

# Part 2

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**See Section 2.1 for the specific Material Standard (AS 1163) referred to by the section type and steel grade in these Tables.**

See page (ii) for the appropriate use of this publication.

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### 2.1 Range of Structural Steel Grades and Sections

These Tables cover the full range of structural steel hollow sections supplied by Smorgon Steel Tube Mills manufactured in accordance with AS 1163.

The section sizes and their respective grades listed in the Tables include:

- AS 1163 Grade C250L0 Circular Hollow Sections (CHS)
- AS 1163 Grade C350L0 Circular Hollow Sections (CHS)
- AS 1163 Grade C350L0/C450L0 DualGrade® Rectangular Hollow Sections (RHS)
- AS 1163 Grade C350L0/C450L0 DualGrade® Square Hollow Sections (SHS)

The grade designation (e.g. C450L0) is based on the nominal minimum yield strength of the steel (in MPa). The prefix 'C' is used before the value of the nominal yield strength of the steel to indicate that the section is cold-formed. It should be noted that AS 1163 only considers cold-formed structural steel hollow sections. The suffix 'L0' denotes impact properties at 0°C as specified in AS 1163. Hollow sections rated with impact properties such as L0 are not only important in lower temperature environments but also for welded structures subject to dynamic loads. This becomes much more important for hollow sections with larger thickness (i.e.  $t > 6.0$  mm).

AS 1163 Grade C350L0/C450L0 or DualGrade® RHS/SHS comply with the strength and elongation requirements of both Grade C350L0 and C450L0. The key mechanical properties of DualGrade® are covered in Section 2.2 and a further description of DualGrade® is given Section 2.4. Where relevant, DualGrade® RHS/SHS are designed as AS 1163 Grade C450L0 sections in these Tables to capitalise on the higher strength benefits of this steel grade – see Section 2.4.2.

Further information on the availability of the sections listed in the Tables is noted in Section 2.7.

### 2.1.1 Specifications

Hollow sections supplied by Smorgon Steel Tube Mills are manufactured by cold-forming and high-frequency Electric Resistance Welding (ERW). The ERW process allows cold-formed hollow sections to be welded at ambient temperatures without subsequent stress relieving.

However, the Tables only apply to those hollow sections manufactured in accordance with AS 1163 and supplied by Smorgon Steel Tube Mills.

Specifiers should also note that hollow sections not complying with AS 1163 may be required to be down-graded in yield stress, tensile strength and other mechanical properties when designing to AS 4100 and welding to AS/NZS 1554.1 – see Section 2.6.

To ensure the assumptions, product benefits and quality of structural steel hollow sections considered in these Tables, designers should specifically nominate AS 1163 compliant product in their specifications and general notes. Such wording may be:

*Unless Noted Otherwise –*

- CHS to comply with AS 1163–C350L0
- RHS/SHS to comply with AS 1163–C450L0

As Smorgon Steel Tube Mills now supplies the full range of structural steel hollow sections (for all your tubular needs), you can be confident of the availability of these sections by using the above default Standard and grade designations.

By specifying AS 1163–C450L0 RHS/SHS in the general notes and specifications it will also signal the fabricator to use typically available, prequalified higher strength welding consumables (i.e. E48/W50). This is generally reinforced by the welding part of the specification and general notes which flags the welding consumables to be E48/W50 – unless noted otherwise – which is typical practice. However, should designers not utilise the higher strength benefits of DualGrade® and only use its C350L0 properties, this can be indicated outside of the general notes and specification at the appropriate drawing arrangement or detail.

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It should be noted that Smorgon Steel Tube Mills also supplies AS 1163–C250L0 CHS and, if used and specified, they can also be flagged as such in the relevant part of the engineering/workshop drawings, material lists and/or bills of quantities with the default Standard and grade specification as noted above.

The importance of “L0” impact properties cannot be understated (as noted in Section 2.1) and has to be included in the grade designations of general notes, specifications and other points of steel grade reference.

In conjunction with the above structural steel hollow section Standard and grade designations, further information on the appropriate specification of structural steelwork can be found in Ref.[2.1] or by contacting Smorgon Steel Tube Mills.

### 2.2 Yield Stress and Tensile Strength

Table T2.1 lists the minimum yield stresses and tensile strengths for the structural steel hollow section grades covered by this publication and used for calculating the design capacities.

**TABLE T2.1: Yield Stress and Tensile Strength based on Steel Grade**

Australian Standard	Section Type	Steel Grade	Yield Stress $f_y$ MPa	Tensile Strength $f_u$ MPa
AS 1163	CHS	C250L0	250	320
	CHS	C350L0	350	430
	RHS/SHS	C350L0/C450L0 DualGrade® – designed as C450L0	450	500

**NOTE: See Section 2.4 for a definition of DualGrade® and its use in these Tables.**

More detailed information on the strengths and other mechanical properties of these steels can be found in Table 2.1 of AS 4100, AS 1163, Smorgon Steel Tube Mills' Grade Guide, other SSTM product guides or by contacting SSTM (by the contact details noted at the bottom of the page).

### 2.3 Properties of Steel

The properties of steel adopted in this publication are shown in Table T2.2. Properties such as Poisson's Ratio and Coefficient of Thermal Expansion for structural steel are also listed in Table T2.2.

**TABLE T2.2: Properties of Steel**

Property	Symbol	Value
Young's Modulus of Elasticity	$E$	$200 \times 10^3$ MPa
Shear Modulus of Elasticity	$G$	$80 \times 10^3$ MPa
Density	$\rho$	7850 kg/m <sup>3</sup>
Poisson's Ratio	$\nu$	0.25
Coefficient of Thermal Expansion	$\alpha_T$	$11.7 \times 10^{-6}$ per °C

#### 2.3.1 Masses

The masses given in these Tables are based on a steel density of 7850 kg/m<sup>3</sup>, the nominal section size and standard corner radii (see Section 3.2.1.2). In practice the tabulated values are affected by rolling tolerances and actual corner shape. Masses per metre listed are for the sections only, and do not include any allowances for cleats, end plates, weld metal, etc.

### 2.4 Grades

#### 2.4.1 Circular Hollow Sections (CHS)

Smorgon Steel Tube Mills (SSTM) offers CHS in two AS 1163 grades: C250L0 and C350L0. The Grade C350L0 products provide a more comprehensive range of sections for structural applications and should be commonly specified. SSTM also provide CHS/Pipe products which comply with AS 1074 and AS 1163–C250L0 for low pressure piping applications. As the sizes supplied in the C250L0 CHS range are used in structural applications, they are also offered as Structural CHS by SSTM.

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### 2.4.2 Rectangular/Square Hollow Sections (RHS/SHS) and DualGrade®

Due to the nature of manufacturing cold-formed hollow sections, RHS/SHS generally have higher strengths and lower elongations (from tensile tests) than CHS manufactured from the same type of feed-coil. This is basically due to the additional cold-working RHS/SHS receive during the sizing and finishing stages of shape formation. Consequently, from the three basic strength grades noted in AS 1163, CHS are generally supplied in grades C250L0 and C350L0 whereas RHS/SHS are supplied in the higher strengths of grades C350L0 and C450L0.

Smorgon Steel Tube Mills (SSTM) have always been at the forefront in utilising higher strength hollow sections both in Australia and internationally. This was previously seen by SSTM's push to use Grade C350L0 for CHS, Grade C450L0 for RHS/SHS (the "GreensTuf" range) and now by offering the DualGrade® RHS/SHS across a wide range of pre-coated and uncoated products.

The name DualGrade® is derived from satisfying two key mechanical properties from tensile tests – strength and elongation. These properties undergo opposing effects during manufacturing. As noted above, it is widely known that the cold-forming process increases material strengths of welded cold-formed hollow sections. However, the elongation requirements of the material (a reflection of ductility) generally do not increase with strength. This is best illustrated by the following extract from AS 1163: Structural Steel Hollow Sections –

**Table T2.3: Tensile test requirements for RHS/SHS from Table 3 of AS 1163**

Grade	Minimum yield strength ( $f_y$ ) MPa	Minimum tensile strength ( $f_u$ ) MPa	Minimum elongation as a proportion of the gauge length $5.65\sqrt{S_0}$
C350L0	350	430	16%
C450L0	450	500	14%
<b>DualGrade® C350L0/C450L0</b>	<b>450</b>	<b>500</b>	<b>16%</b>

The above table shows that higher strengths are developed in Grade C450L0 products and higher elongation is attained with Grade C350L0 products. DualGrade® satisfies all the higher values of these key mechanical properties (shaded in Table T2.3 and also summarised in the last row of that table).

The reasons for Smorgon Steel Tube Mills supplying DualGrade® RHS/SHS include:

- Grade C450L0 by itself may not perform well if the hollow section is bent to a tight radius during fabrication (e.g. corners in gate frames, etc). Excess straining sometimes produces section failures. Experience has shown that Grade C450L0 products which possess the C350L0 elongation requirements can be adequately formed in these situations.
- Structural steelwork drawings sometimes nominate C350/C350L0 as the default (i.e. "unless noted otherwise") grade for RHS/SHS. It is often perceived that C450L0 is a new and less readily available grade. This perception is not true as Smorgon Steel Tube Mills has been supplying a large range of DualGrade® RHS/SHS in pre-coated and uncoated finishes for some time. However, there remains some specifiers and end-users who wish to use C350L0 RHS/SHS. DualGrade® can fulfill their requirements as well as fulfill the requirements of those who wish to specify/use higher strength C450L0 and its inherent advantages.
- Dual-stocking of grades for a particular section is costly. If the same section can comply with the requirements of both the commonly specified lower strength grade and the structurally efficient higher strength grade, **a lower cost product** will be available to the specifier and end-user.

**In order to capitalise on the benefits of DualGrade®'s higher strength properties, the Tables contained in this publication consider DualGrade® RHS/SHS to be designed with the strength properties of AS 1163 Grade C450L0 – i.e.  $f_y = 450$  MPa and  $f_u = 500$  MPa.**

As noted in Section 2.1, impact properties such as "L0" are not only important for low temperature applications but very important for welded members subject to dynamic loads. This is particularly so for thicker hollow sections. Hence, "L0" impact rated hollow sections, which is satisfied by all of Smorgon Steel Tube Mills' structural hollow sections, should always be specified.

Further information on AS 1163 Grades C250L0, C350L0 and DualGrade® can be found in Smorgon Steel Tube Mills' (SSTM) Grade Guide and Product Manual. These and other publications and software can be obtained freely from [www.smorgonsteel.com.au/tubemills](http://www.smorgonsteel.com.au/tubemills) or by contacting SSTM via the details noted at the bottom of the page.

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### 2.5 Mill Surface Finishes

It is commonly recognised that pre-primed and pre-coated hollow sections provide considerable benefits and savings for fabrication construction as these sections are coated either prior, during or immediately after the tube forming process. Smorgon Steel Tube Mills are regarded as being innovative in various mill finishes for many years and offer tubular products in the following surface finishes:

- SupaGal® light galvanized products (manufactured to Section 3 of AS/NZS 4792 using hot-dip pre-galvanized strip) which are galvanized on the inside and outside surfaces of the hollow section
- KleenKote® primer-paint finish
- HotDipGal CHS/Piping Products (manufactured to Section 2 of AS/NZS 4792 using a specialised hot-dip batch galvanizing process) which are galvanized on the inside and outside surfaces of the hollow section
- LiteOil hollow sections which are lightly oiled
- NoKote with no oil, paint or coating (NOPC).

It should be noted that due to manufacturing limitations, surface finishes can vary with shape and size of hollow section. Further information on Smorgon Steel Tube Mills' (SSTM) surface finishes can be found in the SSTM Product Solutions Guide and Product Manual. These and other publications and software can be obtained freely from [www.smorgonsteel.com.au/tubemills](http://www.smorgonsteel.com.au/tubemills) or by contacting SSTM via the details noted at the bottom of the page.

### 2.6 Hollow Sections Not Compliant with AS 1163

A key aspect of design within the provisions of a general steel structures Standard as AS 4100 is the inclusion of cold-formed hollow sections. This situation is highly dependent on the integrity of the supporting material Standards. One such material Standard is AS 1163 Structural steel hollow sections.

AS 1163 has been developed to reflect the way cold-formed hollow sections have been manufactured, specified, fabricated and subsequently used in Australia. This includes taking account of the enhancement in strength due to cold-forming, superior product tolerances (including dimensional limits and the supply of minimum cross-section material as assumed in design), ductility, weldability and resistance to impact loads.

Designers and specifiers should be very wary of the substitution of AS 1163 product by either unidentified product or specific product complying with other inferior international Standards which do not deliver the full range of AS 1163 product requirements.

AS 4100 states that hollow sections not complying with AS 1163 must be tested and checked for compliance. Non-conforming hollow sections must be down-rated to a design yield stress of 170 MPa and a design ultimate strength of 300 MPa.

Though AS 4100 is a key Standard for the design, fabrication and erection of steelwork, other important Standards are also used to produce the completed structure that is to be eventually fit for purpose. The other important Standards for structural steel hollow sections include welding, painting and galvanizing which, in the case of structural steel hollow sections, are also dependent on compliance with AS 1163. Additionally, as mentioned above, the use of these Tables is also based on hollow sections complying with AS 1163.

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### 2.7 Availability

The sections listed in the Tables are normally readily available from Smorgon Steel Tube Mills' distributors ex-stock in standard lengths. However, the availability should be checked for larger sizes, for larger tonnages of individual sections or for non-standard lengths.

The standard lengths for Smorgon Steel Tube Mills (SSTM) range of structural steel hollow sections are summarised in Table T2.4. Sections may be ordered in other lengths ex-mill rolling subject to SSTM length limitations and minimum order requirements.

**TABLE T2.4: Standard Length Availability**

Section Type	Sizes	Standard Lengths (m)
CHS – Grade C250L0	21.3 OD to 165.1 OD	6.5
CHS – Grade C350L0	26.9 OD to 219.1 OD 273.1 OD to 508 OD	6.5 12.0
RHS – Grade C350L0	50 x 25 to 75 x 25	8.0
RHS – DualGrade® C350L0/C450L0	50 x 25 to 102 x 76 125 x 75 to 250 x 150 300 x 200 to 400 x 300	8.0 8.0 and 12.0* 12.0
SHS – Grade C350L0	13 x 13 to 25 x 25 30 x 30 to 50 x 50	6.5 8.0
SHS – DualGrade® C350L0/C450L0	20 x 20 to 25 x 25 30 x 30 to 89 x 89 100 x 100 to 250 x 250 300 x 300 to 400 x 400	6.5 8.0 8.0 and 12.0* 12.0

Note: \* Some sizes not available in 12.0 m standard lengths – see SSTM Product Manual and CD-ROM.

The structural steel hollow sections listed in the Tables are generally available in all Smorgon Steel Tube Mills' (SSTM) market areas, however, reference should also be made to the SSTM Quick Reference Product Availability Guide (QRPAG) for information on the availability of the listed sections, their grades and associated finishes. The QRPAG is found at the beginning of this publication.

The list of Smorgon Steel Tube Mills' (SSTM) distributors can be found in the SSTM Product Manual and CD-ROM which is freely available from [www.smorgonsteel.com.au/tubemills](http://www.smorgonsteel.com.au/tubemills) or by contacting SSTM via the details noted at the bottom of the page.

Standard lengths and Mass & Bundling data on Smorgon Steel Tube Mills' (SSTM) structural steel hollow sections can be found in the SSTM Product Manual and CD-ROM which is freely available from [www.smorgonsteel.com.au/tubemills](http://www.smorgonsteel.com.au/tubemills) or by contacting SSTM via the details noted at the bottom of the page.

*It is highly recommended* that readers always ensure that they are using current information on the SSTM product range. This can be verified by comparing the **document revision date** (noted at the bottom of the page) with the current version date of each publication. The current version date of the QRPAG, this and other SSTM publications can be obtained by referring to [www.smorgonsteel.com.au/tubemills](http://www.smorgonsteel.com.au/tubemills) or by contacting SSTM (the contact details are noted at the bottom of the page).

### 2.8 References

- [2.1] Syam, A.A. (ed), "A Guide to the Requirements for Engineering Drawings of Structural Steelwork", Steel Construction, Vol. 29, No. 3, Australian Institute of Steel Construction, September 1995 (Note: AISC is now ASI – the Australian Steel Institute).

**See Section 1.1.2 for details on reference Standards.**

See page (ii) for the appropriate use of this publication.

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