ASCERTAINING COMPLIANCE OF STRUCTURAL STEEL

AUSTRALIAN STEEL INSTITUTE

The procurement, fabrication and erection of structural steelwork for buildings, infrastructure and resources projects involves a supply chain that is as varied as it is long. The quality and traceability of steel is therefore dependent on a number of parties in the supply chain. If any link in this chain is broken, the ability to ascertain compliance compromised. The Australian Steel institute's (ASI) 'Steel Verification Protocol' establishes a methodology to ascertain compliance. As with the majority of construction products, structural steel intended for the Australian marketplace must meet the performance intent of: the National Construction Code (NCC), Australian Standards, and the basic principles of duty of care established under Workplace Health and Safety legislation.

THE NATIONAL CONSTRUCTION CODE (NCC)

The NCC is a performance-based code and specifies means to achieve compliance to a range of Performance Requirements (as per Figure 1 opposite). Structural steel that cannot be demonstrated to have been manufactured to the requirements of the Australian Standards called up in AS 4100 cannot be a deemed-to-satisfy solution but must be treated as a Performance Solution and must be demonstrated to comply to all relevant Performance Requirements through an Assessment Method.

Assessing a performance solution is not a trivial task, and in most cases requires information to be assessed early in the process, rather than after a building or structure has been procured. The design, as typically defined in the design drawings and specifications, prescribes the required product compliance, usually by reference to (Australian) Standards. If a product that does not comply with the design requirements is proposed to be procured, authorisation for the change must be obtained from the designer prior to procurement.

AUSTRALIAN STANDARDS

Like most contemporary design standards around the world, AS 4100 *Steel structures* is in limit state format. For a structure subjected to actions, the structural steel elements and connections are designed to ensure the structure is within the limit states for strength, stability, serviceability, brittle fracture, fatigue, fire, ductility and durability. Put simply, the design action (S*) must be less than or equal to the design resistance (ØRu).

Uncertainties relating to both the actions and the actual capacity of the resisting members are resolved by using a probabilistic approach in design. The actions (loads) are considered as having a probability distribution as shown in Figure 2. The design action is represented by S* on the curve, while the upper and lower limit represents the uncertainty which arises due to the lack of control over or incomplete knowledge of the actions.

BASIS FOR DESIGN VALUES

The design equations in limit state standards such as AS 4100 *Steel structures* are calibrated to ensure an acceptably low probability of failure. This calibration exercise considers, amongst other things, members being understrength due to variation in material strength and section properties. To ensure the design assumptions in the calibration exercise remain valid, the structural steels produced by manufacturers must meet long-term minimum, or in some cases maximum values, also known as long-term quality (LTQ) levels. To achieve these long-term quality levels, the manufacturer will target a mean value of material property higher than the minimum target value to allow for production variability. Figure 3 indicates a typical distribution curve of actual yield stress from an Australian manufacturer testing for a 300 Grade steel. Notice the majority of tests are significantly higher than 300 MPa, with an average of around 350-355 MPa. The NCC requires that for a 300 grade steel the yield strength shown at the 5% mark of the

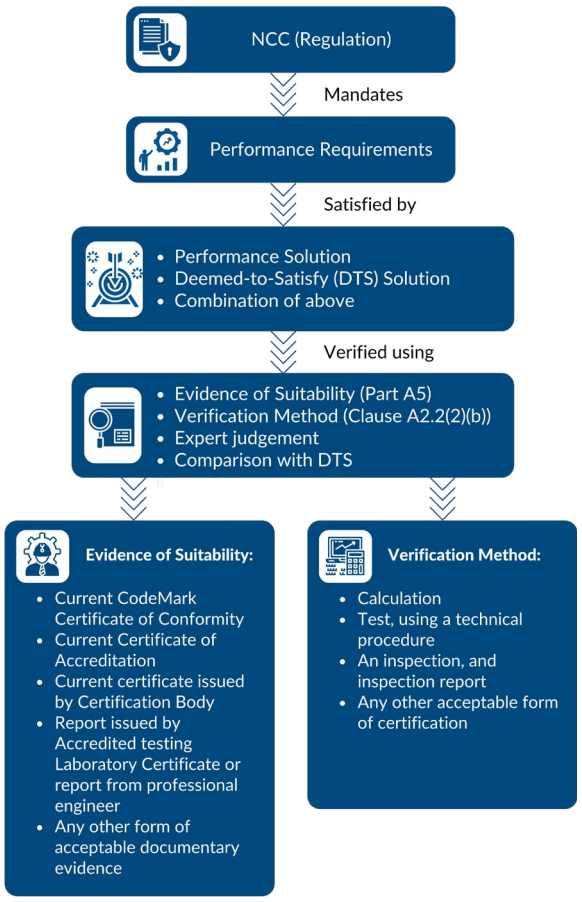

Figure 1. NCC verification hierarchy

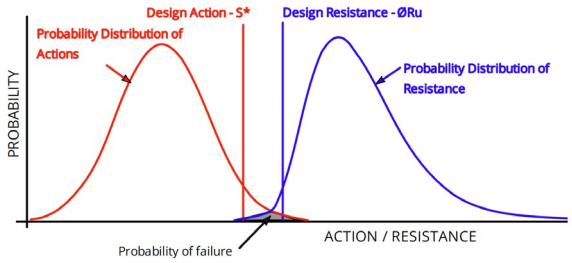

Figure 2. Probability distribution of actions and resistance superimposed

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distribution curve be at least 300 MPa. This is called the 5 percentile characteristic strength. This means that 95% of the yield strength test results for the steel are above the required 300 MPa yield strength. It follows that:

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

Therefore:

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

STEEL VERIFICATION PROTOCOL

A robust steel verification protocol as shown in Figure 4 must:

1. Establish the veracity of the product at multiple points in the journey from manufacturer to intended use on the project.
2. Maintain verifiable traceability, that is, the ability to link the credentials (documentation provided by the manufacturer) of the steel to the product in hand
3. Be able to be applied to both locally manufactured and imported product.
4. Maintain a similar 'quality bar' (the quality defined by the Australian Standards), regardless of point of manufacture.
5. Be cost effective and commercially viable and, ideally, reward good procurement practice with more cost-effective outcomes.
6. Be able to respond in a timely manner to supply of necessary documentation and when product non-compliance is identified.

Accordingly, within the context of the current Australian procurement environment, the recommended steel verification protocol must:

1. Establish the acceptable quality credentials of the steel manufacturer
2. Establish the acceptable quality credentials of the steel
3. Establish traceability of the product from manufacturer to use on the project
4. Where steel is not manufactured to an Australian Standard, establish the acceptable performance requirements of the steel defined in the applicable Australian Standard for the steel product concerned, as referenced in the NCC.
5. Assign appropriate responsibility to the applicable stakeholders in the supply chain.

For further details, please refer to ASI Technical Note TN015 *Ascertaining Compliance of Structural Steel*, which is free to download at https://www.steel.org.au/resources/elibrary/technical-notes/

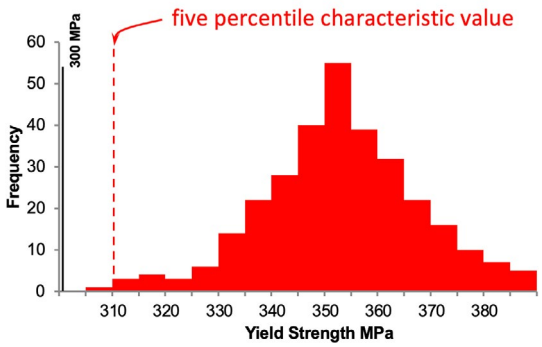
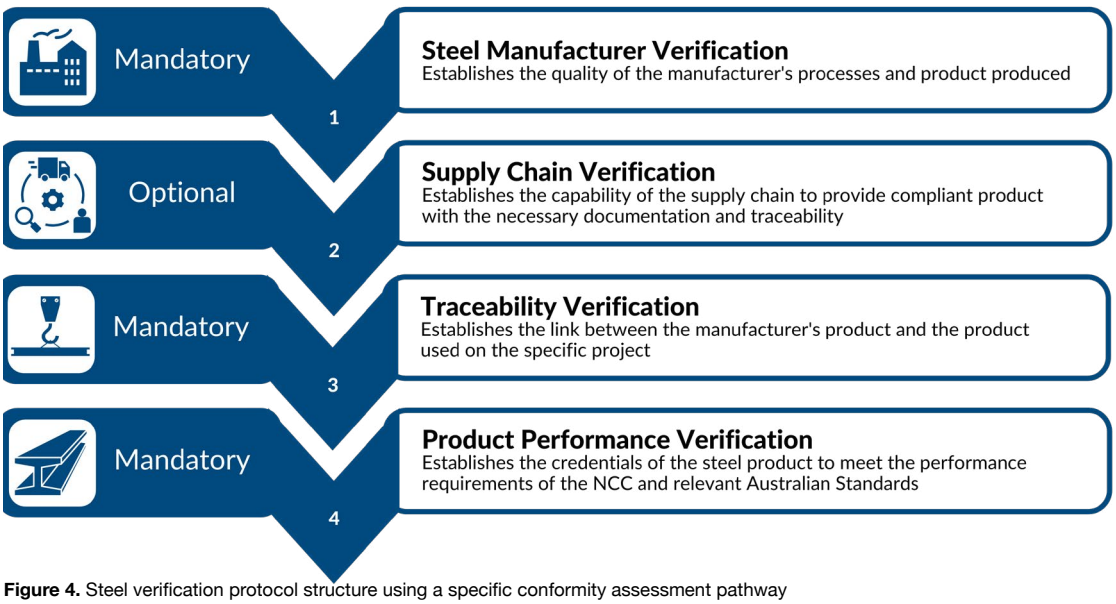


Figure 3. Yield strength histogram based on manufacturer production testing – 300 Grade steel. (Image courtesy InfraBuild).

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



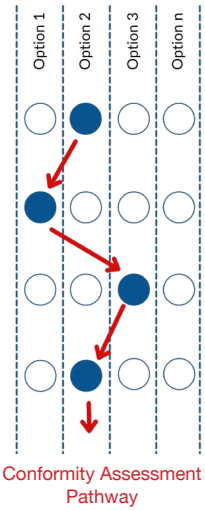


Figure 4. Steel verification protocol structure using a specific conformity assessment pathway