# *USE OF IMPORTED STEEL AND DESIGN USING AS 4100*

As Clause C2.2 of the Commentary to AS 4100 states:

> ***"C2.2 STRUCTURAL STEEL***
>
> *The Standard has been written around the range of structural steels manufactured in Australia to the Australian Standards quoted in Clause 2.2.1. The Standards quoted are product type Standards."*

The assumption made is that all steel is manufactured in accordance with the Standards quoted in Clause 2.2.1 in all respects. That is what a certificate from an Australian manufacturer is intended to warrant.

The member design sections (5, 6, 7, 8) of AS 4100 use general expressions for steel member design applicable over a wide range of steels, provided that the yield stress used in design does not exceed the value of 450 MPa nominated in Clause 1.11 (b) of AS 4100, which is about the upper limit of available test data available to the committee at the time of writing the Code. The capacity factors nominated in Section 3.4 of AS 4100 were derived using statistical analysis of results from steel testing of material complying with the Standards listed in Clause 2.2 of AS 4100. References cited in the Commentary to AS 4100 describe in detail how the capacity factors were derived for different member types and design actions. The Commentary to AS 4100 advises that, (see C3.4 on page 13):

> *"The capacity factor (Φ) takes the following into account:*
>
> *(i) The probability of understrength members or connections due to variations in material strength, material properties, sizes of members and connection elements, and homogeneity.*
>
> *(ii) The differences between the strengths in tests of isolated members, connections, or test pieces and the strength of the member in the structure.*
>
> *(iii) The inaccuracies in the design equations related to member or connection design and inadequacies in our understanding of member and connection behaviour.*
>
> *(iv) The degree of ductility and reliability required of the member or connection element under the action effects being considered.*
>
> *(v) The accidental eccentricities in columns, beams, and connections.*
>
> *The Standard is arranged on the basis of member-by-member or connection element design. The design clauses for each member or connection element are formulated to give the best possible estimates of the nominal capacity of the member or connection element taking into account the conflicting requirements of accuracy and simplicity.*

*The capacity factors were derived by a process called 'code calibration' through the use of a 'safety index'. The safety index is a convenient measure of the notional safety taking into account the variabilities of the loads and the structural capacities. From a consideration of the values of safety indices for past successful designs to earlier Codes, values of target safety indices were chosen for the Standard. The capacity factors were then selected so that for designs to the standard, the associated safety indices are close to the chosen target values."*

It is essential to understand that the quality of the steel and its guaranteed mechanical properties are the basis on which the capacity factors of AS 4100 have been derived. Steels not complying with the Standards listed in AS 4100 may not have the same distribution of strength as those steels which do comply and hence may require the use of different capacity factors to those listed in AS4100.

There is also the question of weldability and brittle fracture to consider. If the steel does not comply with a Standard nominated in AS 1554.1 , then Clause 2.1 of AS 1554.1 specifically requires that either :

*1. testing of the material to determine compliance with any of the grade types in the Standards nominated .... has been carried out to the satisfaction of the Principal ;*

*2. a comparison of supplied test certificates with the requirements of any of the grade types in the Standards nominated ..... has been performed to the satisfaction of the Principal.*

Since AS 4100 calls up AS 1554.1 as the welding standard which must be met, this means that any evaluation of the steel must consider the chemical properties in order that the steel may be assigned the correct weld group number for use with AS 1554.1 and for use with Section 10 of AS 4100. Method of manufacture may also influence the assignment to a weld group.

Consequently, AS 4100 relies on guaranteed values for chemical composition, mechanical properties, tolerances on dimensions and chemical composition, method of manufacture and quality control provisions.

For steels not manufactured in Australia, Clause 1.5.1 provides a method whereby they may be used as a "new material". The Commentary to this Clause (Cl. 5) advises as follows:

*"Standards Australia Committee BD/1, Steel Structures, is responsible for the Standard and is available to offer opinions on new materials or methods. It is usually necessary to seek approval from the appropriate building authority for the use of new materials or methods."*

Seeking approval from an "appropriate building authority" would be a torturous process so an alternative route is needed. The possible routes by which designs to AS 4100 may be carried out using steels not manufactured in Australia are as follows:-

1. obtain sufficient statistical data on the chemical and mechanical properties of the steels and if they are similar to those of the of the steels cited in Clause 2.2 of AS 4100, then use the capacity factors in Clause 3.4. The logical source of data is the manufacturer but see comments under item below. The volume of data and the need to verify it required mitigates against the practical use of this method.

   If the data are not similar, then carry out sufficient statistical studies on the available data to derive new capacity factors, yield stress and tensile strength using the approaches detailed in the references to the Commentary to AS 4100. Chemical composition will also have to be assessed to allow assignment to a weld group in AS 1554.1 and Section 10 of AS 4100.This process would be very lengthy as well , thus mitigating against its use also.

OR

2. obtain test certificates from the mill certifying that the

   a. product chemistry

   b. mechanical properties

   c. methods of manufacture

   d. tolerances

   e. dimensions of rolled sections

   comply with the requirements of the relevant Australian Standards in Clause 2.2 of AS 4100. The importer of the steel should be able to supply this information and should ideally supply independent verification of the information from an independent laboratory. It should be noted that the quality and reliability of the original documentation will vary according to source and country of origin and the structural engineer needs to be satisfied as to the veracity of the information received.. If no independent verification is available, serious consideration should be given to independent testing as in item (3) below. It is understood that structural engineers in the United States and Canada are encouraged not to accept any imported steel for structural purposes without independent laboratory certification to the relevant standard.

3. have sufficient tests done by an independent laboratory and obtain certification from the independent laboratory to enable the steel to be fitted into a grade in the relevant Standard in terms of yield stress and tensile strength. The laboratory should also assess the chemical composition so as to enable the steel to be allocated a weld group number in terms of AS 1554.1 (weldability) and section 10 of AS 4100 (brittle fracture)

OR

4. treat the steel as unidentified steel. As the Commentary to AS 4100 notes:-

   "It is preferable that any unidentified steel should be tested in accordance with AS 1391, but if this is not possible, the Standard requires the severe assumption that a design yield stress not exceeding 170 MPa and a design tensile strength not exceeding 300 MPa be used, as appropriate. Most steels will have a yield stress and tensile strength in excess of these and testing may give a more economic result."

There is no provision in Section 17 of AS 4100 for proof testing of steel in order to derive a yield stress or tensile strength to be used in design, as there is in NZS 3404. Section 17 only relates to proof testing of structures, members or connections.

There is thus no bar to the use of steel not manufactured in Australia for the design of steel members using AS 4100 if any one of the above four paths are followed. In terms of design using the provisions of AS 4100 , all steel must fit into one of the grades nominated in Clause 2.2.1 for the reasons given earlier. The intention is to ensure that all steel does comply with the relevant nominated Standard. Compliance with another Standard or Specification is not acceptable nor relevant.