requirements for welds and welding. AS/NZS 5131 references the relevant parts of the AS/NZS 1554 series (Ref. 14) for the requirements related to welding consumables.

3.3 Product Identification

The steel material standards listed in Clause 2.2.1 of AS 4100 all contain specific provisions which enable the purchaser or their representative to check whether the material supplied complies with the provisions of the nominated Standard. This includes inline (physical) marking of the product that can be related back to the corresponding test (mill) certificate.

The provisions for physical marking vary slightly between the different product types but the common requirements are:

1. Reference to the applicable Standard (e.g. AS/NZS 3678)
2. The manufacturer’s name or mark or both
3. The grade of steel
4. The identification of the heat of steel from which it was made
5. Identification numbers allowing the product to be traced to a test certificate
6. The nominal product dimensions
7. The marking specified above shall be:
    a. Produced at the time of manufacture
    b. Legible and durable to the point of fabrication
    c. Applied to each individual piece supplied
    d. Not be detrimental to the use of the product
8. If the identified portion of the product is subsequently removed, then the identification shall be transferred to each remaining portion of the product

Depending on the product, there are also similar requirements for bundle/pack markings.

The Standards state that if the product is not marked in accordance with the above, then the product is non-compliant with the Standard.

It is therefore clear that the manufactured steel products received into the fabrication process must be marked and the marking must allow tracing back to the corresponding test certificate. Steel product manufacturers will usually provide examples of their marking on the product website.

For high strength structural bolts to AS/NZS 1252.1, which are the most common bolts used in structural steel construction, AS/NZS 1252.1 requires that:

- bolt assemblies are supplied to the purchaser either in the original unopened single sealed container or alternatively in the separate sealed containers of the manufacturer of the assemblies.
- The nuts, bolts and washers are supplied as a complete assembly from the one manufacturer.
- Mixing of different bolt assembly types in the same box is not permitted.

The delivery condition of high strength bolts is critical to the intended performance characteristics, in particular with regard to tensioning. Clean, dry unbroken packaging helps to ensure the intended surface condition is maintained. Similarly, storage and treatment on site must ensure the as-received condition of the assemblies is maintained.

Each package or box shall be clearly identified with the product designation, the name and address of the manufacturer or supplier, batch and heat identification number from which the bolt, nut and washer were taken, the k-class (where not shown, K0 shall be assumed) and a manufacturing or trace lot number.

For welding consumables, AS/NZS 1554.1 requires that electrodes and filler wires are stored in their original packets in protected storage. The requirements for identification on the packaging is as per the Standards for consumables referenced by AS/NZS 1554.1.

3.4 Linkage between product compliance and product identification

The linkage between product compliance (the test certificate and/or other credentials) and product identification (the physical marking on the product and/or product bundles actually supplied) is mandated by the requirements in the Standards, as noted above. All products must have identification that can be traced back to a valid test certificate for that particular batch of product.

The structural steel product therefore commences the journey through the fabrication process and on to erection in the final structure with the linkage between product compliance and product identification in place. How that linkage is maintained, to ensure traceability during and after the fabrication process, is the challenge that is defined by the requirements in AS/NZS 5131.

An equally important consideration as the linkage itself is the longevity of that linkage, such that it is still actionable after 50 years of the building design life. Clearly, the type and robustness of any physical marking of product must be considered in this regard. Maintaining linkage through marking plans (drawings) may be an option.

Key takeaways:

- The requirements for product compliance are clearly defined in our structural steel product Standards
- The requirements for identification of products are clearly defined in our structural steel product Standards
- A positively identified compliant product is the starting point for the required traceability outcomes
- Maintaining the linkage between product compliance and product identification through the fabrication and erection process is the focus of this Tech Note, set within the context that traceability must be maintained through the complete supply chain

4. TRACEABILITY IN THE FABRICATION PROCESS

4.1 Context

At its most fundamental level, traceability is the ability to trace a component back to the manufacturing specification, which may be necessary for a number of reasons, including:

1. To confirm the component is compliant, perhaps as part of an audit or certification process or similar
2. To implement 'damage control' after a failure incident. Knowing the batch or product run the failed component came from would allow the other components from that batch to be traced and product recall or repair undertaken in as cost and risk effective manner as possible

If traceability is not implemented, then there is no ability to confirm compliance after the fact, and a failed component may result in a product recall becoming widespread and expensive. With a known identified batch, the recall/repair can be limited to that batch only.

Within the context of structural steelwork fabrication, traceability goes beyond the simplest 1:1 requirement noted above, where a component remains in its original manufactured form throughout its lifecycle. With structural steelwork fabrication, steel products from many different batches are cut, separated and fabricated together into a completed steel assembly. That assembly would usually also have surface preparation undertaken followed by some form of corrosion protection, which may damage and/or obliterate markings. The steelwork components may then be assembled on site utilising bolted connections. Traceability under these circumstances can be challenging and expensive if implemented in full.

The *type* and *scope* of traceability are important considerations and can be modified in order to be responsive to different project scenarios or client requirements. AS/NZS 5131 provides definition of different types and scopes of traceability in this regard, correlated to the *Construction Category*.

4.2 The Construction Category

The selection of a '**Construction Category**' as applicable to a steel structure or components therein is a risk-based approach intended to provide consistency with the reliability-based philosophy and principles on which the fundamental load assessment (AS/NZS 1170 series (Ref. 15)) and structural design (AS 4100 (Ref. 4) and AS/NZS 5100.6 (Ref. 16)) are based. The approach translates into a fit-for-purpose assessment that ensures the fabrication and erection of steel structures is based on a rational risk assessment, recognising the importance of the structure, what maintenance and inspection measures will be in place, the consequences of failure and the complexity of the fabrication and erection.

The Construction Category is assessed by the design engineer based on the guidance provided in AS 4100 (and similarly contained in AS/NZS 5131). Assessment is based on three input variables:

- The 'importance level' of the structure, which reflects the risk to life and consequences of failure
- The 'Service Category', which reflects the actions to which the structure and its parts are likely to be exposed, such as earthquake or fatigue
- The 'Fabrication Category', which reflects the complexity of the fabrication of the structure and its components

Four Construction Categories are defined, from CC1 with least risk/complexity to CC4 with most risk/complexity. The Construction Category is assessed by the design engineer based on project-specific circumstances. However, the practical reality is that most structures in Australia should be categorised as CC2, with road and rail bridges and more complex structures housing large numbers of people classified as CC3.

ASI Tech Note TN011 (Ref. 17) provides a more detailed analysis of the selection of the appropriate Construction Category and the structure types likely to be covered by each of the Construction Categories.

The *type* and *level* of traceability is defined in AS/NZS 5131 for each of the Construction Categories.

4.3 AS/NZS 5131 Requirements – *Type* of traceability

Clause 4.7 of AS/NZS 5131 defines three *types* of traceability:

- **Lot traceability**: "For lot traceability, the material for a lot of identically fabricated components (main members, purlin cleats, etc.) shall be traceable back to a set of parent material test certificates, but an individual test certificate cannot be assigned to an individual piece of material within that lot of components. Material identification shall be transferred when part material is returned to stock and before further being allocated to other jobs"
- **Piece-mark traceability**: "For piece-mark traceability, the raw material or fabricated component shall be traceable to the parent material test certificates at all stages through fabrication to incorporation into the works on-site, for each piece-mark, of which there may be many individual pieces. Raw material including all plate and section bought or allocated from stock for the work shall be correlated to the test certificates and incoming inspection records. Material identification shall be transferred when part material is returned to stock and before further being allocated to other jobs"
- **Piece traceability**: For piece traceability, the raw material or fabricated component shall be traceable to the parent material test certificates at all stages through fabrication to incorporation into the works on-site, for each piece of steel. Raw material including all plate and section bought or allocated from stock for the work shall be correlated to the test certificates and incoming inspection records. Material identification shall be transferred when part material is returned to stock and before further being allocated to other jobs"

In respect of the types of traceability, it is significant to note that:

1. In all cases, as a minimum, a compliant set of test certificates for the structure concerned is required and any piece of steel must be able to be traced back to that set of test certificates for the structure, whilst not necessarily being able to be traced to an individual certificate within that set.
2. Lot traceability applies to a *lot* of identically fabricated components. Item 1 above applies within that lot, not across a number of lots.
3. The wording "identically fabricated" needs some interpretation. It is not "identical members" but rather members/components that have been fabricated in an identical fashion. For example, consider a set of fabricated rafter members. The main I-beam members may be identical or there may be slight differences in end-cut slope or notching, or different numbers of purlin cleats. They are still considered identically fabricated. Whether the main member (I-beam) can have differing size but still be considered within the same lot is not clear from the definition in the Standard.
4. In all cases, material identification must be maintained for part material returned to stock. If material returned to stock is not able to be identified it can only be used in structures designed to AS 4100 and fabricated to AS/NZS 5131 if it is treated as 'unidentified steel' in accordance with Clause 2.2.3 of AS 4100, which imposes significant limitations on the design yield strength and tensile strength to be used. Clearly, unidentified material cannot meet the requirements for identification and traceability in AS/NZS 5131, no matter what

Construction Category. The handling of part material returned to stock therefore requires particular attention.

5. The requirements for Lot, Piece-mark and Piece traceability in AS/NZS 5131 have been deliberately configured as ‘performance requirements’, that is, they define what performance outcomes are required, not how to achieve them. This is significant to note, as it provides users with maximum flexibility to adopt whatever systems and processes are appropriate, provided the performance requirements are met. Later sections in this Tech Note suggest possible approaches, but these are only suggestions.

Table 1 summarises the essential characteristics of each *type* of traceability.

Table 1 – Essential characteristics of *type* of traceability

Attribute	Lot	Piece-mark	Piece
Test certificates:	Required	Required	Required
Material identification:	Required, including part material returned to stock	Required, including part material returned to stock	Required, including part material returned to stock
Definition:	A collection of identically fabricated* components	A collection of identical components	An individual steel member or component
Test certificate linkage:	A set of test certificates linked to each Lot of members	A set of test certificates linked to each piece-marked collection of members	A test certificate linked to each piece of steelwork
*Note: ‘Identically fabricated’ does not mean ‘identical’, but rather the same member size with similar fitments and fabricated in the same way			

To further explain and illustrate the functional requirements for Lot, Piece-mark and Piece traceability, a simple example has been provided in Appendix B.

4.4 AS/NZS 5131 Requirements – *Level* of traceability

Clause 5.2.3 addresses the *level of traceability*, which is the relationship between the scope of traceability and the particular Construction Category defined by AS/NZS 5131. The scope defines the extent of the structural component types over which the particular *type of traceability* is applied, as follows:

- **For CC1**: “Test certificates shall be available for all steel material. The grade of steel shall remain identifiable for all steel material. Individual plate and section components shall be marked or otherwise designated to ensure the grade can be correlated directly with the fabrication drawing or data”
- **For CC2**: “Test certificates shall be provided for all steel material. Lot traceability for main structural members, connections between main structural members and major plate components (for fabricated plate web girders and the like)”
- **For CC3 and CC4**: “Test certificates shall be provided for all steel material. Lot traceability for all items (including cleats, brackets and the like). Piece or piece-mark traceability is required if so designated in the construction specification”

In terms of scope of application of traceability, it is important to note that:

1. AS/NZS 5131 considers the steel structure to be categorised into two groups:
    a. Main structural members, connections between main structural members and major plate components.
    b. The remaining smaller members and ancillary fitments such as cleats, brackets and the like
2. For CC1 there is no specifically named traceability required. However, the grade of the plate or section must be marked or otherwise designated to ensure it can be correlated to the requirements of the construction specification (i.e. the drawings or other documentation). Being able to identify the different grades of steel is the most fundamental requirement.
3. For CC2, CC3 and CC4, **lot traceability** is the required minimum *type* of traceability. There is no mandated requirement within the Standard for a higher *type* of traceability.
4. For CC3 and CC4, '**Piece-mark**' or '**piece**' traceability is <u>only required if designated in the construction specification</u> (i.e. the engineering drawings, project specification and/or fabrication drawings). Therefore, the specifier, client or relevant authority must mandate a higher *type* of traceability than Lot traceability if they require it. Piece-mark and piece traceability have been defined in the Standard as a standardised terminology if the specifier wishes to call up other than lot traceability.

AS/NZS 5131 provides no further definition of what is considered a main member. Logically it must be considered to be one where failure of the member would lead to significant localised failure or total failure of the structure. Where clarification is required, guidance from the design engineer must be sought.

In practice, fabricators who intend to undertake CC3 or CC4 designated fabrication must have the processes in place to action *piece-mark traceability* or *piece traceability*. Fabricators who wish to be certified to CC3 would be required to demonstrate that the capability and processes required for *piece-mark traceability* and *piece traceability* are in place.

4.5 AS/NZS 5131 Requirements – Summary

Taken together, the requirements for traceability in AS/NZS 5131 may be summarised as shown in Table 2.

Table 2 – Summary of steel material traceability requirements in AS/NZS 5131

		Construction Category			
		CC1	**CC2**	**CC3**	**CC4**(1)
Grade designation		Required	Required	Required	Required
Traceability	**Type**	Not required	'Lot' required	'Lot' required 'Piece-mark' optional(2) 'Piece' optional(2)	'Lot' required 'Piece-mark' optional(2) 'Piece' optional(2)
	Scope	Not applicable	Main structural	All pieces	All pieces

			members and connections Major plate elements		
Notes:	(1) The requirements for CC4, if additional to CC3, are project specific and defined by the client or appropriate authority (2) 'Piece-mark' or 'Piece' traceability only required if stated in the construction specification				

4.6 Traceability – Bolts

AS/NZS 5131 makes no specific reference to requirements for traceability of bolts. Nevertheless, the location where each lot number of bolts is used on the steel frame should be recorded because once the bolts are removed from the box, they are no longer traceable unless a record is kept of what bolt diameter × length combination went where.

A lot number is an alphanumeric code assigned by the manufacturer/distributor which identifies the manufacturer and the manufacturing lot number. Each diameter × length combination should have a separate lot number for traceability purposes. It is essential that bolt importers/distributors, fabricators and erectors ensure traceability of the bolts used in a particular project by way of identifying each bolt diameter × length combination using the lot number on the box in which the bolts are supplied.

4.7 Traceability – Welding

AS/NZS 5131 draws a distinction between traceability of welds, welders and weld procedures.

Specifically:

- Clause 7.4.1.2 'Validity of a welding procedure qualification' states "For CC3 and CC4, weld procedure traceability is required"
- Clause 7.4.2 'Qualification of welders' states "For CC3 and CC4, identification and traceability of welders is required"
- Note 5 to Table 7.4 states "Identification and traceability of welds and welders to individual welds is required when specified by either the quality plan or within the contract documents. Identification of the welder can be by welder ID stamps or weld map." It should be noted that there is conflict over interpretation of Section 7.4, because readers either miss or ignore Note 5 to Table 7.4

Hence, unlike the steel material traceability noted previously, traceability related to welding is scoped according to the Construction Category only, with no reference to different types of traceability.

4.8 Fabrication of similar structures

In some cases, the project comprises fabrication of a number of identical structures. For example, the fabrication and supply of transmission towers. In this case it is likely that material with the same test certificate may be used across a number of structures, challenging how the application of the traceability types defined in A/NZS 5131 is undertaken.

There is no single correct answer to application of traceability in this instance. Considering the transmission tower example, at one extreme, the total of all of the transmission towers might be considered a 'structure' for the project and traceability treated across all transmission towers as if they were one structure. The practical consequence of this is that if Lot traceability is actioned and there is a problem with a particular test certificate, that might necessitate correction to all towers, because where the material is located is not known.

With the more conventional application scenario, where one tower is considered a single structure for the purposes of application of traceability, with Lot traceability any issues with a test certificate will be contained to a single tower.

Therefore, it is clear that the choice becomes one of risk mitigation, which the client and/or constructor must decide and action.

Key takeaways:

- Steel structures designed to AS 4100 and fabricated and erected to AS/NZS 5131 must have the whole structure, or parts thereof, assigned a 'Construction Category' from CC1 to CC4, by the structural engineer
- The Construction Category influences the scope (range of members) of traceability required
- AS/NZS 5131 defines three *types* of traceability, 'Lot', 'Piece-mark' and 'Piece'.
- Lot traceability is the default for Construction Categories CC2, CC3 and CC4. Piece-mark or Piece traceability is only required if specified in the construction specification
- Traceability of welders and weld procedures is required for CC3 and CC4 structures.
- Traceability of welds is only required if specified in the construction specification or quality documentation
- Traceability of bolts to the installed location on the structure is not specified in AS/NZS 5131 but is recommended to be implemented consistent with the scope of the structural steel traceability required
- The implementation of traceability when fabricating many identical or similar structures requires the owner or constructor to make decisions based on a risk assessment

5. IMPLEMENTING LOT TRACEABILITY

5.1 Context

A general definition of '*lot traceability*' in a manufacturing environment might be something like "Lot traceability applies to a group or 'lot' of products that were made together in the same production run and produced using the same materials". It is relatively straightforward and commonplace to apply within a manufacturing environment with production of many identical items. Structural steel product manufacture is an example of lot traceability, where a batch of steel members or plates from the same cast of steel is assigned a unique identifier and linked to a specific test certificate.

Once the steel members or plates enter the fabrication process, the application of lot traceability becomes more complicated. Fabricated components for steel structures are usually bespoke and often unique. There is generally limited opportunity for production of identical pieces, with the possible exception of steel processors, who may apply limited cutting and holing operations to steel members and plates to produce identical or near-identical components. Therefore, lot traceability requires a more responsive definition than might be applicable in other manufacturing environments.

5.2 Interpretation

In AS/NZS 5131, *lot traceability* requires that "the material for a lot of identically fabricated components (main members, purlin cleats, etc.) shall be traceable back to a set of parent material test certificates, but an individual test certificate cannot be assigned to an individual piece of material within that lot of components".

This definition implies that:

1. The components within a lot must have had identical fabrication operations performed on them. Sensibly, minor differences in respect of cut angles, notching, holing, cleats etc should be ignored in this regard. For example, the I-beam components of a set of fabricated rafters for the same portal frame building might be considered a 'lot' and the purlin cleats on these rafters might be considered a separate 'lot'. The complete (with end plates and purlin cleats welded on) fabricated rafters themselves would be considered a lot as well.
2. A 'lot' of components does not have to come from the same steel batch (i.e. the same test certificate). For example, the I-beam components noted above may have come from three different steel batches with three different test certificates. The purlin cleats may have come from five different batches of steel plate. The only requirement is that the rafters and purlin cleats, if considered lots, are each traceable back to a set of mill certificates. In this case the 'set' of mill certificates would be the three mill certificates for the rafter lot and the five mill certificates for the purlin cleat lot.

5.3 Implementation

The implementation of Lot traceability is best described with reference to an example project, in this case the portal frame building structure shown in Figure 3, comprising nine portal frames connected with struts and roof bracing in selected bays. The building has end wall columns and is fully clad, with the cladding supported by Z section purlins and girts bolted to cleats welded to the portal frames.

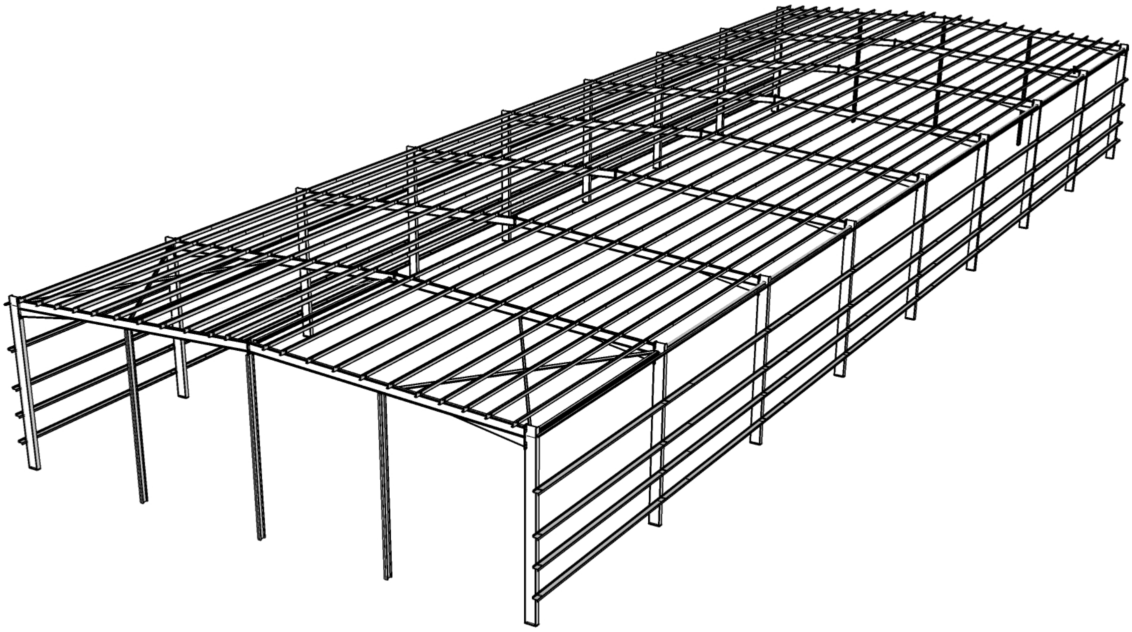

Figure 3 – Example portal frame building

The details of a typical portal frame are shown in Figure 4 and a typical end portal frame with end wall columns in Figure 5.

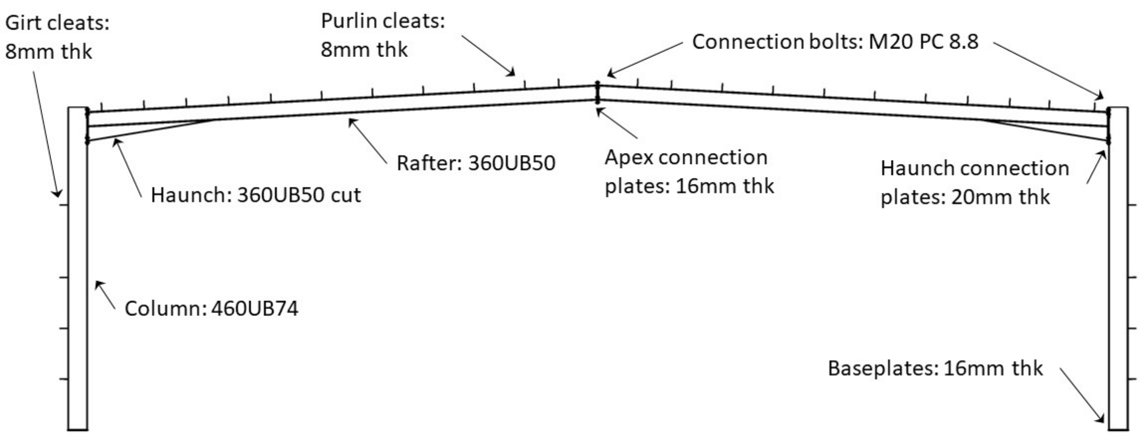

Figure 4 – Typical portal frame details

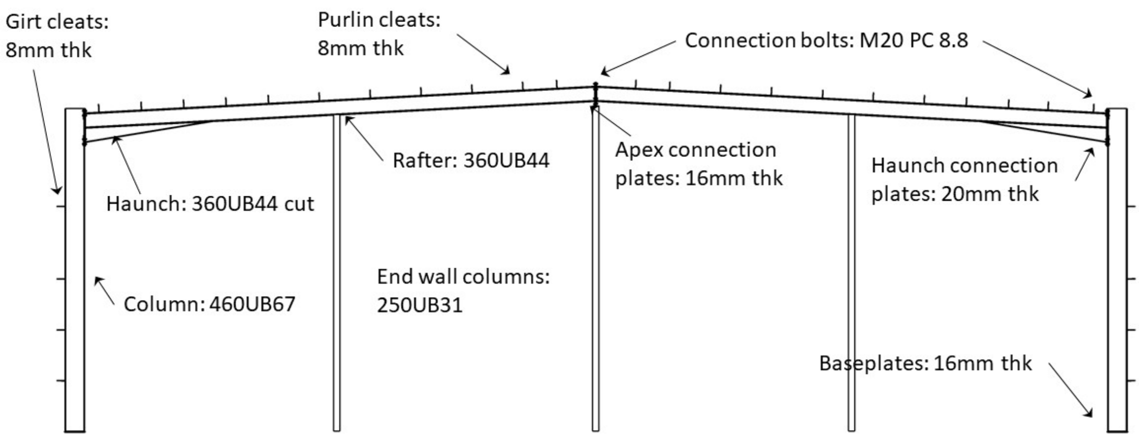

Figure 5 – Typical end wall portal frame details

A potential segmentation into lots might be:

1. Lot A: All rafter components for the internal portal frames
2. Lot B: The rafter components for the end frames, as they are a different member size to the internal rafters and have end wall column cleats
3. Lot C: All column components for the internal portal frames
4. Lot D: All column components for the end frames
5. Lot E: Purlin cleats and girt cleats together
6. Lot F: All end wall columns
7. Lot G: Connection plates
8. Lot H: Baseplates

The components within each lot can have different mill certificates. Note however that there would usually be a more refined type of traceability able to be actioned within each Lot, by virtue of the fact that different forms of input material (plate, size of rolled section etc) would be present within a Lot, with the form of input material then linked to the form stated on the mill certificates.

The definition of the required 'Lots' for the project is important and should be undertaken prior to the commencement of fabrication.

Layered on top of this, the *level* of traceability, defined by the Construction Category for the structure or part, defines which of the above Lots must be actioned. For CC2, the *level* of traceability is "main structural members, connections between main structural members and major plate components (for fabricated plate web girders and the like)". Therefore, Lots A, B, C, D, G and H would need to be actioned. For CC3, Lot traceability is required for all steel items. Therefore, Lots E and F would need to be actioned in addition. Lot F (end wall columns) might be considered as secondary steelwork, as their failure would not usually result in significant collapse.

For a structure such as a portal frame building, which is structurally not very redundant (ie most members contribute to the load carrying capacity and, if failed, might result in collapse of a significant portion of the structure), there is not a great difference between CC2 and CC3 in respect of the level of traceability. For other structures, the difference may be greater.

There is obviously some discretion in the interpretation of what is considered a 'Lot'. It must always be remembered that the intent of a specific *type* of traceability is to define the extent to which an identified problem with a material or component can be traced to the relevant items in the steel structure, and therefore the consequences of the problem and extent of rectification required.

For example, if an issue was discovered with a mill certificate that was assigned to Lot A above (the internal rafters), and there were three mill certificates for the rafter material in Lot A, it would not be possible to assign the problematic mill certificate to any one or group of rafters and therefore all rafters in the group would be suspect and potentially require rectification. That would be a significant (and likely costly) dislocation to the project schedule and/or compliance and safety of the final structure.

Where the selection of what is considered to be 'main structural members' and 'major plate components' is not clear or evident, the structural engineer must be consulted and direction sought in writing.

Key takeaways:

- Lot traceability is the default for Construction Categories CC2, CC3 and CC4
- The definition of the required 'Lots' for the project is important and should be undertaken prior to the commencement of fabrication
- The scope of members over which lot traceability is required is defined by the Construction Category
- For the purposes of identifying 'main structural members' and 'major plate components' for CC2 projects, if unclear, the direction of the structural engineer must be sought
- For the purposes of application of the correct scope of traceability, the construction specification must define the main structural members and major plate components that are safety critical

6. IMPLEMENTING PIECE-MARK TRACEABILITY

6.1 Context

Piece-mark traceability is the next level of traceability up from lot traceability. A ‘piece-mark’ in the context of steel fabrication is a unique mark (alphanumeric identifier usually) placed on a single piece of steel which would usually allow that piece to be related back to the location on the fabrication drawings. Where the pieces are completely identical (in respect of finished form and fabrication process) they are usually given the same piece-mark, because any of the identical pieces can be used in any of the designated locations.

6.2 Interpretation

Piece-mark traceability in the context of AS/NZS 5131 requires “the raw material or fabricated component shall be traceable to the parent material test certificates at all stages through fabrication to incorporation into the works on-site, for each piece-mark, of which there may be many individual pieces”

Where pieces are individually different, each piece would then have a piece-mark and the traceability becomes, in effect, the same as piece traceability described below.

6.3 Implementation

Referring to the previous example of the portal frame building, the implementation of Piece-mark traceability might result in the following piece-mark batches:

1. Piece-mark batch A: All internal rafters excepting those with connections to diagonal roof bracing (on the basis that they are identical to each other, interchangeable on site and could be given the same piece-mark on a fabrication drawing)
2. Piece-mark batch B: All internal rafters with diagonal roof bracing connections. Similar rational to batch A
3. Piece-mark batch C: End wall rafters, if all identical.
4. Piece-mark batches D and E: End wall columns of same height
5. Piece-mark batch F: Purlin cleats
6. Piece-mark batch G: Girt cleats
7. Piece-mark batches H to …: Connection plates and baseplates

This assignment is obviously strongly aligned to what components are identical and could therefore be given the same piece-mark. Within each piece-mark batch, there might be multiple mill certificates applicable.

As discussed previously, the *level* of traceability, defined by the Construction Category for the structure or part, defines which of the above batches must be actioned, with similar considerations to what was described for Lot traceability.

Key takeaways:

- A ‘piece-mark’ is usually applied to a set of identical components that could be used interchangeably in locations in the final structure
- The collection of identical items attributed to one piece-mark can have different mill certificates
- Any steel item can be traced back via the piece-mark to a set of mill certificates but not necessarily a single mill certificate

7. IMPLEMENTING PIECE TRACEABILITY

7.1 Context

Piece traceability is the most involved form of traceability specifically defined in AS/NZS 5131. A ‘piece’ is either one item, such as a steel I-section, purlin cleat or end plate, or a fabricated component, such as a complete rafter member comprising the I-beam with end plates and purlin cleats welded in place.

7.2 Interpretation

Piece traceability in the context of AS/NZS 5131 requires “raw material including all plate and section bought or allocated from stock for the work shall be correlated to the test certificates and incoming inspection records”.

7.3 Implementation

Piece traceability effectively requires separate unique identifiers (piece marks or equivalent) for every piece. Subassemblies must also be uniquely identified and their location in the final structure recorded. There is little scope for alternative interpretation. Systems must be in place to link each piece to the specific mill certificate applicable to that piece and each piece to the subassembly.

If identical pieces can be sourced from the same steel material (ie same mill certificate), then a piece-mark can be assigned to these batch of pieces and that single piece-mark linked back to the single relevant mill certificate. In this case, piece traceability is functionally equivalent to piece-mark traceability but with the added requirement that there can be only one mill certificate for each piece-mark batch. However, practically, this scenario requires pre-planning that is generally not possible in the usual production workflow, as shop drawings will usually be developed before steel is ordered and mill certificates available for assignment of steel to the various steel pieces.

As discussed previously, the *level* of traceability, defined by the Construction Category for the structure or part, defines which of the components must be actioned, with similar considerations to what was described for Lot traceability.

7.4 Application guidance

As noted previously, the requirements defining Lot, Piece-mark and Piece traceability in AS/NZS 5131 are configured as performance requirements, allowing application of any approach that meets the performance intent.

Suggestions for possible application approach for Piece traceability include:

1. Specialist software systems exist which help automate the process of applying globally unique identification numbers (GUID’s) to each piece of steel. Because GUID’s may not necessarily be logical in terms of a naming/numbering convention, their use is part of an automated system that manages the complete traceability process, from initial procurement of material through to shipping of the final fabricated steel components. The investment in a system of this form must be considered to be part of an initiative to integrate all operations.
2. Existing steelwork traceability is often implemented via the use of a ‘part number’, which might be applied to a unique component (comprising a number of pieces welded together) or to an individual set of geometrically identical pieces (i.e. a piece-mark). One approach to modifying this process that has been found to be conveniently workable is to apply a unique ‘trailer number’ to the end of the part number for cases where the part number refers to a collection of identical units. Therefore, for example, purlin cleat part number

PC-200 becomes PC-200-001, PC-200-002, PC-200-003 etc for each of the individual purlin cleats. Existing systems can often be modified to accommodate this trailer number, with suitable controls in place to ensure uniqueness and manage changes.

3. The trailer number approach detailed above can be simplified somewhat if geometrically identical pieces (e.g. purlin cleats) can all be associated with one or other material certificates. In this case the modified part number can refer to the collection of purlin cleats with the same material certificate. This meets the performance requirement for piece traceability in AS/NZS 5131.

Key takeaways:

- Piece traceability requires every separate piece, and assemblies of pieces, to be traceable back to a specific mill certificate
- If all pieces are unique, this effectively requires a separate unique identifier for each piece
- If pieces are identical geometrically, then a unique identifier (piece-mark) can be applied to all those identical pieces which have the same mill certificate. This meets the functional requirement to be able to trace any of the pieces back to an individual mill certificate

8. IMPLEMENTING BOLT TRACEABILITY

8.1 Context

AS/NZS 5131 makes no specific reference to requirements for traceability of bolts. However, traceability of bolts is good practice and the type and level of traceability of bolts must logically be consistent with the performance intent described in the preceding sections for steelwork traceability. The project specification may also nominate traceability of all items of steelwork, including bolts.

8.2 Interpretation

Traceability of bolts refers to being able to link the bolts in a bolted connection at any location on a project to a specific lot number of the bolts.

A lot number is an alphanumeric code assigned by the manufacturer/distributor which identifies the manufacturer and the manufacturing lot number. Each diameter × length combination should have a separate lot number for traceability purposes. The lot number is linked to the compliance documentation for the bolts.

Each package or box must be clearly identified with the product designation, the name and address of the manufacturer or supplier, batch and heat identification number from which the bolt, nut and washer were taken, the k-class (where not shown, K0 shall be assumed) and a manufacturing or trace lot number. This information must be recorded for traceability purposes.

8.3 Implementation

To be consistent with the performance intent of the traceability requirements for structural steel described previously, the scope of traceability for bolts must be:

1. **For CC2 projects**: connections between main structural members and connections between major plate components. In respect of the portal frame example given in Figures 3 and 4, this would be the apex, haunch and baseplate connections
2. **For CC3 and CC4 projects**: all connections between structural steel members. Connections between the purlins/girts and structural steel would be excluded.

Key takeaways:

- Bolt traceability is not required by AS/NZS 5131
- However, bolt traceability is highly recommended, to be consistent with the intent of the traceability requirements for the steel structure
- Logically, bolt traceability must apply over the same scope or extent of steelwork as defined by the *level* of traceability for the steel structure, which is related to the Construction Category

9. IMPLEMENTING WELDING TRACEABILITY

9.1 Context

In respect of AS/NZS 5131, welding related traceability is specified in three areas:

- Clause 7.4.1.2 'Validity of a welding procedure qualification' states "For CC3 and CC4, weld procedure traceability is required"
- Clause 7.4.2 'Qualification of welders' states "For CC3 and CC4, identification and traceability of welders is required"
- Note 5 to Table 7.4 states "Identification and traceability of welds and welders to individual welds is required when specified by either the quality plan or within the contract documents. Identification of the welder can be by welder ID stamps or weld map."

It should be noted that there are three distinct application areas for traceability related to welding:

1. Weld procedures
2. Welders
3. Welds

Taken together, traceability of <u>welders</u> and <u>weld procedures</u> is required for CC3 and CC4.

Traceability of <u>welds</u> is <u>only required</u> if specified in the construction specification or quality documentation, irrespective of the Construction Category.

9.2 Interpretation

9.2.1 Scope

The requirements for traceability of welders and weld procedures are related to the Construction Category, with CC3 and CC4 requiring traceability. There is no mention of the level of traceability, indicating to what members/connections it is applied, as there is with the steel component traceability discussed previously.

Sensibly, the traceability requirements for welders and welding procedures must apply to the same scope of components as defined for the steel component traceability. For CC3 and CC4, this is all steel components. Therefore, it may be interpreted that <u>welder and weld procedure traceability is required for all steel components and connections for CC3 and CC4</u>.

9.2.2 Welder and weld procedure traceability

There is no specific functional description in AS/NZS 5131 as to what welder or weld procedure traceability means. Commonly accepted industry interpretation suggests:

a. **Welder traceability** means the ability to trace the welder (identified through a welder ID) to the welds undertaken, such that if there is a problem with a particular weld, the welder who laid down that weld can be identified.

b. **Weld procedure traceability** means the ability to trace a weld procedure to the weld it was used on.

9.2.3 Weld traceability

Weld traceability, where specified in the construction specification or quality documentation, is the ability to provide for each weld potentially a range of relevant information, which may include:

- weld procedure used
- the identification of the welder

- date when welded
- unique identification number of the weld
- drawing number
- weld consumable batch number
- materials welded
- NDE / NDT report numbers
- inspector identification and
- inspection results.

As there is no specific definition of what weld traceability means in AS/NZS 5131, and it is left to the specification or quality documentation to mandate weld traceability, the specification or quality documentation must also define specifically what aspects of weld traceability are required.

9.3 Implementation

9.3.1 Welder traceability

Welder traceability may be actioned in a number of ways, including:

1. The welder leaving their mark on the workpiece
2. The welder signing off the job card
3. Welder identification being recorded on the NDT report
4. The welder identification being recorded on as-built drawings
5. Inspection reports (not just NDT reports) should also include reference to the welder's name or ID when inspecting specific joints. Inspection reports can be written by in-house inspection personnel or supervisor/coordinator, or 3rd party inspector.
6. Welders may self-inspect and sign a job card or traveller sheet that stays with the component being fabricated.

In respect of use of drawings, on smaller components, where one or a limited number of welders undertake all the welds on the component, welder traceability can be actioned simply by making reference on the fabrication drawing to the ID of the welder who performed the welds documented on the drawing. Where more than one welder per drawing is involved, the welds undertaken by each welder will have to be identified.

On larger components which might be expected to be welded up by a number of welders, the above process is still workable but might be supplemented with some form of formal weld identification to facilitate the process. The logical extension of this becomes processes similar to those required for weld traceability.

The various methods noted above are all workable, depending on the scale and complexity of the project. Each method has pros and cons that need to be considered based on the project type and fabricator setup. If configured properly, any of these methods would meet the performance intent of AS/NZS 5131.

9.3.2 Weld procedure traceability

Similar to welder traceability, weld procedure traceability can be actioned for simpler components via a table relating the weld type(s) on the drawing to the ID of the documented weld procedure. Usually weld procedures are unique to a joint type and a limited range of grades of steel, making this correlation easier. If all welds are the same type and use the same procedure, then a simple note on the drawing will suffice. For example: "All fillet welds to WPS-XXX". This may also extend to multi-run fillet welds and butt welds, depending on the nature of the design.

For more complex components a limited form of weld mapping may be required (refer section 9.3.3), particularly if other requirements also come into play.

9.3.3 Weld traceability

Given information needs to be provided for each weld, the practical reality is that each weld needs to be uniquely identified, so that the information can be referenced to a unique weld. A common industry term for this process is ‘weld mapping’ and usually comprises identification numbers assigned on the fabrication drawings to each weld. A paper or computer-based system can then be used to document the required information for each weld.

In the most general case, for a component that is large, complex and contains a number of different welds, and given the information required for each weld, there is limited scope to rationalise the weld mapping exercise, and identification of each weld will be required. In some cases, for smaller components with one or very limited weld types, it may be possible to simplify the weld mapping exercise, and identify welds in groups of similar welds, rather than individual welds, provided the same information is applicable to the group of welds.

AS/NZS ISO 3834 parts 2 and 3 sets out various extents of weld traceability components when specified. They should be used sparingly and only when justified by the level of risk as each layer of weld traceability added increases the cost of the fabricated structure due to the need to employ additional people to manage the traceability process.

It should be obvious that weld traceability is inclusive of welder and weld procedure traceability and is the most extensive form of traceability possible. It must also be stated again that <u>weld traceability is only required if stated in the construction specification or quality documentation</u>, which must also define what aspects of weld traceability are required.

9.3.4 Inspection of welds

Inspection companies performing NDT, which is usually as a minimum undertaken on critical welds, will usually record the name of the welder and weld procedure details, which can add to welding related traceability and may suffice in some cases.

Key takeaways:

- Welder and weld procedure traceability is required by AS/NZS 5131 for CC3 projects only
- Weld traceability is <u>not</u> required by AS/NZS 5131. Weld traceability may be required by the Construction Specification or quality plan, which should also define what aspects are required
- Welder and weld procedure traceability is comparatively straightforward to implement, depending on the type of steel structure and simplicity of the components
- On all but the simplest of structures, weld traceability (if required) would usually require unique identification of each weld

10 STAKEHOLDER RESPONSIBILITIES

10.1 Context

Traceability requires a supply chain solution, because if any link in the supply chain is broken, traceability is lost. It therefore places particular responsibility on stakeholders in the supply chain in respect of:

1. Actioning traceability correctly within their operations
2. Ensuring the interface between stakeholders upstream and downstream is managed correctly. Product identification and traceability must be maintained through these interfaces

Overlaid on these responsibilities, and complicating the implementation of robust traceability, is the variable nature of contractual relationships in modern construction practice. A number of different contractual models are in common use, each of which may result in different contractual responsibilities between the various stakeholders (as distinct from traceability responsibilities).

For the purposes of the current discussion, the 'simple' supply chain chart in Figure 6 has been adopted. It must be noted that there are variations and permutations of this 'simple' model, including for example:

- Local steel distributors with inhouse processing capability
- Local steel distributors that outsource processing to third parties
- Local steel distributors that use a combination of the above
- Local steel distributors that supply standard lengths only (all the above scenarios can be supplied direct to a customer or internally transferred)
- International distributors or trading houses that sell to international fabricators
- International fabricators that outsource part processing to third parties

Shipping, freight and product handling can add significant complexity in maintaining through chain traceability. This is the primary responsibility of the manufacturer, the trader and their respective agents or intermediaries (e.g. 3PL).

Regardless of the actual contractual model, the performance requirements for traceability are the same.

The stakeholder responsibilities outlined in the following sections are limited to those responsibilities that affect traceability, specifically compliance, identification and marking and the linkage between compliance and the physical product. There are numerous other responsibilities these stakeholders have as part of the steel supply chain that are outside of the remit of this Tech Note.

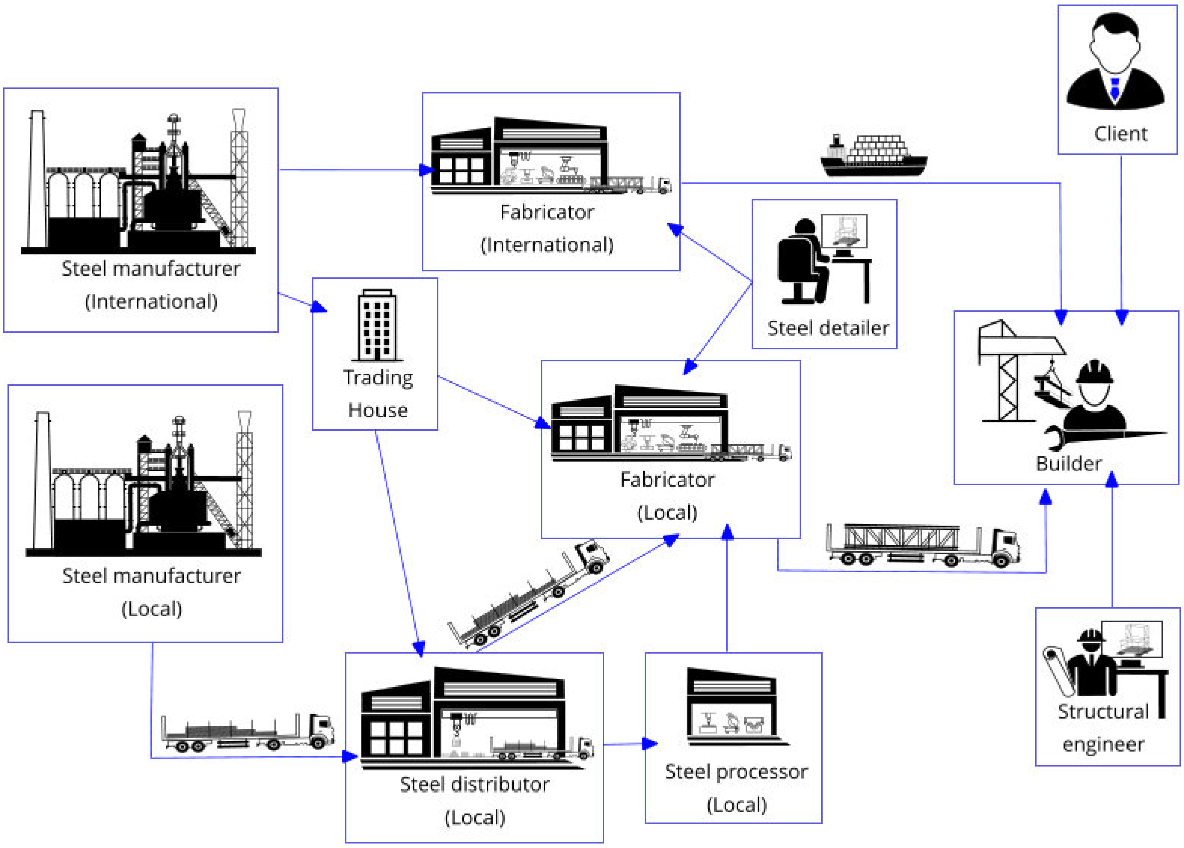

Figure 6 Steel supply chain

10.2 Responsibility of Steel Manufacturers

The responsibilities of steel manufacturers (whether local or international) as regards traceability are defined clearly in the applicable steel product Standards and include:

A. Ensure product compliance – refer Section 3.2 of this Tech Note:

   a. Implement inline marking at the time of manufacture

   b. Provide test reports or test certificates (mill certificates) clearly displaying the information specified in the relevant Standard

B. Ensure product identification – refer Section 3.3 of this Tech Note:

   a. Physical marking of individual pieces of the product

   b. Marking of bundles or packs

C. Ensure linkage (traceability) between the product identification/marking and the product compliance statement (mill certificate)

Applied together, these responsibilities effectively implement piece traceability at the commencement of the supply chain journey for the primary product and enable the various levels of traceability defined in AS/NZS 5131 to be actioned as required further along the supply chain.

An important consideration is ensuring that mill certificates are available (and provided) at the time of procurement of the product.

10.3 Responsibility of Structural Engineer

The structural engineer / designer is responsible for developing the structural design of the building in accordance with the client brief and providing the construction specification to the fabricator and other relevant parties. The structural engineer is also responsible for site inspections and certification of the completed structure where contracted to do so.

In respect of traceability, the responsibility of the structural engineer includes:

A. Ensuring the construction specification (drawings, design, engineering specification etc) is fully resolved and clearly and correctly documented

B. Ensuring correct specification of the construction category or categories

C. Understanding and providing technical support for the traceability requirements in AS/NZS 5131

10.4 Responsibility of Steel Distributor / Supplier

10.4.1 Context

Structural steel distributors and/or suppliers typically act as the link between the producer (the steel mill) and the fabricator. They maintain stock levels for commonly required section, plate and strip sizes and act, in effect, as ‘buyer’s agents’ with the steel mills for less common sizes and/or large orders.

Distributors provide a significant service to the supply chain by:

- Ensuring responsive supply from stock for small-to-medium-size project requirements
- Providing supply in a diverse range of geographical locations without delays
- Negotiating with steel mills for larger orders
- Ensuring that materials supplied meet the requirements of the purchase order and the relevant Standards quoted on the purchase order.
- Processing (cutting, holing) steel in some cases

Product packaging, marking and traceability are important components of ensuring compliant supply that <u>must be maintained</u> by the distribution channel. The responsibilities of steel distributors therefore include:

A. Ensuring product compliance to the Standards required by the purchase order.

B. Ensuring traceability of the product back to the mill certificate is maintained, in order that the purchaser may action the type of traceability (lot, piece-mark, piece) required for the project

C. Providing the applicable mill certificates to the procurer <u>at the time the product is supplied</u>

D. Providing a Supplier Declaration of Conformity (SDoC) where requested by the procurer. An SDoC is particularly necessary where the supplied steel has been sourced internationally and has been verified to the performance requirements of the NCC and relevant Australian Standards (refer Section 8.3.2). Details of the SDoC are provided in Appendix D of ASI Tech Note TN015 (Ref. 3).

Steel distributors may also perform limited simple fabrication, typically cutting and holing of lots of identical items such as cleat plates or cutting to length, coping and holing of beams. They generally do not perform welding operations. This function has come to be termed ‘processing’.

Where distributors also undertake processing, the responsibilities outlined in Section 10.6 also apply.

10.4.2 Ensuring product compliance

Supplying compliant product to the market is a fundamental requirement that distributors must demonstrably action. Duty of care under Workplace Health and Safety (WHS) Regulations and our building Regulation (the National Construction Code) mandate that products are fit-for-purpose and can be demonstrated to meet mandated performance requirements (refer Section 2).

In most cases, a compliant product is one which can be demonstrated to meet the requirements of the relevant Australian Standards, in this case our steel product Standards (Refs. 7, 8, 9, 10). Demonstration of that is usually via valid test (mill) certificates (for product manufactured to Australian Standards) linked (traceable) to the physical product through identification and markings, as discussed in Section 3.4.

Distributors may also import steel product for sale to the Australian steel supply chain that has been manufactured to alternative international Standards. Compliant product to these Standards may well meet the performance requirements of the NCC and Australian Standards, but this must be verified before the product is put into the Australian marketplace.

Verification is not necessarily straightforward but must be undertaken. ASI Tech Note TN015 ‘Ascertaining compliance of structural steel’ (Ref. 3) provides a detailed context to the process and clear guidance through the developed ‘steel verification protocol’. As noted in TN015, “Structural steel that has not been manufactured to Australian Standards **must** be treated as a performance solution” under the requirements of the NCC.

Steel distributors must action this process for any structural steel product they place in the Australian marketplace. They are also strongly encouraged to secure ‘Verified supplier status’, as outlined in TN015. Verified supplier status would usually take the form of a 3rd party certification of their operations to the requirements of AS/NZS 5131.

Verified suppliers will differentiate themselves in the marketplace and provide significant efficiencies for all stakeholders in the supply chain. An alternative ‘trusted supplier status’, which is based on a managed relationship between a specific purchaser and the distributor, is discussed in TN015.

10.4.3 Ensuring traceability

Steel product with identification from the manufacturer must have that identification recorded and the linkage between identification and the physical product maintained, regardless of how the product may be bundled, unbundled, processed and managed within the distribution centre.

As outlined in Section 4.3, steel product intended for the Australian market and to be fabricated to the requirements of AS/NZS 5131 will need to be traceable, the type and extent of which is related to the ‘Construction Category’, which would usually be CC2 for most construction but may also be CC3 for projects with higher risk and/or subject to high levels of fatigue (such as road and rail bridges). The distributor may not know before the fact what Construction Category the steel product will be used for and therefore the distributor must logically ensure traceability is maintained consistent with the need for purchasers to implement the highest level of traceability, namely CC3.

As outlined in Section 4.3, CC3 traceability requires ‘Lot’ traceability as the default but specifies that ‘piece-mark’ or ‘piece’ traceability may be called up in the construction specification if required. Therefore, distributors must ensure lot traceability is implemented and piece level traceability is able to be provided to the procurer if requested.

10.5 Responsibility of Steel Detailers

Structural steel detailers specialise in preparing detailed ‘shop drawings’ for the fabrication and erection of the steel framework used in the construction of buildings, bridges and infrastructure. The steel detailing information is extracted from interpretation of the structural engineer’s drawings and project specifications.

The responsibility of steel detailers includes:

A. Accurately transferring the information on the structural engineer's drawings (including specification of required Standards) to the shop drawings. It is recommended the applicable Construction Category to AS/NZS 5131 is also indicated (refer Section 4.3), either on the individual drawings or a cover drawing for the drawing set.

B. Implementing necessary marking protocols on the items shown on the shop drawings. The type and extent of marking will depend on the type and extent of traceability required for the structural components (refer Sections 4.2 and 4.3) which in turn depends on the particular Construction Category for the project or parts. 'Lot', 'piece-mark' and 'piece' traceability types are defined. 'Lot' traceability is the default for all Construction Categories. The Construction Category is nominated by the design engineer in the project specification and/or drawings.

The type and extent of traceability must be clarified with the engineer if it is not clear from the engineering drawings and specifications.

Significant innovation has impacted the steel detailing process, with 3D computer aided drafting (CAD) software, building information modelling/management (BIM), 3D laser scanning and numerically controlled fabrication processes all becoming more commonplace.

The merging of these new technologies into the function of the traditional steel detailer has resulted in them becoming what might be termed 'construction modellers', with the 3D construction model becoming the single point of truth for all the information defining the project and construction process.

The same technology facilitates greater control over traceability and the opportunity to implement workable cost-effective solutions. Steel detailers should therefore be considered a key facilitator for robust traceability implementation.

10.6 Responsibility of Steel Processors

The pervasive implementation of fabrication technology and numerical control driven by data fed from advanced CAD systems has led to the introduction of automated fabrication machinery such as 'beam lines', which can cut to length, cope and drill holes in long products, and automated plasma cutting machines. While initially targeted at fabrication shops, this technology has also been adopted by a number of distributors who can now offer services to cut and hole beams and other long products and cut plate products to order.

These distributors, who perform certain easily automated fabrication tasks, have come to be termed 'steel processors'. Whilst steel processors can exist as a separate function, it is increasingly common for this to be included by the distributor as a value-add service.

The responsibility of steel processors includes:

A. Accurately transferring the information on the shop drawings (including specification of required Standards) to the numerically controlled fabrication machinery (where implemented) or workshop personnel. It is recommended the applicable Construction Category to AS/NZS 5131 is also indicated (refer Section 4.3).

B. Marking items according to the marking protocols on the items shown on the shop drawings. The type and extent of marking will depend on the type and extent of traceability required for the structural components (refer Sections 4.2 and 4.3) which in turn depends on the particular Construction Category for the project or parts. 'Lot', 'piece-mark' and 'piece' traceability types are defined. 'Lot' traceability is the default for all Construction Categories. The Construction Category is nominated by the design engineer in the project specification and/or drawings.

C. Providing a Supplier Declaration of Conformity (SDoC) where requested by the procurer. An SDoC is particularly necessary where the supplied steel has been sourced internationally and has been verified to the performance requirements of the NCC and relevant Australian Standards (refer Section 8.3.2). Details of an example SDoC are provided in Appendix D of ASI Tech Note TN015 (Ref. 3).

10.7 Responsibility of Steel Fabricators

Steel fabricators perform the significant majority of fabrication work on steel structures and the requirements defined in AS/NZS 5131 are directly applicable to the processes they undertake.

The responsibility of steel fabricators includes:

A. Assessment of the construction specification to correctly identify the steel types and grades required and, importantly in relation to this current Tech Note, the Construction Category and traceability requirements. Unless specified otherwise, ‘Lot’ traceability according to AS/NZS 5131 is the default.

B. Provision of correct information to the steel detailers (where employed by or contracted by the steel fabricator)

C. Procurement of steel materials demonstrably compliant to the requirements of the Standards mandated in the construction specification, together with the documentation proving compliance as required by the relevant steel product Standards. Where steel materials cannot be verified as manufactured to Australian Standards, then either:

   a. The distributor must supply evidence of compliance to the relevant Australian Standards, as outlined in ASI Tech Note TN015 (Ref. 3), including an appropriate SDoC, or

   b. the verification protocol outlined in ASI Tech Note TN015 must be actioned by the fabricator. From a supply chain efficiency perspective, it is obviously more efficient for the distributor to implement the verification protocol on larger lots of material than fabricators having to implement on part-lots.

D. Verification of the linkage between the physical steel products procured and the documentation provided with the product. This is important, as it verifies traceability is intact at the point that the fabrication is commenced. The fabricator will not be able to meet the requirements of AS/NZS 5131 if this is not able to be verified.

E. Implementation of traceability protocols that meet the performance intent of the requirements in AS/NZS 5131 for either lot, piece-mark or piece traceability. The required traceability must be able to be actioned on the finished fabricated steel assemblies.

F. Documentation of the completed structure sufficient to allow traceability to be actioned on the elements of the completed fabricated and erected steel structure at any point in the future, should issues arise or if the structure is disassembled for re-use at end of life. The as-built documentation suite is usually referred to as the ‘Manufacturer Data Report’ (MDR).

10.8 Responsibility of Builder (Steelwork Constructor)

10.8.1 Context

The steelwork constructor, who might also be termed the ‘principal contractor’ or ‘builder’, is the entity that is usually contracted by the client to construct the building or structure of which the steelwork is part. Regardless of the contractual arrangements for the particular project, the steelwork constructor is the party responsible to the client for ensuring the project scope for which they are contracted is constructed on time and within budget. The steelwork constructor is also responsible for ensuring the project is constructed in accordance with the client specification, the relevant Standards, the requirements of building Regulation (the NCC) and Workplace Health and Safety (WHS) Regulation.

The nature of the construction commercial environment is such that there will always be a tension between the quality and compliance of the completed structure, the regulatory and contractual obligations of the steelwork contractor and commercial imperatives to secure a reasonable profit whilst providing the client a fit-for-purpose solution.

The requirement for compliance is non-negotiable. Securing compliance with a cost-effective solution is the aim.

For the purposes of project management of the job, these responsibilities might conveniently be developed into a RACI matrix.

10.8.2 Project initiation

The client and steelwork constructor must take shared responsibility for understanding the contemporary procurement environment and engaging with the project delivery team to ensure a cost-effective risk-minimised quality solution is the outcome. That includes making decisions about how best to ensure compliant outcomes, including actioning traceability.

The specific responsibilities of the steelwork constructor include:

A. Preparation of a Compliance Management Plan prior to the project procurement commencing as an agreed protocol to address potential non-compliance. The details of the Compliance Management Plan are discussed in ASI Tech Note TN015 (Ref. 3)

B. Procurement decisions to minimise risk of non-compliant steel product must be made and actioned for the project. The use of 3rd party certified steel manufacturers and ‘verified suppliers’ is strongly encouraged. Further details are provided in ASI Tech Note TN015

C. Inspection and Test Plans (ITP’s) for the project must be developed, reviewed and approved. These ITP’s must include the appropriate inspection of compliance documentation and traceability at all stages of the construction process (design development, material sourcing, fabrication, erection and project completion)

D. Responsibilities for actions, in particular for compliance and traceability, must be defined to ensure all stakeholders know and understand their specific responsibilities. For the absence of doubt, for the scope of work covered by AS/NZS 5131, the Standard defines ‘responsibilities to be assigned’ in Section B3

E. Implementing a robust system to ensure the necessary data that is to be provided by stakeholders can be submitted efficiently, maintained and provided to the asset owner at project completion

10.8.3 Steel procurement

The ‘Responsible Steel Procurement Framework’ outlined in ASI Tech Note TN015 (Ref. 3) defines a shared responsibility for procurement of the primary steel products. The specific responsibilities of the steelwork constructor include:

A. Specific review of the proposed steel source list and evidence of conformity of the procured steel are two recommended hold points. A mandated review will help ensure the veracity of the procurement process.

B. Acceptance of procured steel: the steelwork constructor has a shared responsibility with the fabricator to accept the procured steel based on the demonstrated compliance credentials of the steel. Steel that is not compliant must not be procured.

C. Review and approval of traceability protocols: given that implementing traceability is a supply chain requirement, the steelwork constructor is best placed to ensure the individual stakeholders in the supply chain are working in concert to deliver fit-for-purpose traceability

10.8.4 Steel fabrication

The fabricator is often directly contracted by the steelwork constructor. In respect of ensuring fit-for-purpose compliant outcomes from the fabrication process, the responsibilities of the steelwork constructor include:

A. Decisions to minimise risk of non-compliant fabricated steel product must be made, whether the steelwork is locally fabricated or sourced internationally. The use of steel fabricators 3rd party certified for capability to AS/NZS 5131 is strongly recommended. Further details are provided in ASI Tech Note TN014 'Structural steelwork certification in Australia' (Ref. 18)

B. Review and approval of ITP's for fabrication, with particular focus on compliance and traceability. Consistency with the Compliance Management Plan must be confirmed.

C. Review and approval of 'as-fabricated' documentation (usually part of the MDR), confirming in particular that traceability has been maintained. Note that it is too late to wait until fabrication is complete to find out that traceability is not fit-for-purpose, as it will be almost impossible to establish after the fact. It is recommended that fabricator documentation and process is confirmed early and monitored periodically.

10.8.5 Steelwork erection

Erection of the structural steelwork may commonly be either subcontracted to the steel fabricator (many of whom have in-house erection crews or relationships with 3rd party erectors) or may be undertaken directly by the builder through their own in-house or subcontracted services.

Irrespective of the contractual scenario, the responsibilities of the steelwork constructor include:

A. Decisions to minimise risk of non-compliant steelwork erection must be made. The use of steelwork erectors 3rd party certified for capability to AS/NZS 5131 is strongly recommended. Further details are provided in ASI Tech Note TN014 'Structural steelwork certification in Australia' (Ref. 18)

B. Review of the erection drawings to ensure the traceability protocols adopted will maintain the desired type and extent of traceability in the final erected structure

C. Where traceability of bolts to connection locations on the project is required, ensuring said traceability is actioned by the steelwork erector. Refer Section 8.

D. Ensuring records of bolt tensioning are taken and included in the as-built documentation. Installation of bolted connections to AS/NZS 5131 is described in ASI Tech Note TN016 (Ref. 19)

E. Where site modifications to structural steel are found necessary, ensuring these are recorded and outcomes traceable.

F. Where site welding is undertaken, ensuring weld/welder/weld procedure traceability, as appropriate, is maintained. Refer Section 9.

10.9 Responsibility of Client / Owner

Ultimately the client is the party who must ensure they receive a fit-for-purpose structure with the quality, durability and sustainability attributes they have contracted and paid for.

Whilst the client is likely not a technical expert in the field of design and construction, they must inform themselves of the regulatory requirements and their own duty of care under Workplace Health and Safety Regulation to ensure a safe compliant structure both during construction and in subsequent operation.

In respect of traceability, the responsibility of the client / owner includes:

A. Ensuring they are engaged in a process with the builder to confirm compliance of the completed structure to both building regulations and the intended sustainability performance. That compliance needs to be demonstrable, which means that traceability needs to be actioned.

B. Ensuring there is a process in place for them to be informed and approve variations to the construction specification, in particular alternative sourcing for products and services that are not to Australian Standards. Such products or services must be considered a ‘performance solution’ under the National Construction Code, which then requires a documented protocol for ascertaining compliance, including traceability.

Key takeaways:

- The structural steelwork supply chain is long and potentially complex
- Relationships in the supply chain can change, depending on the project type and contractual models adopted
- Robust traceability requires every member of the supply chain to understand and action their responsibilities as regards both the inputs to their processes and outputs from their processes

11 CONSTRUCTION PRODUCT TRACEABILITY – CURRENT INITIATIVES

11.1 Supply Chain Context

Traceability requires a supply chain solution, because if any link in the supply chain is broken, traceability is, at the very least, compromised and more likely lost. It therefore places particular responsibility on all members of the steel supply chain to:

1. Ensure they receive or have access to the appropriate documentation for and identification of the products they receive
2. Maintain identification and traceability of the product throughout the processes they undertake on the product
3. Provide the required documentation and identification in a timely manner to the parties that the products are passed on to

The supply chain for construction products is complex, no matter what the material or product. By way of example, Figure 5 illustrates the supply chain for structural steel products. There are numerous different stakeholders involved and multiple paths possible.

Given the complexity of the supply chain, the many stakeholders involved, and the alternate contractual models possible, the obligations on the supply chain to maintain traceability are significant. Any solution must work within day-to-day processes and minimise additional overhead if it is to be accepted holistically and implemented practically by the supply chain.

11.2 Functional Requirements for a Supply Chain Solution

The functional requirements of any solution for traceability over the complete supply chain should be inclusive of the following performance aspects:

- **Digital**: to provide just-in-time visibility to geographically distributed stakeholders. A migration path from legacy paper-based systems would also be desirable
- **Open**: any platform(s) used to support the digital framework must be interoperable with a range of user systems using open architecture and protocols, preferably supporting and/or leveraging on existing systems where possible
- **Non-proprietary**: to avoid lock-in to particular vendors and increase robustness of the framework
- **Trustworthy**: to increase acceptance of the framework against which veracity of information can be assured
- **Visible**: to all relevant supply chain members and/or stakeholders
- **Flexible**: to be able to input, store and retrieve the range of data required in a meaningful, timely, complete and authentic manner

Do we have a final framework? The short answer is "no', but a range of current initiatives, as described in the next sections, both locally and globally, provide insight into the steps being taken towards a workable framework.

11.3 Application of globally unique identification

Globally unique identification is seen as a necessary cornerstone of traceability down to a specific instance of a product. GS1 (www.gs1.org) develops, maintains and administers on behalf of industry a suite of globally trusted and authenticated Standards for globally unique identification and data transmission and associated services. GS1 is a global standards and services organisation with direct representation in 116 countries supporting some 2 million businesses in over 150 countries who utilise GS1 standards in their business operations. GS1 Australia (www.gs1au.org) is the local GS1 chapter servicing the Australian market.

The GS1 Standards appear well positioned to provide the identification requirements supporting robust traceability solutions.

ASI are members of the Australian National GS1 Traceability Advisory Group (Ref. 19) and are working with GS1 to ensure the structural steel supply chain both helps to shape fit-for-purpose solutions and are positioned to be early adopters of such solutions.

11.4 Structural Steel Pilot Study – GS1 / NATA / JASANZ

GS1 (www.gs1.org), NATA (https://nata.com.au/) and JASANZ (https://www.jasanz.org/about-us) have developed, with funding from Department of Industry Science and resources, a 'sandbox' website to demonstrate an online tool for finding and exploring certificates issued by testing, inspection and certification bodies having operations in Australia. The 'ConformityID' website (https://sandbox.conformity.id/) is designed to engage with the community while demonstrating non-proprietary approaches to digital discoverability, based on international norms and standards.

The online tool has been initially populated with steel-specific information and the steel sector has been selected for the first pilot study, however, in principle the tool can be used for any type of construction product. The steel product pilot study, once complete, will inform potential implementation pathways for the future support of robust digital traceability solutions.

11.5 Standards Development

ASI is actively involved on Standards development committees that support, in various ways, the mission to develop a workable construction industry solution for traceability, including:

Standards Committee IT-034 Automatic Identification and Data Capture Techniques

ASI is a nominating organisation and has a representative on Standards Committee IT-034. See Automatic Identification and Data Capture Techniques - Standards Australia

Standards Committee IT-034 scope is:

Standardization of data formats, data syntax, data structures, data encoding, and technologies for the process of automatic identification and data capture and of associated devices utilized in inter-industry applications and international business interchanges and for mobile applications.

At this stage IT-034 has adopted these standards:

Designation	Title
AS ISO/IEC 15459.1	Information technology – Automatic identification and data capture techniques – Unique identification, Part 1: Individual transport units
AS ISO/IEC 15459.4	Information technology – Automatic identification and data capture techniques – Unique identification, Part 4: Individual products and product packages
AS ISO/IEC 15459.5	Information technology – Automatic identification and data capture techniques – Unique identification, Part 5: Individual returnable transport units (RTI's)
AS ISO/IEC 15459.6	Information technology – Automatic identification and data capture techniques – Unique identification, Part 6: Groupings
AS ISO/IEC 15418	Information technology – Automatic identification and data capture techniques – GS1 Application Identifiers and ASC MH10 Data identifiers and maintenance

IT-034 is a national mirror committee to ISO/IEC JTC 1/SC 31 'Automatic identification and data capture techniques' and meets monthly to discuss and vote on current ballots relating to its national mirror committee.

ASI supports the outcomes of IT-034 as facilitating seamless international trade. Within the remit of traceability, internationally aligned data structure and technologies will help ensure seamless and robust transfer of authenticated credentialling information along the complete supply chain.

11.6 Product Certification Schemes

The use of Product Certification Schemes is a natural adjunct to the primary purpose of ensuring robust traceability, that purpose being to ensure the construction products and processes that comprise the finished structure are known and compliant. There is absolutely no point in implementing robust traceability if the product you are tracing is non-compliant and/or fraudulent! Ensuring compliance is the remit of Product Certification Schemes.

ASI Technical Note TN014 (Ref. 17) provides a view into and details of structural steelwork certification in Australia. As relates to structural steelwork, a number of third-party certification schemes are in operation in Australia, including:

- **ACRS** – The Australasian Certification Authority for Reinforcing and Structural Steels (ACRS) (Ref. 21) administers a specialist industry-based, independent, not for profit, third-party product certification scheme which certifies reinforcing, prestressing and structural steels to Australian Standards such as AS/NZS 1163, 3678, 3679 parts 1 and 2, 4671 and 4672 parts 1 and 2. This scheme has been in place for steel reinforcing and prestressing materials since 2003, and for structural steels since 2011. ACRS is accredited by JAS-ANZ to AS/NZS ISO/IEC 17065:2013.
- **NSSCS** – The ASI National Structural Steelwork Compliance Scheme (NSSCS) (Ref. 22) is an independent third-party quality compliance and certification system for supply, fabrication and erection of structural steelwork in Australia. The technical basis for the NSSCS is founded on AS/NZS 5131 'Structural steelwork – Fabrication and erection' (Ref. 11) and is applicable to structures designed to AS 4100 (structural steelwork), AS/NZS 5100.6 (bridges) and supporting Australian Standards, including those for steel products, welding, bolting and corrosion protection. Fabricators (and others in the supply chain) are certified under the NSSCS by Steelwork Compliance Australia (SCA) (Ref. 23). SCA is accredited by JAS-ANZ to AS/NZS 5131.
- **AS/NZS ISO 3834** – AS/NZS ISO 3834 'Quality requirements for fusion welding of metallic materials' (Ref. 24) specifies the production control requirements expected for fusion welded products globally, whether fabricated on-site or in a workshop. It is the internationally recognised benchmark for welding quality. Organisations such as Weld Australia (Ref. 25) offer certification of welding personnel to the requirements of AS/NZS ISO 3834 and related Standards.
- **ATIC Scheme 10** – Australian Technical Infrastructure Committee (ATIC) is a technical group under the Australasian Procurement and Construction Council (Ref. 26). ATIC Scheme 10 – 'Requirements for bodies certifying manufacturers of structural steel products' comprises the following main sections:
- Section 1: Requirements for bodies certifying manufacturers of structural steel products
- Section 2: Requirements for manufacturers of certified structural steel
- Section 3: Requirements for certified structural steel products to
    - AS/NZS 1163 Cold formed structural steel hollow sections
    - AS/NZS 3678 Structural steel – hot rolled plates, floor plates and slabs
    - AS/NZS 3679.1 Structural steel, Part 1: Hot-rolled bars and sections
    - AS/NZS 3679.2 Structural steel, Part 2: Welded I sections

In addition to these Schemes, Government authorities such as main roads departments and some larger construction companies may run pre-qualification schemes for sourcing of steel and fabricated structures. <u>One of the significant opportunities for garnering efficiency in the</u>

construction market in Australia is the rationalisation of these pre-qualification schemes under one of the broader-based third-party certification schemes such as the NSSCS noted above.

11.7 Building Information Modelling (BIM) as a facilitator

The advantages of Building Information Modelling/Management (BIM) for collaboration in design of the built environment are well documented and BIM continues to make advances in application to many areas involved with the creation, operation and maintenance of our building and infrastructure assets.

The BIM model is recognised as much more than simply a 3D representation of building objects. The 3D representation is convenient as a mechanism for visualisation of and interaction with what is in essence a '3D database' of building components and their relationship to each other. The information associated with each object in that database (the 'metadata') is virtually unlimited and the challenge becomes inputting and interrogating that information in a meaningful and pragmatic way.

In respect of traceability, the BIM model can contain for each object the validated information associated with identification, traceability and compliance for that object, including but not limited to:

1. Material test certificates and other compliance related documentation
2. Sustainability indicators, for example the embodied carbon
3. Traceability related information, such as a globally unique identifier, identification details, links to reports and the like

With that information recorded in the BIM model, and the BIM model maintained as an 'operating manual' of sorts during the operation and maintenance phase, traceability to the end of life and repurposing, reuse or recycling becomes a reality.

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20. Australian National GS1 Traceability Advisory Group: https://www.gs1au.org/
21. ACRS website: https://steelcertification.com/
22. National Structural Steelwork Compliance Scheme: https://www.steel.org.au/focus-areas/quality-and-compliance/national-structural-steelwork-compliance-scheme/
23. SCA website: https://scacompliance.com.au/
24. AS/NZS ISO 3834 series Quality requirements for fusion welding of metallic materials
25. WELD Australia website: https://weldaustralia.com.au/
26. Australasian Procurement and Construction Council website: https://www.apcc.gov.au/

APPENDIX A

INDUSTRY STAKEHOLDER REVIEW PANEL

The Technical Note was prepared under the guidance of an ASI steering committee and was peer reviewed by a range of representatives and organisations as listed below. The contribution of these entities for the benefit of the Australian steel community is gratefully acknowledged.

Name	Company	Company type
Anthony Galgano	APEX welding and steel fabrication Pty Ltd	Fabricator
Bruce Cannon	Weld Australia	Industry body
David McNeil	Infrabuild	Manufacturer
Glenn Thiele	Spectrosource	Service provider
Jerome Harris	John Holland Group	Constructor
Jerusha Beresford	Steel Sustainability Australia	Compliance assessment
Jimmy Purcell	Alfabs Engineering Group	Fabricator
John Merrick	Arcadis	Engineer
Julian Serra	Roam Engineering	Engineer
Marijana Upton	Bluescope Distribution	Distributor
Mark Resevsky	Infrabuild Steel Centre	Distributor
Patrick Beshara	Independent steel specialist	Consultant – steel supply chain
Phil Shanks	SteelCAD	Steel detailer
Rob Johnson	Independent steel specialist	Consultant – steel supply chain
Shaun Brown	Crisp Bros. & Haywards	Fabricator
Thomas Tyndall	Bluescope	Manufacturer
Tim Fox	DBM Vircon	Steel detailer
Vikki Wood	Vulcan	Distributor

APPENDIX B

EXAMPLE APPLICATION OF TRACEABILITY REQUIREMENTS

B.1 Context

A 20 storey office building has the typical main structural steelwork framing for one floor as shown in Figure B.1. The building has a concrete core with lift well and stairs, with the floor beams supported off this core and perimeter columns.

All beams are UB sections and columns UC sections. Beams are connected at each end typically with web side plate connections and columns connected together with bolted splice connections, as illustrated in Figure B.1 in 3D view and in Figure B.2 as an engineering plan view with member sizes and connection details. The beams support a composite concrete deck (not shown in 3D view) with decking and shear studs applied on site.

Consider the application of the three *types* of traceability: Lot, piece-mark and piece.

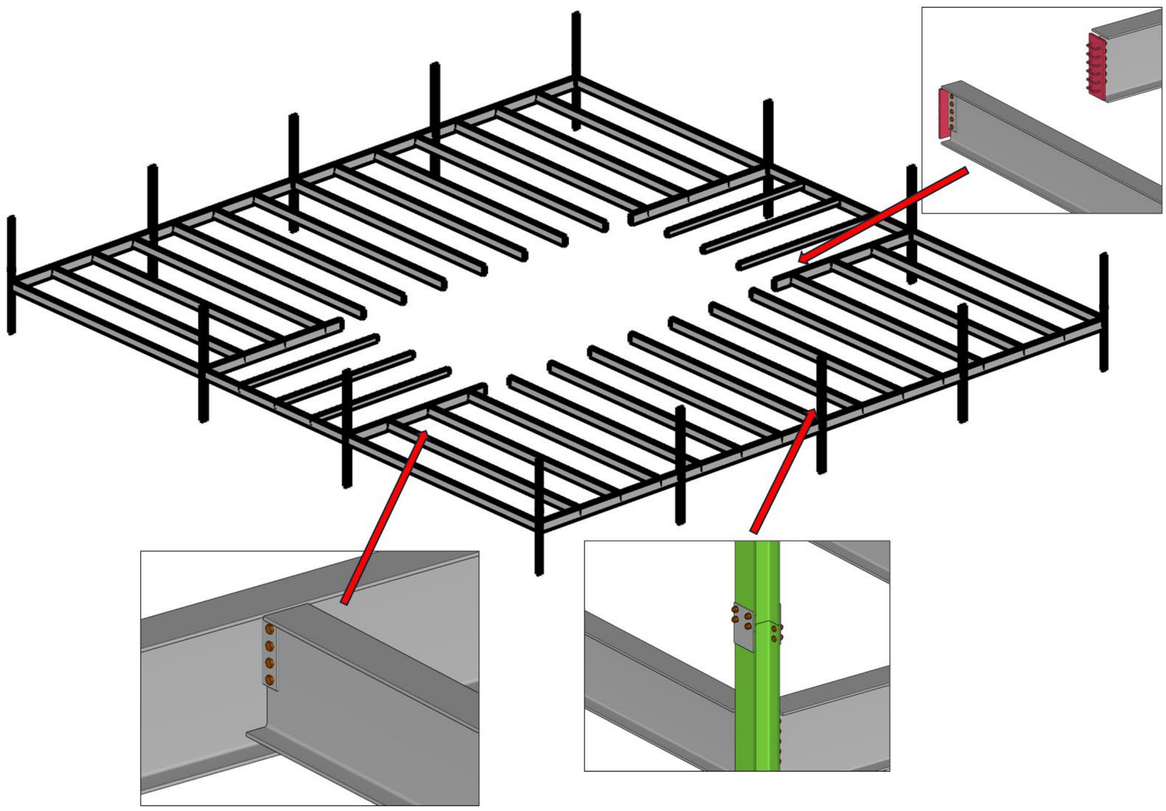

Figure B.1 - Typical floor framing in 20 storey office building – 3D view

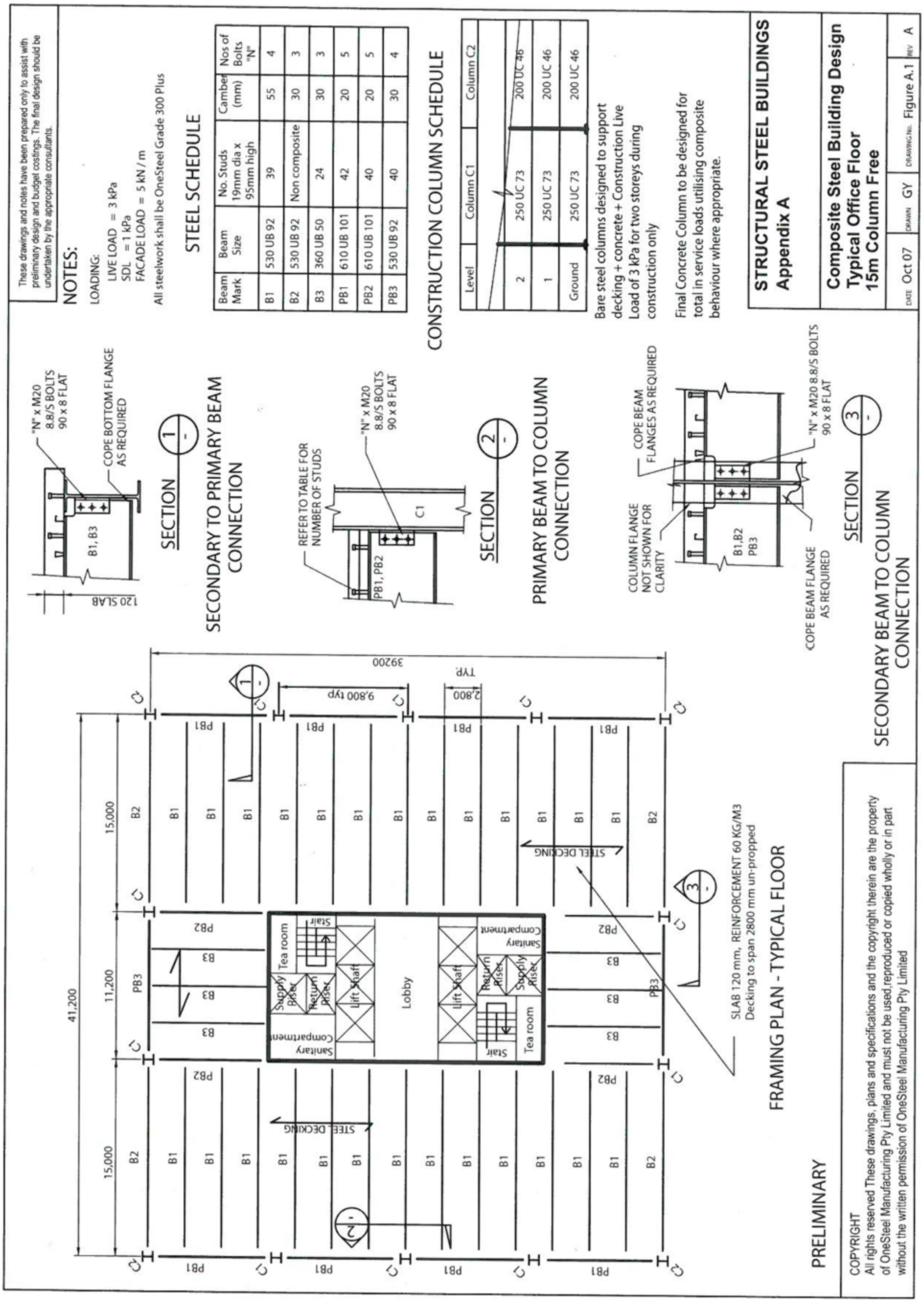

Figure B.2 - Typical floor framing in 20 storey office building – Engineering plan

B.2 Application of Lot traceability

Definition from AS/NZS 5131:

Lot traceability: “For lot traceability, the material for a lot of identically fabricated components (main members, purlin cleats, etc.) shall be traceable back to a set of parent material test certificates, but an individual test certificate cannot be assigned to an individual piece of material within that lot of components. Material identification shall be transferred when part material is returned to stock and before further being allocated to other jobs”

With reference to the member designation in Figure B.2, the application of Lot traceability is summarised in Table B.1.

Table B.1 Application of Lot traceability

Item	Member designation	Number of test certificates	Lot	Basis
1*	B1, B2	4	A	Same member size, similar end connections
2*	B3	2	B	Same member size, similar end connections
3	PB1, PB2	3	C	Same member size, similar end connections
4	PB3	1	D	Same member size, similar end connections
4	C1, C2	2	E	Same member size, similar end connections
*Note: It would be possible to combine, for example, Lots A and B, because B3 is a different section size to B1 and B2 and therefore the test certificates, which indicate the member size, can be assigned to the relevant members without the need for the separate A and B lots.				

The members designated ‘Lot A’ are beam members with the same size and similar end connections, hence considered “identically fabricated’. There are four test certificates applicable to this collection of beam members. If a material related problem was found with one of the beams in this collection, the exact beams related to that problem could not be identified back to the specific test certificate, but the problem could be limited to those in Lot A and remedial measures may need to be undertaken on all beams in Lot A.

Similar rationale to above for Lots B, C, D and E.

B.3 Application of Piece-mark traceability

Definition from AS/NZS 5131:

Piece-mark traceability: “For piece-mark traceability, the raw material or fabricated component shall be traceable to the parent material test certificates at all stages through fabrication to incorporation into the works on-site, for each piece-mark, of which there may be many individual pieces. Raw material including all plate and section bought or allocated from stock for the work shall be correlated to the test certificates and incoming inspection records. Material identification shall be transferred when part material is returned to stock and before further being allocated to other jobs”

With reference to the member designation in Figure B.2, the application of Piece-mark traceability is summarised in Table B.2.

Table B.2 Application of Piece-mark traceability

Item	Member designation	Test cert number	Piece-mark	Basis
1	B1	Mill-cert-001 Mill-cert-002	PM-001	Identical member size, end connections and all ancillary fitments
2	B1	Mill-cert-003	PM-002	Identical member size, end connections and all ancillary fitments
3	B2	Mill-cert-004	PM-003	Identical member size, end connections and all ancillary fitments
4	B3	Mill-cert-005 Mill-cert-006	PM-004	Identical member size, end connections and all ancillary fitments
5	PB1	Mill-cert-007 Mill-cert-008	PM-005	Identical member size, end connections and all ancillary fitments
6	PB2	Mill-cert-009	PM-006	Identical member size, end connections and all ancillary fitments
7	PB3	Mill-cert-010	PM-007	Identical member size, end connections and all ancillary fitments
7	C1	Mill-cert-011	PM-008	Identical member size, end connections and all ancillary fitments
8	C2	Mill-cert-012	PM-009	Identical member size, end connections and all ancillary fitments

The B1 designated members, items 1 and 2 in Table B.2, have separate piece-marks because some frame into steel beams both ends and some frame into a steel beam at one end and the concrete core at the other end, hence they have slightly different end connections and hence not identical. For item 1, this collection of identical beams is covered by two different test certificates.

For B2 designated members, they are identical length and frame into similar columns, hence identical. They are covered by a single test certificate.

For B3 designated members, they are identical length and connected identically at one end into a beam and at the other into the concrete core. They are covered by two test certificates.

Similar rationale for the remaining member designations.

If a material related problem was found with one of the members, the issue could be limited to the members within the piece-mark of the problematic material, which would typically be a smaller number of members than the Lot traceability case.

B.4 Application of Piece traceability

> **Definition from AS/NZS 5131:**
>
> **Piece traceability**: “For piece traceability, the raw material or fabricated component shall be traceable to the parent material test certificates at all stages through fabrication to incorporation into the works on-site, for each piece of steel. Raw material including all plate and section bought or allocated from stock for the work shall be correlated to the test certificates and incoming inspection records. Material identification shall be transferred when part material is returned to stock and before further being allocated to other jobs”

With reference to the member designation in Figure B.2, the application of Piece traceability essentially means that each individual member and connection plates are given an individual item number, and that item number can be related back to the test certificate corresponding to the member.