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# DESIGN CAPACITY TABLES

FOR STRUCTURAL STEEL HOLLOW SECTIONS



# Design Capacity Tables for Structural Steel Hollow Sections

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# Design Capacity Tables for Structural Steel Hollow Sections



Australian Tube Mills  
A.B.N. 21 123 666 679

## DESIGN CAPACITY TABLES FOR STRUCTURAL STEEL HOLLOW SECTIONS

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### Relevance of information contained in this Publication

#### Material Standards and product qualities:

USERS OF THIS PUBLICATION SHOULD NOTE THAT THE DESIGN CAPACITIES, CALCULATIONS, TABULATIONS AND OTHER INFORMATION PRESENT IN THIS PUBLICATION ARE SPECIFICALLY RELEVANT TO STRUCTURAL STEEL HOLLOW SECTIONS SUPPLIED BY Australian Tube Mills.

Consequently, the information contained in this publication cannot be readily used for hollow sections supplied from other manufacturers as those sections may vary significantly in grade, thickness, size, material Standard compliance (including chemical composition, mechanical properties, tolerances) and quality when compared to structural steel hollow sections supplied from Australian Tube Mills (ATM).

In many instances, the higher strengths and qualities provided by ATM structural steel hollow sections to obtain efficient and economical designs from structural mass reductions cannot be readily provided by hollow sections from other sources.

#### Structural steelwork/engineering Standards:

The maximum design loads and design capacities listed in this publication are based on the limit states design method of AS 4100 and the factored limit states design loads and combinations considered within AS/NZS 1170. Hence, much of the information contained herein will only be of use to persons familiar with the limit states design method and the use of:

- AS 4100 Steel structures
- AS/NZS 1170 Structural design actions

#### Product availability & other information:

As the section, grade and finish of all products are subject to continuous improvement, reference should be made to the ATM *PRODUCT AVAILABILITY GUIDE (PAG)* for information on the availability of listed sections and associated finishes. The current version of the PAG can be found on the ATM website [www.austubemills.com](http://www.austubemills.com).

#### TubeComp® Software:

Much of the information contained in this publication can also be readily obtained from the computer software package TubeComp® which can be run in Windows® 95, 98, 2000 and XP. TubeComp® is a simple calculator for structural steel hollow sections designed to AS 4100:1998. TubeComp® can provide exact calculated values for specific effective lengths and screens are dynamically updated when data is entered. Most of the information in this publication can be obtained by just four "clicks of a mouse" in TubeComp® which can be freely obtained by contacting ATM or visiting [www.austubemills.com](http://www.austubemills.com).

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# Foreword

Australian Tube Mills is one of the world's premier producers of welded steel tube and pipe for structural, mechanical and low pressure reticulation applications. For many years, Australian Tube Mills has been at the industry forefront with numerous innovations delivering significant value to a wide range of key industries. With manufacturing facilities strategically located in Australia (Brisbane, Newcastle, Melbourne and Perth), Australian Tube Mills is effectively placed to supply high quality tubular steel products to markets in Australia, New Zealand, South Pacific and South-East Asia.

Australian Tube Mills' innovative approach to the development of tubular products has been noted by various industries for many years. This has included the introduction and ongoing push of higher strength RHS and Pipe products which reduce weight and cut costs for end-users. Strength enhancements began with Grade C350L0 ("TruBlu"), then Grade C450L0 ("GreensTuf") and DuraGal® and now C450PLUS® (previously DualGrade® C350L0/C450L0) products. Australian Tube Mills were the first to develop and promote these grades into Australian Standards and its market areas and now offer the largest range of C450PLUS® sections – not only in Australia but across the world.

Development of tubular shapes has also been an important strategy for Australian Tube Mills. Specific shapes (some of which carry patents and trademarks) were developed for defined industries and include the SiloTube, UniRail, StockRail and Architectural sections. Limited rollings of other forms of hollow sections can be supplied on a special order basis.

Apart from material improvements, Australian Tube Mills' plants also produce different types of coating systems for tubular products. Revolutionary primer-paint systems were developed with industry participation to protect hollow sections from rust during warehouse storage, transportation and fabrication as well as offer a smooth clean work surface during and after fabrication.

Australian Tube Mills now supplies the largest range of welded tubular steel products in Australia which vary in shape, grade and finish.

Compared to other steel products, the worldwide consumption of welded tubular steel products is significantly increasing. The main reasons for this outcome is due to the aesthetics, engineering efficiencies, cost-effectiveness, increased specifier/end-user awareness and the high value-adding inherent with tubular products. This has now firmly positioned Australian Tube Mills as the preferred tubular supplier within many industries.

Quality products, people and service sets Australian Tube Mills apart from its competitors.

## Acknowledgements

Australian Tube Mills gratefully acknowledges the assistance provided by the Australian Steel Institute (ASI) – previously the Australian Institute of Steel Construction (AISC) – for permitting the use of their "Design Capacity Tables" text and format in the development of various parts of this publication.

Additionally, Australian Tube Mills wishes to acknowledge the detailed contributions from the following:

- ➔ Russell Watkins of Australian Tube Mills for writing, generating and checking the text, tables and graphs used in this publication;
- ➔ OneSteel's marketing services team for artwork and coordination; and Nick van der Kreek at Australian Tube Mills for checking and updating various aspects of this publication.

# Preface

The “Design Capacity Tables for Structural Steel” (DCT) suite of publications from the Australian Steel Institute (ASI) – previously the Australian Institute of Steel Construction (AISC) – has been commonly used by design engineers for at least a decade. The actual origin of these publications goes back to 1969 when the Safe Load Tables (SLT) was published by AISC (at the time) for the then permissible stress based steel structures Standards AS CA-1 and subsequently AS 1250. The SLT was published in six editions (the last edition being in 1987) with both hot-rolled “open” sections (e.g. UB, UC, PFC, etc) and structural steel hollow sections (CHS, RHS and SHS) included in its contents.

The release of AS 4100 Steel Structures in 1990 to supersede AS 1250 saw a change in design philosophy from permissible stress to limit states design principles. Such a change prompted the revision of the SLT to manifest itself as the DCT. The first edition of the DCT had an overall format which was similar to the sixth edition of the SLT and included both open and hollow sections. However, due to the growing popularity, increasing range and innovation of hollow section construction, the DCT was effectively split in 1992 with the release of the “Design Capacity Tables for Structural Steel Hollow Sections” (DCTHS) which only considered tubular members. Thereafter, a second edition of the DCTHS was released in 1999 entitled “Design Capacity Tables for Structural Steel – Volume 2: Hollow Sections” (DCT-v2:HS).

While somewhat of a challenge, the aim of the DCT-v2:HS (and preceding DCTHS/DCT) was to provide current information on hollow sections available from various manufacturers. However, at the time of publication, the consolidated product range listing from each of the manufacturers was disjointed and not reflective of available sections. Even though the DCT-v2:HS listed a large range of hollow sections, this positive aspect was negated by imprecise information on product

availability. Various manufacturers also complicated the situation by producing their own versions of the DCTHS even though they had a smaller product/size range. Subsequent market studies by Australian Tube Mills revealed that there was growing specifier and industry frustration from the numerous but fragmented publications available that attempted to describe the total range of hollow sections compliant with Australian Standards. Market feedback also indicated some level of confusion with what sizes were available in various grades. There was no ready answer to this frustration and confusion – unless, of course, a single manufacturer could confidently supply a total consistent range of hollow sections.

As part of its ongoing Sales & Marketing strategies, and after much analysis, Australian Tube Mills are undertaking various initiatives to significantly grow the tubular market with a substantial increase in product range and technical support. Prior to this initiative, one of the limitations with tubular construction was the restricted range of large readily available hollow sections that are fully compliant with Australian Standards. For RHS/SHS this was seen to typically “top out” at 250 x 250 SHS with thickness up to 9 mm thick. The situation with CHS was slightly different with the availability of larger “down-graded” line-pipe though there were some issues reported on the compliance of such products to the structural requirements of AS/NZS 1163 Grade C350L0.

The ability to supply a full range of structural steel hollow sections coupled with the ability to ease industry frustration from the lack of consolidated correct information of such sections also sees Australian Tube Mills providing a large array of technical/marketing media (i.e. literature and software). Part of the media includes this DCTHS which is based on AS 4100–1998.

In order to embrace the acceptance level of the previously published industry document, this

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# Preface (continued)

DCTHS follows the same format as the ASI/AISC DCTHS. This means that the Parts of this publication follow the same numeric sequence as those in the ASI/AISC DCTHS and AS 4100. The tabulated data and much of the text in this publication also follows the same format and sequence as the ASI/AISC DCTHS which now makes it a ready companion to the DCT for hot-rolled “open” sections. Hence, if readers are familiar with the current ASI/AISC DCTs they will also be familiar with this publication.

Whilst based on the ASI/AISC DCTHS, some minor revisions, corrections and updates were incorporated in this publication as well as recognition of the changed “loading” Standards to AS/NZS 1170 and other related Standards. Also, readers will note that this publication is produced in “landscape” format – i.e. the width of the page is the longer dimension. The rationale behind this modification followed industry surveys that noted the generally published “portrait” format did not suit publications substantially containing landscape tables. Consequently, this and several other Australian Tube Mills publications have been produced in landscape format. For additional information, readers should also refer to page (ii) for the appropriate use of this DCTHS.

As a complementary design aid to this publication, Australian Tube Mills has also produced a simple calculator for structural steel hollow sections designed to AS 4100. Called *TubeComp*<sup>®</sup>, the software provides much of the information contained in this publication with just four (4) “clicks of a mouse”. The data screens of *TubeComp*<sup>®</sup> are dynamically updated and can provide

exact values of design capacities for effective lengths not listed in the tables of this publication without the need for linear interpolation or extrapolation. *TubeComp*<sup>®</sup>, like this and other publications, are freely available from Australian Tube Mills by using the contact details noted below.

It is interesting to note that after nearly twenty years since the release of the first DCTHS, the same basic team involved in the first document has been brought together to develop this publication. This team includes engineers for computations, content and project management as well as graphic designers. Accordingly, we trust this publication is of value to designers of hollow section construction and would appreciate any feedback on its adequacy or ways to refine it.

May your designs in tubular construction be fruitful ones!

Arun Syam  
Editor & Tubular Development Manager  
Australian Tube Mills

# Notation & Abbreviations

$A_e$	effective sectional area of a hollow section in shear, or effective area of a compression member
$A_g$	gross area of a cross-section
$A_n$	net area of a cross-section
AISC	Australian Institute of Steel Construction (now ASI)
ASI	Australian Steel Institute (formerly AISC)
$b$	width of a section
$b_b, b_{bf}, b_{bw}$	bearing widths
$b_f$	width of a flange
$b_s$	stiff bearing length
$C$	torsional modulus for a cross-section; or Compact section (in bending)
C250L0	cold-formed Grade C250 hollow section to AS/NZS 1163 with L0 properties
C350L0	cold-formed Grade C350 hollow section to AS/NZS 1163 with L0 properties
C450L0	cold-formed Grade C450 hollow section to AS/NZS 1163 with L0 properties
C450PLUS™	RHS/SHS which satisfy the strength and elongation requirements of AS/NZS 1163 Grade C350L0 and C450L0
CHS	Circular Hollow Section(s)
$c_m$	factor for unequal moments
$d$	depth of a section
$d_o$	outside diameter of a Circular Hollow Section (CHS)
$d_1$	clear depth between flanges
$d_5$	flat width of web
DN	nominal size OD for Pipe (CHS) sections (as noted in AS 1074)
$E$	Young's modulus of elasticity, $200 \times 10^3$ MPa
ERW	electric resistance welding
FLR	maximum value of (beam) segment length for Full Lateral Restraint

$f_u$	tensile strength used in design, as defined in AS 4100
$f_y$	yield stress used in design, as defined in AS 4100
$f_{va}^*$	average design shear stress in a web
$f_{vm}^*$	maximum design shear stress in a web
$G$	shear modulus of elasticity, $80 \times 10^3$ MPa; or nominal permanent actions (e.g. dead loads)
$G^*$	design (factored) permanent actions (e.g. dead loads)
$h_s$	storey height
$I$	second moment of area of a cross-section
$I_w$	warping constant for a cross-section ( $\approx 0$ for hollow sections)
$I_x$	$I$ about the cross-section major principal x-axis
$I_y$	$I$ about the cross-section minor principal y-axis
$J$	torsion constant for a cross-section
$k_e$	member effective length factor
$k_f$	form factor for members subject to axial compression
$k_l$	effective length factor for load height
$k_r$	effective length factor for restraint against lateral rotation
$k_{sm}$	exposed surface area to mass ratio
$k_t$	correction factor for distribution of forces in a tension member; or effective length factor for twist restraints
$k_v$	ratio of flat width of web ( $d_5$ ) to thickness ( $t$ ) of hollow section
$L$	span or member length; or sub-segment length (also see note at end of notation)
$L_e$	effective length of a compression member or laterally unrestrained member (also see note at end of notation)
L0	impact properties (as noted in AS/NZS 1163)
$M_b$	nominal member moment capacity

## Notation & Abbreviations (continued)

$M_{bx}$	$M_b$ about major principal x-axis	$N_t$	nominal section capacity in tension
$M_{cx}$	lesser of $M_{ix}$ and $M_{ox}$	$N^*$	design axial force, tensile or compressive
$M_i$	nominal in-plane member moment capacity	$n$	axis through corners of a SHS
$M_{ix}$	$M_i$ about major principal x-axis	n/a	not applicable
$M_{iy}$	$M_i$ about minor principal y-axis	OD	outside diameter (for CHS)
$M_o$	reference elastic buckling moment for a member subject to bending; or nominal out-of-plane member moment capacity	ATM	Australian Tube Mills
$M_{oa}$	amended elastic buckling moment for a member subject to bending	$P$	applied concentrated load
$M_{ox}$	$M_o$ about major principal x-axis	PAG	Product Availability Guide by Australian Tube Mills
$M_{rx}$	$M_s$ about major principal x-axis reduced by axial force	$Q$	nominal imposed actions (e.g. live loads)
$M_{ry}$	$M_s$ about minor principal y-axis reduced by axial force	$Q^*$	design (factored) imposed actions (e.g. live loads)
$M_s$	nominal section moment capacity	$R_b$	nominal bearing capacity of a web
$M_{sx}$	$M_s$ about major principal x-axis	$R_{bb}$	nominal bearing buckling capacity of a web
$M_{sy}$	$M_s$ about minor principal y-axis	$R_{by}$	nominal bearing yield capacity of a web
$M^*$	design bending moment	$R_u$	nominal capacity
$M_m^*$	maximum calculated design bending moment along the length of a member or segment	$r$	radius of gyration; or radius
$M_x^*$	design bending moment about major principal x-axis	$r_{ext}$	outside radius of hollow section
$M_y^*$	design bending moment about minor principal y-axis	$r_x$	radius of gyration about major principal x-axis
$N$	Non-compact section (in bending)	$r_y$	radius of gyration about minor principal y-axis
$N_c$	nominal member capacity in axial compression	$R^*$	design bearing force; or design reaction
$N_{cx}$	$N_c$ for member buckling about major principal x-axis	$\phi R_u$	design capacity
$N_{cy}$	$N_c$ for member buckling about minor principal y-axis	RHS	Rectangular Hollow Section(s)
$N_{om}$	elastic buckling load	$S$	plastic section modulus; or Slender section (in bending)
$N_{omb}$	$N_{om}$ for a braced member	$S_x$	(plastic) $S$ about major principal x-axis
$N_s$	nominal section capacity of a concentrically loaded compression member	$S_y$	(plastic) $S$ about minor principal y-axis
		$S^*$	design action effect, as defined in AS 4100
		SHS	Square Hollow Section(s)



## Notation & Abbreviations (continued)

$t$	thickness of a section
$t_f$	thickness of a flange
$t_w$	thickness of a web
UNO	unless noted otherwise
$V_u$	nominal shear capacity of a web with a uniform shear stress distribution
$V_v$	nominal shear capacity of a web
$V_{vm}$	nominal shear capacity of a web in the presence of bending moment
$V^*$	design shear force
$W$	total uniformly distributed applied load
$W^*$	design action; or design (factored) $W$
$W_{EM}^*$	equivalent strength Maximum Design Load based on Moment (Table T5.1)
$W_{ES}^*$	equivalent serviceability Maximum Design Load based on Deflection (Table T5.1)
$W_{EV}^*$	equivalent strength Maximum Design Load based on Shear (Table T5.1)
$W_{\uparrow}^*$	strength limit state maximum design load
$W_{\uparrow 1}^*$	$W_{\uparrow}^*$ based on design moment capacity
$W_{\uparrow 2}^*$	$W_{\uparrow}^*$ based on design shear capacity
$W_{\S}^*$	serviceability limit state maximum design load
$W_{\S 1}^*$	$W_{\S}^*$ based on deflection limit
$W_{\uparrow \S}^*$	$W_{\S}^*$ based on first yield load
$x$	major principal axis coordinate
$y$	minor principal axis coordinate
$Z$	elastic section modulus
$Z_e$	effective section modulus
$Z_{ex}$	$Z_e$ for bending about major principal x-axis
$Z_{ey}$	$Z_e$ for bending about minor principal y-axis
$Z_n$	$Z$ about the n-axis through the corners of an SHS
$Z_x$	$Z$ for bending about major principal x-axis
$Z_y$	$Z$ for bending about minor principal y-axis

$\alpha_a$	compression member factor
$\alpha_b$	compression member section constant
$\alpha_c$	compression member slenderness reduction factor
$\alpha_m$	moment modification factor for bending
$\alpha_s$	slenderness reduction factor
$\alpha_T$	coefficient of thermal expansion
$\beta_m$	ratio of smaller to larger bending moments at the ends of a member
$\gamma$	ratio for compression member stiffness to end restraint stiffness
$\Delta_s$	deflection
$\Delta_b$	translational displacement of the top relative to the bottom for a storey height
$\delta_b$	moment amplification factor for a braced member
$\delta_m$	moment amplification factor, taken as the greater of $\delta_b$ and $\delta_s$
$\delta_s$	moment amplification factor for a sway member
$\xi$	compression member factor
$\eta$	compression member imperfection factor
$\pi$	pi ( $\approx 3.14159$ )
$\lambda$	slenderness ratio
$\lambda_c$	elastic buckling load factor
$\lambda_e$	plate element slenderness
$\lambda_{ep}$	plate element plasticity slenderness limit
$\lambda_{ey}$	plate element yield slenderness limit
$\lambda_n$	modified compression member slenderness
$\nu$	Poisson's ratio
$\rho$	density of a material
$\phi$	capacity factor

### Notes:

1. The Tables use  $L_e$  and  $L$  in lieu of  $I_e$  and  $I$  respectively (as noted in AS 4100) to avoid confusion with the standard typeface used.

# Standard and Other References

The Australian Standards referred to in this publication are centrally listed in Section 1.1.2. Other references are listed at the end of the initial text portion in each respective Part of the publication (i.e. prior to the main table listings).

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# Part 1

## INTRODUCTION

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The maximum design loads and design capacities listed in this publication are based on the limit states design method of AS 4100 and the **factored** limit states design actions and combinations considered within AS/NZS 1170. Hence, much of the information contained herein will **only** be of use to persons familiar with the limit states design method and the use of:

- AS 4100 Steel structures
- AS/NZS 1170 Structural design actions

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

# Part 1

## INTRODUCTION

### 1.1 General

#### 1.1.1 Steel Structures Standard

The tables in this publication have been calculated in accordance with the Australian Standard AS 4100–1998 Steel Structures. As far as possible, the notation and terminology used are the same as those adopted in that Standard.

Cold-formed hollow sections manufactured in accordance with Australian Standard AS/NZS 1163:2009 Structural Steel Hollow Sections are included within the scope of AS 4100. Extensive research [1.1,1.2,1.3] undertaken over a number of years has confirmed that cold-formed hollow sections compliant with AS/NZS 1163 meet the inherent requirements of AS 4100. Cold-formed hollow sections may also be designed to AS/NZS 4600:2005 Cold-Formed Steel Structures which is outside of the scope of this publication.

#### 1.1.2 Reference Standards

“AS 1074” refers to AS 1074–1989 Steel tubes and tubulars for ordinary service

“AS 4100” refers to AS 4100–1998 Steel structures

“AS/NZS 1163” refers to AS/NZS 1163:2009 Cold-formed structural steel hollow sections

“AS/NZS 1170” refers to AS/NZS 1170:2002 Structural design actions

“AS/NZS 1554.1” refers to AS/NZS 1554.1:2011 Structural steel welding – Welding of steel structures

“AS/NZS 2312” refers to AS/NZS 2312:2002 Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings

“AS/NZS 4600” refers to AS/NZS 4600:2005 Cold-formed steel structures

“AS/NZS 4792” refers to AS/NZS 4792:2006 Hot-dip galvanized (zinc) coatings on ferrous hollow sections, applied by a continuous or a specialized process

#### 1.1.3 Table Format and Usage

Within this publication the terms “Table” and “Tables” refer to information in this edition and volume of the Design Capacity Tables for Structural Steel Hollow Sections by Australian Tube Mills.

A brief list of the Tables’ contents is provided in Section 1.5. It should be noted that the main tables listing design capacities and other member information are placed at the end of the initial text portion of each Part of this publication. The main tables will generally be listed within a numerical sequence – e.g. Table 5.1 series (Maximum Design Loads for Simply Supported Beams with Full Lateral Restraint), Table 5.2 series (Design Section Moment and Web Capacities), Table 5.3 series (Design Moment Capacities for Members without Full Lateral Restraint), etc. Any table listed in the (initial) text portion of each Part of this Publication will have a “T” before the Table number – e.g. Table T2.1 in Section 2.2.

### 1.2 Range of Structural Steel Grades and Sections

The Tables contain information on the currently available (at the time of publication) structural steel hollow sections supplied by Australian Tube Mills (ATM) which fully comply with AS/NZS 1163. Section 2 should be consulted for further details on the structural steel hollow sections considered in the Tables.

Reference should also be made to the Australian Tube Mills Product Availability Guide (PAG) for general information on the **availability** of the **listed sections** and associated **finishes**.

### 1.3 Units

The units in the Tables are consistent with those in the SI (metric) system. The base units utilised in the Tables are newton (N) for force, metre (m) for length, and kilogram (kg) for mass. Where noted, stress is expressed in megapascals (MPa).

With some minor exceptions, all values in the Tables are rounded to three (3) significant figures.

# Part 1

## INTRODUCTION

### 1.4 Limit States Design using these Tables

AS 4100 sets out the minimum requirements for the design, fabrication and erection of steelwork in accordance with the limit states design method and follows a semi-probabilistic limit state approach presented in a deterministic format.

*Definition of limit states* – When a structure or part of a structure is rendered unfit for use it reaches a 'limit state'. In this state it ceases to perform the functions or to satisfy the conditions for which it was designed. Relevant limit states for structural steel include strength, serviceability, stability, fatigue, brittle fracture, fire, and earthquake. Only two limit states are considered in the Tables – the strength limit state and, where applicable, the serviceability limit state.

Limit states design requires structural members and connections to be proportioned such that the **design action effect** ( $S^*$ ) resulting from the **design action** ( $W^*$ ), is less than or equal to the **design capacity** ( $\phi R_u$ ) i.e.

$$S^* \leq \phi R_u$$

**Design action** or **design load** ( $W^*$ ) is the combination of the nominal actions or loads imposed upon the structure (e.g. transverse loads on a beam) multiplied by the appropriate load combination factors as specified in AS/NZS 1170 (Structural design actions). These design actions/loads are identified by an asterisk (\*) after the appropriate action/load (e.g.  $W^*_T$  is the maximum design transverse load on a beam).

**Design action effects** ( $S^*$ ) are the actions (e.g. design bending moments, shear forces, axial loads) calculated from the **design actions** or **design loads** using an acceptable method of analysis (Section 4 of AS 4100). These effects are identified by an asterisk (\*) after the appropriate action effect (e.g.  $M^*$  describes the design bending moment).

**Design capacity** ( $\phi R_u$ ) is the product of the nominal capacity ( $R_u$ ) and the appropriate capacity factor ( $\phi$ ) found in Table 3.4 of AS 4100.  $R_u$  is determined from the characteristic values and specified parameters found in Sections 5 to 9 of AS 4100.

For example, consider the strength limit state design of a simply supported beam which has full lateral restraint subject to a total transverse **design load** ( $W^*$ ) distributed uniformly along the beam.

For flexure, the appropriate **design action effect** ( $S^*$ ) is the **design bending moment** ( $M^*$ ) which is determined by:

$$M^* = \frac{W^* L}{8}$$

where  $L$  = span of the beam.

In this case the **design capacity** ( $\phi R_u$ ) is equal to the **design section moment capacity** ( $\phi M_s$ ), given by:

$$\phi M_s = \phi f_y Z_e$$

where  $\phi$  = the capacity factor

$f_y$  = yield stress used in design

$Z_e$  = effective section modulus

To satisfy the strength limit state, the following relationship (equivalent to  $S^* \leq \phi R_u$ ) is used:

$$M^* \leq \phi M_s$$

The **maximum design bending moment** ( $M^*$ ) is therefore equal to the **design section moment capacity** ( $\phi M_s$ ), and the **maximum design load** is that **design load** ( $W^*$ ) which corresponds to the maximum  $M^*$ . (It should be noted that other checks on the beam may be necessary – e.g. shear capacity, bearing capacity, etc).

When considering external loads, in the context of this publication, the **maximum design load** ( $W^*_T$ ) given in the relevant table must be greater than or equal to the imposed **design load** ( $W^*$ ).

Where applicable, the Tables give values of **design capacity** ( $\phi R_u$ ) and **maximum design load** ( $W^*_T$ ) determined in accordance with AS 4100. When using the Tables, the designer must determine the relevant *strength limit state design action* ( $W^*$ ) and/or corresponding **design action effect** ( $S^*$ ) to ensure that the strength limit state requirements of AS 4100 are satisfied. Where relevant, other limit states (e.g. serviceability, fatigue, etc) must also be considered by the designer. Some useful information for checking the serviceability limit state is included in the Tables.

# Part 1

## INTRODUCTION

### 1.5 Table Contents

For the range of structural steel grades and sections considered, tables are provided for:

- (i) section dimensions and section properties:
  - Dimensions and Properties + Properties for Design to AS 4100 (PART 3)
  - Fire Engineering Design (PART 3)
  - Telescoping Information (PART 3)
- (ii) design capacity ( $\phi R_u$ ) for:
  - Members Subject to Bending (PART 5)
  - Members Subject to Axial Compression (PART 6)
  - Members Subject to Axial Tension (PART 7)
  - Members Subject to Combined Actions (PART 8)
- (iii) maximum design load ( $W^*$ ) for:
  - Strength Limit State ( $W^*_t$ ) for Beams (PART 5)
  - Serviceability Limit State ( $W^*_s$ ) for Beams (PART 5)

Acceptable methods of analysis for determining the design action effects are defined in Section 4 of AS 4100 and material relevant to some of these methods of analysis is briefly presented in Part 4 of this publication.

### 1.6 References

- [1.1] Hasan, S.W. and Hancock, G.J., "Plastic Bending Tests of Cold-Formed Rectangular Hollow Sections", Steel Construction, Vol. 23, No. 4, Australian Institute of Steel Construction, 1989 (Note: AISC is now ASI – Australian Steel Institute).
- [1.2] Key, P.W., Hasan, S.W. and Hancock, G.J., "Column Behaviour of Cold-Formed Hollow Sections", Journal of Structural Engineering, American Society of Civil Engineers, Vol. 114, No. 2, 1988.
- [1.3] Zhao, X.L. and Hancock, G.J., "Tests to Determine Plate Slenderness Limits for Cold-Formed Rectangular Hollow Sections of Grade C450", Steel Construction, Vol. 25, No. 4, Australian Institute of Steel Construction, 1991 (Note: AISC is now ASI – Australian Steel Institute).

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

# Part 2

## MATERIALS

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



# Part 2

## MATERIALS

### 2.1 Range of Structural Steel Grades and Sections

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

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

- AS/NZS 1163 Grade C250L0 Circular Hollow Sections (CHS)
- AS/NZS 1163 Grade C350L0 Circular Hollow Sections (CHS)
- AS/NZS 1163 Grade C350L0 Rectangular Hollow Sections (RHS) ('small' sizes only)
- AS/NZS 1163 Grade C450PLUS® RHS
- AS/NZS 1163 Grade C350L0 Square Hollow Sections (SHS) ('small' sizes only)
- AS/NZS 1163 Grade C450PLUS® 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/NZS 1163 only considers cold-formed structural steel hollow sections. The suffix 'L0' denotes impact properties at 0°C as specified in AS/NZS 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.  $t \geq 6.0$  mm). AS/NZS 1163 Grade C450PLUS® RHS/SHS comply with the strength and elongation requirements of both Grade C350L0 and C450L0. The key mechanical properties of C450PLUS® are covered in Section 2.2 and a further description of C450PLUS® is given in Section 2.4. Where relevant, C450PLUS® RHS/SHS are designed as AS/NZS 1163 Grade C450L0 sections in these Tables to capitalise on the higher strength benefits of this steel grade – see Section 2.4.2. C450PLUS® are registered trademarks of Australian Tube Mills.

Further general 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 Australian 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/NZS 1163 and supplied by Australian Tube Mills.

Specifiers should also note that hollow sections not complying with AS/NZS 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/NZS 1163 compliant product in their specifications and general notes. Such wording may be:

***Unless Noted Otherwise –***

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

Note, for SHS with overall dimensions of 50 x 50 and smaller (and equivalent perimeter RHS), ATM typically supplies these sizes in Grade C350L0 to AS/NZS 1163. However, these sizes are available ex-rolling to AS/NZS 1163–C450L0 subject to minimum order requirements.

By specifying AS/NZS 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. E49/W50). This is generally reinforced by the welding part of the specification and general notes which flags the welding consumables to be E49/W50 – unless noted otherwise – as this is typical practice. However, should designers not utilise the higher strength benefits of C450PLUS® and only use its C350L0 properties, this can be indicated outside of the general notes and specification at the appropriate drawing arrangement or detail.

# Part 2

## MATERIALS

It should be noted that Australian Tube Mills also supplies AS/NZS 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 Australian 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/NZS 1163	CHS	C250L0	250	320
	CHS	C350L0	350	430
	RHS/SHS	C450PLUS® (designed as C450L0)	450	500

**NOTE:** See Section 2.4 for a definition of C450PLUS® 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/NZS 1163, other ATM product guides or by contacting ATM (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)

Australian Tube Mills (ATM) offers CHS in two AS/NZS 1163 grades: C250L0 and C350L0.

The Grade C350L0 products provide a more comprehensive range of sections for structural applications and should be commonly specified. ATM also provide CHS/Pipe products which comply with AS 1074 and AS/NZS 1163–C250L0 for structural and 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 ATM.

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## MATERIALS

### 2.4.2 Rectangular/Square Hollow Sections (RHS/SHS) and C450PLUS®

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/NZS 1163, CHS are generally supplied in grades C250L0 and C350L0 whereas RHS/SHS are supplied in the higher strengths of grades C350L0 and C450L0.

Australian Tube Mills (ATM) have always been at the forefront in utilising higher strength hollow sections both in Australia and internationally. This was previously seen by ATM's push to use Grade C350L0 for CHS, Grade C450L0 for RHS/SHS (the "GreensTuf" range) and now by offering the C450PLUS® RHS/SHS across a wide range of pre-coated and uncoated products.

The name C450PLUS® 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/NZS 1163: Structural Steel Hollow Sections –

**Table T2.3: Tensile test requirements for RHS/SHS from Table 6 of AS/NZS 1163**

Grade	Minimum yield strength ( $f_y$ ) MPa	Minimum tensile strength ( $f_u$ ) MPa	Minimum elongation as a proportion of the gauge length $5.65\sqrt{S_0}$ RHS, SHS b/t, d/t		
			≤ 15	> 15 ≤ 30	> 30
			C350L0	350	430
C450L0	450	500	10%	12%	14%
<b>C450PLUS®</b>	<b>450</b>	<b>500</b>	<b>12%</b>	<b>14%</b>	<b>16%</b>

NOTE: These elongation limits apply to the face from which the tensile test is taken.

The above table shows that higher strengths are developed in Grade C450L0 products and higher elongation is attained with Grade C350L0 products. C450PLUS® satisfies all the higher values of these key mechanical properties (shaded in Table T2.3 and also summarised in bold in the last row of that table).

Apart from higher strength and lighter weight benefits, the reasons for Australian Tube Mills

supplying C450PLUS® 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 Australian Tube Mills has been supplying a large range of C450PLUS® 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. C450PLUS® can fulfill their requirements as well as 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 C450PLUS®'s higher strength properties, the Tables contained in this publication consider C450PLUS® RHS/SHS to be designed with the strength properties of AS/NZS 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 ATM AS/NZS 1163 compliant structural hollow sections, should always be specified.

Further information on AS/NZS 1163 Grades C250L0, C350L0 and C450PLUS® can be found in the Australian Tube Mills' (ATM) Product Manual. These and other publications and software can be obtained freely from [www.austubemills.com](http://www.austubemills.com) or by contacting ATM via the details noted at the bottom of the page.

# Part 2

## MATERIALS

### 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. Australian Tube Mills are regarded as being innovative in various mill finishes for many years and offer tubular products in the following surface finishes: DuraGal<sup>®</sup>, SupaGal<sup>®</sup>, (semi-continuous) hot-dip galvanized, primer-painted, oiled, and NOP (no oil or paint) coatings. ATM's galvanized coatings comply with AS/NZS 4792.

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

AS/NZS 2312 also provides useful information on this topic.

### 2.6 Hollow Sections Not Compliant with AS/NZS 1163

A key aspect of design within the provisions of a national 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/NZS 1163 Structural steel hollow sections.

AS/NZS 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/NZS 1163 product by either unidentified product or specific product complying with other inferior international Standards which do not deliver the full range of AS/NZS 1163 product requirements.

AS 4100 states that hollow sections not complying with AS/NZS 1163 must be tested and checked for compliance. Non-conforming or unidentified 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/NZS 1163. Additionally, as noted in Sections 1.1, 1.2, 2.1 and 2.2, *the use of these Tables is also based on hollow sections complying with AS/NZS 1163.*

# Part 2

## MATERIALS

### 2.7 Availability

The sections listed in the Tables are normally readily available from Australian Tube Mills' distributors 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 Australian Tube Mills (ATM) range of structural steel hollow sections are summarised in Table T2.4. Sections may be ordered in other lengths ex-mill rolling subject to ATM length limitations and minimum order requirements.

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

Section Type	Sizes	Standard Lengths (m)
CHS – Grade C250L0	26.9 OD to 165.1 OD	6.5
CHS – Grade C350L0	26.9 OD to 165.1 OD 168.3 OD to 508 OD	6.5 12.0
RHS – Grade C350L0	50 x 20 to 75 x 25	8.0
RHS – Grade C450PLUS®	50 x 20 to 75 x 25# 75 x 50 to 250 x 150 300 x 200 to 400 x 300	8.0 8.0 and/or 12.0* 12.0
SHS – Grade C350L0	20 x 20 to 25 x 25 30 x 30 to 50 x 50	6.5 8.0
SHS – Grade C450PLUS®	20 x 20 to 25 x 25# 30 x 30 to 65 x 65# 75 x 75 to 250 x 250 300 x 300 to 400 x 400	6.5 8.0 8.0 and/or 12.0* 12.0

Notes:

\* See ATM Product Manual for further details.

# For small sizes up to 50 x 50 SHS and RHS of equivalent perimeter, the standard grade is AS/NZS 1163 Grade C350L0.

The structural steel hollow sections listed in the Tables are generally available in all Australian Tube Mills' (ATM) market areas, however, reference should also be made to the ATM Product Availability Guide (PAG) for information on the availability of the listed sections, their grades and associated finishes.

The list of Australian Tube Mills' (ATM) distributors can be found in the ATM Product Manual which is freely available from [www.austubemills.com](http://www.austubemills.com) or by contacting ATM via the details noted at the bottom of the page.

Standard lengths and Mass & Bundling data on Australian Tube Mills' (ATM) structural steel hollow sections can be found in the ATM Product Manual which is freely available from [www.austubemills.com](http://www.austubemills.com) or by contacting ATM 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 ATM product range. This can be done by reference to the ATM Product Availability Guide (PAG) as noted in [www.austubemills.com](http://www.austubemills.com).

### 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.**

# Part 3

## SECTION PROPERTIES

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

# Part 3

## SECTION PROPERTIES

### 3.1 General

The section property tables include all relevant section dimensions and properties necessary for assessing steel structures in accordance with AS 4100. The AS/NZS 1163 structural hollow sections included in these tables are:

➤	Circular Hollow Sections	Grade C250L0
➤	Circular Hollow Sections	Grade C350L0
➤	Rectangular Hollow Sections	Grade C350L0 (smaller sizes as noted in the Tables)
➤	Rectangular Hollow Sections	Grade C450PLUS™
➤	Square Hollow Sections	Grade C350L0 (smaller sizes as noted in the Tables)
➤	Square Hollow Sections	Grade C450PLUS™

C450PLUS™ RHS/SHS are designed as Grade C450L0 – see Section 2.4.2 for further details.

### 3.2 Section Property Tables

For each group of structural hollow section the Tables include:

➤	Dimensions, Ratios and Properties
➤	Properties for Design to AS 4100

These parameters are considered in Tables 3.1-1 to 3.1-6 inclusive.

#### 3.2.1 Dimensions, Ratios and Properties

The Tables give standard dimensions and properties for the structural steel hollow sections noted in Sections 2.1, 2.7 and 3.1. These properties, such as gross cross-section area ( $A_g$ ), second moments of area ( $I_x, I_y$ ), elastic and plastic section moduli ( $Z_x, S_x, Z_y, S_y$ ) and the torsion constant ( $J$ ) are the fundamental geometric properties required by design Standards. It should be noted that Clause 5.6 of AS 4100 indicates that the warping constant ( $I_w$ ) for hollow sections may be taken as zero.

Additionally, the external surface area of the hollow section – as used in estimating quantities of protective coatings – is also considered within these Tables.

#### 3.2.1.1 Torsion Constants

The torsional constant ( $J$ ) and the torsional modulus constant ( $C$ ) for square and rectangular hollow sections are defined as follows:

$$J = \left( t^3 \frac{h}{3} + 2kA_h \right)$$

$$C = \left( \frac{t^3 \frac{h}{3} + 2kA_h}{t + \frac{k}{t}} \right)$$

where

$$R_c = \frac{R_o + R_i}{2}$$

$$h = 2[(b-t) + (d-t)] - 2R_c(4-\pi)$$

$$A_h = (b-t)(d-t) - R_c^2(4-\pi)$$

$$k = \frac{2A_h t}{h}$$

and

$t$  = specified thickness of section  
 $b$  = width of section  
 $d$  = depth of section  
 $R_o$  = outer corner radius  
 $R_i$  = inner corner radius  
 $R_c$  = mean corner radius  
 $h$  = length of the mid-contour  
 $A_h$  = area enclosed by  $h$   
 $k$  = integration constant

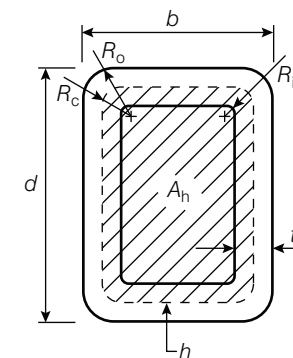


Figure 3.1: Parameters for Calculation of Torsion Constants

as shown in Figure 3.1.

The above calculation method of  $J$  and  $C$  is extracted from Ref. [3.1]. For CHS,  $J$  and  $C$  are calculated by the traditional methods, i.e.  $J = \pi/32(d_o^4 - d_i^4)$  and  $C = J/(d_o/2)$  where  $d_o$  = outside diameter and  $d_i$  = inside diameter =  $d_o - 2t$ .

# Part 3

## SECTION PROPERTIES

### 3.2.1.2 Corner Radii

The section properties presented in this publication are calculated in accordance with AS/NZS 1163. Figure 3.2 shows the corner radii detail used in determining section properties. However, it should be noted that the actual corner geometry may vary from that shown.

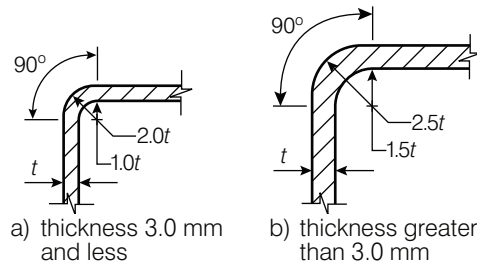


Figure 3.2: Corner Geometry for Determining Section Properties

### 3.2.2 Properties for Design to AS 4100

These properties are necessary for calculating the section capacities of hollow sections in accordance with AS 4100. The section form factor ( $k_f$ ), compactness and effective section moduli ( $Z_e$ ,  $Z_{ex}$ ,  $Z_{ey}$ ) are tabulated. These values are dependent on steel grade.

### 3.2.2.1 Compactness

In Clauses 5.2.3, 5.2.4 and 5.2.5 of AS 4100, sections are described as **compact**, **non-compact** or **slender** (C, N or S respectively). This categorisation provides a measure of the relative importance of yielding and local buckling of the plate elements which make up a section when subject to compression caused by bending.

The “Design to AS 4100” listings include a column(s) headed “Compactness” for a given (principal) axis of bending.

The compactness of a hollow section is also important when selecting the methods of analysis (elastic or plastic) used to determine the design action effects (Clause 4.5 of AS 4100) or in using the higher tier provisions of Section 8 of AS 4100 for designing members subject to combined actions. Clause 4.5 of AS 4100 does not currently permit plastic analysis when designing with hollow sections.

General worked examples for calculating section compactness are provided in Section 3.2.3 and Refs. [3.2, 3.3].

### 3.2.2.2 Effective Section Modulus

Having evaluated the compactness of a hollow section, the effective section modulus ( $Z_e$ ) is then evaluated. This parameter is based on the section moduli ( $S$ ,  $Z$ ) and is used in the determination of the design section moment capacity ( $\phi M_s$ ).  $Z_e$  is then calculated using Clauses 5.2.3, 5.2.4 and 5.2.5 of AS 4100. The equations for determining  $Z_e$  reflect the proportion of the hollow section that is effective in resisting compression in the section caused by flexure - that is whether the section is compact, non-compact or slender.

From Table 5.2 of AS 4100, the cold-formed (CF) residual stress category is used in the calculation of  $Z_e$  for hollow section complying with AS/NZS 1163. It should be noted that the deformation limit ( $\lambda_{ed}$ ) is not exceeded for hollow sections manufactured in accordance with AS/NZS 1163 and listed in these Tables and therefore noticeable deformations will not occur for such sections. General worked examples for calculating  $Z_e$  are provided in Section 3.2.3 and Refs. [3.2, 3.3].



# Part 3

## SECTION PROPERTIES

### 3.2.2.3 Form Factor

The form factor ( $k_f$ ) is defined in Clause 6.2.2 of AS 4100.  $k_f$  is used to determine the design section capacity of a concentrically loaded compression member ( $\phi N_s$ ). The calculation of  $k_f$  indicates the degree to which the plate elements which make up the column section will buckle locally before squashing (i.e. yielding).  $k_f$  represents the proportion of the hollow section that is effective in compression and is based on the effective width of each element in the section (i.e.  $k_f = 1.0$  signifies a column section which will yield rather than buckle locally in a short or stub column test). The evaluation of  $k_f$  is also important when designing to the higher tier provisions for members subject to combined actions as noted in Section 8 of AS 4100.

From Table 6.2.4 of AS 4100, the cold-formed (CF) residual stress category is used in the calculation of  $k_f$  for hollow sections complying with AS/NZS 1163. General worked examples for calculating  $k_f$  are provided in Section 3.2.3 and Refs. [3.2, 3.3].

### 3.2.3 Example

Determine  $Z_{ex}$  and  $k_f$  for a 400 x 200 x 8.0 RHS in C450PLUS™ – designed as an AS/NZS 1163 Grade C450L0 structural steel hollow section.

**Solution:** (All relevant data are obtained from Table 3.1-4(1))

Design Yield Stress  $f_y = 450$  MPa

$$\text{Flange slenderness } \lambda_{ef} = \frac{b-2t}{t} \sqrt{\frac{f_y}{250}} = 23.0 \sqrt{\frac{450}{250}} = 30.9$$

$$\text{Web slenderness } \lambda_{ew} = \frac{d-2t}{t} \sqrt{\frac{f_y}{250}} = 48.0 \sqrt{\frac{450}{250}} = 64.4$$

(a) To calculate  $Z_{ex}$  the plate element slenderness values are compared with the plate element slenderness limits in Table 5.2 of AS 4100.

Bending about the section x-axis puts the flange in uniform compression. Hence,

$$\lambda_{ef} = 30.9 \quad \lambda_{ep} = 30 \quad \lambda_{ey} = 40 \quad \lambda_{ef} / \lambda_{ey} = 0.773$$

Bending about the section x-axis places one edge of the web in tension and the other in compression. Hence,

$$\lambda_{ew} = 64.4 \quad \lambda_{ep} = 82 \quad \lambda_{ey} = 115 \quad \lambda_{ew} / \lambda_{ey} = 0.560$$

The flange has the higher value of  $\lambda_e / \lambda_{ey}$  and is the critical element in the section.

From Clause 5.2.2 of AS 4100 the section slenderness and slenderness limits are the flange values, i.e.

$$\lambda_s = 30.9 \quad \lambda_{sp} = 30 \quad \lambda_{sy} = 40$$

Now  $\lambda_{sp} < \lambda_s \leq \lambda_{sy}$  ∴ The section is NON-COMPACT (hence "N" in Table 3.1-4(1)).

$$Z_x = 949 \times 10^3 \text{ mm}^3 \quad S_x = 1170 \times 10^3 \text{ mm}^3$$

$$Z_{cx} = \min. [S_x, 1.5Z_x] = \min. [1170, 1.5 \times 949] \times 10^3 = 1170 \times 10^3 \text{ mm}^3$$

$$Z_{ex} = Z_x + \left[ \frac{(\lambda_{sy} - \lambda_s)}{(\lambda_{sy} - \lambda_{sp})} (Z_{cx} - Z_x) \right] = 949 \times 10^3 + \left[ \frac{(40 - 30.9)}{(40 - 30)} (1170 - 949) \right] \times 10^3$$

$$= 1150 \times 10^3 \text{ mm}^3$$

(b) To determine the form factor ( $k_f$ ) the plate element slenderness for both the flange and web are compared with the plate element yield slenderness limits ( $\lambda_{ey}$ ) in Table 6.2.4 of AS 4100.

Flange  $\lambda_{ef} = 30.9 < \lambda_{ey} = 40$  – i.e. flange is fully effective

Web  $\lambda_{ew} = 64.4 > \lambda_{ey} = 40$  – i.e. web is not fully effective

Effective width of web =  $d_{ew} = \lambda_{ey} / \lambda_{ew} (d-2t) = 40/64.4 \times (400 - 2 \times 8) = 238.5$  mm

Gross Area =  $A_g = 9120$  mm<sup>2</sup>

$$\text{Effective Area} = A_e = A_g - 2 \times (d - 2t - d_{ew}) t$$

$$= 9120 - 2 \times (400 - 2 \times 8 - 238.5) \times 8 = 6790 \text{ mm}^2$$

$$\therefore k_f = A_e / A_g = 6790/9120 = 0.745$$

# Part 3

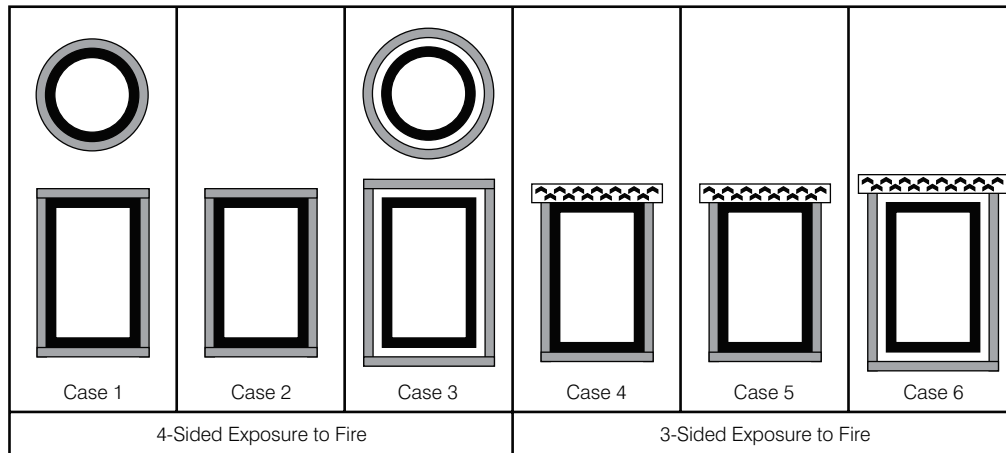
## SECTION PROPERTIES

### 3.3 Properties for Fire Design

To assist with the design of structural steel hollow sections for fire resistance (Section 12 of AS 4100), values of the exposed surface area to mass ratio ( $k_{sm}$ ) are presented in Tables 3.2-1 to 3.2-4 for the various cases shown in Figure 3.3.

For **unprotected steel hollow sections** the values of  $k_{sm}$  corresponding to four- and three-sided exposure should be taken as those corresponding to Cases 1 and 4 respectively in Figure 3.3.

For members requiring the addition of fire protection materials, Ref. [3.4] may be used to determine the thickness of proprietary materials required for a given value of  $k_{sm}$  and Fire Resistance Level (FRL). It should be noted that  $k_{sm}$  is equivalent to  $E$  in Ref. [3.4]. Further information and worked examples on fire design to Section 12 of AS 4100 can be found in Refs. [3.5, 3.6, 3.7].



#### Cases of fire exposure considered:

- |   |   |
|---|---|
| 1 = Total Perimeter, Profile-protected        | 4 = Top Flange Excluded, Profile-protected        |
| 2 = Total Perimeter, Box-protected, No Gap    | 5 = Top Flange Excluded, Box-protected, No Gap    |
| 3 = Total Perimeter, Box-protected, 25 mm Gap | 6 = Top Flange Excluded, Box-protected, 25 mm Gap |

Figure 3.3: Cases for Calculation of Exposed Surface Area to Mass Ratio

### 3.4 Telescoping Sections

Tables 3.3-1 to 3.3-3 can be used to determine hollow sections which are suitable for telescoping. Within these tables the total available clearance is tabulated to allow designers to select hollow sections with suitable clearance for the type of fit required. Sections with clearances less than 2.0 mm are shown in **bold** in the tables. Figure 3.4 shows the typical telescoping data required to select appropriate sections.

All calculations used in the preparation of the tables are based on the nominal dimensions of hollow sections and manufacturing tolerances specified in AS/NZS 1163. Owing to dimensional tolerances permitted within that Standard actual clearances of sections manufactured to this specification will vary marginally from the values tabulated.

For tight fits, varying corner radii and internal weld heights can affect telescoping of sections and it is recommended that some form of testing is carried out prior to committing material. Where telescoping over some length is required, additional clearance may be needed to allow for straightness of the section.

Telescoping of SHS and RHS where the female (outer) has a larger wall thickness requires careful consideration of corner clearance due to the larger corner radii of the thicker section. Typical corner geometry may differ from that used for the calculation of section properties and reference should be made to Australian Tube Mills for further information (see contact details at the bottom of the page).

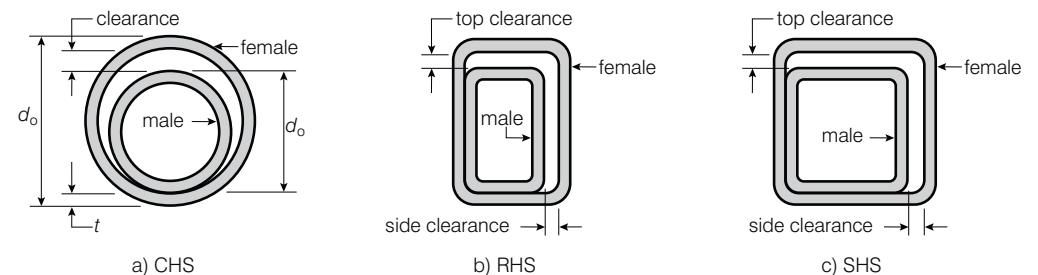


Figure 3.4: Parameters for Telescoping Tables

# Part 3

## SECTION PROPERTIES

### 3.5 References

- [3.1] International Standard Organisation, ISO 657/XIV, "Hot-rolled steel sections – Part XIV: Hot-finished structural hollow sections – Dimensions and sectional properties", International Standards Organisation, 1977.
- [3.2] Bradford, M.A., Bridge, R.Q. and Trahair, N.S., "Worked Examples for Steel Structures", third edition, Australian Institute of Steel Construction, 1997 (Note: AISC is now ASI – the Australian Steel Institute).
- [3.3] AISC, "Design Capacity Tables for Structural Steel – Volume 1: Open Sections", fourth edition, Australian Steel Institute, 2009.
- [3.4] Proe, D.J., Bennetts, I.D., Thomas, I.R. and Szeto, W.T., "Handbook of Fire Protection Materials for Structural Steel", Australian Institute of Steel Construction, 1990 (Note: AISC is now ASI – the Australian Steel Institute).
- [3.5] Thomas, I.R., Bennetts, I.D. and Proe, D.J., "Design of Steel Structures for Fire Resistance in Accordance with AS 4100", Steel Construction, Vol. 26, No. 3, Australian Institute of Steel Construction, 1992 (Note: AISC is now ASI – the Australian Steel Institute).
- [3.6] O'Meagher, A.J., Bennetts, I.D., Dayawansa, P.H. and Thomas, I.R., "Design of Single Storey Industrial Buildings for Fire Resistance", Steel Construction, Vol. 26, No. 2, Australian Institute of Steel Construction, 1992 (Note: AISC is now ASI – the Australian Steel Institute).
- [3.7] Rakic, J., "Structural Steel Fire Guide - Guide to the Use of Fire Protection Materials", Steel Construction, Vol. 42, No. 1, Australian Steel Institute, 2008.

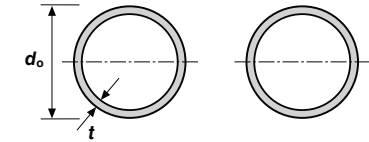
**See Section 1.1.2 for details on reference Standards.**

TABLE 3.1-1

# Circular Hollow Sections AS/NZS 1163 Grade C250L0

## DIMENSIONS AND PROPERTIES

- 1 CHS
- 2 C250L0
- 3 Finish



Dimensions and Ratios							Properties							Properties for Design to AS 4100		
Designation		Mass per m	External Surface Area		$\frac{d_o}{t}$	Gross Section Area	About any axis					Torsion Constant	Torsion Modulus	Form Factor	About any axis	
$d_o$	t		per m	per t			$A_g$	I	Z	S	r				J	C
mm	mm	kg/m	m <sup>2</sup> /m	m <sup>2</sup> /t	mm <sup>2</sup>	10 <sup>6</sup> mm <sup>4</sup>	10 <sup>3</sup> mm <sup>3</sup>	10 <sup>3</sup> mm <sup>3</sup>	mm	10 <sup>6</sup> mm <sup>4</sup>	10 <sup>3</sup> mm <sup>3</sup>			10 <sup>3</sup> mm <sup>3</sup>		
165.1	x 5.4	CHS	21.3	0.519	24.4	30.6	2710	8.65	105	138	56.5	17.3	209	1.00	C	138
	5.0	CHS	19.7	0.519	26.3	33.0	2510	8.07	97.7	128	56.6	16.1	195	1.00	C	128
139.7	x 5.4	CHS	17.9	0.439	24.5	25.9	2280	5.14	73.7	97.4	47.5	10.3	147	1.00	C	97.4
	5.0	CHS	16.6	0.439	26.4	27.9	2120	4.81	68.8	90.8	47.7	9.61	138	1.00	C	90.8
114.3	x 5.4	CHS	14.5	0.359	24.8	21.2	1850	2.75	48.0	64.1	38.5	5.49	96.1	1.00	C	64.1
	4.5	CHS	12.2	0.359	29.5	25.4	1550	2.34	41.0	54.3	38.9	4.69	82.0	1.00	C	54.3
101.6	x 5.0	CHS	11.9	0.319	26.8	20.3	1520	1.77	34.9	46.7	34.2	3.55	69.9	1.00	C	46.7
	4.0	CHS	9.63	0.319	33.2	25.4	1230	1.46	28.8	38.1	34.5	2.93	57.6	1.00	C	38.1
88.9	x 5.9	CHS	12.1	0.279	23.1	15.1	1540	1.33	30.0	40.7	29.4	2.66	59.9	1.00	C	40.7
	5.0	CHS	10.3	0.279	27.0	17.8	1320	1.16	26.2	35.2	29.7	2.33	52.4	1.00	C	35.2
	4.0	CHS	8.38	0.279	33.3	22.2	1070	0.963	21.7	28.9	30.0	1.93	43.3	1.00	C	28.9
76.1	x 5.9	CHS	10.2	0.239	23.4	12.9	1300	0.807	21.2	29.1	24.9	1.61	42.4	1.00	C	29.1
	4.5	CHS	7.95	0.239	30.1	16.9	1010	0.651	17.1	23.1	25.4	1.30	34.2	1.00	C	23.1
	3.6	CHS	6.44	0.239	37.1	21.1	820	0.540	14.2	18.9	25.7	1.08	28.4	1.00	C	18.9
60.3	x 5.4	CHS	7.31	0.189	25.9	11.2	931	0.354	11.8	16.3	19.5	0.709	23.5	1.00	C	16.3
	4.5	CHS	6.19	0.189	30.6	13.4	789	0.309	10.2	14.0	19.8	0.618	20.5	1.00	C	14.0
	3.6	CHS	5.03	0.189	37.6	16.8	641	0.259	8.58	11.6	20.1	0.517	17.2	1.00	C	11.6
48.3	x 4.0	CHS	4.37	0.152	34.7	12.1	557	0.138	5.70	7.87	15.7	0.275	11.4	1.00	C	7.87
	3.2	CHS	3.56	0.152	42.6	15.1	453	0.116	4.80	6.52	16.0	0.232	9.59	1.00	C	6.52
42.4	x 4.0	CHS	3.79	0.133	35.2	10.6	483	0.0899	4.24	5.92	13.6	0.180	8.48	1.00	C	5.92
	3.2	CHS	3.09	0.133	43.1	13.3	394	0.0762	3.59	4.93	13.9	0.152	7.19	1.00	C	4.93
33.7	x 4.0	CHS	2.93	0.106	36.1	8.43	373	0.0419	2.49	3.55	10.6	0.0838	4.97	1.00	C	3.55
	3.2	CHS	2.41	0.106	44.0	10.5	307	0.0360	2.14	2.99	10.8	0.0721	4.28	1.00	C	2.99
26.9	x 4.0	CHS	2.26	0.0845	37.4	6.73	288	0.0194	1.45	2.12	8.22	0.0389	2.89	1.00	C	2.12
	3.2	CHS	1.87	0.0845	45.2	8.41	238	0.0170	1.27	1.81	8.46	0.0341	2.53	1.00	C	1.81
	2.6	CHS	1.56	0.0845	54.2	10.3	198	0.0148	1.10	1.54	8.64	0.0296	2.20	1.00	C	1.54

**Notes:**

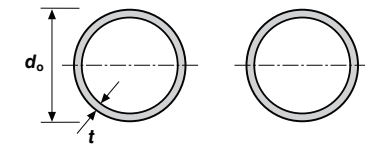
- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- For Grade C250L0:  $f_y = 250$  MPa and  $f_u = 320$  MPa;  $f_y$  = yield stress used in design;  $f_u$  = tensile strength used in design; as defined in AS 4100.
- C = Compact Section; N = Non-Compact Section; S = Slender Section (as defined in AS 4100).
- Grade C250L0 to AS/NZS 1163 is cold-formed and is therefore allocated the CF residual stresses classification in AS 4100.
- This product is also compliant with AS 1074 – Steel tubes and tubulars for ordinary service. Refer to the ATM Product Manual for details on AS 1074 sections.

TABLE 3.1-2(1)

# Circular Hollow Sections AS/NZS 1163 Grade C350L0

## DIMENSIONS AND PROPERTIES

- 1 CHS
- 2 C350L0
- 3 Finish



Dimensions and Ratios						Properties							Properties for Design to AS 4100			
Designation		Mass per m	External Surface Area		$\frac{d_o}{t}$	Gross Section Area	About any axis				Torsion Constant	Torsion Modulus	Form Factor	About any axis		
$d_o$	t		per m	per m			per t	$A_g$	I	Z				S	r	J
mm	mm	kg/m	m <sup>2</sup> /m	m <sup>2</sup> /t		mm <sup>2</sup>	10 <sup>6</sup> mm <sup>4</sup>	10 <sup>3</sup> mm <sup>3</sup>	10 <sup>3</sup> mm <sup>3</sup>	mm	10 <sup>6</sup> mm <sup>4</sup>	10 <sup>3</sup> mm <sup>3</sup>		(C,N,S)	10 <sup>3</sup> mm <sup>3</sup>	
508.0	x 12.7	CHS	155	1.60	10.3	40.0	19800	606	2390	3120	175	1210	4770	1.00	N	3050
	9.5	CHS	117	1.60	13.7	53.5	14900	462	1820	2360	176	925	3640	1.00	N	2170
	6.4	CHS	79.2	1.60	20.2	79.4	10100	317	1250	1610	177	634	2500	0.857	N	1290
457.0	x 12.7	CHS	139	1.44	10.3	36.0	17700	438	1920	2510	157	876	3830	1.00	N	2500
	9.5	CHS	105	1.44	13.7	48.1	13400	334	1460	1900	158	669	2930	1.00	N	1790
	6.4	CHS	71.1	1.44	20.2	71.4	9060	230	1010	1300	159	460	2010	0.904	N	1090
406.4	x 12.7	CHS	123	1.28	10.4	32.0	15700	305	1500	1970	139	609	3000	1.00	C	1970
	9.5	CHS	93.0	1.28	13.7	42.8	11800	233	1150	1500	140	467	2300	1.00	N	1450
	6.4	CHS	63.1	1.28	20.2	63.5	8040	161	792	1020	141	322	1580	0.960	N	895
355.6	x 12.7	CHS	107	1.12	10.4	28.0	13700	201	1130	1490	121	403	2260	1.00	C	1490
	9.5	CHS	81.1	1.12	13.8	37.4	10300	155	871	1140	122	310	1740	1.00	N	1130
	6.4	CHS	55.1	1.12	20.3	55.6	7020	107	602	781	123	214	1200	1.00	N	710
323.9	x 12.7	CHS	97.5	1.02	10.4	25.5	12400	151	930	1230	110	301	1860	1.00	C	1230
	9.5	CHS	73.7	1.02	13.8	34.1	9380	116	717	939	111	232	1430	1.00	C	939
	6.4	CHS	50.1	1.02	20.3	50.6	6380	80.5	497	645	112	161	994	1.00	N	601
273.1	x 12.7	CHS	81.6	0.858	10.5	21.5	10400	88.3	646	862	92.2	177	1290	1.00	C	862
	9.3	CHS	60.5	0.858	14.2	29.4	7710	67.1	492	647	93.3	134	983	1.00	C	647
	6.4	CHS	42.1	0.858	20.4	42.7	5360	47.7	349	455	94.3	95.4	699	1.00	N	441
	4.8	CHS	31.8	0.858	27.0	56.9	4050	36.4	267	346	94.9	72.8	533	1.00	N	312
219.1	x 8.2	CHS	42.6	0.688	16.1	26.7	5430	30.3	276	365	74.6	60.5	552	1.00	C	365
	6.4	CHS	33.6	0.688	20.5	34.2	4280	24.2	221	290	75.2	48.4	442	1.00	C	290
	4.8	CHS	25.4	0.688	27.1	45.6	3230	18.6	169	220	75.8	37.1	339	1.00	N	210
168.3	x 7.1	CHS	28.2	0.529	18.7	23.7	3600	11.7	139	185	57.0	23.4	278	1.00	C	185
	6.4	CHS	25.6	0.529	20.7	26.3	3260	10.7	127	168	57.3	21.4	254	1.00	C	168
	4.8	CHS	19.4	0.529	27.3	35.1	2470	8.25	98.0	128	57.8	16.5	196	1.00	C	128

**Notes:**

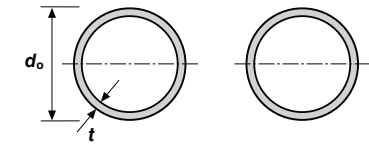
- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- For Grade C350L0:  $f_y = 350$  MPa and  $f_u = 430$  MPa;  $f_y$  = yield stress used in design;  $f_u$  = tensile strength used in design; as defined in AS 4100.
- C = Compact Section; N = Non-Compact Section; S = Slender Section (as defined in AS 4100).
- Grade C350L0 to AS/NZS 1163 is cold-formed and is therefore allocated the CF residual stresses classification in AS 4100.

TABLE 3.1-2(2)

# Circular Hollow Sections AS/NZS 1163 Grade C350L0

## DIMENSIONS AND PROPERTIES

- 1 CHS
- 2 C350L0
- 3 Finish



Dimensions and Ratios						Properties							Properties for Design to AS 4100			
Designation		Mass per m	External Surface Area		$\frac{d_o}{t}$	Gross Section Area	About any axis					Torsion Constant	Torsion Modulus	Form Factor	About any axis	
$d_o$	t		per m	per t			$A_g$	I	Z	S	r				J	C
mm	mm	kg/m	m <sup>2</sup> /m	m <sup>2</sup> /t	mm <sup>2</sup>	10 <sup>6</sup> mm <sup>4</sup>	10 <sup>3</sup> mm <sup>3</sup>	10 <sup>3</sup> mm <sup>3</sup>	mm	10 <sup>6</sup> mm <sup>4</sup>	10 <sup>3</sup> mm <sup>3</sup>		(C,N,S)	10 <sup>3</sup> mm <sup>3</sup>		
165.1	x 3.5	CHS	13.9	0.519	37.2	47.2	1780	5.80	70.3	91.4	57.1	11.6	141	1.00	N	86.6
	3.0	CHS	12.0	0.519	43.2	55.0	1530	5.02	60.8	78.8	57.3	10.0	122	1.00	N	71.9
139.7	x 3.5	CHS	11.8	0.439	37.3	39.9	1500	3.47	49.7	64.9	48.2	6.95	99.5	1.00	N	63.7
	3.0	CHS	10.1	0.439	43.4	46.6	1290	3.01	43.1	56.1	48.3	6.02	86.2	1.00	N	53.3
114.3	x 3.6	CHS	9.83	0.359	36.5	31.8	1250	1.92	33.6	44.1	39.2	3.84	67.2	1.00	C	44.1
	3.2	CHS	8.77	0.359	41.0	35.7	1120	1.72	30.2	39.5	39.3	3.45	60.4	1.00	N	39.5
101.6	x 3.2	CHS	7.77	0.319	41.1	31.8	989	1.20	23.6	31.0	34.8	2.40	47.2	1.00	C	31.0
	2.6	CHS	6.35	0.319	50.3	39.1	809	0.991	19.5	25.5	35.0	1.98	39.0	1.00	N	25.1
88.9	x 3.2	CHS	6.76	0.279	41.3	27.8	862	0.792	17.8	23.5	30.3	1.58	35.6	1.00	C	23.5
	2.6	CHS	5.53	0.279	50.5	34.2	705	0.657	14.8	19.4	30.5	1.31	29.6	1.00	C	19.4
76.1	x 3.2	CHS	5.75	0.239	41.6	23.8	733	0.488	12.8	17.0	25.8	0.976	25.6	1.00	C	17.0
	2.3	CHS	4.19	0.239	57.1	33.1	533	0.363	9.55	12.5	26.1	0.727	19.1	1.00	C	12.5
60.3	x 2.9	CHS	4.11	0.189	46.1	20.8	523	0.216	7.16	9.56	20.3	0.432	14.3	1.00	C	9.56
	2.3	CHS	3.29	0.189	57.6	26.2	419	0.177	5.85	7.74	20.5	0.353	11.7	1.00	C	7.74
48.3	x 2.9	CHS	3.25	0.152	46.7	16.7	414	0.107	4.43	5.99	16.1	0.214	8.86	1.00	C	5.99
	2.3	CHS	2.61	0.152	58.2	21.0	332	0.0881	3.65	4.87	16.3	0.176	7.30	1.00	C	4.87
42.4	x 2.6	CHS	2.55	0.133	52.2	16.3	325	0.0646	3.05	4.12	14.1	0.129	6.10	1.00	C	4.12
	2.0	CHS	1.99	0.133	66.8	21.2	254	0.0519	2.45	3.27	14.3	0.104	4.90	1.00	C	3.27
33.7	x 2.6	CHS	1.99	0.106	53.1	13.0	254	0.0309	1.84	2.52	11.0	0.0619	3.67	1.00	C	2.52
	2.0	CHS	1.56	0.106	67.7	16.9	199	0.0251	1.49	2.01	11.2	0.0502	2.98	1.00	C	2.01
26.9	x 2.3	CHS	1.40	0.0845	60.6	11.7	178	0.0136	1.01	1.40	8.74	0.0271	2.02	1.00	C	1.40
	2.0	CHS	1.23	0.0845	68.8	13.5	156	0.0122	0.907	1.24	8.83	0.0244	1.81	1.00	C	1.24

**Notes:**

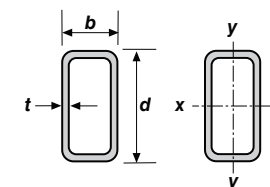
- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The **PAG** can be found at [www.austubemills.com](http://www.austubemills.com).
- For Grade C350L0:  $f_y = 350$  MPa and  $f_u = 430$  MPa;  $f_y$  = yield stress used in design;  $f_u$  = tensile strength used in design; as defined in AS 4100.
- C = Compact Section; N = Non-Compact Section; S = Slender Section (as defined in AS 4100).
- Grade C350L0 to AS/NZS 1163 is cold-formed and is therefore allocated the CF residual stresses classification in AS 4100.

TABLE 3.1-3

# Rectangular Hollow Sections AS/NZS 1163 Grade C350L0

## DIMENSIONS AND PROPERTIES

- 1 RHS
- 2 C350L0
- 3 Finish



Dimensions and Ratios							Properties											Properties for Design to AS 4100						
Designation			Mass per m	External Surface Area		b-2t	d-2t	Gross Section Area	About x-axis				About y-axis				Torsion Constant	Torsion Modulus	Form Factor	About x-axis		About y-axis		
d	b	t		per m	per t				A <sub>g</sub>	I <sub>x</sub>	Z <sub>x</sub>	S <sub>x</sub>	r <sub>x</sub>	I <sub>y</sub>	Z <sub>y</sub>	S <sub>y</sub>				r <sub>y</sub>	J	C	k <sub>f</sub>	Compactness
mm	mm	mm	kg/m	m <sup>2</sup> /m	m <sup>2</sup> /t	t	t	mm <sup>2</sup>	10 <sup>6</sup> mm <sup>4</sup>	10 <sup>3</sup> mm <sup>3</sup>	10 <sup>3</sup> mm <sup>3</sup>	mm	10 <sup>6</sup> mm <sup>4</sup>	10 <sup>3</sup> mm <sup>3</sup>	10 <sup>3</sup> mm <sup>3</sup>	mm	10 <sup>6</sup> mm <sup>4</sup>	10 <sup>3</sup> mm <sup>3</sup>	(C,N,S)	10 <sup>3</sup> mm <sup>3</sup>	(C,N,S)	10 <sup>3</sup> mm <sup>3</sup>		
75 x 25	x	2.5	RHS	3.60	0.191	53.1	8.00	28.0	459	0.285	7.60	10.1	24.9	0.0487	3.89	4.53	10.3	0.144	7.14	1.00	C	10.1	N	4.33
		2.0	RHS	2.93	0.193	65.8	10.5	35.5	374	0.238	6.36	8.31	25.3	0.0414	3.31	3.77	10.5	0.120	6.04	0.964	C	8.31	S	3.18
		1.6	RHS	2.38	0.195	81.7	13.6	44.9	303	0.197	5.26	6.81	25.5	0.0347	2.78	3.11	10.7	0.0993	5.05	0.813	C	6.81	S	2.22
65 x 35	x	4.0	RHS	5.35	0.183	34.2	6.75	14.3	681	0.328	10.1	13.3	22.0	0.123	7.03	8.58	13.4	0.320	12.5	1.00	C	13.3	C	8.58
		3.0	RHS	4.25	0.190	44.7	9.67	19.7	541	0.281	8.65	11.0	22.8	0.106	6.04	7.11	14.0	0.259	10.4	1.00	C	11.0	C	7.11
		2.5	RHS	3.60	0.191	53.1	12.0	24.0	459	0.244	7.52	9.45	23.1	0.0926	5.29	6.13	14.2	0.223	9.10	1.00	C	9.45	C	6.13
		2.0	RHS	2.93	0.193	65.8	15.5	30.5	374	0.204	6.28	7.80	23.4	0.0778	4.44	5.07	14.4	0.184	7.62	1.00	C	7.80	N	4.69
50 x 25	x	3.0	RHS	3.07	0.140	45.5	6.33	14.7	391	0.112	4.47	5.86	16.9	0.0367	2.93	3.56	9.69	0.0964	5.18	1.00	C	5.86	C	3.56
		2.5	RHS	2.62	0.141	54.0	8.00	18.0	334	0.0989	3.95	5.11	17.2	0.0328	2.62	3.12	9.91	0.0843	4.60	1.00	C	5.11	C	3.12
		2.0	RHS	2.15	0.143	66.6	10.5	23.0	274	0.0838	3.35	4.26	17.5	0.0281	2.25	2.62	10.1	0.0706	3.92	1.00	C	4.26	C	2.62
		1.6	RHS	1.75	0.145	82.5	13.6	29.3	223	0.0702	2.81	3.53	17.7	0.0237	1.90	2.17	10.3	0.0585	3.29	1.00	C	3.53	N	2.05
50 x 20	x	3.0	RHS	2.83	0.130	45.8	4.67	14.7	361	0.0951	3.81	5.16	16.2	0.0212	2.12	2.63	7.67	0.0620	3.88	1.00	C	5.16	C	2.63
		2.5	RHS	2.42	0.131	54.2	6.00	18.0	309	0.0848	3.39	4.51	16.6	0.0192	1.92	2.32	7.89	0.0550	3.49	1.00	C	4.51	C	2.32
		2.0	RHS	1.99	0.133	66.8	8.00	23.0	254	0.0723	2.89	3.78	16.9	0.0167	1.67	1.96	8.11	0.0466	3.00	1.00	C	3.78	C	1.96
		1.6	RHS	1.63	0.135	82.7	10.5	29.3	207	0.0608	2.43	3.14	17.1	0.0142	1.42	1.63	8.29	0.0389	2.55	1.00	C	3.14	N	1.54

**Notes:**

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- For Grade C350L0:  $f_y = 350$  MPa and  $f_u = 430$  MPa;  $f_y$  = yield stress used in design;  $f_u$  = tensile strength used in design; as defined in AS 4100.
- C = Compact Section; N = Non-Compact Section; S = Slender Section (as defined in AS 4100).
- Grade C350L0 to AS/NZS 1163 is cold-formed and is therefore allocated the CF residual stresses classification in AS 4100.

**ADDITIONAL NOTES:**

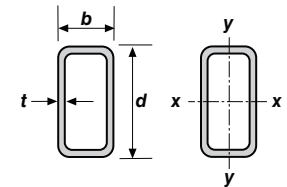
- (A) **THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS®.**
- (B) **SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.**

TABLE 3.1-4(1)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DIMENSIONS AND PROPERTIES

- 1 RHS
- 2 C450PLUS®
- 3 Finish



Dimensions and Ratios						Properties													Properties for Design to AS 4100					
Designation		Mass per m	External Surface Area		$\frac{b-2t}{t}$	$\frac{d-2t}{t}$	Gross Section Area	About x-axis					About y-axis					Torsion Constant	Torsion Modulus	Form Factor	About x-axis		About y-axis	
d	b		per m	per t				$A_g$	$I_x$	$Z_x$	$S_x$	$r_x$	$I_y$	$Z_y$	$S_y$	$r_y$	J				C	$k_f$	Compact-ness	$Z_{ex}$
mm	mm	kg/m	m <sup>2</sup> /m	m <sup>2</sup> /t		mm <sup>2</sup>	10 <sup>6</sup> mm <sup>4</sup>	10 <sup>3</sup> mm <sup>3</sup>	10 <sup>3</sup> mm <sup>3</sup>	mm	10 <sup>6</sup> mm <sup>4</sup>	10 <sup>3</sup> mm <sup>3</sup>	10 <sup>3</sup> mm <sup>3</sup>	mm	10 <sup>6</sup> mm <sup>4</sup>	10 <sup>3</sup> mm <sup>3</sup>		(C,N,S)	10 <sup>3</sup> mm <sup>3</sup>	(C,N,S)	10 <sup>3</sup> mm <sup>3</sup>			
400 x 300 x	16.0 RHS	161	1.33	8.27	16.8	23.0	20500	453	2260	2750	149	290	1940	2260	119	586	3170	1.00	C	2750	N	2230		
	12.5 RHS	128	1.35	10.5	22.0	30.0	16300	370	1850	2230	151	238	1590	1830	121	471	2590	0.996	C	2230	S	1580		
	10.0 RHS	104	1.36	13.0	28.0	38.0	13300	306	1530	1820	152	197	1320	1500	122	384	2130	0.877	N	1600	S	1120		
	8.0 RHS	84.2	1.37	16.2	35.5	48.0	10700	251	1260	1490	153	162	1080	1220	123	312	1750	0.715	S	1140	S	800		
400 x 200 x	16.0 RHS	136	1.13	8.33	10.5	23.0	17300	335	1670	2140	139	113	1130	1320	80.8	290	2000	1.00	C	2140	N	1300		
	12.5 RHS	109	1.15	10.6	14.0	30.0	13800	277	1380	1740	141	94.0	940	1080	82.4	236	1650	0.996	C	1740	S	936		
	10.0 RHS	88.4	1.16	13.1	18.0	38.0	11300	230	1150	1430	143	78.6	786	888	83.6	194	1370	0.855	C	1430	S	658		
	8.0 RHS	71.6	1.17	16.3	23.0	48.0	9120	190	949	1170	144	65.2	652	728	84.5	158	1130	0.745	N	1150	S	464		
350 x 250 x	16.0 RHS	136	1.13	8.33	13.6	19.9	17300	283	1620	1990	128	168	1340	1580	98.5	355	2230	1.00	C	1990	C	1580		
	12.5 RHS	109	1.15	10.6	18.0	26.0	13800	233	1330	1620	130	139	1110	1290	100	287	1840	1.00	C	1620	N	1200		
	10.0 RHS	88.4	1.16	13.1	23.0	33.0	11300	194	1110	1330	131	116	927	1060	101	235	1520	0.943	N	1320	S	865		
	8.0 RHS	71.6	1.17	16.3	29.3	41.8	9120	160	914	1090	132	95.7	766	869	102	191	1250	0.833	N	928	S	614		
300 x 200 x	16.0 RHS	111	0.931	8.42	10.5	16.8	14100	161	1080	1350	107	85.7	857	1020	78.0	193	1450	1.00	C	1350	C	1020		
	12.5 RHS	89.0	0.946	10.6	14.0	22.0	11300	135	899	1110	109	72.0	720	842	79.7	158	1210	1.00	C	1110	C	842		
	10.0 RHS	72.7	0.957	13.2	18.0	28.0	9260	113	754	921	111	60.6	606	698	80.9	130	1010	1.00	C	921	N	628		
	8.0 RHS	59.1	0.966	16.3	23.0	35.5	7520	93.9	626	757	112	50.4	504	574	81.9	106	838	0.903	N	746	S	447		
	6.0 RHS	45.0	0.974	21.7	31.3	48.0	5730	73.0	487	583	113	39.3	393	443	82.8	81.4	651	0.753	S	474	S	288		
250 x 150 x	16.0 RHS	85.5	0.731	8.55	7.38	13.6	10900	80.2	641	834	85.8	35.8	478	583	57.3	88.2	836	1.00	C	834	C	583		
	12.5 RHS	69.4	0.746	10.8	10.0	18.0	8840	68.5	548	695	88.0	30.8	411	488	59.0	73.4	710	1.00	C	695	C	488		
	10.0 RHS	57.0	0.757	13.3	13.0	23.0	7260	58.3	466	582	89.6	26.3	351	409	60.2	61.2	602	1.00	C	582	N	404		
	9.0 RHS	51.8	0.761	14.7	14.7	25.8	6600	53.7	430	533	90.2	24.3	324	375	60.7	56.0	554	1.00	C	533	N	352		
	8.0 RHS	46.5	0.766	16.5	16.8	29.3	5920	48.9	391	482	90.8	22.2	296	340	61.2	50.5	504	1.00	C	482	N	299		
	6.0 RHS	35.6	0.774	21.8	23.0	39.7	4530	38.4	307	374	92.0	17.5	233	264	62.2	39.0	395	0.843	N	368	S	191		
	5.0 RHS	29.9	0.779	26.0	28.0	48.0	3810	32.7	262	317	92.6	15.0	199	224	62.6	33.0	337	0.762	N	275	S	144		

**Notes:**

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the availability of listed sections and associated finishes. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- For C450PLUS™:  $f_y = 450$  MPa and  $f_u = 500$  MPa;  $f_y$  = yield stress used in design;  $f_u$  = tensile strength used in design; as defined in AS 4100.
- C = Compact Section; N = Non-Compact Section; S = Slender Section (as defined in AS 4100).
- Australian Tube Mills C450PLUS to AS/NZS 1163 is cold-formed and is therefore allocated the CF residual stresses classification in AS 4100.





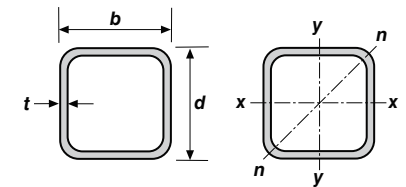


TABLE 3.1-5

# Square Hollow Sections AS/NZS 1163 Grade C350L0

## DIMENSIONS AND PROPERTIES

- 1 SHS
- 2 C350L0
- 3 Finish



Dimensions and Ratios							Section Properties								Properties for Design to AS 4100							
Designation			Mass per m	External Surface Area		b-2t/t	Gross Section Area	About x-, y- and n-axis					Torsion Constant	Torsion Modulus	Form Factor	About x and y-axis						
d	b	t		per m	per t			A <sub>g</sub>	I <sub>x</sub>	Z <sub>x</sub>	Z <sub>n</sub>	S <sub>x</sub>				r <sub>x</sub>	J	C	k <sub>f</sub>	λ <sub>o</sub>	Compactness	Z <sub>ex</sub>
mm	mm	mm	kg/m	m <sup>2</sup> /m	m <sup>2</sup> /t	mm <sup>2</sup>	10 <sup>6</sup> mm <sup>4</sup>	10 <sup>3</sup> mm <sup>3</sup>	10 <sup>3</sup> mm <sup>3</sup>	10 <sup>3</sup> mm <sup>3</sup>	mm	10 <sup>6</sup> mm <sup>4</sup>	10 <sup>3</sup> mm <sup>3</sup>			(C,N,S)	10 <sup>3</sup> mm <sup>3</sup>					
50 x 50 x	50	50	6.0 SHS	7.32	0.174	23.8	6.33	932	0.275	11.0	9.45	14.5	17.2	0.518	17.7	1.00	7.49	C	14.5			
			5.0 SHS	6.39	0.179	27.9	8.00	814	0.257	10.3	8.51	13.2	17.8	0.469	16.3	1.00	9.47	C	13.2			
			4.0 SHS	5.35	0.183	34.2	10.5	681	0.229	9.15	7.33	11.4	18.3	0.403	14.3	1.00	12.4	C	11.4			
			3.0 SHS	4.25	0.190	44.7	14.7	541	0.195	7.79	5.92	9.39	19.0	0.321	11.8	1.00	17.4	C	9.39			
			2.5 SHS	3.60	0.191	53.1	18.0	459	0.169	6.78	5.09	8.07	19.2	0.275	10.2	1.00	21.3	C	8.07			
			2.0 SHS	2.93	0.193	65.8	23.0	374	0.141	5.66	4.20	6.66	19.5	0.226	8.51	1.00	27.2	C	6.66			
40 x 40 x	40	40	4.0 SHS	4.09	0.143	34.9	8.00	521	0.105	5.26	4.36	6.74	14.2	0.192	8.33	1.00	9.47	C	6.74			
			3.0 SHS	3.30	0.150	45.3	11.3	421	0.0932	4.66	3.61	5.72	14.9	0.158	7.07	1.00	13.4	C	5.72			
			2.5 SHS	2.82	0.151	53.7	14.0	359	0.0822	4.11	3.13	4.97	15.1	0.136	6.21	1.00	16.6	C	4.97			
			2.0 SHS	2.31	0.153	66.4	18.0	294	0.0694	3.47	2.61	4.13	15.4	0.113	5.23	1.00	21.3	C	4.13			
			1.6 SHS	1.88	0.155	82.3	23.0	239	0.0579	2.90	2.15	3.41	15.6	0.0927	4.36	1.00	27.2	C	3.41			
			35 x 35 x	35	35	3.0 SHS	2.83	0.130	45.8	9.67	361	0.0595	3.40	2.67	4.23	12.8	0.102	5.18	1.00	11.4	C	4.23
2.5 SHS	2.42	0.131				54.2	12.0	309	0.0529	3.02	2.33	3.69	13.1	0.0889	4.58	1.00	14.2	C	3.69			
2.0 SHS	1.99	0.133				66.8	15.5	254	0.0451	2.58	1.95	3.09	13.3	0.0741	3.89	1.00	18.3	C	3.09			
1.6 SHS	1.63	0.135				82.7	19.9	207	0.0379	2.16	1.62	2.57	13.5	0.0611	3.26	1.00	23.5	C	2.57			
30 x 30 x	30	30				3.0 SHS	2.36	0.110	46.5	8.00	301	0.0350	2.34	1.87	2.96	10.8	0.0615	3.58	1.00	9.47	C	2.96
						2.5 SHS	2.03	0.111	54.8	10.0	259	0.0316	2.10	1.65	2.61	11.0	0.0540	3.20	1.00	11.8	C	2.61
			2.0 SHS	1.68	0.113	67.4	13.0	214	0.0272	1.81	1.39	2.21	11.3	0.0454	2.75	1.00	15.4	C	2.21			
			1.6 SHS	1.38	0.115	83.3	16.8	175	0.0231	1.54	1.16	1.84	11.5	0.0377	2.32	1.00	19.8	C	1.84			
			25 x 25 x	25	25	3.0 SHS	1.89	0.0897	47.4	6.33	241	0.0184	1.47	1.21	1.91	8.74	0.0333	2.27	1.00	7.49	C	1.91
						2.5 SHS	1.64	0.0914	55.7	8.00	209	0.0169	1.35	1.08	1.71	8.99	0.0297	2.07	1.00	9.47	C	1.71
2.0 SHS	1.36	0.0931				68.3	10.5	174	0.0148	1.19	0.926	1.47	9.24	0.0253	1.80	1.00	12.4	C	1.47			
1.6 SHS	1.12	0.0945				84.1	13.6	143	0.0128	1.02	0.780	1.24	9.44	0.0212	1.54	1.00	16.1	C	1.24			
20 x 20 x	20	20				2.0 SHS	1.05	0.0731	69.7	8.00	134	0.00692	0.692	0.554	0.877	7.20	0.0121	1.06	1.00	9.47	C	0.877
						1.6 SHS	0.873	0.0745	85.4	10.5	111	0.00608	0.608	0.474	0.751	7.39	0.0103	0.924	1.00	12.4	C	0.751

**Notes:**

1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
2. For Grade C350L0:  $f_y = 350$  MPa and  $f_u = 430$  MPa;  $f_y$  = yield stress used in design;  $f_u$  = tensile strength used in design; as defined in AS 4100.
3. C = Compact Section; N = Non-Compact Section; S = Slender Section (as defined in AS 4100).
4. Grade C350L0 to AS/NZS 1163 is cold-formed and is therefore allocated the CF residual stresses classification in AS 4100.

**ADDITIONAL NOTES:**

**(A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS™.**

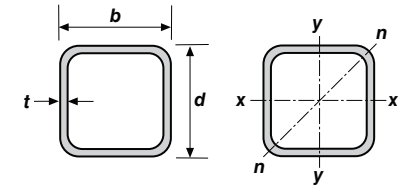
**(B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS™ PRODUCTS.**

TABLE 3.1-6(1)

# Square Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DIMENSIONS AND PROPERTIES

- 1 SHS
- 2 C450PLUS®
- 3 Finish



Dimensions and Ratios							Section Properties							Properties for Design to AS 4100				
Designation			Mass per m	External Surface Area		b-2t	Gross Section Area	About x-, y- and n-axis					Torsion Constant	Torsion Modulus	Form Factor	About x and y-axis		
d	b	t		per m	per t			A <sub>g</sub>	I <sub>x</sub>	Z <sub>x</sub>	Z <sub>n</sub>	S <sub>x</sub>				r <sub>x</sub>	J	C
mm	mm	mm	kg/m	m <sup>2</sup> /m	m <sup>2</sup> /t	t	mm <sup>2</sup>	10 <sup>6</sup> mm <sup>4</sup>	10 <sup>3</sup> mm <sup>3</sup>	10 <sup>3</sup> mm <sup>3</sup>	10 <sup>3</sup> mm <sup>3</sup>	mm	10 <sup>6</sup> mm <sup>4</sup>	10 <sup>3</sup> mm <sup>3</sup>		(C,N,S)	10 <sup>3</sup> mm <sup>3</sup>	
400 x 400 x	16.0	SHS	186	1.53	8.23	23.0	23700	571	2850	2140	3370	155	930	4350	1.00	30.9	N	3320
	12.5	SHS	148	1.55	10.5	30.0	18800	464	2320	1720	2710	157	744	3520	0.994	40.2	S	2310
	10.0	SHS	120	1.56	13.0	38.0	15300	382	1910	1400	2210	158	604	2890	0.785	51.0	S	1650
350 x 350 x	16.0	SHS	161	1.33	8.27	19.9	20500	372	2130	1610	2530	135	614	3250	1.00	26.7	C	2530
	12.5	SHS	128	1.35	10.5	26.0	16300	305	1740	1300	2040	137	493	2650	1.00	34.9	N	1900
	10.0	SHS	104	1.36	13.0	33.0	13300	252	1440	1060	1670	138	401	2180	0.904	44.3	S	1350
	8.0	SHS	84.2	1.37	16.2	41.8	10700	207	1180	865	1370	139	326	1790	0.715	56.0	S	971
300 x 300 x	16.0	SHS	136	1.13	8.33	16.8	17300	226	1510	1160	1810	114	378	2310	1.00	22.5	C	1810
	12.5	SHS	109	1.15	10.6	22.0	13800	187	1240	937	1470	116	305	1900	1.00	29.5	C	1470
	10.0	SHS	88.4	1.16	13.1	28.0	11300	155	1030	769	1210	117	250	1570	1.00	37.6	N	1080
	8.0	SHS	71.6	1.17	16.3	35.5	9120	128	853	628	991	118	203	1290	0.840	47.6	S	768
250 x 250 x	16.0	SHS	111	0.931	8.42	13.6	14100	124	992	774	1210	93.8	212	1530	1.00	18.3	C	1210
	12.5	SHS	89.0	0.946	10.6	18.0	11300	104	830	634	992	95.7	173	1270	1.00	24.1	C	992
	10.0	SHS	72.7	0.957	13.2	23.0	9260	87.1	697	523	822	97.0	142	1060	1.00	30.9	N	811
	9.0	SHS	65.9	0.961	14.6	25.8	8400	79.8	639	477	750	97.5	129	972	1.00	34.6	N	699
	8.0	SHS	59.1	0.966	16.3	29.3	7520	72.3	578	429	676	98.0	116	878	1.00	39.2	N	586
	6.0	SHS	45.0	0.974	21.7	39.7	5730	56.2	450	330	521	99.0	88.7	681	0.753	53.2	S	380
200 x 200 x	16.0	SHS	85.5	0.731	8.55	10.5	10900	58.6	586	469	728	73.3	103	914	1.00	14.1	C	728
	12.5	SHS	69.4	0.746	10.8	14.0	8840	50.0	500	389	607	75.2	85.2	772	1.00	18.8	C	607
	10.0	SHS	57.0	0.757	13.3	18.0	7260	42.5	425	324	508	76.5	70.7	651	1.00	24.1	C	508
	9.0	SHS	51.8	0.761	14.7	20.2	6600	39.2	392	297	465	77.1	64.5	599	1.00	27.1	C	465
	8.0	SHS	46.5	0.766	16.5	23.0	5920	35.7	357	268	421	77.6	58.2	544	1.00	30.9	N	415
	6.0	SHS	35.6	0.774	21.8	31.3	4530	28.0	280	207	327	78.6	44.8	425	0.952	42.0	S	272
	5.0	SHS	29.9	0.779	26.0	38.0	3810	23.9	239	175	277	79.1	37.8	362	0.785	51.0	S	207
150 x 150 x	10.0	SHS	41.3	0.557	13.5	13.0	5260	16.5	220	173	269	56.1	28.4	341	1.00	17.4	C	269
	9.0	SHS	37.7	0.561	14.9	14.7	4800	15.4	205	159	248	56.6	26.1	316	1.00	19.7	C	248
	8.0	SHS	33.9	0.566	16.7	16.8	4320	14.1	188	144	226	57.1	23.6	289	1.00	22.5	C	226
	6.0	SHS	26.2	0.574	22.0	23.0	3330	11.3	150	113	178	58.2	18.4	229	1.00	30.9	N	175
	5.0	SHS	22.1	0.579	26.2	28.0	2810	9.70	129	96.2	151	58.7	15.6	197	1.00	37.6	N	135

**Notes:**

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- For C450PLUS™:  $f_y = 450$  MPa and  $f_u = 500$  MPa;  $f_y$  = yield stress used in design;  $f_u$  = tensile strength used in design; as defined in AS 4100.
- C = Compact Section; N = Non-Compact Section; S = Slender Section (as defined in AS 4100).
- Australian Tube Mills C450PLUS to AS/NZS 1163 is cold-formed and is therefore allocated the CF residual stresses classification in AS 4100.

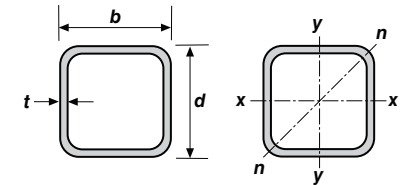


TABLE 3.1-6(2)

# Square Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DIMENSIONS AND PROPERTIES

- 1 SHS
- 2 C450PLUS®
- 3 Finish



Designation				Dimensions and Ratios				Section Properties								Properties for Design to AS 4100			
d	b	t	SHS	Mass per m	External Surface Area		b-2t	Gross Section Area	About x-, y- and n-axis					Torsion Constant	Torsion Modulus	Form Factor	About x and y-axis		
					per m	per t			$I_x$	$Z_x$	$Z_n$	$S_x$	$r_x$				$J$	$C$	$k_f$
mm	mm	mm		kg/m	m <sup>2</sup> /m	m <sup>2</sup> /t	t	mm <sup>2</sup>	10 <sup>6</sup> mm <sup>4</sup>	10 <sup>3</sup> mm <sup>3</sup>	10 <sup>3</sup> mm <sup>3</sup>	10 <sup>3</sup> mm <sup>3</sup>	mm	10 <sup>6</sup> mm <sup>4</sup>	10 <sup>3</sup> mm <sup>3</sup>			(C,N,S)	10 <sup>3</sup> mm <sup>3</sup>
125 x 125 x	125	10.0	SHS	33.4	0.457	13.7	10.5	4260	8.93	143	114	178	45.8	15.7	223	1.00	14.1	C	178
			SHS	30.6	0.461	15.1	11.9	3900	8.38	134	106	165	46.4	14.5	208	1.00	16.0	C	165
			SHS	27.7	0.466	16.8	13.6	3520	7.75	124	96.8	151	46.9	13.3	192	1.00	18.3	C	151
			SHS	21.4	0.474	22.1	18.8	2730	6.29	101	76.5	120	48.0	10.4	154	1.00	25.3	C	120
			SHS	18.2	0.479	26.3	23.0	2310	5.44	87.1	65.4	103	48.5	8.87	133	1.00	30.9	N	101
100 x 100 x	100	10.0	SHS	25.6	0.357	14.0	8.00	3260	4.11	82.2	68.1	105	35.5	7.50	130	1.00	10.7	C	105
			SHS	23.5	0.361	15.4	9.11	3000	3.91	78.1	63.6	98.6	36.1	7.00	123	1.00	12.2	C	98.6
			SHS	21.4	0.366	17.1	10.5	2720	3.66	73.2	58.6	91.1	36.7	6.45	114	1.00	14.1	C	91.1
			SHS	16.7	0.374	22.4	14.7	2130	3.04	60.7	47.1	73.5	37.7	5.15	93.6	1.00	19.7	C	73.5
			SHS	14.2	0.379	26.6	18.0	1810	2.66	53.1	40.5	63.5	38.3	4.42	81.4	1.00	24.1	C	63.5
90 x 90 x	90	10.0	SHS	11.6	0.383	32.9	23.0	1480	2.23	44.6	33.5	52.6	38.8	3.63	68.0	1.00	30.9	N	51.9
			SHS	8.96	0.390	43.5	31.3	1140	1.77	35.4	26.0	41.2	39.4	2.79	53.2	0.952	42.0	S	34.4
			SHS	7.53	0.391	52.0	38.0	959	1.51	30.1	21.9	34.9	39.6	2.35	45.2	0.787	51.0	S	26.1
			SHS	6.07	0.393	64.7	48.0	774	1.23	24.6	17.8	28.3	39.9	1.91	36.9	0.624	64.4	S	18.8
			SHS	6.74	0.351	52.1	34.0	859	1.09	24.1	17.6	28.0	35.6	1.70	36.2	0.878	45.6	S	22.3
89 x 89 x	89	2.5	SHS	5.45	0.353	64.8	43.0	694	0.889	19.7	14.3	22.8	35.8	1.38	29.6	0.696	57.7	S	16.0
			SHS	14.7	0.330	22.5	12.8	1870	2.06	46.4	36.4	56.7	33.2	3.55	71.8	1.00	17.2	C	56.7
			SHS	12.5	0.335	26.7	15.8	1590	1.82	40.8	31.5	49.2	33.8	3.06	62.8	1.00	21.2	C	49.2
			SHS	9.07	0.341	37.6	23.4	1150	1.38	31.0	23.3	36.5	34.6	2.25	47.2	1.00	31.4	N	35.8
			SHS	5.38	0.349	64.9	42.5	686	0.858	19.3	14.0	22.3	35.4	1.33	29.0	0.704	57.0	S	15.7
75 x 75 x	75	6.0	SHS	12.0	0.274	22.8	10.5	1530	1.16	30.9	24.7	38.4	27.5	2.04	48.2	1.00	14.1	C	38.4
			SHS	10.3	0.279	27.0	13.0	1310	1.03	27.5	21.6	33.6	28.0	1.77	42.6	1.00	17.4	C	33.6
			SHS	8.49	0.283	33.3	16.8	1080	0.882	23.5	18.1	28.2	28.6	1.48	36.1	1.00	22.5	C	28.2
			SHS	7.53	0.285	37.9	19.4	959	0.797	21.3	16.1	25.3	28.8	1.32	32.5	1.00	26.1	C	25.3
			SHS	6.60	0.290	43.9	23.0	841	0.716	19.1	14.2	22.5	29.2	1.15	28.7	1.00	30.9	N	22.2
65 x 65 x	65	2.5	SHS	5.56	0.291	52.4	28.0	709	0.614	16.4	12.0	19.1	29.4	0.971	24.6	1.00	37.6	N	17.0
			SHS	4.50	0.293	65.1	35.5	574	0.505	13.5	9.83	15.6	29.7	0.790	20.2	0.841	47.6	S	12.1
			SHS	10.1	0.234	23.1	8.83	1290	0.706	21.7	17.8	27.5	23.4	1.27	34.2	1.00	11.9	C	27.5
			SHS	8.75	0.239	27.3	11.0	1110	0.638	19.6	15.6	24.3	23.9	1.12	30.6	1.00	14.8	C	24.3
			SHS	7.23	0.243	33.6	14.3	921	0.552	17.0	13.2	20.6	24.5	0.939	26.2	1.00	19.1	C	20.6
65 x 65 x	65	3.0	SHS	5.66	0.250	44.1	19.7	721	0.454	14.0	10.4	16.6	25.1	0.733	21.0	1.00	26.4	C	16.6
			SHS	4.78	0.251	52.6	24.0	609	0.391	12.0	8.91	14.1	25.3	0.624	18.1	1.00	32.2	N	13.7
			SHS	3.88	0.253	65.3	30.5	494	0.323	9.94	7.29	11.6	25.6	0.509	14.9	0.978	40.9	S	9.80
			SHS	3.13	0.255	81.2	38.6	399	0.265	8.16	5.94	9.44	25.8	0.414	12.2	0.774	51.8	S	7.01

**Notes:**

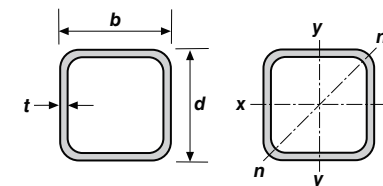
- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- For C450PLUS™:  
 $f_y = 450$  MPa and  $f_u = 500$  MPa;  
 $f_y$  = yield stress used in design;  $f_u$  = tensile strength used in design; as defined in AS 4100.
- C = Compact Section; N = Non-Compact Section; S = Slender Section (as defined in AS 4100).
- Australian Tube Mills C450PLUS to AS/NZS 1163 is cold-formed and is therefore allocated the CF residual stresses classification in AS 4100.

TABLE 3.1-6(3)

# Square Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DIMENSIONS AND PROPERTIES

- 1 SHS
- 2 C450PLUS®
- 3 Finish



Dimensions and Ratios								Section Properties							Properties for Design to AS 4100				
Designation			Mass per m	External Surface Area		b-2t	Gross Section Area	About x-, y- and n-axis					Torsion Constant	Torsion Modulus	Form Factor	About x and y-axis			
d	b	t		per m	per t			A <sub>g</sub>	I <sub>x</sub>	Z <sub>x</sub>	Z <sub>n</sub>	S <sub>x</sub>				r <sub>x</sub>	J	C	k <sub>t</sub>
mm	mm	mm	kg/m	m <sup>2</sup> /m	m <sup>2</sup> /t	mm <sup>2</sup>	10 <sup>6</sup> mm <sup>4</sup>	10 <sup>3</sup> mm <sup>3</sup>	10 <sup>3</sup> mm <sup>3</sup>	10 <sup>3</sup> mm <sup>3</sup>	mm	10 <sup>6</sup> mm <sup>4</sup>	10 <sup>3</sup> mm <sup>3</sup>			(C.N.S)	10 <sup>3</sup> mm <sup>3</sup>		
50 x 50 x		6.0	SHS	7.32	0.174	23.8	6.33	932	0.275	11.0	9.45	14.5	17.2	0.518	17.7	1.00	8.50	C	14.5
		5.0	SHS	6.39	0.179	27.9	8.00	814	0.257	10.3	8.51	13.2	17.8	0.469	16.3	1.00	10.7	C	13.2
		4.0	SHS	5.35	0.183	34.2	10.5	681	0.229	9.15	7.33	11.4	18.3	0.403	14.3	1.00	14.1	C	11.4
		3.0	SHS	4.25	0.190	44.7	14.7	541	0.195	7.79	5.92	9.39	19.0	0.321	11.8	1.00	19.7	C	9.39
		2.5	SHS	3.60	0.191	53.1	18.0	459	0.169	6.78	5.09	8.07	19.2	0.275	10.2	1.00	24.1	C	8.07
		2.0	SHS	2.93	0.193	65.8	23.0	374	0.141	5.66	4.20	6.66	19.5	0.226	8.51	1.00	30.9	N	6.58
		1.6	SHS	2.38	0.195	81.7	29.3	303	0.117	4.68	3.44	5.46	19.6	0.185	7.03	1.00	39.2	N	4.74
40 x 40 x		4.0	SHS	4.09	0.143	34.9	8.00	521	0.105	5.26	4.36	6.74	14.2	0.192	8.33	1.00	10.7	C	6.74
		3.0	SHS	3.30	0.150	45.3	11.3	421	0.0932	4.66	3.61	5.72	14.9	0.158	7.07	1.00	15.2	C	5.72
		2.5	SHS	2.82	0.151	53.7	14.0	359	0.0822	4.11	3.13	4.97	15.1	0.136	6.21	1.00	18.8	C	4.97
		2.0	SHS	2.31	0.153	66.4	18.0	294	0.0694	3.47	2.61	4.13	15.4	0.113	5.23	1.00	24.1	C	4.13
		1.6	SHS	1.88	0.155	82.3	23.0	239	0.0579	2.90	2.15	3.41	15.6	0.0927	4.36	1.00	30.9	N	3.37
35 x 35 x		3.0	SHS	2.83	0.130	45.8	9.67	361	0.0595	3.40	2.67	4.23	12.8	0.102	5.18	1.00	13.0	C	4.23
		2.5	SHS	2.42	0.131	54.2	12.0	309	0.0529	3.02	2.33	3.69	13.1	0.0889	4.58	1.00	16.1	C	3.69
		2.0	SHS	1.99	0.133	66.8	15.5	254	0.0451	2.58	1.95	3.09	13.3	0.0741	3.89	1.00	20.8	C	3.09
		1.6	SHS	1.63	0.135	82.7	19.9	207	0.0379	2.16	1.62	2.57	13.5	0.0611	3.26	1.00	26.7	C	2.57
30 x 30 x		3.0	SHS	2.36	0.110	46.5	8.00	304	0.0350	2.34	1.87	2.96	10.8	0.0615	3.58	1.00	10.7	C	2.96
		2.5	SHS	2.03	0.111	54.8	10.0	259	0.0316	2.10	1.65	2.61	11.0	0.0540	3.20	1.00	13.4	C	2.61
		2.0	SHS	1.68	0.113	67.4	13.0	214	0.0272	1.81	1.39	2.21	11.3	0.0454	2.75	1.00	17.4	C	2.21
		1.6	SHS	1.38	0.115	83.3	16.8	175	0.0231	1.54	1.16	1.84	11.5	0.0377	2.32	1.00	22.5	C	1.84
25 x 25 x		3.0	SHS	1.89	0.0897	47.4	6.33	241	0.0184	1.47	1.21	1.91	8.74	0.0333	2.27	1.00	8.50	C	1.91
		2.5	SHS	1.64	0.0914	55.7	8.00	209	0.0169	1.35	1.08	1.71	8.99	0.0297	2.07	1.00	10.7	C	1.71
		2.0	SHS	1.36	0.0931	68.3	10.5	174	0.0148	1.19	0.926	1.47	9.24	0.0253	1.80	1.00	14.1	C	1.47
		1.6	SHS	1.12	0.0945	84.1	13.6	143	0.0128	1.02	0.780	1.24	9.44	0.0212	1.54	1.00	18.3	C	1.24
20 x 20 x		2.0	SHS	1.05	0.0731	69.7	8.00	134	0.00692	0.692	0.554	0.877	7.20	0.0121	1.06	1.00	10.7	C	0.877
		1.6	SHS	0.873	0.0745	85.4	10.5	111	0.00608	0.608	0.474	0.751	7.39	0.0103	0.924	1.00	14.1	C	0.751

### Notes:

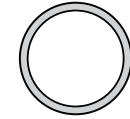
- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- For C450PLUS™:  
 $f_y = 450$  MPa and  $f_u = 500$  MPa;  
 $f_y$  = yield stress used in design;  $f_u$  = tensile strength used in design; as defined in AS 4100.
- C = Compact Section; N = Non-Compact Section; S = Slender Section (as defined in AS 4100).
- Australian Tube Mills C450PLUS to AS/NZS 1163 is cold-formed and is therefore allocated the CF residual stresses classification in AS 4100.
- NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**

TABLE 3.2-1

# Circular Hollow Sections AS/NZS 1163 Grade C250L0

FIRE ENGINEERING DESIGN – EXPOSED SURFACE AREA TO MASS RATIO (m<sup>2</sup>/tonne)

1	CHS
2	C250L0
3	Finish



d <sub>o</sub> mm	x	Designation		Mass per m kg/m	1	2	3	4	5	6
		t mm								
165.1	x	5.4	CHS	21.3	24.4	-	31.8	-	-	-
		5.0	CHS	19.7	26.3	-	34.2	-	-	-
139.7	x	5.4	CHS	17.9	24.5	-	33.3	-	-	-
		5.0	CHS	16.6	26.4	-	35.9	-	-	-
114.3	x	5.4	CHS	14.5	24.8	-	35.6	-	-	-
		4.5	CHS	12.2	29.5	-	42.4	-	-	-
101.6	x	5.0	CHS	11.9	26.8	-	40.0	-	-	-
		4.0	CHS	9.63	33.2	-	49.5	-	-	-
88.9	x	5.9	CHS	12.1	23.1	-	36.1	-	-	-
		5.0	CHS	10.3	27.0	-	42.2	-	-	-
		4.0	CHS	8.38	33.3	-	52.1	-	-	-
76.1	x	5.9	CHS	10.2	23.4	-	38.8	-	-	-
		4.5	CHS	7.95	30.1	-	49.9	-	-	-
		3.6	CHS	6.44	37.1	-	61.5	-	-	-
60.3	x	5.4	CHS	7.31	25.9	-	47.4	-	-	-
		4.5	CHS	6.19	30.6	-	56.0	-	-	-
		3.6	CHS	5.03	37.6	-	68.8	-	-	-
48.3	x	4.0	CHS	4.37	34.7	-	70.7	-	-	-
		3.2	CHS	3.56	42.6	-	86.8	-	-	-
42.4	x	4.0	CHS	3.79	35.2	-	76.6	-	-	-
		3.2	CHS	3.09	43.1	-	93.8	-	-	-
33.7	x	4.0	CHS	2.93	36.1	-	89.8	-	-	-
		3.2	CHS	2.41	44.0	-	109	-	-	-
26.9	x	4.0	CHS	2.26	37.4	-	107	-	-	-
		3.2	CHS	1.87	45.2	-	129	-	-	-
		2.6	CHS	1.56	54.2	-	155	-	-	-

### Notes:

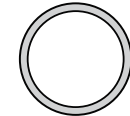
1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the availability of listed sections and associated finishes. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
2. For Grade C250L0:  $f_y = 250$  MPa and  $f_u = 320$  MPa;  $f_y$  = yield stress used in design;  $f_u$  = tensile strength used in design; as defined in AS 4100.
3. 1 = Total Perimeter, Profile-protected  
2 = Total Perimeter, Box-protected, No Gap  
3 = Total Perimeter, Box-protected, 25 mm Gap  
4 = Top Flange Excluded, Profile-protected  
5 = Top Flange Excluded, Box-protected, No Gap  
6 = Top Flange Excluded, Box-protected, 25 mm Gap
4. See Section 3.3 for details on cases of fire exposure considered.
5. This product is also compliant with AS 1074 – Steel tubes and tubulars for ordinary service. Refer to the ATM Product Manual for details on AS 1074 sections.

TABLE 3.2-2

# Circular Hollow Sections AS/NZS 1163 Grade C350L0

FIRE ENGINEERING DESIGN – EXPOSED SURFACE AREA TO MASS RATIO (m<sup>2</sup>/tonne)

- 1 CHS
- 2 C350L0
- 3 Finish



Designation			Mass per m kg/m	1	2	3	4	5	6
d <sub>o</sub> mm	t mm	CHS							
508.0 x	12.7	CHS	155	10.3	-	11.3	-	-	-
	9.5	CHS	117	13.7	-	15.0	-	-	-
	6.4	CHS	79.2	20.2	-	22.1	-	-	-
457.0 x	12.7	CHS	139	10.3	-	11.4	-	-	-
	9.5	CHS	105	13.7	-	15.2	-	-	-
	6.4	CHS	71.1	20.2	-	22.4	-	-	-
406.4 x	12.7	CHS	123	10.4	-	11.6	-	-	-
	9.5	CHS	93.0	13.7	-	15.4	-	-	-
	9.4	CHS	63.1	20.2	-	22.7	-	-	-
355.6 x	12.7	CHS	107	10.4	-	11.9	-	-	-
	9.5	CHS	81.1	13.8	-	15.7	-	-	-
	6.4	CHS	55.1	20.3	-	23.1	-	-	-
323.9 x	12.7	CHS	97.5	10.4	-	12.1	-	-	-
	9.5	CHS	73.7	13.8	-	15.9	-	-	-
	6.4	CHS	50.1	20.3	-	23.4	-	-	-
273.1 x	12.7	CHS	81.6	10.5	-	12.4	-	-	-
	9.3	CHS	60.5	14.2	-	16.8	-	-	-
	6.4	CHS	42.1	20.4	-	24.1	-	-	-
	4.8	CHS	31.8	27.0	-	32.0	-	-	-
219.1 x	8.2	CHS	42.6	16.1	-	19.8	-	-	-
	6.4	CHS	33.6	20.5	-	25.2	-	-	-
	4.8	CHS	25.4	27.1	-	33.3	-	-	-
168.3 x	7.1	CHS	28.2	18.7	-	24.3	-	-	-
	6.4	CHS	25.6	20.7	-	26.8	-	-	-
	4.8	CHS	19.4	27.3	-	35.4	-	-	-

Designation			Mass per m kg/m	1	2	3	4	5	6
d <sub>o</sub> mm	t mm	CHS							
165.1 x	3.5	CHS	13.9	37.2	-	48.4	-	-	-
	3.0	CHS	12.0	43.2	-	56.3	-	-	-
139.7 x	3.5	CHS	11.8	37.3	-	50.7	-	-	-
	3.0	CHS	10.1	43.4	-	58.9	-	-	-
114.3 x	3.6	CHS	9.83	36.5	-	52.5	-	-	-
	3.2	CHS	8.77	41.0	-	58.9	-	-	-
101.6 x	3.2	CHS	7.77	41.1	-	61.3	-	-	-
	2.6	CHS	6.35	50.3	-	75.0	-	-	-
88.9 x	3.2	CHS	6.76	41.3	-	64.5	-	-	-
	2.6	CHS	5.53	50.5	-	78.9	-	-	-
76.1 x	3.2	CHS	5.75	41.6	-	68.9	-	-	-
	2.3	CHS	4.19	57.1	-	94.6	-	-	-
60.3 x	2.9	CHS	4.11	46.1	-	84.4	-	-	-
	2.3	CHS	3.29	57.6	-	105	-	-	-
48.3 x	2.9	CHS	3.25	46.7	-	95.1	-	-	-
	2.3	CHS	2.61	58.2	-	118	-	-	-
42.4 x	2.6	CHS	2.55	52.2	-	114	-	-	-
	2.0	CHS	1.99	66.8	-	146	-	-	-
33.7 x	2.6	CHS	1.99	53.1	-	132	-	-	-
	2.0	CHS	1.56	67.7	-	168	-	-	-
26.9 x	2.3	CHS	1.40	60.6	-	173	-	-	-
	2.0	CHS	1.23	68.8	-	197	-	-	-

**Notes:**

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- For Grade C350L0:  $f_y = 350$  MPa and  $f_u = 430$  MPa;  $f_y$  = yield stress used in design;  $f_u$  = tensile strength used in design; as defined in AS 4100.
- 1 = Total Perimeter, Profile-protected  
2 = Total Perimeter, Box-protected, No Gap  
3 = Total Perimeter, Box-protected, 25 mm Gap  
4 = Top Flange Excluded, Profile-protected  
5 = Top Flange Excluded, Box-protected, No Gap  
6 = Top Flange Excluded, Box-protected, 25 mm Gap
- See Section 3.3 for details on cases of fire exposure considered.



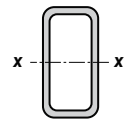
TABLE 3.2-3(1)

# Rectangular Hollow Sections To AS/NZS 1163

FIRE ENGINEERING DESIGN – EXPOSED SURFACE AREA TO MASS RATIO (m<sup>2</sup>/tonne)

*slab/wall parallel to x-axis*

Designation			Mass per m	1	2	3	4	5	6
d	b	t							
mm	mm	mm	kg/m						
400 x 300	x 300	16.0 RHS	161	8.27	8.70	9.94	6.91	6.84	7.46
		12.5 RHS	128	10.5	10.9	12.5	8.65	8.58	9.36
		10.0 RHS	104	13.0	13.5	15.4	10.6	10.6	11.5
		8.0 RHS	84.2	16.2	16.6	19.0	13.1	13.1	14.3
400 x 200	x 200	16.0 RHS	136	8.33	8.84	10.3	7.45	7.36	8.10
		12.5 RHS	109	10.6	11.0	12.9	9.29	9.21	10.1
		10.0 RHS	88.4	13.1	13.6	15.8	11.4	11.3	12.4
		8.0 RHS	71.6	16.3	16.8	19.5	14.0	14.0	15.4
350 x 250	x 250	16.0 RHS	136	8.33	8.84	10.3	7.08	7.00	7.73
		12.5 RHS	109	10.6	11.0	12.9	8.83	8.75	9.67
		10.0 RHS	88.4	13.1	13.6	15.8	10.8	10.8	11.9
		8.0 RHS	71.6	16.3	16.8	19.5	13.3	13.3	14.7
300 x 200	x 200	16.0 RHS	111	8.42	9.04	10.8	7.33	7.23	8.13
		12.5 RHS	89.0	10.6	11.2	13.5	9.09	8.99	10.1
		10.0 RHS	72.7	13.2	13.8	16.5	11.1	11.0	12.4
		8.0 RHS	59.1	16.3	16.9	20.3	13.6	13.5	15.2
250 x 150	x 150	16.0 RHS	85.5	8.55	9.35	11.7	7.73	7.60	8.77
		12.5 RHS	69.4	10.8	11.5	14.4	9.50	9.37	10.8
		10.0 RHS	57.0	13.3	14.0	17.6	11.5	11.4	13.2
		9.0 RHS	51.8	14.7	15.4	19.3	12.7	12.5	14.5
		8.0 RHS	46.5	16.5	17.2	21.5	14.1	14.0	16.1
		6.0 RHS	35.6	21.8	22.5	28.1	18.4	18.3	21.1
		5.0 RHS	29.9	26.0	26.7	33.4	21.8	21.7	25.0

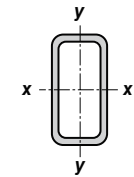


*slab/wall parallel to y-axis*

Designation			Mass per m	1	2	3	4	5	6
d	b	t							
mm	mm	mm	kg/m						
400 x 300	x 300	16.0 RHS	161	8.27	8.70	9.94	6.29	6.21	6.84
		12.5 RHS	128	10.5	10.9	12.5	7.87	7.80	8.58
		10.0 RHS	104	13.0	13.5	15.4	9.68	9.61	10.6
		8.0 RHS	84.2	16.2	16.6	19.0	11.9	11.9	13.1
400 x 200	x 200	16.0 RHS	136	8.33	8.84	10.3	5.98	5.89	6.63
		12.5 RHS	109	10.6	11.0	12.9	7.45	7.36	8.28
		10.0 RHS	88.4	13.1	13.6	15.8	9.13	9.05	10.2
		8.0 RHS	71.6	16.3	16.8	19.5	11.2	11.2	12.6
350 x 250	x 250	16.0 RHS	136	8.33	8.84	10.3	6.34	6.26	7.00
		12.5 RHS	109	10.6	11.0	12.9	7.91	7.82	8.75
		10.0 RHS	88.4	13.1	13.6	15.8	9.70	9.62	10.8
		8.0 RHS	71.6	16.3	16.8	19.5	11.9	11.9	13.3
300 x 200	x 200	16.0 RHS	111	8.42	9.04	10.8	6.43	6.33	7.23
		12.5 RHS	89.0	10.6	11.2	13.5	7.96	7.86	8.99
		10.0 RHS	72.7	13.2	13.8	16.5	9.73	9.63	11.0
		8.0 RHS	59.1	16.3	16.9	20.3	11.9	11.9	13.5
250 x 150	x 150	16.0 RHS	85.5	8.55	9.35	11.7	6.56	6.43	7.60
		12.5 RHS	69.4	10.8	11.5	14.4	8.05	7.93	9.37
		10.0 RHS	57.0	13.3	14.0	17.6	9.78	9.66	11.4
		9.0 RHS	51.8	14.7	15.4	19.3	10.7	10.6	12.5
		8.0 RHS	46.5	16.5	17.2	21.5	11.9	11.8	14.0
		6.0 RHS	35.6	21.8	22.5	28.1	15.6	15.5	18.3
		5.0 RHS	29.9	26.0	26.7	33.4	18.5	18.4	21.7



- 1 RHS
- 2 C450PLUS®
- 3 Finish



**Notes:**

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the availability of listed sections and associated finishes. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- 1 = Total Perimeter, Profile-protected  
2 = Total Perimeter, Box-protected, No Gap  
3 = Total Perimeter, Box-protected, 25 mm Gap  
4 = Top Flange Excluded, Profile-protected  
5 = Top Flange Excluded, Box-protected, No Gap  
6 = Top Flange Excluded, Box-protected, 25 mm Gap
- See Section 3.3 for details on cases of fire exposure considered.
- See Tables 3.1-3 and 3.1-4 for Grade allocation of these hollow sections.

TABLE 3.2-3(2)

# Rectangular Hollow Sections To AS/NZS 1163

FIRE ENGINEERING DESIGN – EXPOSED SURFACE AREA TO MASS RATIO (m<sup>2</sup>/tonne)

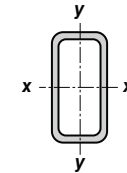
*slab/wall parallel to x-axis*

Designation			Mass per m kg/m	1	2	3	4	5	6
d	b	t							
mm	mm	mm							
200 x 100	x 10.0	RHS	41.3	13.5	14.5	19.4	12.3	12.1	14.5
		9.0 RHS	37.7	14.9	15.9	21.2	13.4	13.3	15.9
		8.0 RHS	33.9	16.7	17.7	23.6	14.9	14.7	17.7
		6.0 RHS	26.2	22.0	22.9	30.6	19.3	19.1	22.9
		5.0 RHS	22.1	26.2	27.2	36.2	22.8	22.6	27.2
		4.0 RHS	17.9	32.5	33.5	44.7	28.1	27.9	33.5
152 x 76	x 6.0	RHS	19.4	22.2	23.5	33.9	19.8	19.6	24.8
		5.0 RHS	16.4	26.4	27.7	39.9	23.3	23.1	29.2
150 x 100	x 10.0	RHS	33.4	13.7	15.0	20.9	12.2	12.0	15.0
		9.0 RHS	30.6	15.1	16.3	22.9	13.3	13.1	16.3
		8.0 RHS	27.7	16.8	18.1	25.3	14.7	14.5	18.1
		6.0 RHS	21.4	22.1	23.3	32.6	18.8	18.6	23.3
		5.0 RHS	18.2	26.3	27.5	38.5	22.2	22.0	27.5
		4.0 RHS	14.8	32.7	33.9	47.4	27.3	27.1	33.9
150 x 50	x 6.0	RHS	16.7	22.4	23.9	35.8	21.2	20.9	26.9
		5.0 RHS	14.2	26.6	28.1	42.1	24.8	24.6	31.6
		4.0 RHS	11.6	32.9	34.4	51.6	30.3	30.1	38.7
		3.0 RHS	8.96	43.5	44.7	67.0	39.3	39.1	50.2
		2.5 RHS	7.53	52.0	53.1	79.7	46.7	46.5	59.8
		2.0 RHS	6.07	64.7	65.9	98.8	57.8	57.6	74.1
127 x 51	x 6.0	RHS	14.7	22.5	24.3	37.9	21.1	20.8	27.6
		5.0 RHS	12.5	26.7	28.4	44.4	24.7	24.4	32.4
		3.5 RHS	9.07	37.6	39.3	61.3	33.9	33.6	44.7
125 x 75	x 6.0	RHS	16.7	22.4	23.9	35.8	19.7	19.4	25.4
		5.0 RHS	14.2	26.6	28.1	42.1	23.1	22.8	29.8
		4.0 RHS	11.6	32.9	34.4	51.6	28.2	28.0	36.6
		3.0 RHS	8.96	43.5	44.7	67.0	36.5	36.3	47.5
		2.5 RHS	7.53	52.0	53.1	79.7	43.4	43.2	56.5
		2.0 RHS	6.07	64.7	65.9	98.8	53.7	53.5	70.0
102 x 76	x 6.0	RHS	14.7	22.5	24.3	37.9	19.4	19.1	25.9
		5.0 RHS	12.5	26.7	28.4	44.4	22.7	22.4	30.4
		3.5 RHS	9.07	37.6	39.3	61.3	31.2	30.9	41.9

*slab/wall parallel to y-axis*

Designation			Mass per m kg/m	1	2	3	4	5	6
d	b	t							
mm	mm	mm							
200 x 100	x 10.0	RHS	41.3	13.5	14.5	19.4	9.87	9.69	12.1
		9.0 RHS	37.7	14.9	15.9	21.2	10.8	10.6	13.3
		8.0 RHS	33.9	16.7	17.7	23.6	12.0	11.8	14.7
		6.0 RHS	26.2	22.0	22.9	30.6	15.5	15.3	19.1
		5.0 RHS	22.1	26.2	27.2	36.2	18.3	18.1	22.6
		4.0 RHS	17.9	32.5	33.5	44.7	22.5	22.3	27.9
152 x 76	x 6.0	RHS	19.4	22.2	23.5	33.9	15.9	15.7	20.8
		5.0 RHS	16.4	26.4	27.7	39.9	18.7	18.5	24.6
150 x 100	x 10.0	RHS	33.4	13.7	15.0	20.9	10.7	10.5	13.5
		9.0 RHS	30.6	15.1	16.3	22.9	11.6	11.4	14.7
		8.0 RHS	27.7	16.8	18.1	25.3	12.9	12.7	16.3
		6.0 RHS	21.4	22.1	23.3	32.6	16.5	16.3	21.0
		5.0 RHS	18.2	26.3	27.5	38.5	19.5	19.3	24.8
		4.0 RHS	14.8	32.7	33.9	47.4	23.9	23.7	30.5
150 x 50	x 6.0	RHS	16.7	22.4	23.9	35.8	15.2	14.9	20.9
		5.0 RHS	14.2	26.6	28.1	42.1	17.8	17.6	24.6
		4.0 RHS	11.6	32.9	34.4	51.6	21.7	21.5	30.1
		3.0 RHS	8.96	43.5	44.7	67.0	28.1	27.9	39.1
		2.5 RHS	7.53	52.0	53.1	79.7	33.4	33.2	46.5
		2.0 RHS	6.07	64.7	65.9	98.8	41.3	41.2	57.6
127 x 51	x 6.0	RHS	14.7	22.5	24.3	37.9	15.9	15.6	22.4
		5.0 RHS	12.5	26.7	28.4	44.4	18.6	18.3	26.3
		3.5 RHS	9.07	37.6	39.3	61.3	25.5	25.3	36.3
125 x 75	x 6.0	RHS	16.7	22.4	23.9	35.8	16.7	16.4	22.4
		5.0 RHS	14.2	26.6	28.1	42.1	19.6	19.3	26.3
		4.0 RHS	11.6	32.9	34.4	51.6	23.9	23.7	32.3
		3.0 RHS	8.96	43.5	44.7	67.0	30.9	30.7	41.9
		2.5 RHS	7.53	52.0	53.1	79.7	36.7	36.5	49.8
		2.0 RHS	6.07	64.7	65.9	98.8	45.5	45.3	61.7
102 x 76	x 6.0	RHS	14.7	22.5	24.3	37.9	17.6	17.3	24.1
		5.0 RHS	12.5	26.7	28.4	44.4	20.6	20.3	28.3
		3.5 RHS	9.07	37.6	39.3	61.3	28.3	28.0	39.0

- 1 RHS
- 2 C450PLUS®
- 3 Finish



**Notes:**

1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
2. 1 = Total Perimeter, Profile-protected  
2 = Total Perimeter, Box-protected, No Gap  
3 = Total Perimeter, Box-protected, 25 mm Gap  
4 = Top Flange Excluded, Profile-protected  
5 = Top Flange Excluded, Box-protected, No Gap  
6 = Top Flange Excluded, Box-protected, 25 mm Gap
3. See Section 3.3 for details on cases of fire exposure considered.
4. See Tables 3.1-3 and 3.1-4 for Grade allocation of these hollow sections.

TABLE 3.2-3(3)

# Rectangular Hollow Sections To AS/NZS 1163

FIRE ENGINEERING DESIGN – EXPOSED SURFACE AREA TO MASS RATIO (m<sup>2</sup>/tonne)

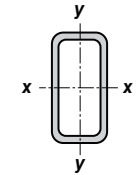
*slab/wall parallel to x-axis*

Designation			Mass per m kg/m	1	2	3	4	5	6
d mm	b mm	t mm							
100 x 50	x	6.0 RHS	12.0	22.8	24.9	41.6	21.1	20.8	29.1
		5.0 RHS	10.3	27.0	29.1	48.5	24.6	24.2	33.9
		4.0 RHS	8.49	33.3	35.4	58.9	29.8	29.5	41.2
		3.5 RHS	7.53	37.9	39.9	66.4	33.5	33.2	46.5
		3.0 RHS	6.60	43.9	45.5	75.8	38.1	37.9	53.0
		2.5 RHS	5.56	52.4	53.9	89.8	45.2	44.9	62.9
		2.0 RHS	4.50	65.1	66.6	111	55.8	55.5	77.7
1.6 RHS	3.64	81.0	82.5	138	69.0	68.8	96.3		
76 x 38	x	4.0 RHS	6.23	33.9	36.6	68.7	31.0	30.5	46.6
		3.0 RHS	4.90	44.4	46.5	87.3	39.1	38.7	59.1
		2.5 RHS	4.15	52.8	54.9	103	46.1	45.8	69.8
75 x 50	x	6.0 RHS	9.67	23.2	25.8	46.5	21.1	20.7	31.0
		5.0 RHS	8.35	27.4	29.9	53.9	24.4	23.9	35.9
		4.0 RHS	6.92	33.7	36.1	65.1	29.3	28.9	43.4
		3.0 RHS	5.42	44.2	46.1	83.0	37.2	36.9	55.3
		2.5 RHS	4.58	52.7	54.5	98.2	43.9	43.6	65.4
		2.0 RHS	3.72	65.4	67.2	121	54.1	53.8	80.7
1.6 RHS	3.01	81.3	83.1	150	66.8	66.5	99.7		
75 x 25	x	2.5 RHS	3.60	53.1	55.5	111	49.0	48.6	76.3
		2.0 RHS	2.93	65.8	68.2	136	60.0	59.7	93.7
		1.6 RHS	2.38	81.7	84.0	168	73.9	73.5	116
65 x 35	x	4.0 RHS	5.35	34.2	37.4	74.8	31.4	30.9	49.6
		3.0 RHS	4.25	44.7	47.1	94.2	39.3	38.9	62.4
		2.5 RHS	3.60	53.1	55.5	111	46.2	45.8	73.6
		2.0 RHS	2.93	65.8	68.2	136	56.6	56.2	90.3
50 x 25	x	3.0 RHS	3.07	45.5	48.9	114	41.3	40.7	73.3
		2.5 RHS	2.62	54.0	57.2	134	48.2	47.7	85.8
		2.0 RHS	2.15	66.6	69.8	163	58.7	58.2	105
		1.6 RHS	1.75	82.5	85.6	200	71.9	71.4	128
		3.0 RHS	2.83	45.8	49.4	120	43.0	42.4	77.7
50 x 20	x	2.5 RHS	2.42	54.2	57.7	140	50.1	49.5	90.7
		2.0 RHS	1.99	66.8	70.3	171	60.8	60.3	110
		1.6 RHS	1.63	82.7	86.1	209	74.3	73.8	135

*slab/wall parallel to y-axis*

Designation			Mass per m kg/m	1	2	3	4	5	6
d mm	b mm	t mm							
100 x 50	x	6.0 RHS	12.0	22.8	24.9	41.6	17.0	16.6	24.9
		5.0 RHS	10.3	27.0	29.1	48.5	19.7	19.4	29.1
		4.0 RHS	8.49	33.3	35.4	58.9	23.9	23.6	35.4
		3.5 RHS	7.53	37.9	39.9	66.4	26.9	26.6	39.9
		3.0 RHS	6.60	43.9	45.5	75.8	30.6	30.3	45.5
		2.5 RHS	5.56	52.4	53.9	89.8	36.2	35.9	53.9
		2.0 RHS	4.50	65.1	66.6	111	44.7	44.4	66.6
1.6 RHS	3.64	81.0	82.5	138	55.3	55.0	82.5		
76 x 38	x	4.0 RHS	6.23	33.9	36.6	68.7	24.9	24.4	40.5
		3.0 RHS	4.90	44.4	46.5	87.3	31.3	31.0	51.4
		2.5 RHS	4.15	52.8	54.9	103	37.0	36.6	60.7
75 x 50	x	6.0 RHS	9.67	23.2	25.8	46.5	18.5	18.1	28.4
		5.0 RHS	8.35	27.4	29.9	53.9	21.4	20.9	32.9
		4.0 RHS	6.92	33.7	36.1	65.1	25.7	25.3	39.8
		3.0 RHS	5.42	44.2	46.1	83.0	32.6	32.3	50.7
		2.5 RHS	4.58	52.7	54.5	98.2	38.5	38.2	60.0
		2.0 RHS	3.72	65.4	67.2	121	47.4	47.1	74.0
1.6 RHS	3.01	81.3	83.1	150	58.5	58.2	91.4		
75 x 25	x	2.5 RHS	3.60	53.1	55.5	111	35.1	34.7	62.5
		2.0 RHS	2.93	65.8	68.2	136	43.0	42.6	76.7
		1.6 RHS	2.38	81.7	84.0	168	52.9	52.5	94.5
65 x 35	x	4.0 RHS	5.35	34.2	37.4	74.8	25.8	25.3	44.0
		3.0 RHS	4.25	44.7	47.1	94.2	32.2	31.8	55.4
		2.5 RHS	3.60	53.1	55.5	111	37.9	37.5	65.2
		2.0 RHS	2.93	65.8	68.2	136	46.4	46.0	80.1
50 x 25	x	3.0 RHS	3.07	45.5	48.9	114	33.1	32.6	65.2
		2.5 RHS	2.62	54.0	57.2	134	38.7	38.2	76.3
		2.0 RHS	2.15	66.6	69.8	163	47.1	46.5	93.1
		1.6 RHS	1.75	82.5	85.6	200	57.6	57.1	114
		3.0 RHS	2.83	45.8	49.4	120	32.4	31.8	67.1
50 x 20	x	2.5 RHS	2.42	54.2	57.7	140	37.7	37.1	78.4
		2.0 RHS	1.99	66.8	70.3	171	45.8	45.2	95.4
		1.6 RHS	1.63	82.7	86.1	209	55.9	55.3	117

- 1 RHS
- 2 C450PLUS®
- 3 Finish



- Notes:**
- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the availability of listed sections and associated finishes. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
  - 1 = Total Perimeter, Profile-protected  
2 = Total Perimeter, Box-protected, No Gap  
3 = Total Perimeter, Box-protected, 25 mm Gap  
4 = Top Flange Excluded, Profile-protected  
5 = Top Flange Excluded, Box-protected, No Gap  
6 = Top Flange Excluded, Box-protected, 25 mm Gap
  - See Section 3.3 for details on cases of fire exposure considered.
  - See Tables 3.1-3 and 3.1-4 for Grade allocation of these hollow sections.



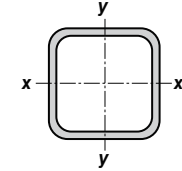
TABLE 3.2-4(1)

# Square Hollow Sections To AS/NZS 1163

FIRE ENGINEERING DESIGN – EXPOSED SURFACE AREA TO MASS RATIO (m<sup>2</sup>/tonne)

*slab/wall parallel to x- or y-axis*

- 1 SHS
- 2 C450PLUS®
- 3 Finish



Designation			Mass per m kg/m	1	2	3	4	5	6
d mm	b mm	t mm							
400 x 400	x	16.0 SHS	186	8.23	8.60	9.68	6.51	6.45	6.99
		12.5 SHS	148	10.5	10.8	12.2	8.17	8.11	8.79
		10.0 SHS	120	13.0	13.4	15.0	10.1	10.0	10.9
350 x 350	x	16.0 SHS	161	8.27	8.70	9.94	6.60	6.53	7.15
		12.5 SHS	128	10.5	10.9	12.5	8.26	8.19	8.97
		10.0 SHS	104	13.0	13.5	15.4	10.2	10.1	11.1
		8.0 SHS	84.2	16.2	16.6	19.0	12.5	12.5	13.7
300 x 300	x	16.0 SHS	136	8.33	8.84	10.3	6.71	6.63	7.36
		12.5 SHS	109	10.6	11.0	12.9	8.37	8.28	9.21
		10.0 SHS	88.4	13.1	13.6	15.8	10.3	10.2	11.3
		8.0 SHS	71.6	16.3	16.8	19.5	12.6	12.6	14.0
250 x 250	x	16.0 SHS	111	8.42	9.04	10.8	6.88	6.78	7.68
		12.5 SHS	89.0	10.6	11.2	13.5	8.53	8.43	9.55
		10.0 SHS	72.7	13.2	13.8	16.5	10.4	10.3	11.7
		9.0 SHS	65.9	14.6	15.2	18.2	11.5	11.4	12.9
		8.0 SHS	59.1	16.3	16.9	20.3	12.8	12.7	14.4
		6.0 SHS	45.0	21.7	22.2	26.7	16.8	16.7	18.9
200 x 200	x	16.0 SHS	85.5	8.55	9.35	11.7	7.15	7.01	8.18
		12.5 SHS	69.4	10.8	11.5	14.4	8.78	8.65	10.1
		10.0 SHS	57.0	13.3	14.0	17.6	10.7	10.5	12.3
		9.0 SHS	51.8	14.7	15.4	19.3	11.7	11.6	13.5
		8.0 SHS	46.5	16.5	17.2	21.5	13.0	12.9	15.1
		6.0 SHS	35.6	21.8	22.5	28.1	17.0	16.9	19.7
		5.0 SHS	29.9	26.0	26.7	33.4	20.2	20.0	23.4
150 x 150	x	10.0 SHS	41.3	13.5	14.5	19.4	11.1	10.9	13.3
		9.0 SHS	37.7	14.9	15.9	21.2	12.1	11.9	14.6
		8.0 SHS	33.9	16.7	17.7	23.6	13.4	13.3	16.2
		6.0 SHS	26.2	22.0	22.9	30.6	17.4	17.2	21.0
		5.0 SHS	22.1	26.2	27.2	36.2	20.5	20.4	24.9

Designation			Mass per m kg/m	1	2	3	4	5	6
d mm	b mm	t mm							
125 x 125	x	10.0 SHS	33.4	13.7	15.0	20.9	11.4	11.2	14.2
		9.0 SHS	30.6	15.1	16.3	22.9	12.5	12.3	15.5
		8.0 SHS	27.7	16.8	18.1	25.3	13.8	13.6	17.2
		6.0 SHS	21.4	22.1	23.3	32.6	17.7	17.5	22.1
		5.0 SHS	18.2	26.3	27.5	38.5	20.8	20.6	26.1
100 x 100	x	4.0 SHS	14.8	32.7	33.9	47.4	25.6	25.4	32.2
		10.0 SHS	25.6	14.0	15.6	23.5	12.0	11.7	15.6
		9.0 SHS	23.5	15.4	17.0	25.5	13.0	12.7	17.0
		8.0 SHS	21.4	17.1	18.7	28.1	14.3	14.0	18.7
		6.0 SHS	16.7	22.4	23.9	35.8	18.2	17.9	23.9
		5.0 SHS	14.2	26.6	28.1	42.1	21.3	21.1	28.1
		4.0 SHS	11.6	32.9	34.4	51.6	26.0	25.8	34.4
		3.0 SHS	8.96	43.5	44.7	67.0	33.7	33.5	44.7
		2.5 SHS	7.53	52.0	53.1	79.7	40.0	39.9	53.1
		2.0 SHS	6.07	64.7	65.9	98.8	49.6	49.4	65.9
90 x 90	x	2.5 SHS	6.74	52.1	53.4	83.1	40.3	40.0	54.9
		2.0 SHS	5.45	64.8	66.1	103	49.8	49.6	67.9
89 x 89	x	6.0 SHS	14.7	22.5	24.3	37.9	18.5	18.2	25.0
		5.0 SHS	12.5	26.7	28.4	44.4	21.6	21.3	29.3
		3.5 SHS	9.07	37.6	39.3	61.3	29.7	29.4	40.5
		2.0 SHS	5.38	64.9	66.1	103	49.8	49.6	68.2
75 x 75	x	6.0 SHS	12.0	22.8	24.9	41.6	19.1	18.7	27.0
		5.0 SHS	10.3	27.0	29.1	48.5	22.2	21.8	31.5
		4.0 SHS	8.49	33.3	35.4	58.9	26.8	26.5	38.3
		3.5 SHS	7.53	37.9	39.9	66.4	30.2	29.9	43.2
		3.0 SHS	6.60	43.9	45.5	75.8	34.3	34.1	49.2
		2.5 SHS	5.56	52.4	53.9	89.8	40.7	40.4	58.4
		2.0 SHS	4.50	65.1	66.6	111	50.2	50.0	72.2
65 x 65	x	6.0 SHS	10.1	23.1	25.6	45.3	19.6	19.2	29.1
		5.0 SHS	8.75	27.3	29.7	52.6	22.7	22.3	33.7
		4.0 SHS	7.23	33.6	36.0	63.6	27.4	27.0	40.8
		3.0 SHS	5.66	44.1	45.9	81.3	34.8	34.5	52.1
		2.5 SHS	4.78	52.6	54.4	96.2	41.1	40.8	61.7
		2.0 SHS	3.88	65.3	67.1	119	50.6	50.3	76.1
		1.6 SHS	3.13	81.2	83.0	147	62.5	62.2	94.1

**Notes:**

1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
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4 = Top Flange Excluded, Profile-protected  
5 = Top Flange Excluded, Box-protected, No Gap  
6 = Top Flange Excluded, Box-protected, 25 mm Gap
3. See Section 3.3 for details on cases of fire exposure considered.
4. See Tables 3.1-5 and 3.1-6 for Grade allocation of these hollow sections.

TABLE 3.2-4(2)

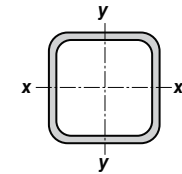
# Square Hollow Sections To AS/NZS 1163

FIRE ENGINEERING DESIGN – EXPOSED SURFACE AREA TO MASS RATIO (m<sup>2</sup>/tonne)

*slab/wall parallel to x- or y-axis*

Designation			Mass per m	1	2	3	4	5	6		
d	b	t								kg/m	
mm	mm	mm									
50	x	50	x	6.0 SHS	7.32	23.8	27.3	54.7	21.1	20.5	34.2
				5.0 SHS	6.39	27.9	31.3	62.6	24.0	23.5	39.1
				4.0 SHS	5.35	34.2	37.4	74.8	28.6	28.1	46.8
				3.0 SHS	4.25	44.7	47.1	94.2	35.7	35.3	58.9
				2.5 SHS	3.60	53.1	55.5	111	42.0	41.6	69.4
				2.0 SHS	2.93	65.8	68.2	136	51.5	51.1	85.2
40	x	40	x	4.0 SHS	4.09	34.9	39.1	88.0	30.0	29.3	53.8
				3.0 SHS	3.30	45.3	48.4	109	36.8	36.3	66.6
				2.5 SHS	2.82	53.7	56.8	128	43.1	42.6	78.1
				2.0 SHS	2.31	66.4	69.4	156	52.5	52.0	95.4
				1.6 SHS	1.88	82.3	85.2	192	64.4	63.9	117
				35	x	35	x	3.0 SHS	2.83	45.8	49.4
2.5 SHS	2.42	54.2	57.7					140	43.9	43.3	84.5
2.0 SHS	1.99	66.8	70.3					171	53.3	52.7	103
1.6 SHS	1.63	82.7	86.1					209	65.1	64.6	126
30	x	30	x	3.0 SHS	2.36	46.5	50.8	136	38.8	38.1	80.5
				2.5 SHS	2.03	54.8	59.0	157	45.0	44.3	93.5
				2.0 SHS	1.68	67.4	71.5	191	54.3	53.7	113
				1.6 SHS	1.38	83.3	87.3	233	66.1	65.5	138
25	x	25	x	3.0 SHS	1.89	47.4	52.9	159	40.6	39.7	92.6
				2.5 SHS	1.64	55.7	61.0	183	46.6	45.7	107
				2.0 SHS	1.36	68.3	73.3	220	55.8	55.0	128
				1.6 SHS	1.12	84.1	89.0	267	67.5	66.7	156
20	x	20	x	2.0 SHS	1.05	69.7	76.2	267	58.2	57.2	152
				1.6 SHS	0.873	85.4	91.7	321	69.8	68.8	183

- 1 SHS
- 2 C350LO
- 3 Finish

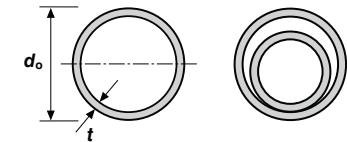


**Notes:**

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4 = Top Flange Excluded, Profile-protected  
5 = Top Flange Excluded, Box-protected, No Gap  
6 = Top Flange Excluded, Box-protected, 25 mm Gap
3. See Section 3.3 for details on cases of fire exposure considered.
4. See Tables 3.1-5 and 3.1-6 for Grade allocation of these hollow sections.

**TABLE 3.3-1**  
**Circular Hollow Sections to AS/NZS 1163**  
**TELESCOPING INFORMATION**

- 1 CHS
- 2 Grade
- 3 Finish



Female (outer)			Male (inner)		Nominal Clearance
d <sub>o</sub>	t		d <sub>o</sub>		
mm	mm		mm		mm
508.0	x	12.7	CHS	457.0	16.0
		9.5		457.0	22.4
		6.4		457.0	28.6
457.0	x	12.7	CHS	406.4	16.6
		9.5		406.4	23.0
		6.4		406.4	29.2
406.4	x	12.7	CHS	355.6	17.8
		9.5		355.6	24.2
		6.4		355.6	30.4
355.6	x	12.7	CHS	273.1	50.8
		9.5		323.9	5.9
		6.4		323.9	12.1
323.9	x	12.7	CHS	273.1	19.4
		9.5		273.1	25.8
		6.4		273.1	32.0
273.1	x	12.7	CHS	219.1	23.7
		9.3		219.1	30.5
		6.4		219.1	36.3
		4.8		219.1	39.5
219.1	x	8.2	CHS	168.3	30.5
		6.4		168.3	34.1
		4.8		168.3	37.3
168.3	x	7.1	CHS	139.7	11.3
		6.4		139.7	12.7
		4.8		139.7	15.9
165.1	x	5.4	CHS	139.7	11.6
		5.0		139.7	12.4
		3.5		139.7	15.4
		3.0		139.7	16.4
		3.0		139.7	16.4
139.7	x	5.4	CHS	114.3	12.1
		5.0		114.3	12.9
		3.5		114.3	15.9
		3.0		114.3	16.9
114.3	x	5.4	CHS	88.9	12.6
		4.5		101.6	1.5
		3.6		101.6	3.3
		3.2		101.6	4.1

Female (outer)			Male (inner)		Nominal Clearance
d <sub>o</sub>	t		d <sub>o</sub>		
mm	mm		mm		mm
101.6	x	5.0	CHS	88.9	<b>0.8</b>
		4.0		88.9	2.8
		3.2		88.9	4.4
		2.6		88.9	5.6
88.9	x	5.9	CHS	60.3	15.3
		5.0		76.1	<b>1.2</b>
		4.0		76.1	3.2
		3.2		76.1	4.8
76.1	x	5.9	CHS	60.3	2.6
		4.5		60.3	5.4
		3.6		60.3	7.2
		3.2		60.3	8.0
60.3	x	5.4	CHS	60.3	9.8
		2.3		60.3	9.8
		5.4		48.3	<b>0.2</b>
		4.5		48.3	<b>2.0</b>
48.3	x	3.6	CHS	48.3	3.8
		2.9		48.3	5.2
		2.3		48.3	6.4
		4.0		33.7	5.4
42.4	x	3.2	CHS	33.7	7.0
		2.9		33.7	7.6
		2.3		42.4	<b>0.1</b>
		4.0		26.9	6.3
33.7	x	3.2	CHS	33.7	<b>1.1</b>
		2.6		33.7	2.3
		2.0		33.7	3.5
		4.0		n/a	n/a
26.9	x	3.2	CHS	n/a	n/a
		2.6		26.9	<b>0.4</b>
		2.0		26.9	<b>1.6</b>
		4.0		n/a	n/a
26.9	x	4.0	CHS	n/a	n/a
		3.2		n/a	n/a
		2.6		n/a	n/a
		2.3		n/a	n/a
26.9	x	2.0	CHS	n/a	n/a
		2.0		n/a	n/a

**How to use this chart:**

- Select the size of Female (or Outer) member closest to your requirements from the left hand column.
- The next column lists the closest size Male (Inner) Member when positioned in the Female Member as noted in the Figure at the bottom right of this page.
- Based on (A) and (B) above, the Nominal Clearance between the Male and Female Members are listed in the last column(s). The configuration of these Nominal Clearances are as shown in the Figure below.  
 Note that the clearance is the total available difference between member dimensions, not the gap on both sides.
- Depending on the two members being telescoped, the available clearance will also be dependent on end application requirements. Members may need to slide freely inside each other, or be locked with a pin, spot welded or fixed with wedges. This means, in some cases, a 'sloppy' fit may be suitable, while for others the tightest fit possible may be more appropriate.
- Where two telescoping sections are being used, thickness should be similar and will be determined by normal structural requirements. If a third section is to be used, consideration of both clearance and thickness within the size list available may be required.
- Pipe may need to be fixed against twisting by welding or bolting.
- Press Fit: for short pieces with no need for separation or sliding, an interference fit can be achieved using the available ductility of the steel. Sizes where clearance is shown as 0.0 may occasionally require press fit.

**Notes:**

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Clearance = (AS/NZS 1163 Min. d<sub>o</sub> - 2t) - (AS/NZS 1163 Max. d<sub>i</sub>).
- CHS is not a precision tube and all dimensions shown in this chart, although in accordance with the specifications, may vary marginally. Internal weld bead may need to be considered when a closer fit is required.
- Sizes with a clearance less than 2.0 mm are shown **bold** in the charts.
- For tight fits it is recommended that some form of testing is carried out prior to committing to material. Where telescoping over some length is required, additional allowance may be needed for straightness.

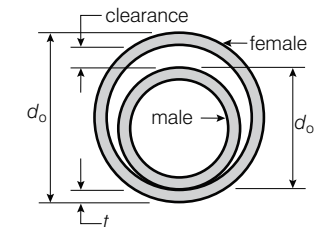


TABLE 3.3-2

# Rectangular Hollow Sections to AS/NZS 1163

## TELESCOPING INFORMATION

- 1 **RHS**
- 2 **Grade**
- 3 **Finish**

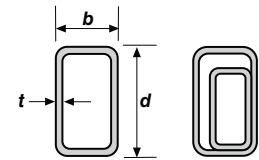
Female (outer)			Male (inner)		Nominal Clearance	
d	b	t	d	b	top	side
mm	mm	mm	mm	mm	mm	mm
400 x 300 x	16.0	RHS	350	250	18.0	18.0
	12.5	RHS	350	250	25.0	25.0
	10.0	RHS	350	250	30.0	30.0
	8.0	RHS	350	250	34.0	34.0
400 x 200 x	16.0	RHS	250	150	118.0	18.0
	12.5	RHS	250	150	125.0	25.0
	10.0	RHS	250	150	130.0	30.0
	8.0	RHS	250	150	134.0	34.0
350 x 250 x	16.0	RHS	300	200	18.0	18.0
	12.5	RHS	300	200	25.0	25.0
	10.0	RHS	300	200	30.0	30.0
	8.0	RHS	300	200	34.0	34.0
300 x 200 x	16.0	RHS	250	150	18.0	18.0
	12.5	RHS	250	150	25.0	25.0
	10.0	RHS	250	150	30.0	30.0
	8.0	RHS	250	150	34.0	34.0
	6.0	RHS	250	150	38.0	38.0
250 x 150 x	16.0	RHS	200	100	18.0	18.0
	12.5	RHS	200	100	25.0	25.0
	10.0	RHS	200	100	30.0	30.0
	9.0	RHS	200	100	32.0	32.0
	8.0	RHS	200	100	34.0	34.0
	6.0	RHS	200	100	38.0	38.0
	5.0	RHS	200	100	40.0	40.0
200 x 100 x	10.0	RHS	152	76	28.0	4.0
	9.0	RHS	152	76	30.0	6.0
	8.0	RHS	152	76	32.0	8.0
	6.0	RHS	152	76	36.0	12.0
	5.0	RHS	152	76	38.0	14.0
	4.0	RHS	152	76	40.0	16.0
152 x 76 x	6.0	RHS	127	51	13.0	13.0
	5.0	RHS	127	51	15.0	15.0
150 x 100 x	10.0	RHS	127	51	3.0	29.0
	9.0	RHS	127	51	5.0	31.0
	8.0	RHS	127	51	7.0	33.0
	6.0	RHS	127	51	11.0	37.0
	5.0	RHS	127	51	13.0	39.0
	4.0	RHS	127	51	15.0	41.0

Female (outer)			Male (inner)		Nominal Clearance	
d	b	t	d	b	top	side
mm	mm	mm	mm	mm	mm	mm
150 x 50 x	6.0	RHS	76	38	62.0	<b>0.0</b>
	5.0	RHS	76	38	64.0	2.0
	4.0	RHS	76	38	66.0	4.0
	3.0	RHS	76	38	68.0	6.0
	2.5	RHS	76	38	69.0	7.0
	2.0	RHS	76	38	70.0	8.0
127 x 51 x	6.0	RHS	76	38	39.0	<b>1.0</b>
	5.0	RHS	76	38	41.0	3.0
	3.5	RHS	76	38	44.0	6.0
125 x 75 x	6.0	RHS	100	50	13.0	13.0
	5.0	RHS	100	50	15.0	15.0
	4.0	RHS	100	50	17.0	17.0
	3.0	RHS	100	50	19.0	19.0
	2.5	RHS	100	50	20.0	20.0
	2.0	RHS	100	50	21.0	21.0
102 x 76 x	6.0	RHS	76	38	14.0	26.0
	5.0	RHS	76	38	16.0	28.0
	3.5	RHS	76	38	19.0	31.0
100 x 50 x	6.0	RHS	76	38	12.0	<b>0.0</b>
	5.0	RHS	76	38	14.0	2.0
	4.0	RHS	76	38	16.0	4.0
	3.5	RHS	76	38	17.0	5.0
	3.0	RHS	76	38	18.0	6.0
	2.5	RHS	76	38	19.0	7.0
	2.0	RHS	76	38	20.0	8.0
	1.6	RHS	76	38	20.8	8.8
76 x 38 x	4.0	RHS	50	25	18.0	5.0
	3.0	RHS	50	25	20.0	7.0
	2.5	RHS	50	25	21.0	8.0
75 x 50 x	6.0	RHS	50	25	13.0	13.0
	5.0	RHS	65	35	<b>0.0</b>	5.0
	4.0	RHS	65	35	2.0	7.0
	3.0	RHS	65	35	4.0	9.0
	2.5	RHS	65	35	5.0	10.0
	2.0	RHS	65	35	6.0	11.0
	1.6	RHS	65	35	6.8	11.8

Female (outer)			Male (inner)		Nominal Clearance	
d	b	t	d	b	top	side
mm	mm	mm	mm	mm	mm	mm
75 x 25 x	2.5	RHS	n/a	n/a	n/a	n/a
	2.0	RHS	n/a	n/a	n/a	n/a
	1.6	RHS	n/a	n/a	n/a	n/a
65 x 35 x	4.0	RHS	50	25	7.0	2.0
	3.0	RHS	50	25	9.0	4.0
	2.5	RHS	50	25	10.0	5.0
	2.0	RHS	50	25	11.0	6.0
50 x 25 x	3.0	RHS	n/a	n/a	n/a	n/a
	2.5	RHS	n/a	n/a	n/a	n/a
	2.0	RHS	n/a	n/a	n/a	n/a
	1.6	RHS	n/a	n/a	n/a	n/a
50 x 20 x	3.0	RHS	n/a	n/a	n/a	n/a
	2.5	RHS	n/a	n/a	n/a	n/a
	2.0	RHS	n/a	n/a	n/a	n/a
	1.6	RHS	n/a	n/a	n/a	n/a

### How to use this chart:

- A. Select the size of Female (or Outer) member closest to your requirements from the left hand column.
- B. The next column lists the closest size Male (Inner) Member when positioned in the Female Member as noted in the Figure at the bottom right of this page.
- C. Based on (A) and (B) above, the Nominal Clearance between the Male and Female Members are listed in the last column(s). The configuration of these Nominal Clearances are as shown in the Figure below.  
Note that the clearance is the total available difference between member dimensions, not the gap on both sides.
- D. Depending on the two members being telescoped, the available clearance will also be dependent on end application requirements. Members may need to slide freely inside each other, or be locked with a pin, spot welded or fixed with wedges. This means, in some cases, a 'sloppy' fit may be suitable, while for others the tightest fit possible may be more appropriate.
- E. Where two telescoping sections are being used, thickness should be similar and will be determined by normal structural requirements. If a third section is to be used consideration of both clearance and thickness within the size list available may be required.



- F. RHS has the obvious advantage that its shape prevents rotation of the section.
- G. Press Fit: for short pieces with no need for separation or sliding, an interference fit can be achieved using the available ductility of the steel. Sizes where clearance is shown as 0.0 may occasionally require press fit.

### Notes:

1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
2. RHS is not a precision tube and all dimensions shown in this chart, although in accordance with the specifications, may vary marginally. Varying corner radii and the internal weld bead may need to be considered when a closer fit is required.
3. Sizes with a clearance less than 2.0 mm are shown **bold** in the charts.
4. For tight fits it is recommended that some form of testing is carried out prior to committing to material. Where telescoping over some length is required, additional allowance may be needed for straightness.

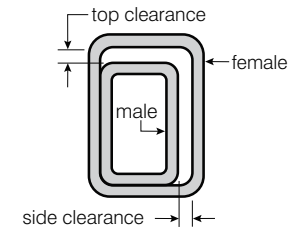


TABLE 3.3-3

# Square Hollow Sections AS/NZS 1163

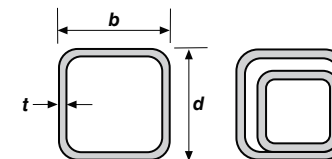
## TELESCOPING INFORMATION

- 1 SHS
- 2 Grade
- 3 Finish

Female (outer)			Male (inner)		Nominal Clearance	
d	b	t	d	b	top	side
mm	mm	mm	mm	mm	mm	mm
400 x 400 x	16.0	SHS	350	350	18.0	18.0
	12.5	SHS	350	350	25.0	25.0
	10.0	SHS	350	350	30.0	30.0
350 x 350 x	16.0	SHS	300	300	18.0	18.0
	12.5	SHS	300	300	25.0	25.0
	10.0	SHS	300	300	30.0	30.0
300 x 300 x	16.0	SHS	250	250	18.0	18.0
	12.5	SHS	250	250	25.0	25.0
	10.0	SHS	250	250	30.0	30.0
250 x 250 x	16.0	SHS	200	200	18.0	18.0
	12.5	SHS	200	200	25.0	25.0
	10.0	SHS	200	200	30.0	30.0
200 x 200 x	16.0	SHS	150	150	18.0	18.0
	12.5	SHS	150	150	25.0	25.0
	10.0	SHS	150	150	30.0	30.0
150 x 150 x	10.0	SHS	125	125	5.0	5.0
	9.0	SHS	125	125	7.0	7.0
	8.0	SHS	125	125	9.0	9.0
125 x 125 x	10.0	SHS	100	100	5.0	5.0
	9.0	SHS	100	100	7.0	7.0
	8.0	SHS	100	100	9.0	9.0

Female (outer)			Male (inner)		Nominal Clearance	
d	b	t	d	b	top	side
mm	mm	mm	mm	mm	mm	mm
100 x 100 x	10.0	SHS	75	75	5.0	5.0
	9.0	SHS	75	75	7.0	7.0
	8.0	SHS	75	75	9.0	9.0
	6.0	SHS	75	75	13.0	13.0
	5.0	SHS	90	90	<b>0.0</b>	<b>0.0</b>
	4.0	SHS	90	90	2.0	2.0
90 x 90 x	2.5	SHS	90	90	4.0	4.0
	2.0	SHS	90	90	5.0	5.0
	2.0	SHS	90	90	6.0	6.0
89 x 89 x	2.5	SHS	75	75	10.0	10.0
	2.0	SHS	75	75	11.0	11.0
	6.0	SHS	75	75	2.0	2.0
	5.0	SHS	75	75	4.0	4.0
75 x 75 x	3.5	SHS	75	75	7.0	7.0
	2.0	SHS	75	75	10.0	10.0
	6.0	SHS	50	50	13.0	13.0
	5.0	SHS	65	65	<b>0.0</b>	<b>0.0</b>
65 x 65 x	4.0	SHS	65	65	2.0	2.0
	3.5	SHS	65	65	3.0	3.0
	3.0	SHS	65	65	4.0	4.0
	2.5	SHS	65	65	5.0	5.0
	2.0	SHS	65	65	6.0	6.0
	1.6	SHS	65	65	6.0	6.0
50 x 50 x	6.0	SHS	50	50	3.0	3.0
	5.0	SHS	50	50	5.0	5.0
	4.0	SHS	50	50	7.0	7.0
	3.0	SHS	50	50	9.0	9.0
	2.5	SHS	50	50	10.0	10.0
	2.0	SHS	50	50	11.0	11.0

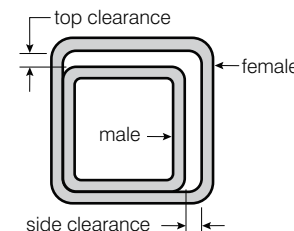
Female (outer)			Male (inner)		Nominal Clearance	
d	b	t	d	b	top	side
mm	mm	mm	mm	mm	mm	mm
40 x 40 x	4.0	SHS	30	30	2.0	2.0
	3.0	SHS	30	30	4.0	4.0
	2.5	SHS	35	35	<b>0.0</b>	<b>0.0</b>
	2.0	SHS	35	35	<b>1.0</b>	<b>1.0</b>
	1.6	SHS	35	35	<b>1.8</b>	<b>1.8</b>
35 x 35 x	3.0	SHS	25	25	4.0	4.0
	2.5	SHS	30	30	<b>0.0</b>	<b>0.0</b>
	2.0	SHS	30	30	<b>1.0</b>	<b>1.0</b>
30 x 30 x	1.6	SHS	30	30	<b>1.8</b>	<b>1.8</b>
	3.0	SHS	20	20	4.0	4.0
	2.5	SHS	25	25	<b>0.0</b>	<b>0.0</b>
25 x 25 x	2.0	SHS	25	25	<b>1.0</b>	<b>1.0</b>
	1.6	SHS	25	25	<b>1.8</b>	<b>1.8</b>
	3.0	SHS	n/a	n/a	n/a	n/a
20 x 20 x	2.5	SHS	20	20	<b>0.0</b>	<b>0.0</b>
	2.0	SHS	20	20	<b>1.0</b>	<b>1.0</b>
	1.6	SHS	20	20	<b>1.8</b>	<b>1.8</b>



- E. Where two telescoping sections are being used, thickness should be similar and will be determined by normal structural requirements. If a third section is to be used consideration of both clearance and thickness within the size list available may be required.
- F. SHS has the obvious advantage that its shape prevents rotation of the section.
- G. Press Fit: for short pieces with no need for separation or sliding, an interference fit can be achieved using the available ductility of the steel. Sizes where clearance is shown as 0.0 may occasionally require press fit.

**Notes:**

1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the availability of listed sections and associated finishes. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
2. SHS is not a precision tube and all dimensions shown in this chart, although in accordance with the specifications, may vary marginally. Varying corner radii and the internal weld bead may need to be considered when a closer fit is required.
3. Sizes with a clearance less than 2.0 mm are shown **bold** in the charts.
4. For tight fits it is recommended that some form of testing is carried out prior to committing to material. Where telescoping over some length is required, additional allowance may be needed for straightness.



**How to use this chart:**

- A. Select the size of Female (or Outer) member closest to your requirements from the left hand column.
- B. The next column lists the closest size Male (Inner) Member when positioned in the Female Member as noted in the Figure at the bottom right of this page.
- C. Based on (A) and (B) above, the Nominal Clearance between the Male and Female Members are listed in the last column(s). The configuration of these Nominal Clearances are as shown in the Figure below.  
Note that the clearance is the total available difference between member dimensions, not the gap on both sides.
- D. Depending on the two members being telescoped, the available clearance will also be dependent on end application requirements. Members may need to slide freely inside each other, or be locked with a pin, spot welded or fixed with wedges. This means, in some cases, a 'sloppy' fit may be suitable, while for others the tightest fit possible may be more appropriate.



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# Part 4

## METHODS OF STRUCTURAL ANALYSIS

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<b>4.2 Moment Amplification for First-Order Elastic Analysis</b>	<b>4-2</b>
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**See Section 2.1 for the specific Material Standard (AS/NZS 1163) referred to by the section type and steel grade in these Tables.**

# Part 4

## METHODS OF STRUCTURAL ANALYSIS

### 4.1 Methods of Determining Design Action Effects

This section provides guidance on calculating design action effects as required by AS 4100. The methods of analysis recognised by AS 4100 are:

- (a) first-order elastic analysis with moment amplification (Clause 4.4.2 of AS 4100)
- (b) second-order elastic analysis (Appendix E of AS 4100)
- (c) plastic analysis with moment amplification (Clause 4.5 of AS 4100), and
- (d) advanced analysis (Appendix D of AS 4100).

These four methods consider the interaction of load and deformation that produce second-order effects. From an AS 4100 perspective, second-order effects (known as  $P\Delta$  and  $P\delta$  effects) can increase the design bending moment for members subject to bending and axial force.

In first-order analysis, it is assumed that the member remains elastic under the action of the design loads for all strength limit states. As such, method (a) without moment amplification - i.e. first-order elastic analysis - does not consider these second-order effects and may be used for members with bending moments only, axial tension or compression force only and, for braced members, combined bending moments and tension forces.

Second-order effects, which are caused by changes in the geometry of the member, are not accounted for in first-order analysis. Consequently, some modification must be made for second-order effects and AS 4100 includes methods for making a suitable adjustment to the calculated design actions.

Second-order elastic analysis does account for the effects of design loads acting on the structure and its members in their displaced and deformed configuration. With respect to AS 4100, no adjustment is required to the calculated design actions with a second-order analysis. Second-order effects may be substantial in some frames.

All of the methods of analysis are discussed in detail in the commentary to AS 4100 (Ref. [4.2]).

These Design Capacity Tables are intended to be used with first-order and second-elastic analysis, which are currently the most commonly used methods of analysis. For simple structural members, hand methods of analysis are most common, while for frames involving a number of members, analysis is usually by means of a computer program.

Consequently, the tabulated values in Parts 5, 6, 7 and 8 of this publication may be used for design in

those cases where second-order effects:

- can be neglected (members with only: tension force; compression force; bending moments, or; for braced members, combined bending moments and tension force)
- are accounted for by using moment amplification factors in conjunction with a first-order elastic analysis
- are accounted for in a second-order elastic analysis.

Some further consideration of hand methods for assessing second-order effects and subsequently design actions are noted in the balance of this part of the publication.

### 4.2 Moment Amplification for First-Order Elastic Analysis

For a member subjected to combined bending moment and axial force, the bending moments are amplified by the presence of axial force. This occurs for both isolated, statically determinate members and members in a statically indeterminate frame. A first-order elastic analysis alone does not consider second-order effects, however, moment amplification can be used to account for second-order effects. The moment amplification factor is calculated differently for braced and sway members as explained in the following sub-section.

#### 4.2.1 Braced Members

In a braced member the transverse displacement of one end of the member relative to the other is effectively prevented. The moment amplification factor for a braced member is  $\delta_b$ .

If a first-order elastic analysis is carried out then  $\delta_b$  is used to amplify the bending moments between the ends of the member (Clause 4.4.2.2 of AS 4100). A first-order elastic analysis with moment amplification cannot be used if  $\delta_b$  is greater than 1.4. If  $\delta_b$  is greater than 1.4, it may be practical to alter the member sizes or connections so that  $\delta_b \leq 1.4$ . Alternatively a second-order elastic analysis in accordance with Appendix E of AS 4100 may be used.

$\delta_b$  can be calculated from the flow chart in Figure 4.1. The design bending moment ( $M^*$ ) is then given by:

$$\begin{aligned} M^* &= M_m^* && \text{(for braced members subject to axial tension or with zero axial force)} \\ M^* &= \delta_b M_m^* && \text{(for braced members subject to compression)} \end{aligned}$$

where  $M_m^*$  is the maximum design bending moment calculated from a first-order analysis.

# Part 4

## METHODS OF STRUCTURAL ANALYSIS

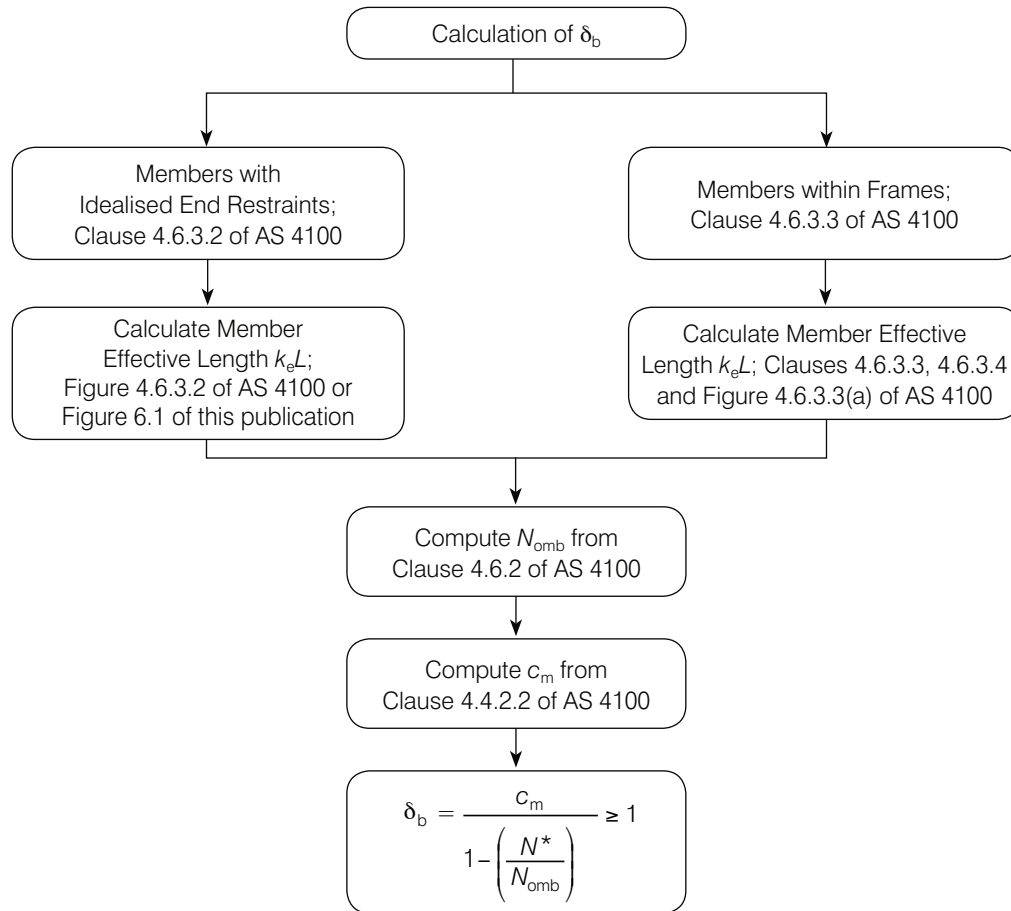


Figure 4.1: Flow Chart for the calculation of the moment amplification factor for a braced member,  $\delta_b$

### 4.2.1.1 Calculation of $c_m$

The factor for unequal moments ( $c_m$ ) is used in the calculation of  $\delta_b$ . If a braced member is subject *only to end moments* then the factor  $c_m$  is calculated as follows:

$$c_m = 0.6 - 0.4\beta_m \leq 1.0 \quad (\text{Clause 4.4.2.2 of AS 4100})$$

where  $\beta_m$  is the ratio of the smaller to the larger bending moment at the ends of the member, taken as positive when the member is bent in reverse curvature.

If the member is subjected to transverse loading, the same expression for  $c_m$  shall be used provided  $\beta_m$  is calculated using one of the following methods:

- $\beta_m = -1.0$  (conservative) (Clause 4.4.2.2(a) of AS 4100)
- $\beta_m$  is obtained by matching the moment distribution options shown in Figure 4.4.2.2 of AS 4100 (Clause 4.4.2.2(b) of AS 4100)
- $\beta_m$  is based on the midspan deflection. (Clause 4.4.2.2(c) of AS 4100)

### 4.2.2 Sway Members

In a sway member the transverse displacement of one end of the member relative to the other is not effectively prevented. The moment amplification factor for a sway member is  $\delta_s$ .

The bending moments calculated from a first-order elastic analysis are modified by the moment amplification factor ( $\delta_m$ ) which is the greater of  $\delta_b$  (see Section 4.2.1) and  $\delta_s$  (Clause 4.4.2.3 of AS 4100). If  $\delta_m$  is greater than 1.4, a second-order elastic analysis must be used in accordance with Appendix E of AS 4100. A detailed explanation of the procedure for calculating  $\delta_s$  may be found in Ref.[4.2].

$\delta_b$  and  $\delta_s$  are calculated from the flow charts shown in Figures 4.1 and 4.2. The design bending moment is given by:

$$M^* = \delta_m M_m^*$$

# Part 4

## METHODS OF STRUCTURAL ANALYSIS

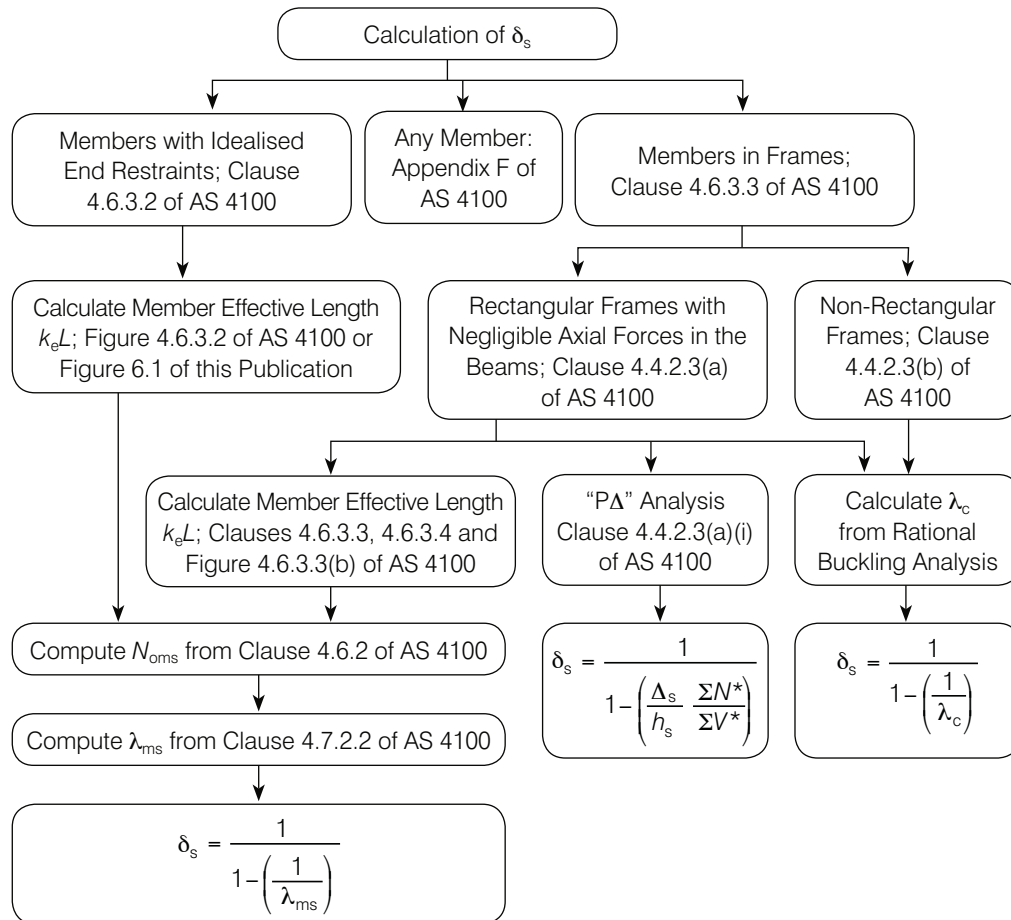


Figure 4.2: Flow Chart for the calculation of the moment amplification factor for a sway member,  $\delta_s$

### 4.2.3 Elastic Flexural Buckling Loads

Elastic flexural buckling loads ( $N_{omx}$ ,  $N_{omy}$ ) are required for the calculation of  $\delta_b$  and  $\delta_m$ . Values of  $N_{om}$  are determined from Clause 4.6.2 of AS 4100 using the expression:

$$N_{om} = \frac{\pi^2 EI}{(k_e L)^2}$$

where  $k_e L = L_e$  = effective length.  $k_e$  is given in Figure 6.1 for members with idealised end restraints or Clause 4.6.3 of AS 4100 for other end restraint conditions. For braced or sway members in frames,  $k_e$  depends on the ratio ( $\gamma$ ) of the compression member stiffness to the end restraint stiffness, calculated at each end of the member. Refs. [4.1,4.3] provide worked examples for the calculation of effective lengths, elastic flexural buckling loads and moment amplification factors for members in those instances.

For a specific effective length, reference can be made to the Dimensions and Properties Tables in Part 3 (i.e. Tables 3.1-1 to 3.1-6 as appropriate) to determine  $I$  (i.e.  $I_x$  or  $I_y$ ) and then simply evaluate the above equation for  $N_{om}$ . No tables relating  $N_{om}$  to effective length are provided in this publication.

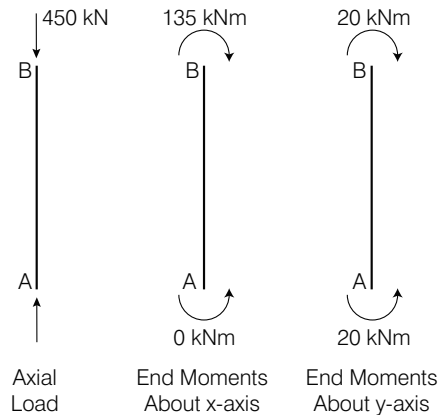
# Part 4

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### 4.3 Examples

#### 1. Braced Beam-Column

Determine the design action effects for an isolated braced beam-column which is subject to the design actions from a first-order elastic analysis as noted in Figure 4.3.



**Figure 4.3: Design action effects on isolated braced beam-column**

#### Design Data:

Section: 250 x 150 x 12.5 RHS in C450PLUS® – designed as AS/NZS 1163 Grade C450L0

Effective Lengths: Axial compression flexural buckling (x-axis),  $L_{ex} = 10.0$  m  
Axial compression flexural buckling (y-axis),  $L_{ey} = 5.0$  m

#### Solution:

$$N^* = 450 \text{ kN}$$

$$N_{ombx} = \frac{\pi^2 E I_x}{L_{ex}^2} = \frac{\pi^2 \times 200 \times 10^3 \times 68.5 \times 10^6}{(10000)^2} \quad (I_x \text{ obtained from Table 3.1-4 (1)})$$

$$= 1350 \text{ kN}$$

$$N_{omby} = \frac{\pi^2 E I_y}{L_{ey}^2} = \frac{\pi^2 \times 200 \times 10^3 \times 30.8 \times 10^6}{(5000)^2} \quad (I_y \text{ obtained from Table 3.1-4 (1)})$$

$$= 2430 \text{ kN}$$

$$M_{mx}^* = 135 \text{ kNm maximum at End B}$$

$$M_{my}^* = 20 \text{ kNm maximum at Ends A and B}$$

$$c_{mx} = 0.60$$

from Section 4.2.1.1 for  $\beta_{mx} = 0$

$$c_{my} = 1.0$$

from Section 4.2.1.1 for  $\beta_{my} = -1.0$

From Figure 4.1 the moment amplification factor ( $\delta_b$ ) is given by:

$$\delta_b = \frac{c_m}{1 - \left( \frac{N^*}{N_{omb}} \right)}$$

Considering flexural buckling about the x-axis:

$$\delta_{bx} = \frac{0.6}{1 - \left( \frac{450}{1350} \right)}$$

$$= 0.900 (< 1) \Rightarrow \delta_{bx} = 1.0$$

$\therefore$  Maximum moment occurs at the ends, i.e. at End A

$$M_x^* = 135 \text{ kNm}$$

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Considering flexural buckling about the y-axis:

$$\begin{aligned}\delta_{by} &= \frac{1.0}{1 - \left(\frac{450}{2430}\right)} \\ &= 1.23 \\ \therefore \text{Maximum moment occurs between ends, i.e. in span } M_y^* &= 1.23 \times 20 \\ &= 24.6 \text{ kNm}\end{aligned}$$

It can be seen that there is a 23% increase in the peak moment about the y-axis due to the second-order interaction effects between bending and axial compression.

### 2. Sway Beam-Column

Due to space limitations, general examples of sway beam-columns are considered in Refs. [4.1,4.3].

### 4.4 Miscellaneous

Readers should note that previous editions of this publication by the Australian Steel Institute (previously AISC) listed tables of  $N_{om}$  at the end of Part 4. These tables were rarely used and could be readily calculated by manual methods (as noted in the example above). Consequently, the  $N_{om}$  tables have been omitted from this part of the Tables and this also aligns with Ref. [4.3] which is a companion publication that considers hot-rolled open sections (UB, UC, etc.)

### 4.5 References

- [4.1] Bradford, M.A., Bridge, R.Q. and Trahair, N.S., "Worked Examples for Steel Structures", third edition, Australian Institute of Steel Construction, 1997 (Note: AISC is now ASI – the Australian Steel Institute).
- [4.2] Standards Australia, AS 4100 Supplement 1-1999: "Steel Structures Commentary" (Supplement to AS 4100-1998), Standards Australia, 1999.
- [4.3] ASI, "Design Capacity Tables for Structural Steel – Volume 1: Open Sections", fourth edition, Australian Steel Institute 2009.

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

# Part 5

## MEMBERS SUBJECT TO BENDING

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



# Part 5

## MEMBERS SUBJECT TO BENDING

### 5.1 Maximum Design Loads for Beams with Full Lateral Restraint Subject to Uniformly Distributed Loading

Tables 5.1-1 to 5.1-6 give values of the maximum design loads for single-span simply-supported beams with full lateral restraint subject to uniformly distributed loads as shown in Figure 5.1 for both the strength and serviceability limit states.

**Designers should assess maximum design loads for the strength and serviceability limit states separately as different load combinations apply to these cases (AS/NZS 1170 Part 0).**

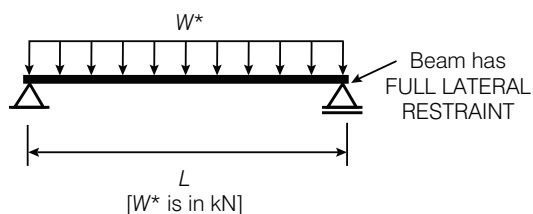


Figure 5.1: Beam configuration for Tables 5.1-1 to 5.1-6

**NOTE: BEAM SELF WEIGHT: For Tables 5.1-1 to 5.1-6, the self-weight of the beam has NOT been deducted. The designer must include the self-weight as part of the dead load when determining the maximum design load  $W_{L1}^*$  or  $W_s^*$ .**

Tables 5.1-1 to 5.1-6 also list the maximum segment length for full lateral restraint (FLR) required to be achieved for each section type loaded and configured as noted in Figure 5.1.

Examples of the use of these tables are given in Section 5.1.6.

#### 5.1.1 $W_{L1}^*$ – Strength Limit State Design Load

For the beam configuration shown in Figure 5.1, the maximum strength limit state design load ( $W_{L1}^*$ ) is the lesser of the maximum design load ( $W_{L1}^*$ ) associated with the design section moment capacity ( $\phi M_{sx}$ ) and the maximum design load ( $W_{L2}^*$ ) associated with the design shear capacity ( $\phi V_s$ ).

The designer must ensure that the strength limit state design load ( $W^*$ ) is less than or equal to the maximum design load  $W_{L1}^*$ , i.e.

$$W^* \leq W_{L1}^*$$

where  $W_{L1}^* = \min. [W_{L1}^*; W_{L2}^*]$ .

$W_{L1}^*$  and  $W_{L2}^*$  are listed in the (A) series tables of the 5.1 Table Series – i.e. Tables 5.1-1 to 5.1-6. The (A) series tables in this instance consider the **strength** limit state. For a specific group of hollow sections, each respective (A) series table is immediately followed by a (B) series table which considers the **serviceability** limit state – see Section 5.1.2 below.

For the beam configuration shown in Figure 5.1, the strength of the beam is not controlled by the interaction of bending moment and shear force (Clause 5.12 of AS 4100). An example on the use of these tables is given in Section 5.1.6.

#### 5.1.1.1 $W_{L1}^*$ – based on Design Moment Capacity

The derivation of the design section moment capacity ( $\phi M_s$ ) is given in Section 5.2.2.1 and listed in Tables 5.2-1 to 5.2-4 for RHS/SHS and Tables 8-1 to 8-6 for all hollow sections (including CHS).

For a single-span simply-supported beam subject to uniformly distributed loading (see Figure 5.1), the maximum design bending moment ( $M_{max}$ ) is given by:

$$M_{max} = \frac{WL}{8}$$

where  $W$  = total load on the beam, including beam self weight  
 $L$  = span of the beam.

The design moment capacity for the beam in Figure 5.1 is  $\phi M_{sx}$ . Therefore, substituting  $\phi M_{sx}$  for  $M_{max}$ , and rearranging the above equation gives:

$$W_{L1}^* = \frac{8(\phi M_{sx})}{L}$$

where  $W_{L1}^*$  is the *Maximum Design Load* based on the design section moment capacity of the beam.

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## MEMBERS SUBJECT TO BENDING

### 5.1.1.2 $W_{L2}^*$ – based on Design Shear Capacity

The derivation of the design shear capacity ( $\phi V_v$ ) is given in Section 5.2.2.4 and listed in Tables 5.2-1 to 5.2-4 for RHS/SHS and Tables 8-1 to 8-6 for all hollow sections (including CHS).

For a single-span, simply-supported beam subject to uniformly distributed loading (see Figure 5.1), the maximum design shear force ( $V_{max}$ ) is given by:

$$V_{max} = \frac{W}{2}$$

Therefore, substituting  $\phi V_v$  for  $V_{max}$  and rearranging the equation gives:

$$W_{L2}^* = 2(\phi V_v)$$

where  $W_{L2}^*$  is the *Maximum Design Load* based on the design shear capacity of the beam.

### 5.1.2 $W_S^*$ – Serviceability Limit State Design Load

For the beam configuration shown in Figure 5.1, the value of maximum serviceability limit state design load ( $W_S^*$ ) given in the tables is the *lesser* of the maximum design load ( $W_{L2}^*$ ) which will achieve a **calculated total elastic deflection** of  $L/250$  (where  $L$  is the span of the beam) and the load at which first yield occurs ( $W_{YL}^*$ ), i.e.

$$W_S^* = \min.[W_{L2}^*; W_{YL}^*]$$

$W_S^*$  is listed in the (B) series tables of the 5.1 Table Series – i.e. Tables 5.1-1 to 5.1-6. The (B) series tables in this instance consider the **serviceability** limit state. For a specific group of hollow sections, each respective (B) series Table is immediately preceded by an (A) series Table which considers the **strength** limit state – see Section 5.1.1 above. An example of the use of these Tables is given in Section 5.1.6.

### 5.1.2.1 $W_{S1}^*$ – based on a Deflection Limit of $L/250$

The maximum *elastic* deflection ( $\Delta_{max}$ ) of the beam shown in Figure 5.1 is given by:

$$\Delta_{max} = \frac{5WL^3}{384EI_x}$$

where  $E = 200 \times 10^3$  MPa

$I_x =$  second moment of area about the major principal x-axis.

Therefore, substituting  $\Delta_{max} = L/250$  and rearranging the equation gives the maximum design load for serviceability based on deflection ( $W_{S1}^*$ ):

$$W_{S1}^* = \frac{384EI_x}{1250L^2}$$

For deflection limits other than  $L/250$ , the value of the maximum design load based on another deflection limit ( $W_{S2}^*$ ) may be calculated by using the method given above but using the new limit.

### 5.1.2.2 $W_{YL}^*$ – based on First Yield Load

The load at which first yield occurs in the member is given by:

$$W_{YL}^* = \frac{8Z_x f_y}{L} \quad \text{since} \quad \frac{W^* L}{8Z_x} \leq f_y$$

### 5.1.3 Full Lateral Restraint

Full lateral restraint may be achieved for a beam by: (a) continuous lateral restraint (Clause 5.3.2.2 of AS 4100), or (b) full, partial or lateral restraint provided at sufficient locations along the beam (Clauses 5.3.2.3 and 5.3.2.4 of AS 4100). The distance between the locations in (b) is termed the segment length and the maximum value of segment length to maintain the full lateral restraint condition is generally noted as “FLR” in the Tables.

**FLR values are not shown in the Tables for CHS and SHS as these sections are not considered to be susceptible to flexural-torsional buckling.** However, FLR values are given in the (A) series of Tables 5.1-3 and 5.1-4 as they consider RHS bending about the major principal axis and these sections may, in some instances, be subject to flexural-torsional buckling. As noted in Tables 5.1-3 and 5.1-4, FLR is only listed in the strength (not serviceability) limit state tables (A).

Formulae for calculating FLR are given in Clause 5.3.2.4 of AS 4100 and Section 5.2.2.2.

For the beam configuration shown in Figure 5.1, the ratio  $\beta_m$  is equal to  $-0.8$  to derive the FLR values in Tables 5.1-3 and 5.1-4.

### 5.1.4 Additional Design Checks

Where loads are transmitted into the webs at supports or at load points, the capacity of the web to resist such forces should be checked in accordance with Section 5.2.2.5, Section 5.2.5 and the values of the web capacities listed in Tables 5.2-1 to 5.2-4.

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## MEMBERS SUBJECT TO BENDING

### 5.1.5 Other Load Conditions

The values given in Tables 5.1-1 to 5.1-6 are for single-span, simply-supported beams subject to uniformly distributed loads (Figure 5.1). However, the information presented in these tables may be used for beams with full lateral restraint and other loading situations using the equivalent uniform design loads given in Table T5.1 and the following procedure:

- (1) Calculate the equivalent uniformly distributed maximum design load for moment ( $W_{EM}^*$ ) using Table T5.1.
- (2) Based on  $W_{EM}^*$  select a section with an adequate maximum design load ( $W_{L1}^*$ ) associated with the design moment capacity from Tables 5.1-1 to 5.1-6.
- (3) Calculate the equivalent uniformly distributed maximum design load for shear ( $W_{EV}^*$ ) using Table T5.1.
- (4) Check that the section selected in (2) has an adequate maximum design load ( $W_{L2}^*$ ) associated with the design shear capacity to resist  $W_{EV}^*$ . If not, select a new section size which can resist  $W_{EV}^*$ .
- (5) Check shear and bending interaction in accordance with Section 5.2.4. A check is not necessary if  $V^* < 0.6(\phi V_v)$  or  $M^* < 0.75(\phi M_s)$ .
- (6) Calculate the equivalent uniformly distributed serviceability maximum design load ( $W_{ES}^*$ ) from Table T5.1.
- (7) Check that the section selected in (4) has an adequate maximum serviceability design load ( $W_{S1}^*$ ) to resist  $W_{ES}^*$ . If not, select a new section size which can resist  $W_{ES}^*$ .

Steps (6) and (7) only work if first yield does not control. If it does, the analysis for serviceability is invalid.

The above procedure is shown in Example 2 of Section 5.1.6.

Table T5.1: Table of Equivalent Uniform Design Loads

Loading	Equivalent Strength Maximum Design Loads		Equivalent Serviceability Maximum Design Load $W_{ES}^*$
	Moment $W_{EM}^*$	Shear $W_{EV}^*$	
	$2P$	$P$	$\frac{8P}{5}$
	$\frac{8abP}{L^2}$	$\frac{2Pb}{L}$	$\frac{8P}{5} \left[ 3 \left( \frac{a}{L} \right) - 4 \left( \frac{a}{L} \right)^3 \right]$ at midspan
	$\frac{8aP}{L}$	$2P$	$\frac{16P}{5} \left[ 3 \left( \frac{a}{L} \right) - 4 \left( \frac{a}{L} \right)^3 \right]$
	$4P$	$3P$	$\frac{19P}{5}$
	$\frac{24P}{5}$	$4P$	$\frac{3024P}{625}$

# Part 5

## MEMBERS SUBJECT TO BENDING

### 5.1.6 Examples

#### 1. Beam with Uniformly Distributed Load

A simply-supported beam of 4 metres span is subjected to the following (unfactored) uniformly distributed loads:

$$\begin{aligned} G \text{ (Dead Load)} &= 20 \text{ kN} && \text{(total load including beam self weight)} \\ Q \text{ (Live Load)} &= 60 \text{ kN} && \text{(short term total load, } \Psi_s = 0.7) \end{aligned}$$

The beam is continuously laterally restrained. The total deflection of the beam under serviceability load must not exceed  $L/250$ . Select an appropriate Grade C450L0 (C450PLUS®) RHS to resist this loading.

#### Solution:

(a) Calculation of maximum design loads:

$$\begin{aligned} \text{Strength Limit State } W_{\perp}^* &= \max. [1.35G; 1.2G + 1.5Q] \\ &= 114 \text{ kN} \\ \text{Serviceability Limit State } W_{\text{S}}^* &= G + 0.7Q \\ &= 62.0 \text{ kN} \end{aligned}$$

Note: The above design load calculations are based on the load combinations in AS/NZS 1170.0.

(b) Use of the Tables:

**Strength Limit State** – Select a section from the Tables such that the maximum design loads  $W_{\perp 1}^*$  (based on moment capacity) and  $W_{\perp 2}^*$  (based on shear capacity) are greater than or equal to  $W_{\perp}^*$ . It can be seen from Table 5.1-4(2)(A) that for a 200 x 100 x 6.0 RHS – C450PLUS® designed as AS/NZS 1163 Grade C450L0 with 4.0 m span, the maximum design loads are:

$$\begin{aligned} W_{\perp 1}^* &= 170 \text{ kN (Tabulated)} \\ W_{\perp 2}^* &= 1040 \text{ kN (Tabulated)} \\ \therefore W_{\perp}^* &= \min [W_{\perp 1}^*; W_{\perp 2}^*] \text{ (Tabulated)} \\ &= 170 \text{ kN (Tabulated)} \quad (> 114 \text{ kN} \dots \text{ COMPLIES}) \end{aligned}$$

Therefore, a 200 x 100 x 6.0 RHS – Grade C450L0 (C450PLUS®) satisfies the strength limit state. (Note: a 200 x 100 RHS in 4 and 5 mm thickness would also have sufficed though the 6 mm thick was selected in advance of satisfying the serviceability limit

state – see below).

**Serviceability Limit State** – From Table 5.1-4(2)(B), it can be seen that for a 200 x 100 x 6.0 RHS – Grade C450L0 (C450PLUS®) with 4.0 m span, the serviceability load for a deflection limit of  $L/250$  is:

$$W_{\text{S}}^* = 64.2 \text{ kN (Tabulated)} \quad (> 62.0 \text{ kN} \dots \text{ COMPLIES})$$

Therefore, a 200 x 100 x 6.0 RHS – Grade C450L0 (C450PLUS®), satisfies the serviceability limit state.

#### 2. Beam with Central Concentrated Load

A beam which is simply-supported has a span of 4.0 metres with full lateral restraint. The beam is subjected to nominal, central dead and short term live loads of 10 kN and 30 kN respectively. Design a suitable RHS in Grade C450L0 (C450PLUS®) with a limit on deflection of span / 250.

#### Solution:

(1) Calculate the equivalent uniformly distributed maximum design load for moment ( $W_{EM}^*$ ). From Table T5.1, the  $W_{EM}^*$  associated with the central load case is:

$$\begin{aligned} W_{EM}^* &= 2P \\ &= 2 \times \max. [1.35 \times 10; 1.2 \times 10 + 1.5 \times 30] \\ &= 114 \text{ kN} \end{aligned}$$

Note: The design load calculations in this Example are based on the load combinations in AS/NZS 1170.0.

(2) Based on  $W_{EM}^*$  select a section with an adequate maximum design load ( $W_{\perp 1}^*$ ) associated with the design section moment capacity.

From Table 5.1-4(2)(A), a 200 x 100 x 5.0 RHS – Grade C450L0 (C450PLUS®) has adequate maximum design load with  $W_{\perp 1}^* = 145 \text{ kN}$  ( $> 114 \text{ kN}$  required).

(3) Calculate the equivalent uniformly distributed maximum design load for shear ( $W_{EV}^*$ ).

$$\begin{aligned} \text{From Table T5.1, } W_{EV}^* \text{ for the central load case is:} \\ W_{EV}^* &= P \\ &= \max. [1.35 \times 10; 1.2 \times 10 + 1.5 \times 30] \\ &= 57 \text{ kN} \end{aligned}$$

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- (4) Check that the section selected in Step (2) has an adequate maximum design load ( $W_{L2}^*$ ) based on design shear capacity.

From Table 5.1-4(2)(A), a 200 x 100 x 5.0 RHS – Grade C450L0 (C450PLUS®) has adequate maximum design load with  $W_{L2}^* = 879$  kN (> 57 kN required).

- (5) See if a shear and bending interaction check is necessary.

$$\begin{aligned}W_{L2}^* &= 879 \text{ kN} && \text{(Table 5.1-4(2)(A))} \\ \phi V_v &= 440 \text{ kN} && \text{(Table 5.2-2(2)(A) or } 0.5 W_{L2}^*) \\ 0.6\phi V_v &= 264 \text{ kN} \\ &> 28.5 \text{ kN} && \text{(} = V^* = W_{EV}^*/2 \text{ from above)}\end{aligned}$$

Therefore no shear and bending check is necessary.

- (6) Calculate the equivalent uniformly distributed serviceability load ( $W_{ES}^*$ ).

From Table T5.1,  $W_{ES}^*$  for the central load case is (for  $\Psi_s = 0.7$ ):

$$\begin{aligned}W_{ES}^* &= \frac{8P}{5} \\ &= \frac{8}{5} (10 + 0.7 \times 30) \\ &= 49.6 \text{ kN}\end{aligned}$$

- (7) From Table 5.1-4(2)(B), a 200 x 100 x 5.0 RHS – Grade C450L0 (C450PLUS®) has adequate maximum serviceability design load with  $W_{ES}^* = 55.2$  kN (> 49.6 kN).

∴ Adopt a 200 x 100 x 5.0 RHS – Grade C450L0 (C450PLUS®) section.

Note: For illustrative purposes, the self-weight of the beam is assumed to be included in the dead load of this example. Nominal beam self weight - 22.1 kg/m x 4.0m = 88.4 kg ⇒ 0.867 kN.

## 5.2 Design Section Moment and Web Capacities

### 5.2.1 General

For RHS and SHS, the 5.2 Table Series – i.e. Tables 5.2-1 to 5.2-4 – contain values of design section moment capacities about the principal x- and y-axes ( $\phi M_{sx}$ ,  $\phi M_{sy}$ ) and the design shear capacity ( $\phi V_v$ ) for shear forces acting in the principal y-axis direction (i.e. for RHS/SHS bending about the x-axis) and in the principal x-axis direction (for RHS only). These values provide the basic information necessary for checking shear-bending interaction. The Tables also provide

listings of the design torsional section moment capacity ( $\phi M_z$ ) for RHS and SHS.

The maximum segment length for full lateral restraint (FLR) for RHS is also listed. FLR values may be used to ensure appropriate spacing of restraints so that the design section moment capacity can be achieved for bending about the x-axis. The Tables also provide values of design web bearing capacities.

Due to there being no specific CHS design provisions for web bearing in AS 4100, **CHS are not considered in the 5.2 Table series** though design section capacities (e.g.  $\phi M_{sx}$ ,  $\phi V_v$  and  $\phi M_z$ ) can be found in the 8.1 and 8.2 Table series.

### 5.2.2 Method

#### 5.2.2.1 Design Section Moment Capacity

The design section moment capacity ( $\phi M_s$ ) is determined from Clauses 5.1 and 5.2.1 of AS 4100 using:

$$\begin{aligned}\phi M_s &= \phi f_y Z_e \\ \text{where } \phi &= 0.9 \text{ (Table 3.4 of AS 4100)} \\ f_y &= \text{yield stress used in design} \\ Z_e &= \text{effective section modulus (see Section 3.2.2.2)}\end{aligned}$$

For RHS, design section moment capacities are listed for bending about both principal axes. These actions are split into two separate tables – the type (A) table for bending about the x-axis (e.g. Table 5.2-2(1)(A) for Grade C450L0 (C450PLUS®) RHS lists  $\phi M_{sx}$ ) which is immediately followed by the type (B) table for bending about the y-axis (e.g. Table 5.2-2(1)(B) for Grade C450L0 (C450PLUS®) RHS lists  $\phi M_{sy}$ ). Due to SHS being doubly-symmetric, the SHS tables (i.e. Tables 5.2-3 and 5.2-4) only consider design section moment capacities about the x-axis.

For RHS bending about the x-axis, the design member moment capacity ( $\phi M_b$ ) equals the design section moment capacity ( $\phi M_s$ ) for members which have full restraint against flexural-torsional buckling (see Section 5.1.3). For SHS bending about the x-axis and RHS bending about the y-axis, flexural-torsional buckling does not normally occur so  $\phi M_b$  equals  $\phi M_s$  (refer section 5.1.3).

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### 5.2.2.2 Segment Length for Full Lateral Restraint (FLR)

The Tables only consider RHS bending about the major principal x-axis to be susceptible to flexural-torsional buckling. For such sections, a beam segment with full or partial restraint at each end may be considered to have full lateral restraint if its length satisfies Clause 5.3.2.4 of AS 4100, i.e.

$$FLR \leq r_y (1800 + 1500 \beta_m) \left( \frac{b_f}{b_w} \right) \left( \frac{250}{f_y} \right)$$

where FLR = maximum segment length for full lateral restraint

$$r_y = \sqrt{\left( \frac{I_y}{A_g} \right)} \quad (\text{see Tables 3.1-3 and 3.1-4})$$

The FLR values listed in the (A) series tables of Tables 5.2-1 and 5.2-2 (for RHS) are calculated using  $\beta_m = -1.0$  which is the most conservative case. However,  $\beta_m = -0.8$  may be used for segments with transverse loads (as in the case of the (A) series tables in Tables 5.1-3 and 5.1-4 for RHS). Alternatively,  $\beta_m$  may be taken as the ratio of the smaller to larger end moments in the length ( $L$ ) for segments without transverse loads (positive when the segment is bent in reverse curvature).

### 5.2.2.3 Design Torsional Moment Section Capacity

The design torsional moment section capacity ( $\phi M_z$ ) listed in the 5.2 Table series is determined in accordance with (a) and (b) as noted below.

- (a) Although AS 4100 makes no provision for the design of members subject to torsion it is nevertheless considered appropriate to provide torsional capacities for hollow sections in the Tables. Hollow sections perform particularly well in torsion and their behaviour under torsional loading is readily analysed by simple procedures. An explanation of torsional effects is provided in Refs. [5.1, 5.2].  
The general theory of torsion established by Saint-Venant is based on uniform torsion. The theory assumes that all cross-sections rotate as a body around the centre of rotation.

When the applied torsional moment is non-uniform, such as when the torsional load is applied midspan between rigid supports or when the free warping of the section is restricted, then the torsional load is shared between uniform and non-uniform torsion or warping. However, in the case of hollow sections, the contribution of non-uniform torsion is negligible and sections can be treated as subject to uniform torsion without any significant loss of precision in analysis.

- (b) For hollow sections, torsional actions can be considered using the following formulae:

*Strength Limit State*

$$M_z^* \leq \phi M_z$$

$$\phi M_z = \phi 0.6 f_y C$$

where  $M_z^*$  = design torsional moment

$$\phi = 0.9 \quad (\text{based on shearing loads and Table 3.4 of AS 4100})$$

$$\phi M_z = \text{design torsional section moment capacity}$$

$$f_y = \text{yield stress used in design}$$

$$C = \text{torsional section modulus (see 3.1 Table series)}$$

*Serviceability Limit State*

The angle of twist per unit length  $\theta$  (in radians) can be determined from the following formula:

$$\theta = \frac{M_z^*}{GJ}$$

where  $G$  = shear modulus of elasticity,  $80 \times 10^3$  MPa

$J$  = torsional section constant (see 3.1 Table series).

The method for determining the constants  $C$  and  $J$  is detailed in Section 3.2.1.1.

# Part 5

## MEMBERS SUBJECT TO BENDING

### 5.2.2.4 Design Shear Capacity of a Web

Designers must ensure that the design shear force ( $V^*$ )  $\leq \phi V_v$  along the beam.

RHS and SHS generally have non-uniform shear stress distributions along their webs.

Consequently, the design shear capacity of a web ( $\phi V_v$ ) for most RHS/SHS in the Tables are primarily determined from Clauses 5.11.3 and 5.11.4 of AS 4100 and is calculated as the lesser of:

$$\phi V_v = \phi V_w \quad (\text{Clause 5.11.4 of AS 4100})$$

$$\text{and } \phi V_v = \frac{2\phi V_u}{0.9 + \left(\frac{f_{vm}^*}{f_{va}^*}\right)} \quad (\text{Clause 5.11.3 of AS 4100})$$

Also, for CHS:

$$\phi V_v = 0.324f_y A_e \quad (\text{Clause 5.11.4 of AS 4100})$$

Where  $\phi = 0.9$  (Table 3.4 of AS 4100)

$$V_w = 0.6f_y (d - 2t) 2t$$

$$V_u = V_w \quad \text{for } \frac{d_1}{t} \sqrt{\left(\frac{f_y}{250}\right)} \leq 82 \text{ and applies for all ATM RHS/SHS in the Tables}$$

$$= \alpha_v V_w \quad \text{for } \frac{d_1}{t} \sqrt{\left(\frac{f_y}{250}\right)} > 82 \text{ and } \alpha_v \text{ is evaluated from Clause 5.11.5 of AS 4100}$$

$f_{va}^*$  = average design shear stress in the web

$f_{vm}^*$  = maximum design shear stress in the web

$f_y$  = yield stress used in design

$A_e$  = effective sectional area of CHS in shear

=  $A_g$  (i.e. gross cross-section of CHS provided there are no holes larger than those required for fasteners, or that the net area is greater than 0.9 times the gross area)

$d$  = full depth of section

$t$  = thickness of section

$d_1$  =  $d - 2t$

The ratio of maximum to average design shear stress in the web ( $f_{vm}^* / f_{va}^*$ ) for bending about the x-axis is calculated [5.3] using:

$$\frac{f_{vm}^*}{f_{va}^*} = \frac{3(2b+d)}{2(3b+d)}$$

where  $d$  = full depth of section

$b$  = full width of section

Note: For bending about the y-axis,  $b$  and  $d$  are interchanged in the calculation of the maximum to average design web shear stress ratio. Non-uniform shear stress governs when  $d/b > 0.75$ .

For calculating the web area, the web depth has been taken as  $d - 2t$  (or  $b - 2t$  when appropriate) for RHS/SHS and 0.6 times the gross cross-section area ( $0.6 A_g$ ) for CHS.

### 5.2.2.5 Design Web Bearing Capacities

Designers must ensure that the design bearing force ( $R^*$ )  $\leq \phi R_b$  at all locations along a beam where bearing forces are present.

The design bearing capacity ( $\phi R_b$ ) is calculated in accordance with Clause 5.13 of AS 4100 and taken as the lesser of:

$$\phi R_{by} = \phi 2\alpha_p b_b t f_y$$

and  $\phi R_{bb} = \phi 2\alpha_c b_b t f_y$

where  $\phi = 0.9$  (Table 3.4 of AS 4100)

$\phi R_{by}$  = design web bearing yield capacity (Clause 5.13.3 of AS 4100)

$\phi R_{bb}$  = design web bearing buckling capacity (Clause 5.13.4 of AS 4100)

$t$  = thickness of section

$f_y$  = yield stress used in design

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(a) For **interior bearing** such that  $b_d \geq 1.5d_5$  (see Figure 5.2(b))

$$b_b = b_s + 5r_{ext} + d_5$$

$b_s$  = actual length of bearing (see Figure 5.2(b))

$d_5$  = flat width of web (see Figure 5.2(a))

$r_{ext}$  = outside corner radius (see Section 3.2.1.2)

$$\alpha_p = \frac{0.5}{k_s} \left[ 1 + (1 - \alpha_{pm}^2) \left( 1 + \frac{k_s}{k_v} - (1 - \alpha_{pm}^2) \frac{0.25}{k_v^2} \right) \right]$$

$$\alpha_{pm} = \frac{1}{k_s} + \frac{0.5}{k_v}$$

$$k_s = \frac{2r_{ext}}{t} - 1$$

$$k_v = \frac{d_5}{t}$$

$\alpha_c$  = member slenderness reduction factor determined from Clause 5.13.4 of AS 4100. This is equal to the design axial compression capacity of a member with area  $t_w b_b$  with  $\alpha_b = 0.5$ ,  $k_f = 1.0$  and slenderness ratio,  $L_e/r = 3.5d_5/t$ .

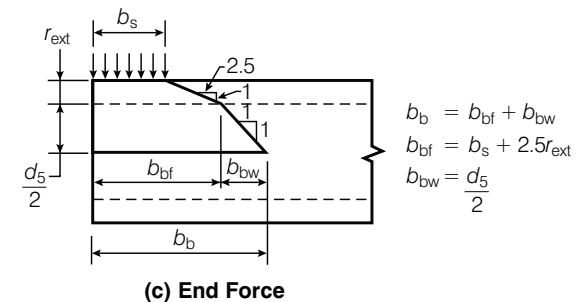
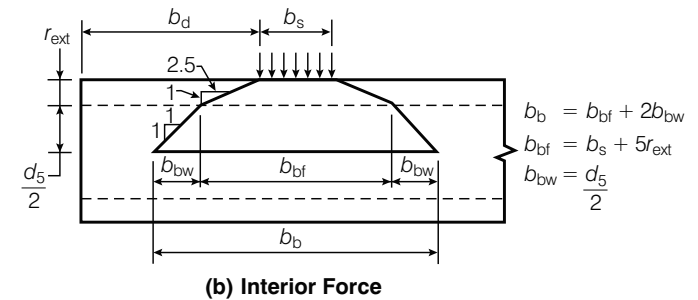
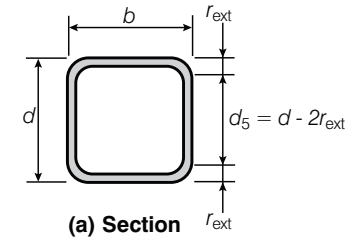


Figure 5.2: Dispersion of force through flange, radius and web of RHS/SHS



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## MEMBERS SUBJECT TO BENDING

(b) For **end bearing** such that  $b_d < 1.5d_5$  (see Figure 5.2(c))

$$b_b = b_s + 2.5r_{\text{ext}} + \frac{d_5}{2}$$

$$\alpha_p = \sqrt{2 + k_s^2} - k_s$$

$\alpha_c$  = member slenderness reduction factor determined from Clause 5.13.4 of AS 4100. This is equal to the design axial compression capacity of a member with area  $t_w b_b$  with  $\alpha_b = 0.5$ ,  $k_f = 1.0$  and slenderness ratio,  $L_e/r = 3.8d_5/t$ .

Tables 5.2-1 to 5.2-4 list values  $\phi R_{by}$  and  $\phi R_{bb}$  in terms of  $\phi R_{by}/b_b$  and  $\phi R_{bb}/b_b$  respectively for RHS/SHS. In both the interior and end bearing cases, the critical web bearing failure mode (i.e. web bearing yield design capacity or web bearing buckling design capacity) is shown in **bold**. Additionally, the terms  $5r_{\text{ext}}$  ( $= 2 \times 2.5r_{\text{ext}}$  for interior bearing),  $2.5r_{\text{ext}}$  (for end bearing),  $b_{bw}$  (see Figures 5.2 (b) and (c)) and  $L_e/r$  are also listed in these tables. For the same section range, the RHS listings in this table series consider shear and bearing forces for flexure about the x-axis (the (A) series tables) which is then immediately followed by the (B) series tables for flexure about the y-axis.

### 5.2.3 Example – Web Bearing

For an interior bearing location, a 150 x 100 x 4.0 RHS – Grade C450L0 (C450PLUS®) section has a central design concentrated force of 150 kN bearing over the full width of the RHS for a length of 100 mm along the RHS (see Figure 5.3). Check the bearing capacity of the beam which is bending about the x-axis.

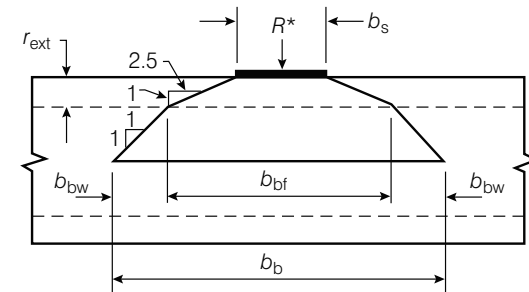


Figure 5.3: Web bearing design example

#### Design Data:

Design bearing force	$R^*$	=	150 kN
Design shear force	$V^*$	=	75 kN
Stiff bearing length	$b_s$	=	100 mm
From Table 5.2-2(2)(A)	$5r_{\text{ext}}$	=	50.0 mm
From Table 5.2-2(2)(A)	$b_{bw}$	=	65.0 mm

#### Solution:

- Check shear capacity
  - $V^* = 75 \text{ kN}$  (assuming  $R^*$  provides the total shearing action)
  - $\phi V_v = 267 \text{ kN}$  (Table 5.2-2(2)(A))
  - $> V^* \therefore \text{O.K.}$

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- (2) Check bearing capacity  
Bearing length at the edge of the corner radius

$$\begin{aligned} b_{bf} &= b_s + 5r_{ext} \\ &= 100 + 50.0 \\ &= 150 \text{ mm} \end{aligned}$$

Bearing length at the centre of the web

$$\begin{aligned} b_b &= b_{bf} + 2b_{bw} \\ &= 150 + (2 \times 65.0) \\ &= 280 \text{ mm} \end{aligned}$$

From Table 5.2-2(2)(A):

- (a) Design web yield capacity

$$\frac{\phi R_{by}}{b_b} = 0.828 \text{ kN/mm}$$

- (b) Design web buckling capacity

$$\frac{\phi R_{bb}}{b_b} = 0.860 \text{ kN/mm}$$

$\therefore$  web yielding will govern (as it is the **bold** entry in the table).

Design web bearing capacity ( $\phi R_b$ )

$$\begin{aligned} \phi R_b &= \phi R_{by} \\ &= 0.828 \times 280 \\ &= 232 \text{ kN} \\ &> R^* \end{aligned}$$

$\therefore$  the 150 x 100 x 4.0 RHS – Grade C450L0 (C450PLUS®) is satisfactory.

### 5.2.4 Shear and Bending Interaction

#### 5.2.4.1 Method

The design web shear capacity determined in Section 5.2.2.4 may be significantly reduced when the section is subject to a large design bending moment at the same location. The reduced design shear capacity ( $\phi V_{vm}$ ) is determined in accordance with Clause 5.12.3 of AS 4100 as:

$$\phi V_{vm} = \phi V_v \quad \text{for } M^* \leq 0.75\phi M_s$$

$$\text{or} \quad \phi V_{vm} = \phi V_v \left[ 2.2 - \left( \frac{1.6M^*}{\phi M_s} \right) \right] \quad \text{for } 0.75\phi M_s < M^* \leq \phi M_s$$

where  $\phi V_v$  = design web shear capacity (see Sections 5.2.1 and 5.2.2.4)

$M^*$  = design bending moment

$\phi M_s$  = design section moment capacity (see Sections 5.2.1 and 5.2.2.1)

Designers must ensure that  $V^* \leq \phi V_{vm}$ .

**Note: If  $V^* \leq 0.6(\phi V_v)$  or if  $M^* \leq 0.75(\phi M_s)$  then no check on the interaction of shear and bending is necessary.**

#### 5.2.4.2 Example

An example of a check on shear and bending interaction is given in Section 5.3.6.

# Part 5

## MEMBERS SUBJECT TO BENDING

### 5.2.5 Bending and Bearing Interaction

#### 5.2.5.1 Method

The design web bearing capacity determined in Section 5.2.2.5 of the Tables may be significantly reduced when the section is subject to a large bending moment at the same location. The effect of this interaction of bending and bearing force in RHS and SHS is considered in AS 4100.

The bending and bearing interaction is dependent on the ratio of bearing length to the width of bearing ( $b_s/b$ ) and web slenderness ( $d_1/t$ ). Clause 5.13.5 of AS 4100 considers the following interaction to apply to RHS and SHS:

$$1.2 \left( \frac{R^*}{\phi R_b} \right) + \left( \frac{M^*}{\phi M_s} \right) \leq 1.5 \quad \text{for } \frac{b_s}{b} \geq 1.0 \text{ and } \frac{d_1}{t} \leq 30$$

or 
$$0.8 \left( \frac{R^*}{\phi R_b} \right) + \left( \frac{M^*}{\phi M_s} \right) \leq 1.0 \quad \text{otherwise}$$

where

$b_s$  = stiff bearing length (see Figure 5.2)

$b$  = width of section

$d_1$  = clear depth between flanges

$t$  = thickness of section

$R^*$  = maximum design bearing force

$\phi$  = capacity factor = 0.9 (Table 3.4 of AS 4100)

$\phi R_b$  = design web bearing capacity (see Section 5.2.2.5)

$M^*$  = maximum design bending moment

$\phi M_s$  = design section moment capacity (see Sections 5.2.1 and 5.2.2.1)

**Note: These formulae only apply to bearing across the full width of section.**

### 5.2.5.2 Example

Assuming a design bending moment of 15.0 kNm is present at the bearing load shown in the example of Section 5.2.3, check the adequacy of the beam under the interaction of bending and bearing.

#### Design Data:

Design bearing force	$R^* = 150$ kN	(Section 5.2.3)
Design web bearing capacity	$\phi R_b = 232$ kN	(Section 5.2.3)
Design bending moment	$M^* = 15.0$ kNm	
Design section moment capacity	$\phi M_s = 37.8$ kNm	(Table 5.2-2(2)(A))
Stiff bearing length	$b_s = 100$ mm	(Section 5.2.3)
Web slenderness	$d_1/t = 35.5$	(Table 3.1-4(2) or $= (d - 2t)/t$ )

#### Solution:

$$\frac{b_s}{b} = \frac{100}{100} \geq 1.0$$

and 
$$\frac{d_1}{t} = 35.5 > 30$$

$\therefore$  the interaction equation is 
$$0.8 \left( \frac{R^*}{\phi R_b} \right) + \left( \frac{M^*}{\phi M_s} \right) \leq 1.0$$

Substituting values 
$$0.8 \left( \frac{150}{232} \right) + \left( \frac{15.0}{37.8} \right) = 0.914 \leq 1.0$$

$\therefore$  the 150 x 100 x 4.0 RHS – Grade C450L0 (C450PLUS®) is satisfactory.

# Part 5

## MEMBERS SUBJECT TO BENDING

### 5.3 Design Moment Capacities for Members Without Full Lateral Restraint

#### 5.3.1 General

Values of design member moment capacity ( $\phi M_b$ ) are given in Tables 5.3-1 and 5.3-2 for various values of effective length ( $L_e$ ) based on the uniform moment case ( $\alpha_m = 1.0$ ) for RHS bending about the x-axis *without full lateral restraint*. The design section moment capacity ( $\phi M_{sx}$  – see Section 5.2.2.1) is also listed to allow easy calculation of  $\phi M_b$  for other moment distributions, as well as the design shear capacity ( $\phi V_v$  – see Section 5.2.2.4) for checking the interaction of shear force and bending. Additionally, the segment length for full lateral restraint (FLR) is also listed in these Tables.

**CHS and SHS are not included in these tables as they are generally not susceptible to flexural-torsional buckling.** For these sections, the design member moment capacity ( $\phi M_b$ ) always equals the design section moment capacity ( $\phi M_s$ ) except for the extreme case when the load acts far above the shear centre (Clause 5.6.1.4 of the Commentary to AS 4100 – Ref. [5.1]). Values of  $\phi M_s$  (and  $\phi V_v$ ) are given in Tables 8-1 to 8-2 for CHS and Tables 5.2-3 and 5.2-4 and/or Tables 8-5 and 8-6 for SHS.

#### 5.3.2 Design Member Moment Capacity

Designers must ensure that the design bending moment ( $M^*$ )  $\leq \phi M_b$  for all beam segments. The tabulated values of design member moment capacity ( $\phi M_b$ ) are determined in accordance with Clause 5.6.1.4 of AS 4100 as:

where

$$\phi M_b = \phi \alpha_m \alpha_s M_s \leq \phi M_s \quad \text{(Table 3.4 of AS 4100)}$$

$$\phi = 0.9 \quad \text{(Clause 5.6.1.1 of AS 4100)}$$

$$\alpha_m = \text{moment modification factor} \quad \text{(Clause 5.6.1.1 of AS 4100)}$$

$$= 1.0 \text{ (Assumed for all entries in the 5.3 series tables based on the uniform bending moment case)}$$

$$\alpha_s = \text{slenderness reduction modification factor} \quad \text{(Clause 5.6.1.1 of AS 4100)}$$

$$= 0.6 \left\{ \sqrt{\left[ \left( \frac{M_s}{M_{oa}} \right)^2 + 3 \right]} - \left( \frac{M_s}{M_{oa}} \right) \right\} \quad \text{(Equation 5.6.1.1(2) of AS 4100)}$$

$$M_{oa} = M_o - \text{the reference buckling moment (Clause 5.6.1.1(a)(iv)(A) of AS 4100)}$$

$$= \sqrt{\left( \frac{\pi^2 E I_y}{L_e} \right) G J} \quad \text{(equation 5.6.1.1(3) of AS 4100 with } I_w = 0 \text{ as required by Clause 5.6.1.4 of AS 4100)}$$

$L_e$  = effective length of beam segment.

#### 5.3.3 Beam Effective Length

The value of  $\phi M_b$  depends on the effective length ( $L_e$ ) of the flexural member.  $L_e$  is determined by:

$$L_e = k_t k_l k_r L \quad \text{(Clause 5.6.3 of AS 4100)}$$

where

$$k_t = \text{twist restraint factor} \quad \text{(Table 5.6.3(1) of AS 4100)}$$

$$k_l = \text{load height factor} \quad \text{(Table 5.6.3(2) of AS 4100)}$$

$$k_r = \text{lateral rotation restraint factor} \quad \text{(Table 5.6.3(3) of AS 4100)}$$

$$L = \text{length of segment}$$

Ref. [5.4] provides guidance on the restraint conditions on flexural members provided by many common structural steelwork connections. Additionally, Ref. [5.5] considers further guidance on unbraced cantilevers.

#### 5.3.4 Other Loading and Restraint Conditions

The design member moment capacities presented in the 5.3 series tables can be used for other loading conditions. For these situations the effective length ( $L_e$ ) corresponding to the actual length and restraint conditions must be assessed and the appropriate value of  $\alpha_m$  determined in accordance with Clause 5.6.1.1(a) of AS 4100. The design member moment capacity can then be determined as the *lesser* of:

$$\phi M_{sx} = \phi f_y Z_{ex}$$

$$\text{and } \phi M_b = \phi \alpha_m \alpha_s f_y Z_{ex}$$

where  $\phi = 0.9$  (Table 3.4 of AS 4100)

$$\phi M_b = \alpha_m \text{ times the value of } \phi M_b (= \phi \alpha_s f_y Z_{ex}) \text{ given in the 5.3 series tables.}$$

**The 5.3 series tables are based on the most critical moment distribution – i.e. uniform moment over the entire beam segment ( $\alpha_m = 1.0$ ). For other values of  $\alpha_m$ , designers should use the lesser of  $\phi M_{sx}$  and  $\alpha_m (\phi M_b)$  where  $\phi M_b$  is the value given in the appropriate Table for the same effective length.**

# Part 5

## MEMBERS SUBJECT TO BENDING

### 5.3.5 Segment Length for Full Lateral Restraint (FLR)

Section 5.2.2.2 provides information for the calculation of FLR for RHS. The tabulated values of FLR in the 5.3 series tables are based on the conservative value of  $\beta_m = -1.0$ . Higher values of FLR may be obtained if transverse loads are present on the beam segment or if the end moments of the beam segment cause other than uniform bending moment – Clause 5.3.2.4 of AS 4100 should be consulted in these situations.

### 5.3.6 Examples

#### 1. Beam with Restraint at Load Points and Ends

A simply supported beam as shown in Figure 5.4 has two concentrated loads applied to the top flange. Full lateral restraint is provided at the load points and the supports. The calculated design load at each point is 60 kN and includes an allowance for self weight. What thickness 200 x 100 RHS – Grade C450L0 (C450PLUS®) is required to support these loads for the strength limit state?

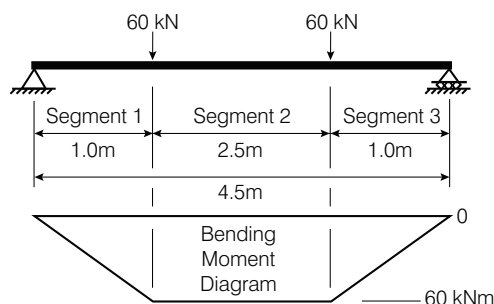


Figure 5.4: Beam and loading configuration for Example 1

#### Design Data:

Design bending moment	$M^*$	=	60 kNm
Design shear force	$V^*$	=	60 kN

#### Solution – Moment and shear:

For beam segment 2: the critical segment by inspection and using Clause 5.3.3 of AS 4100			
End restraint condition	=	FF	(i.e. fully restrained at both ends of the segment)
Twist restraint factor	$k_t$	=	1.0 (Table 5.6.3(1) of AS 4100)
Load height factor	$k_l$	=	1.0 (Table 5.6.3(2) of AS 4100)

$$\begin{aligned} \text{Lateral rotation restraint factor } k_r &= 0.7 && \text{(Table 5.6.3(3) of AS 4100)} \\ \therefore \text{Effective length } L_e &= k_t k_l k_r L \\ &= 1.0 \times 1.0 \times 0.7 \times 2.5 \\ &= 1.75 \text{ m} \\ &\approx 2.0 \text{ m (say, for this example)} \end{aligned}$$

As a uniform bending moment is applied to beam segment 2, then  $\alpha_m = 1.0$  (Table 5.6.1 of AS 4100). Thus the required section can be read directly from Table 5.3-2(2) for a uniform design bending moment of 60 kNm on segment 2 with an effective length ( $L_e$ ) of 2.0 m.

$\therefore$  Choose a 200 x 100 x 5.0 RHS – Grade C450L0 (C450PLUS®) with:

$$\begin{aligned} \phi M_b &= 72.6 \text{ kNm} > M^* \\ \text{and } \phi V_v &= 440 \text{ kN} > V^* \end{aligned} \quad \text{(Note also } 0.6\phi V_v \geq V^* \text{ and no shear – bending interaction check is required. See Section 5.2.4.)}$$

It should also be noted that when looking at Table 5.3-2(2) from the “bottom-up” for the entries of  $\phi M_b > 60.0$  kN in the  $L_e = 2.0$  m column, the 150 x 100 RHS with 8.0, 9.0 and 10.0 mm thickness in C450PLUS® initially satisfy this inequality. However, the 200 x 100 x 5.0 RHS in C450PLUS® was selected as it satisfies the above inequality and is lower in mass (by at least 20%) and has greater stiffness (by at least 24%) than the above listed 150 x 100 RHS.

In terms of design member moment capacity, beam segments 1 and 3 do not have to be checked because they have the same design bending moment (i.e. the maximum segment moment) and end restraints but a shorter effective length when compared with the middle segment. Additionally, the bending moment distribution is less adverse in the end segments (with  $\alpha_m = 1.75$  as noted in Table 5.6.1 of AS 4100). As the end segments have a smaller effective length and larger moment modification factor, the design member moment capacity of these segments cannot be less than that of the central (critical) segment.

This example specifically illustrates the use of the Tables for bending moment and shear design of unrestrained RHS beam sections possibly subject to flexural-torsional buckling (CHS and SHS do not generally experience this instability). However, due to the length, bending moment and restraint conditions, beam segment 2 has full lateral restraint (see Note 4 in Table 5.3-2(2)). The next example considers the above case but without full lateral restraint at the load points (making the RHS subject to flexural-torsional buckling). In all such situations, designers should also undertake checks on bearing (Section 5.2.2.5) and bending-bearing interaction (Section 5.2.5) for the strength limit state and deflections (Sections 5.1 and 5.4) for the serviceability limit state.

# Part 5

## MEMBERS SUBJECT TO BENDING

### 2. Beam with Restraints at Ends Only

Consider the simply supported beam in Example 1 above, check the beam assuming that full lateral restraint is **not** provided at the load points.

#### Design Data:

Design bending moment	$M^*$	=	60 kNm
Design shear force	$V^*$	=	60 kN

#### Solution – Moment and shear:

For entire beam:

End restraint condition		=	FF (i.e. fully restrained at both ends of the segment)
Twist restraint factor	$k_t$	=	1.0 (Table 5.6.3(1) of AS 4100)
Load height factor	$k_l$	=	1.4 (Table 5.6.3(2) of AS 4100 with top flange loading within segment)
Lateral rotation restraint factor	$k_r$	=	1.0 (Table 5.6.3(3) of AS 4100)
∴ Effective length	$L_e$	=	$k_t k_l k_r L$ = $1.0 \times 1.4 \times 1.0 \times 4.5$ = 6.3 m
Moment modification factor	$\alpha_m$	=	1.07 (Second listing in Table 5.6.1 of AS 4100)
To satisfy the strength limit state	$M^*$	≤	$\phi M_b = \phi \alpha_m \alpha_s M_{sx} (\leq \phi M_{sx})$
This can be rewritten as	$M^*/\alpha_m$	=	$60/1.07 = 56.1 \text{ kNm}$ ≤ $\phi(1.0)\alpha_s M_{sx}$

The right hand side of the last inequality is the value of  $\phi M_b$  (based on  $\alpha_m = 1.0$ ) that is found in Table 5.3-2(2).

To design this beam from these Tables

$$M^*/\alpha_m = 56.1 \text{ kNm} < \phi M_b \quad (\text{listed in Table 5.3-2(2)})$$

Therefore the appropriate section can then be read directly from the table using the adjusted design bending moment of  $M^*/\alpha_m$ .

From Table 5.3-2(2), a 200 x 100 x 5.0 RHS – Grade C450L0 (C450PLUS®) has:

$$\begin{aligned} \phi M_b &= 68.6 \text{ kNm (for } L_e = 6.3 \text{ m and } \alpha_m = 1.0 \text{ by linear interpolation)} \\ &> M^*/\alpha_m \quad (= 56.1 \text{ kNm}) \end{aligned}$$

Alternatively, the listed value of  $\phi M_b$  from Table 5.3-2(2) may be multiplied by  $\alpha_m (=1.07)$  and limited if necessary to  $\phi M_{sx}$ . The resulting value then should be greater than or equal to  $M^*$ .

Hence, in terms of design member moment capacity, the 5.0 mm thick section is adequate – that is the same as in Example 1. The reason for this is due to the effect of the (more favourable) non-uniform moment distribution offsetting the negative effects of increased effective length. (An analysis of the effect of increasing effective length on RHS design member moment capacity sees the level of moment capacity reduction being only gradual).

Additionally, from Table 5.3-2(2), for the 200 x 100 x 5.0 RHS – Grade C450L0 (C450PLUS®) section:

$$\phi V_v = 440 \text{ kN} > V^* \quad (\text{Note also } 0.6\phi V_v \geq V^* \text{ and no shear – bending interaction check is required. See Section 5.2.4.)}$$

This example specifically illustrates the use of the Tables for bending moment and shear design of unrestrained RHS beam sections subject to flexural-torsional buckling (CHS and SHS do not generally experience this instability). In such situations, designers should also undertake checks on bearing (Section 5.2.2.5) and bending-bearing interaction (Section 5.2.5) for the strength limit state and deflections (Sections 5.1 and 5.4) for the serviceability limit state.

### 5.4 Calculation of Beam Deflections

Some methods for calculating the elastic deflection of a beam include:

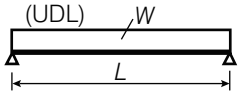
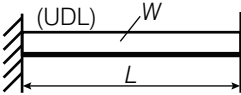
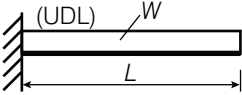
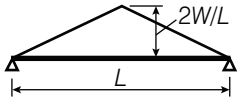
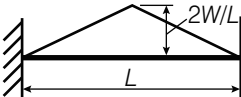
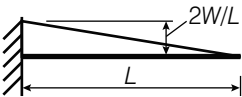
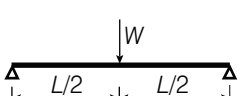
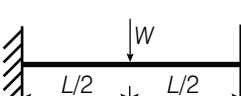
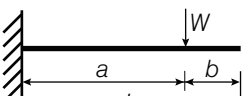
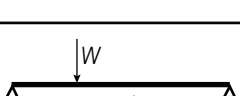
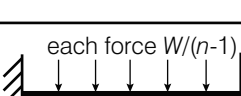
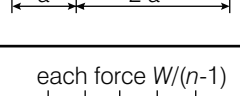
- integration of  $M/EI$  diagram
- moment area
- slope deflection
- published solutions for particular cases
- approximate or numerical methods (e.g. finite elements).

Table T5.2 gives the more commonly used beam deflection formulae. Due to the large range of loading configurations and support conditions considered for beams in design, a comprehensive set of beam deflection formulae is provided in Ref. [5.6].

# Part 5

## MEMBERS SUBJECT TO BENDING

Table T5.2: Beam Deflection Formulae

Simple supported beams	Built in beams	Cantilevers
 $\Delta = \frac{5}{384} \frac{WL^3}{EI}$	 $\Delta = \frac{1}{384} \frac{WL^3}{EI}$	 $\Delta = \frac{1}{8} \frac{WL^3}{EI}$
 $\Delta = \frac{1}{60} \frac{WL^3}{EI}$	 $\Delta = \frac{1.4}{384} \frac{WL^3}{EI}$	 $\Delta = \frac{1}{15} \frac{WL^3}{EI}$
 $\Delta = \frac{1}{48} \frac{WL^3}{EI}$	 $\Delta = \frac{1}{192} \frac{WL^3}{EI}$	 $\Delta = \frac{Wa^3}{EI} \frac{1}{3} \left[ 1 + \frac{3b}{2a} \right]$
 $\Delta = \frac{WL^3}{48EI} \left[ \frac{3a}{L} - 4 \left( \frac{a}{L} \right)^3 \right]$	 $\Delta = \frac{k}{192(n-1)} \frac{WL^3}{EI}$	
 $\Delta = \frac{k}{192(n-1)} \frac{WL^3}{EI}$		
<p><math>n</math> odd, <math>k = \left[ n - \frac{1}{n} \right] \left[ 3 - \frac{1}{2} \left( 1 - \frac{1}{n^2} \right) \right]</math></p> <p><math>n</math> even, <math>k = n \left[ 3 - \frac{1}{2} \left( 1 + \frac{4}{n^2} \right) \right]</math></p>	<p><math>n</math> odd, <math>k = \left[ n - \frac{1}{n} \right] \left[ 1 - \frac{1}{2} \left( 1 - \frac{1}{n^2} \right) \right]</math></p> <p><math>n</math> even, <math>k = \left[ 3 - \frac{1}{2} \left( 1 + \frac{4}{n^2} \right) \right] \times n - \left[ 2 \left( n - \frac{1}{n} \right) \right]</math></p>	

Where:  
 $\Delta$  = maximum deflection  
 $W$  = total load on beam  
 $L$  = span of beam  
 $E$  = Young's modulus of elasticity  
 $I$  = second moment of area of cross-section

# Part 5

## MEMBERS SUBJECT TO BENDING

### 5.5 References

- [5.1] Standards Australia, AS 4100 Supplement 1-1999: "Steel Structures Commentary" (Supplement to AS 4100-1998), Standards Australia, 1999.
- [5.2] Trahair, N.S. and Bradford, M.A., "The Behaviour and Design of Steel Structures to AS 4100", third edition – Australian, E & FN Spon, 1998.
- [5.3] Bridge, R.Q. and Trahair, N.S., "Thin-Walled Beams", Steel Construction, Vol. 15, No. 1, Australian Institute of Steel Construction, 1981 (Note: AISC is now ASI – the Australian Steel Institute).
- [5.4] Trahair, N.S., Hogan, T.J. and Syam, A.A., "Design of Unbraced Beams", Steel Construction, Vol. 27, No. 1, Australian Institute of Steel Construction, March 1993 (Note: AISC is now ASI – the Australian Steel Institute).
- [5.5] Trahair, N.S., "Design of Unbraced Cantilevers", Steel Construction, Vol. 27, No. 3, Australian Institute of Steel Construction, September 1993 (Note: AISC is now ASI – the Australian Steel Institute).
- [5.6] Syam, A.A., "Beam Formulae", Steel Construction, Vol. 26, No. 1, Australian Institute of Steel Construction, March 1992 (Note: AISC is now ASI – the Australian Steel Institute).

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



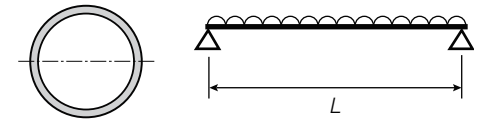
TABLE 5.1-1(A)

# Circular Hollow Sections AS/NZS 1163 Grade C250L0

**STRENGTH** LIMIT STATE MAXIMUM DESIGN LOADS  
FOR SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT

*bending about any axis*

- 1 CHS
- 2 C250L0
- 3 Finish



Designation d <sub>o</sub>	t	Mass per m	W <sub>L1</sub> <sup>*</sup> (kN)															W <sub>L2</sub> <sup>*</sup>
			Span of Beam (L) in metres															
mm	mm	kg/m	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	kN	
165.1	x 5.4	CHS	21.3	496	248	165	124	99.2	82.7	70.9	62.0	55.1	49.6	41.3	35.4	31.0	27.6	439
	5.0	CHS	19.7	462	231	154	115	92.3	76.9	65.9	57.7	51.3	46.2	38.5	33.0	28.8	25.6	407
139.7	x 5.4	CHS	17.9	351	175	117	87.7	70.2	58.5	50.1	43.9	39.0	35.1	29.2	25.1	21.9	19.5	369
	5.0	CHS	16.6	327	163	109	81.7	65.3	54.5	46.7	40.8	36.3	32.7	27.2	23.3	20.4	18.2	343
114.3	x 5.4	CHS	14.5	231	115	76.9	57.7	46.1	38.5	33.0	28.8	25.6	23.1	19.2	16.5	14.4	12.8	299
	4.5	CHS	12.2	195	97.7	65.1	48.9	39.1	32.6	27.9	24.4	21.7	19.5	16.3	14.0	12.2	10.9	251
101.6	x 5.0	CHS	11.9	168	84.1	56.0	42.0	33.6	28.0	24.0	21.0	18.7	16.8	14.0	12.0	10.5	9.34	246
	4.0	CHS	9.63	137	68.6	45.7	34.3	27.4	22.9	19.6	17.2	15.2	13.7	11.4	9.80	8.58	7.62	199
88.9	x 5.9	CHS	12.1	147	73.3	48.9	36.6	29.3	24.4	20.9	18.3	16.3	14.7	12.2	10.5	9.16	8.14	249
	5.0	CHS	10.3	127	63.4	42.3	31.7	25.4	21.1	18.1	15.9	14.1	12.7	10.6	9.06	7.93	7.05	213
	4.0	CHS	8.38	104	51.9	34.6	26.0	20.8	17.3	14.8	13.0	11.5	10.4	8.66	7.42	6.49	5.77	173
76.1	x 5.9	CHS	10.2	105	52.5	35.0	26.2	21.0	17.5	15.0	13.1	11.7	10.5	8.74	7.49	6.56	5.83	211
	4.5	CHS	7.95	83.2	41.6	27.7	20.8	16.6	13.9	11.9	10.4	9.24	8.32	6.93	5.94	5.20	4.62	164
	3.6	CHS	6.44	68.2	34.1	22.7	17.0	13.6	11.4	9.74	8.52	7.58	6.82	5.68	4.87	4.26	3.79	133
60.3	x 5.4	CHS	7.31	58.8	29.4	19.6	14.7	11.8	9.80	8.40	7.35	6.53	5.88	4.90	4.20	3.67	3.27	151
	4.5	CHS	6.19	50.6	25.3	16.9	12.6	10.1	8.43	7.22	6.32	5.62	5.06	4.21	3.61	3.16	2.81	128
	3.6	CHS	5.03	41.7	20.9	13.9	10.4	8.34	6.95	5.96	5.22	4.64	4.17	3.48	2.98	2.61	2.32	104
48.3	x 4.0	CHS	4.37	28.3	14.2	9.45	7.08	5.67	4.72	4.05	3.54	3.15	2.83	2.36	2.02	1.77	1.57	90.2
	3.2	CHS	3.56	23.5	11.7	7.82	5.87	4.69	3.91	3.35	2.93	2.61	2.35	1.96	1.68	1.47	1.30	73.4
42.4	x 4.0	CHS	3.79	21.3	10.7	7.10	5.33	4.26	3.55	3.04	2.66	2.37	2.13	1.78	1.52	1.33	1.18	78.2
	3.2	CHS	3.09	17.7	8.87	5.91	4.44	3.55	2.96	2.53	2.22	1.97	1.77	1.48	1.27	1.11	0.986	63.8
33.7	x 4.0	CHS	2.93	12.8	6.39	4.26	3.19	2.56	2.13	1.83	1.60	1.42	1.28	1.06	0.913	0.799	0.710	60.5
	3.2	CHS	2.41	10.8	5.38	3.59	2.69	2.15	1.79	1.54	1.34	1.20	1.08	0.896	0.768	0.672	0.598	49.7
26.9	x 4.0	CHS	2.26	7.63	3.81	2.54	1.91	1.53	1.27	1.09	0.954	0.848	0.763	0.636	0.545	0.477	0.424	46.6
	3.2	CHS	1.87	6.51	3.25	2.17	1.63	1.30	1.08	0.930	0.814	0.723	0.651	0.542	0.465	0.407	0.362	38.6
	2.6	CHS	1.56	5.55	2.77	1.85	1.39	1.11	0.925	0.793	0.694	0.616	0.555	0.462	0.396	0.347	0.308	32.2

**Notes:**

1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
2. W<sub>L1</sub><sup>\*</sup> = Maximum Design Load based on Design Moment Capacity.
3. W<sub>L2</sub><sup>\*</sup> = Maximum Design Load based on Design Shear Capacity.
4. Maximum Design Load W<sub>L</sub><sup>\*</sup> is LESSER of W<sub>L1</sub><sup>\*</sup> and W<sub>L2</sub><sup>\*</sup>.
5. This product is also compliant with AS 1074 – Steel tubes and tubulars for ordinary service. Refer to the ATM Product Manual for details on AS 1074 sections.

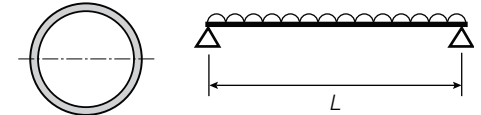
TABLE 5.1-1(B)

# Circular Hollow Sections AS/NZS 1163 Grade C250L0

## **SERVICEABILITY** LIMIT STATE MAXIMUM DESIGN LOADS FOR SIMPLY SUPPORTED BEAMS

*bending about any axis*

- 1 CHS
- 2 C250L0
- 3 Finish



Designation d <sub>o</sub> t	Mass per m	W <sub>s</sub> (kN) Span of Beam (L) in metres														
		kg/m	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0
165.1 x 5.4 CHS	21.3	419	209	140	105	83.8	59.0	43.4	33.2	26.2	21.3	14.8	10.8	8.30	6.56	
	19.7	391	195	130	97.7	78.2	55.1	40.5	31.0	24.5	19.8	13.8	10.1	7.74	6.12	
139.7 x 5.4 CHS	17.9	295	147	98.2	73.7	50.6	35.1	25.8	19.8	15.6	12.6	8.78	6.45	4.94	3.90	
	16.6	275	138	91.7	68.8	47.2	32.8	24.1	18.5	14.6	11.8	8.20	6.03	4.61	3.64	
114.3 x 5.4 CHS	14.5	192	96.1	64.1	42.2	27.0	18.7	13.8	10.5	8.33	6.75	4.69	3.44	2.64	2.08	
	12.2	164	82.0	54.7	36.0	23.0	16.0	11.8	9.00	7.11	5.76	4.00	2.94	2.25	1.78	
101.6 x 5.0 CHS	11.9	140	69.9	46.6	27.3	17.4	12.1	8.90	6.81	5.38	4.36	3.03	2.23	1.70	1.35	
	9.63	115	57.6	38.4	22.5	14.4	9.99	7.34	5.62	4.44	3.60	2.50	1.83	1.40	1.11	
88.9 x 5.9 CHS	12.1	120	59.9	36.4	20.5	13.1	9.09	6.68	5.11	4.04	3.27	2.27	1.67	1.28	1.01	
	10.3	105	52.4	31.8	17.9	11.4	7.94	5.84	4.47	3.53	2.86	1.99	1.46	1.12	0.883	
	8.38	86.7	43.3	26.3	14.8	9.47	6.58	4.83	3.70	2.92	2.37	1.64	1.21	0.925	0.731	
76.1 x 5.9 CHS	10.2	84.9	42.4	22.0	12.4	7.94	5.51	4.05	3.10	2.45	1.98	1.38	1.01	0.775	0.612	
	7.95	68.5	34.2	17.8	10.0	6.40	4.45	3.27	2.50	1.98	1.60	1.11	0.817	0.625	0.494	
	6.44	56.8	28.4	14.7	8.30	5.31	3.69	2.71	2.07	1.64	1.33	0.922	0.677	0.518	0.410	
60.3 x 5.4 CHS	7.31	47.0	21.8	9.67	5.44	3.48	2.42	1.78	1.36	1.07	0.871	0.605	0.444	0.340	0.269	
	6.19	41.0	19.0	8.44	4.75	3.04	2.11	1.55	1.19	0.938	0.759	0.527	0.387	0.297	0.234	
	5.03	34.3	15.9	7.07	3.97	2.54	1.77	1.30	0.994	0.785	0.636	0.442	0.324	0.248	0.196	
48.3 x 4.0 CHS	4.37	22.8	8.46	3.76	2.11	1.35	0.940	0.691	0.529	0.418	0.338	0.235	0.173	0.132	0.104	
	3.56	19.2	7.12	3.16	1.78	1.14	0.791	0.581	0.445	0.352	0.285	0.198	0.145	0.111	0.0879	
42.4 x 4.0 CHS	3.79	17.0	5.52	2.46	1.38	0.884	0.614	0.451	0.345	0.273	0.221	0.153	0.113	0.0863	0.0682	
	3.09	14.4	4.68	2.08	1.17	0.749	0.520	0.382	0.293	0.231	0.187	0.130	0.0955	0.0732	0.0578	
33.7 x 4.0 CHS	2.93	9.95	2.57	1.14	0.644	0.412	0.286	0.210	0.161	0.127	0.103	0.0715	0.0525	0.0402	0.0318	
	2.41	8.56	2.21	0.984	0.554	0.354	0.246	0.181	0.138	0.109	0.0886	0.0615	0.0452	0.0346	0.0273	
26.9 x 4.0 CHS	2.26	4.78	1.19	0.531	0.299	0.191	0.133	0.0975	0.0746	0.0590	0.0478	0.0332	0.0244			
	1.87	4.19	1.05	0.465	0.262	0.167	0.116	0.0854	0.0654	0.0517	0.0419	0.0291	0.0214			
	1.56	3.64	0.910	0.405	0.228	0.146	0.101	0.0743	0.0569	0.0450	0.0364	0.0253				

**Notes:**

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- W<sub>s</sub>\* = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250 or First Yield.
- Red shading indicates serviceability loads governed by yielding.
- This product is also compliant with AS 1074 – Steel tubes and tubulars for ordinary service. Refer to the ATM Product Manual for details on AS 1074 sections.

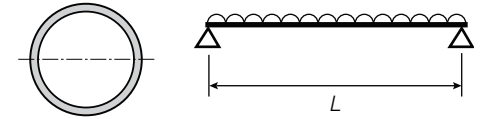
TABLE 5.1-2(1)(A)

# Circular Hollow Sections AS/NZS 1163 Grade C350L0

**STRENGTH** LIMIT STATE MAXIMUM DESIGN LOADS  
FOR SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT

*bending about any axis*

- 1 CHS
- 2 C350L0
- 3 Finish



Designation d <sub>o</sub>	t	Mass per m	W <sub>L</sub> <sup>*</sup> (kN)													W <sub>L2</sub> <sup>*</sup>		
			Span of Beam (L) in metres															
mm	mm	kg/m	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	kN	
508.0 x	12.7	CHS	155	7700	3850	2570	1920	1540	1280	1100	962	855	770	700	641	592	550	4480
	9.5	CHS	117	5470	2730	1820	1370	1090	911	781	683	607	547	497	455	420	390	3370
	6.4	CHS	79.2	3260	1630	1090	816	653	544	466	408	363	326	297	272	251	233	2290
457.0 x	12.7	CHS	139	6310	3160	2100	1580	1260	1050	902	789	701	631	574	526	485	451	4020
	9.5	CHS	105	4520	2260	1510	1130	904	753	646	565	502	452	411	377	348	323	3030
	6.4	CHS	71.1	2750	1370	916	687	550	458	393	343	305	275	250	229	211	196	2050
406.4 x	12.7	CHS	123	4960	2480	1650	1240	992	827	709	620	551	496	451	414	382	354	3560
	9.5	CHS	93.0	3650	1820	1220	912	730	608	521	456	405	365	332	304	281	261	2690
	6.4	CHS	63.1	2260	1130	752	564	451	376	322	282	251	226	205	188	173	161	1820
355.6 x	12.7	CHS	107	3760	1880	1250	941	753	627	538	471	418	376	342	314	290	269	3100
	9.5	CHS	81.1	2850	1420	948	711	569	474	406	356	316	285	259	237	219	203	2340
	6.4	CHS	55.1	1790	894	596	447	358	298	255	224	199	179	163	149	138	128	1590
323.9 x	12.7	CHS	97.5	3100	1550	1030	775	620	517	443	388	345	310	282	258	239	222	2820
	9.5	CHS	73.7	2370	1180	789	592	473	395	338	296	263	237	215	197	182	169	2130
	6.4	CHS	50.1	1510	757	505	379	303	252	216	189	168	151	138	126	117	108	1450
273.1 x	12.7	CHS	81.6	2170	1090	724	543	434	362	310	271	241	217	197	181	167	155	2360
	9.3	CHS	60.5	1630	816	544	408	326	272	233	204	181	163	148	136	126	117	1750
	6.4	CHS	42.1	1110	555	370	278	222	185	159	139	123	111	101	92.5	85.4	79.3	1220
	4.8	CHS	31.8	787	393	262	197	157	131	112	98.3	87.4	78.7	71.5	65.6	60.5	56.2	918
219.1 x	8.2	CHS	42.6	920	460	307	230	184	153	131	115	102	92.0	83.6	76.6	70.7	65.7	1230
	6.4	CHS	33.6	730	365	243	182	146	122	104	91.2	81.1	73.0	66.4	60.8	56.1	52.1	970
	4.8	CHS	25.4	530	265	177	133	106	88.3	75.7	66.3	58.9	53.0	48.2	44.2	40.8	37.9	733
168.3 x	7.1	CHS	28.2	465	233	155	116	93.0	77.5	66.5	58.2	51.7	46.5	42.3	38.8	35.8	33.2	815
	6.4	CHS	25.6	423	211	141	106	84.6	70.5	60.4	52.9	47.0	42.3	38.5	35.2	32.5	30.2	738
	4.8	CHS	19.4	323	162	108	80.9	64.7	53.9	46.2	40.4	35.9	32.3	29.4	27.0	24.9	23.1	559

**Notes:**

1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
2. W<sub>L1</sub><sup>\*</sup> = Maximum Design Load based on Design Moment Capacity.
3. W<sub>L2</sub><sup>\*</sup> = Maximum Design Load based on Design Shear Capacity.
4. Maximum Design Load W<sub>L</sub><sup>\*</sup> is LESSER of W<sub>L1</sub><sup>\*</sup> and W<sub>L2</sub><sup>\*</sup>.

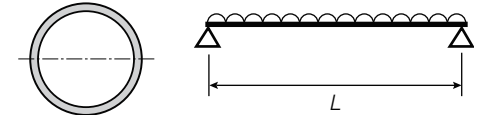
TABLE 5.1-2(1)(B)

# Circular Hollow Sections AS/NZS 1163 Grade C350L0

## **SERVICEABILITY** LIMIT STATE MAXIMUM DESIGN LOADS FOR SIMPLY SUPPORTED BEAMS

*bending about any axis*

- 1 CHS
- 2 C350L0
- 3 Finish



Designation	d <sub>o</sub>	t	Mass per m	W <sub>s</sub> (kN)													
				Span of Beam (L) in metres													
mm	mm	mm	kg/m	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
508.0 x	12.7	CHS	155	6680	3340	2230	1670	1340	1030	760	582	460	373	308	259	220	190
		CHS	117	5100	2550	1700	1270	1020	789	580	444	351	284	235	197	168	145
		CHS	79.2	3500	1750	1170	874	699	541	398	305	241	195	161	135	115	99.4
457.0 x	12.7	CHS	139	5360	2680	1790	1340	1070	747	549	420	332	269	222	187	159	137
		CHS	105	4100	2050	1370	1020	820	571	419	321	254	205	170	143	122	105
		CHS	71.1	2820	1410	939	705	564	393	288	221	174	141	117	98.1	83.6	72.1
406.4 x	12.7	CHS	123	4200	2100	1400	1050	749	520	382	292	231	187	155	130	111	95.5
		CHS	93.0	3220	1610	1070	804	574	398	293	224	177	143	119	99.6	84.8	73.2
		CHS	63.1	2220	1110	739	554	395	275	202	154	122	98.9	81.7	68.6	58.5	50.4
355.6 x	12.7	CHS	107	3170	1590	1060	773	495	344	252	193	153	124	102	85.9	73.2	63.1
		CHS	81.1	2440	1220	812	594	380	264	194	149	117	95.1	78.6	66.0	56.3	48.5
		CHS	55.1	1690	843	562	411	263	183	134	103	81.2	65.8	54.4	45.7	38.9	33.6
323.9 x	12.7	CHS	97.5	2600	1300	868	578	370	257	189	145	114	92.5	76.4	64.2	54.7	47.2
		CHS	73.7	2010	1000	669	446	285	198	146	111	88.0	71.3	58.9	49.5	42.2	36.4
		CHS	50.1	1390	696	464	309	198	137	101	77.3	61.0	49.4	40.9	34.3	29.3	25.2
273.1 x	12.7	CHS	81.6	1810	905	603	339	217	151	111	84.7	67.0	54.2	44.8	37.7	32.1	27.7
		CHS	60.5	1380	688	458	258	165	115	84.2	64.4	50.9	41.2	34.1	28.6	24.4	21.0
		CHS	42.1	978	489	326	183	117	81.4	59.8	45.8	36.2	29.3	24.2	20.4	17.3	15.0
		CHS	31.8	747	373	249	140	89.5	62.2	45.7	35.0	27.6	22.4	18.5	15.5	13.2	11.4
219.1 x	8.2	CHS	42.6	773	387	207	116	74.3	51.6	37.9	29.0	22.9	18.6	15.4	12.9	11.0	9.48
		CHS	33.6	619	309	165	93.0	59.5	41.3	30.4	23.2	18.4	14.9	12.3	10.3	8.80	7.59
		CHS	25.4	474	237	127	71.3	45.6	31.7	23.3	17.8	14.1	11.4	9.42	7.92	6.75	5.82
168.3 x	7.1	CHS	28.2	389	180	79.9	44.9	28.8	20.0	14.7	11.2	8.88	7.19	5.94	4.99	4.25	3.67
		CHS	25.6	355	164	72.9	41.0	26.3	18.2	13.4	10.3	8.10	6.56	5.42	4.56	3.88	3.35
		CHS	19.4	274	127	56.3	31.7	20.3	14.1	10.3	7.92	6.25	5.07	4.19	3.52	3.00	2.58

**Notes:**

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- W<sub>s</sub>\* = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250 or First Yield.
- Red shading indicates serviceability loads governed by yielding.

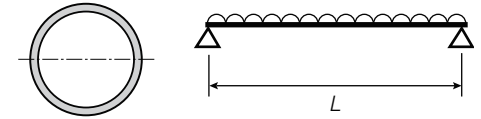
TABLE 5.1-2(2)(A)

# Circular Hollow Sections AS/NZS 1163 Grade C350L0

**STRENGTH** LIMIT STATE MAXIMUM DESIGN LOADS  
FOR SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT

*bending about any axis*

- 1 CHS
- 2 C350L0
- 3 Finish



Designation d <sub>o</sub>	Designation t	Mass per m	W <sub>L1</sub> * (kN) Span of Beam (L) in metres														W <sub>L2</sub> kN	
			0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0		
165.1	x 3.5	CHS	13.9	436	218	145	109	87.3	72.7	62.3	54.5	48.5	43.6	36.4	31.2	27.3	24.2	403
	3.0	CHS	12.0	362	181	121	90.6	72.4	60.4	51.7	45.3	40.2	36.2	30.2	25.9	22.6	20.1	346
139.7	x 3.5	CHS	11.8	321	160	107	80.2	64.2	53.5	45.8	40.1	35.7	32.1	26.7	22.9	20.1	17.8	340
	3.0	CHS	10.1	268	134	89.5	67.1	53.7	44.7	38.3	33.6	29.8	26.8	22.4	19.2	16.8	14.9	292
114.3	x 3.6	CHS	9.83	222	111	74.1	55.6	44.5	37.1	31.8	27.8	24.7	22.2	18.5	15.9	13.9	12.4	284
	3.2	CHS	8.77	199	99.6	66.4	49.8	39.8	33.2	28.4	24.9	22.1	19.9	16.6	14.2	12.4	11.1	253
101.6	x 3.2	CHS	7.77	156	78.1	52.1	39.1	31.2	26.0	22.3	19.5	17.4	15.6	13.0	11.2	9.76	8.68	224
	2.6	CHS	6.35	126	63.2	42.1	31.6	25.3	21.1	18.1	15.8	14.0	12.6	10.5	9.03	7.90	7.02	183
88.9	x 3.2	CHS	6.76	119	59.3	39.5	29.6	23.7	19.8	16.9	14.8	13.2	11.9	9.88	8.46	7.41	6.58	195
	2.6	CHS	5.53	97.6	48.8	32.5	24.4	19.5	16.3	13.9	12.2	10.8	9.76	8.14	6.97	6.10	5.42	160
76.1	x 3.2	CHS	5.75	85.8	42.9	28.6	21.4	17.2	14.3	12.3	10.7	9.53	8.58	7.15	6.13	5.36	4.76	166
	2.3	CHS	4.19	63.2	31.6	21.1	15.8	12.6	10.5	9.02	7.89	7.02	6.32	5.26	4.51	3.95	3.51	121
60.3	x 2.9	CHS	4.11	48.2	24.1	16.1	12.0	9.64	8.03	6.89	6.02	5.36	4.82	4.02	3.44	3.01	2.68	119
	2.3	CHS	3.29	39.0	19.5	13.0	9.75	7.80	6.50	5.57	4.88	4.34	3.90	3.25	2.79	2.44	2.17	95.0
48.3	x 2.9	CHS	3.25	30.2	15.1	10.1	7.54	6.03	5.03	4.31	3.77	3.35	3.02	2.51	2.15	1.89	1.68	93.8
	2.3	CHS	2.61	24.5	12.3	8.18	6.14	4.91	4.09	3.51	3.07	2.73	2.45	2.05	1.75	1.53	1.36	75.4
42.4	x 2.6	CHS	2.55	20.8	10.4	6.93	5.20	4.16	3.46	2.97	2.60	2.31	2.08	1.73	1.48	1.30	1.15	73.7
	2.0	CHS	1.99	16.5	8.23	5.49	4.12	3.29	2.74	2.35	2.06	1.83	1.65	1.37	1.18	1.03	0.915	57.6
33.7	x 2.6	CHS	1.99	12.7	6.35	4.23	3.18	2.54	2.12	1.81	1.59	1.41	1.27	1.06	0.907	0.794	0.706	57.6
	2.0	CHS	1.56	10.1	5.07	3.38	2.54	2.03	1.69	1.45	1.27	1.13	1.01	0.845	0.724	0.634	0.563	45.2
26.9	x 2.3	CHS	1.40	7.04	3.52	2.35	1.76	1.41	1.17	1.01	0.879	0.782	0.704	0.586	0.503	0.440	0.391	40.3
	2.0	CHS	1.23	6.26	3.13	2.09	1.57	1.25	1.04	0.895	0.783	0.696	0.626	0.522	0.447	0.391	0.348	35.5

**Notes:**

1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
2. W<sub>L1</sub>\* = Maximum Design Load based on Design Moment Capacity.
3. W<sub>L2</sub>\* = Maximum Design Load based on Design Shear Capacity.
4. Maximum Design Load W<sub>L</sub>\* is LESSER of W<sub>L1</sub>\* and W<sub>L2</sub>\*.

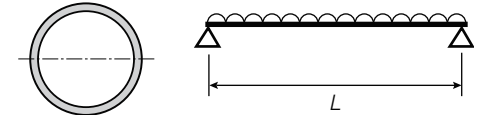
TABLE 5.1-2(2)(B)

# Circular Hollow Sections AS/NZS 1163 Grade C350L0

## **SERVICEABILITY** LIMIT STATE MAXIMUM DESIGN LOADS FOR SIMPLY SUPPORTED BEAMS

*bending about any axis*

- 1 CHS
- 2 C350L0
- 3 Finish



Designation	d <sub>o</sub>	t	Mass per m	W <sub>s</sub> * (kN)													
				Span of Beam (L) in metres													
mm	mm	mm	kg/m	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0
165.1 x 3.5 CHS	3.5	CHS	13.9	394	197	131	89.1	57.0	39.6	29.1	22.3	17.6	14.3	9.90	7.28	5.57	4.40
		CHS	12.0	341	170	114	77.1	49.3	34.3	25.2	19.3	15.2	12.3	8.57	6.29	4.82	3.81
139.7 x 3.5 CHS	3.5	CHS	11.8	279	139	92.9	53.4	34.2	23.7	17.4	13.3	10.5	8.54	5.93	4.36	3.34	2.64
		CHS	10.1	241	121	80.5	46.2	29.6	20.6	15.1	11.6	9.14	7.40	5.14	3.78	2.89	2.28
114.3 x 3.6 CHS	3.6	CHS	9.83	188	94.1	52.4	29.5	18.9	13.1	9.63	7.37	5.82	4.72	3.28	2.41	1.84	1.46
		CHS	8.77	169	84.5	47.1	26.5	17.0	11.8	8.65	6.62	5.23	4.24	2.94	2.16	1.66	1.31
101.6 x 3.2 CHS	3.2	CHS	7.77	132	66.1	32.7	18.4	11.8	8.18	6.01	4.60	3.64	2.95	2.05	1.50	1.15	0.909
		CHS	6.35	109	54.6	27.1	15.2	9.75	6.77	4.97	3.81	3.01	2.44	1.69	1.24	0.952	0.752
88.9 x 3.2 CHS	3.2	CHS	6.76	99.8	48.7	21.6	12.2	7.79	5.41	3.97	3.04	2.40	1.95	1.35	0.993	0.760	0.601
		CHS	5.53	82.8	40.4	17.9	10.1	6.46	4.48	3.29	2.52	1.99	1.61	1.12	0.824	0.631	0.498
76.1 x 3.2 CHS	3.2	CHS	5.75	71.8	30.0	13.3	7.49	4.80	3.33	2.45	1.87	1.48	1.20	0.832	0.612	0.468	0.370
		CHS	4.19	53.5	22.3	9.92	5.58	3.57	2.48	1.82	1.40	1.10	0.893	0.620	0.456	0.349	0.276
60.3 x 2.9 CHS	2.9	CHS	4.11	40.1	13.3	5.90	3.32	2.12	1.47	1.08	0.829	0.655	0.531	0.369	0.271	0.207	0.164
		CHS	3.29	32.8	10.8	4.82	2.71	1.74	1.20	0.885	0.678	0.536	0.434	0.301	0.221	0.169	0.134
48.3 x 2.9 CHS	2.9	CHS	3.25	24.8	6.57	2.92	1.64	1.05	0.730	0.537	0.411	0.325	0.263	0.183	0.134	0.103	0.0812
		CHS	2.61	20.4	5.41	2.41	1.35	0.866	0.602	0.442	0.338	0.267	0.217	0.150	0.111	0.0846	0.0669
42.4 x 2.6 CHS	2.6	CHS	2.55	15.9	3.97	1.77	0.993	0.635	0.441	0.324	0.248	0.196	0.159	0.110	0.0811	0.0621	0.0490
		CHS	1.99	12.8	3.19	1.42	0.797	0.510	0.354	0.260	0.199	0.158	0.128	0.0886	0.0651	0.0498	0.0394
33.7 x 2.6 CHS	2.6	CHS	1.99	7.60	1.90	0.845	0.475	0.304	0.211	0.155	0.119	0.0938	0.0760	0.0528	0.0388	0.0297	0.0235
		CHS	1.56	6.17	1.54	0.686	0.386	0.247	0.171	0.126	0.0965	0.0762	0.0617	0.0429	0.0315	0.0241	
26.9 x 2.3 CHS	2.3	CHS	1.40	3.33	0.833	0.370	0.208	0.133	0.0926	0.0680	0.0521	0.0412	0.0333	0.0231			
		CHS	1.23	3.00	0.750	0.333	0.187	0.120	0.0833	0.0612	0.0469	0.0370	0.0300	0.0208			

**Notes:**

1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
2. W<sub>s</sub>\* = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250 or First Yield.
3. Red shading indicates serviceability loads governed by yielding.

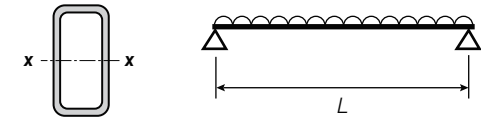
TABLE 5.1-3(A)

# Rectangular Hollow Sections AS/NZS 1163 Grade C350L0

**STRENGTH** LIMIT STATE MAXIMUM DESIGN LOADS  
FOR SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT

*bending about x-axis*

- 1 RHS
- 2 C350L0
- 3 Finish



d	Designation			Mass per m	$W_{L1}^*$ (kN)														$W_{L2}^*$	FLR		
	b	t			Span of Beam (L) in metres																	
mm	mm	mm		kg/m	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	4.50	5.00	6.00	kN	m		
75	x	25	x	2.5	RHS	3.60	50.7	33.8	25.4	20.3	16.9	14.5	12.7	10.1	8.45	7.24	6.34	5.63	5.07	4.23	123	1.47
				2.0	RHS	2.93	41.9	27.9	20.9	16.8	14.0	12.0	10.5	8.38	6.98	5.98	5.23	4.65	4.19	3.49	99.9	1.50
				1.6	RHS	2.38	34.3	22.9	17.2	13.7	11.4	9.81	8.59	6.87	5.72	4.91	4.29	3.82	3.43	2.86	80.8	1.53
65	x	35	x	4.0	RHS	5.35	66.9	44.6	33.5	26.8	22.3	19.1	16.7	13.4	11.2	9.56	8.37	7.44	6.69	5.58	165	3.10
				3.0	RHS	4.25	55.4	36.9	27.7	22.2	18.5	15.8	13.8	11.1	9.23	7.91	6.92	6.16	5.54	4.62	128	3.23
				2.5	RHS	3.60	47.6	31.8	23.8	19.1	15.9	13.6	11.9	9.53	7.94	6.81	5.96	5.29	4.76	3.97	108	3.28
				2.0	RHS	2.93	39.3	26.2	19.7	15.7	13.1	11.2	9.83	7.86	6.55	5.62	4.91	4.37	3.93	3.28	88.2	3.33
50	x	25	x	3.0	RHS	3.07	29.5	19.7	14.8	11.8	9.85	8.44	7.39	5.91	4.92	4.22	3.69	3.28	2.95	2.46	95.0	2.08
				2.5	RHS	2.62	25.7	17.2	12.9	10.3	8.58	7.35	6.43	5.15	4.29	3.68	3.22	2.86	2.57	2.14	81.0	2.12
				2.0	RHS	2.15	21.5	14.3	10.7	8.59	7.16	6.14	5.37	4.30	3.58	3.07	2.69	2.39	2.15	1.79	66.2	2.17
				1.6	RHS	1.75	17.8	11.8	8.88	7.11	5.92	5.08	4.44	3.55	2.96	2.54	2.22	1.97	1.78	1.48	53.9	2.21
50	x	20	x	3.0	RHS	2.83	26.0	17.3	13.0	10.4	8.66	7.43	6.50	5.20	4.33	3.71	3.25	2.89	2.60	2.17	93.8	1.31
				2.5	RHS	2.42	22.7	15.2	11.4	9.10	7.58	6.50	5.68	4.55	3.79	3.25	2.84	2.53	2.27	1.89	80.0	1.35
				2.0	RHS	1.99	19.1	12.7	9.53	7.63	6.35	5.45	4.77	3.81	3.18	2.72	2.38	2.12	1.91	1.59	65.4	1.39
				1.6	RHS	1.63	15.8	10.5	7.91	6.33	5.27	4.52	3.95	3.16	2.64	2.26	1.98	1.76	1.58	1.32	53.2	1.42

**Notes:**

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- $W_{L1}^*$  = Maximum Design Load based on Design Moment Capacity.
- $W_{L2}^*$  = Maximum Design Load based on Design Shear Capacity.
- Maximum Design Load  $W_L$  is LESSER of  $W_{L1}^*$  and  $W_{L2}^*$ .
- FLR – segment length for Full Lateral Restraint (Clause 5.3.2.4 of AS 4100) based on transverse load case with  $\beta_m = -0.8$ .

**ADDITIONAL NOTES:**

- THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.
- SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.

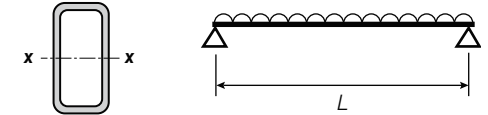
TABLE 5.1-3(B)

# Rectangular Hollow Sections AS/NZS 1163 Grade C350L0

## **SERVICEABILITY** LIMIT STATE MAXIMUM DESIGN LOADS FOR SIMPLY SUPPORTED BEAMS

*bending about x-axis*

- 1 RHS
- 2 C350L0
- 3 Finish



Designation			Mass per m	W <sub>s</sub> (kN)																
d	b	t		Span of Beam (L) in metres																
mm	mm	mm	kg/m	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	4.50	5.00	6.00			
75	x	25	x	2.5	RHS	3.60	42.6	28.4	17.5	11.2	7.79	5.72	4.38	2.80	1.95	1.43	1.10	0.865	0.701	0.487
				2.0	RHS	2.93	35.6	23.7	14.6	9.37	6.51	4.78	3.66	2.34	1.63	1.20	0.915	0.723	0.586	0.407
				1.6	RHS	2.38	29.5	19.6	12.1	7.76	5.39	3.96	3.03	1.94	1.35	0.990	0.758	0.599	0.485	0.337
65	x	35	x	4.0	RHS	5.35	56.6	35.8	20.2	12.9	8.96	6.58	5.04	3.23	2.24	1.65	1.26	0.996	0.807	0.560
				3.0	RHS	4.25	48.4	30.7	17.3	11.1	7.67	5.64	4.32	2.76	1.92	1.41	1.08	0.853	0.691	0.480
				2.5	RHS	3.60	42.1	26.7	15.0	9.61	6.68	4.90	3.76	2.40	1.67	1.23	0.939	0.742	0.601	0.417
				2.0	RHS	2.93	35.2	22.3	12.5	8.02	5.57	4.09	3.13	2.01	1.39	1.02	0.783	0.619	0.501	0.348
50	x	25	x	3.0	RHS	3.07	25.0	12.2	6.86	4.39	3.05	2.24	1.72	1.10	0.763	0.560	0.429	0.339	0.275	0.191
				2.5	RHS	2.62	22.1	10.8	6.07	3.89	2.70	1.98	1.52	0.972	0.675	0.496	0.380	0.300	0.243	0.169
				2.0	RHS	2.15	18.8	9.16	5.15	3.30	2.29	1.68	1.29	0.824	0.572	0.420	0.322	0.254	0.206	0.143
				1.6	RHS	1.75	15.7	7.67	4.31	2.76	1.92	1.41	1.08	0.690	0.479	0.352	0.269	0.213	0.172	0.120
50	x	20	x	3.0	RHS	2.83	21.3	10.4	5.84	3.74	2.60	1.91	1.46	0.935	0.649	0.477	0.365	0.289	0.234	0.162
				2.5	RHS	2.42	19.0	9.26	5.21	3.33	2.31	1.70	1.30	0.833	0.579	0.425	0.325	0.257	0.208	0.145
				2.0	RHS	1.99	16.2	7.90	4.44	2.84	1.97	1.45	1.11	0.711	0.494	0.363	0.278	0.219	0.178	0.123
				1.6	RHS	1.63	13.6	6.64	3.74	2.39	1.66	1.22	0.934	0.598	0.415	0.305	0.234	0.184	0.149	0.104

**Notes:**

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- W<sub>s</sub>\* = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250 or First Yield.
- Red shading indicates serviceability loads governed by yielding.

**ADDITIONAL NOTES:**

- (A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.
- (B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.



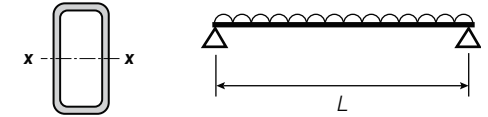
TABLE 5.1-4(1)(A)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

**STRENGTH** LIMIT STATE MAXIMUM DESIGN LOADS  
FOR SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT

*bending about x-axis*

- 1 RHS
- 2 C450PLUS®
- 3 Finish



d	Designation			Mass per m	$W_L^*$ (kN)														$W_{L2}^*$	FLR	
	b	t			Span of Beam (L) in metres																
mm	mm	mm		kg/m	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	kN	m	
400	x	300	x	16.0 RHS	161	8920	4460	2970	2230	1780	1490	1270	1110	991	892	811	743	686	637	5570	29.8
				12.5 RHS	128	7210	3610	2400	1800	1440	1200	1030	901	801	721	656	601	555	515	4440	30.2
				10.0 RHS	104	5190	2590	1730	1300	1040	865	741	649	577	519	472	432	399	371	3600	30.5
				8.0 RHS	84.2	3710	1850	1240	927	742	618	530	463	412	371	337	309	285	265	2910	30.7
400	x	200	x	16.0 RHS	136	6930	3460	2310	1730	1390	1150	990	866	770	693	630	577	533	495	5450	13.5
				12.5 RHS	109	5640	2820	1880	1410	1130	940	806	705	627	564	513	470	434	403	4340	13.7
				10.0 RHS	88.4	4650	2320	1550	1160	929	774	664	581	516	465	422	387	357	332	3520	13.9
				8.0 RHS	71.6	3740	1870	1250	935	748	623	534	467	415	374	340	312	288	267	2840	14.1
350	x	250	x	16.0 RHS	136	6460	3230	2150	1610	1290	1080	922	807	717	646	587	538	497	461	4800	23.5
				12.5 RHS	109	5250	2630	1750	1310	1050	876	751	657	584	525	478	438	404	375	3840	23.9
				10.0 RHS	88.4	4260	2130	1420	1070	852	710	609	533	474	426	387	355	328	304	3120	24.2
				8.0 RHS	71.6	3010	1500	1000	752	601	501	429	376	334	301	273	251	231	215	2520	24.4
300	x	200	x	16.0 RHS	111	4380	2190	1460	1100	877	731	626	548	487	438	399	365	337	313	4030	17.3
				12.5 RHS	89.0	3600	1800	1200	901	720	600	515	450	400	360	327	300	277	257	3230	17.7
				10.0 RHS	72.7	2980	1490	995	746	597	497	426	373	332	298	271	249	230	213	2630	18.0
				8.0 RHS	59.1	2420	1210	805	604	483	403	345	302	268	242	220	201	186	173	2140	18.2
				6.0 RHS	45.0	1540	768	512	384	307	256	220	192	171	154	140	128	118	110	1630	18.4
250	x	150	x	16.0 RHS	85.5	2700	1350	900	675	540	450	386	338	300	270	246	225	208	193	3260	11.5
				12.5 RHS	69.4	2250	1130	751	563	451	376	322	282	250	225	205	188	173	161	2630	11.8
				10.0 RHS	57.0	1890	943	629	471	377	314	269	236	210	189	171	157	145	135	2150	12.0
				9.0 RHS	51.8	1730	864	576	432	345	288	247	216	192	173	157	144	133	123	1950	12.1
				8.0 RHS	46.5	1560	781	521	391	312	260	223	195	174	156	142	130	120	112	1750	12.2
				6.0 RHS	35.6	1190	597	398	298	239	199	171	149	133	119	109	99.5	91.8	85.3	1340	12.4
				5.0 RHS	29.9	891	446	297	223	178	149	127	111	99.0	89.1	81.0	74.3	68.6	63.7	1120	12.5

**Notes:**

1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3.  $W_{L1}^*$  = Maximum Design Load based on Design Moment Capacity.
4.  $W_{L2}^*$  = Maximum Design Load based on Design Shear Capacity.
5. Maximum Design Load  $W_L^*$  is LESSER of  $W_{L1}^*$  and  $W_{L2}^*$ .
6. FLR – segment length for Full Lateral Restraint (Clause 5.3.2.4 of AS 4100) based on transverse load case with  $\beta_m = -0.8$ .

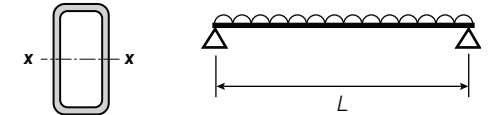
TABLE 5.1-4(1)(B)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

**SERVICEABILITY** LIMIT STATE MAXIMUM DESIGN LOADS  
FOR SIMPLY SUPPORTED BEAMS

*bending about x-axis*

- 1 RHS
- 2 C450PLUS®
- 3 Finish



Designation				Mass per m	W <sub>s</sub> <sup>*</sup> (kN)															
d	b	t			Span of Beam (L) in metres															
mm	mm	mm		kg/m	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0		
400	x	300	x	16.0	RHS	161	8150	4070	2720	1740	1110	772	567	434	343	278	230	193	165	142
				12.5	RHS	128	6670	3330	2220	1420	910	632	464	356	281	228	188	158	135	116
				10.0	RHS	104	5510	2750	1840	1180	752	522	384	294	232	188	155	131	111	96.0
				8.0	RHS	84.2	4520	2260	1510	965	617	429	315	241	191	154	128	107	91.3	78.7
400	x	200	x	16.0	RHS	136	6020	3010	2010	1280	822	571	419	321	254	206	170	143	122	105
				12.5	RHS	109	4980	2490	1660	1060	680	472	347	265	210	170	140	118	101	86.7
				10.0	RHS	88.4	4140	2070	1380	883	565	393	288	221	174	141	117	98.1	83.6	72.1
				8.0	RHS	71.6	3420	1710	1140	729	466	324	238	182	144	117	96.3	81.0	69.0	59.5
350	x	250	x	16.0	RHS	136	5820	2910	1930	1090	695	483	355	271	214	174	144	121	103	88.6
				12.5	RHS	109	4800	2400	1590	896	574	398	293	224	177	143	119	99.6	84.9	73.2
				10.0	RHS	88.4	3990	2000	1320	745	477	331	243	186	147	119	98.5	82.8	70.6	60.8
				8.0	RHS	71.6	3290	1650	1090	614	393	273	201	154	121	98.3	81.2	68.3	58.2	50.2
300	x	200	x	16.0	RHS	111	3870	1940	1100	619	396	275	202	155	122	99.1	81.9	68.8	58.6	50.6
				12.5	RHS	89.0	3240	1620	921	518	332	230	169	130	102	82.9	68.5	57.6	49.0	42.3
				10.0	RHS	72.7	2720	1360	772	434	278	193	142	109	85.8	69.5	57.4	48.3	41.1	35.5
				8.0	RHS	59.1	2250	1130	641	361	231	160	118	90.1	71.2	57.7	47.7	40.1	34.1	29.4
	6.0	RHS	45.0	1750	876	498	280	179	125	91.5	70.1	55.4	44.9	37.1	31.1	26.5	22.9			
250	x	150	x	16.0	RHS	85.5	2310	1150	547	308	197	137	101	77.0	60.8	49.3	40.7	34.2	29.1	25.1
				12.5	RHS	69.4	1970	986	468	263	168	117	85.9	65.8	52.0	42.1	34.8	29.2	24.9	21.5
				10.0	RHS	57.0	1680	839	398	224	143	99.4	73.0	55.9	44.2	35.8	29.6	24.9	21.2	18.3
				9.0	RHS	51.8	1550	773	367	206	132	91.6	67.3	51.5	40.7	33.0	27.3	22.9	19.5	16.8
				8.0	RHS	46.5	1410	704	334	188	120	83.4	61.3	46.9	37.1	30.0	24.8	20.8	17.8	15.3
				6.0	RHS	35.6	1110	553	262	147	94.3	65.5	48.1	36.8	29.1	23.6	19.5	16.4	13.9	12.0
	5.0	RHS	29.9	942	471	223	126	80.4	55.8	41.0	31.4	24.8	20.1	16.6	14.0	11.9	10.3			

**Notes:**

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- $W_s^*$  = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250 or First Yield.
- Red shading indicates serviceability loads governed by yielding.

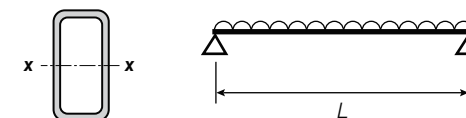
TABLE 5.1-4(2)(A)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

**STRENGTH** LIMIT STATE MAXIMUM DESIGN LOADS  
FOR SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT

*bending about x-axis*

- 1 RHS
- 2 C450PLUS®
- 3 Finish



d	Designation			Mass per m	$W_L^*$ (kN)														$W_{L2}^*$	FLR
	b	t			Span of Beam (L) in metres															
mm	mm	mm		kg/m	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	kN	m
200	x 100	x 10.0	RHS	41.3	1030	515	344	258	206	172	147	129	115	103	93.7	85.9	79.3	73.6	1670	6.57
			RHS	37.7	951	475	317	238	190	158	136	119	106	95.1	86.4	79.2	73.1	67.9	1520	6.65
			RHS	33.9	866	433	289	216	173	144	124	108	96.2	86.6	78.7	72.2	66.6	61.9	1360	6.73
			RHS	26.2	681	340	227	170	136	113	97.3	85.1	75.7	68.1	61.9	56.7	52.4	48.6	1040	6.89
			RHS	22.1	581	290	194	145	116	96.8	83.0	72.6	64.5	58.1	52.8	48.4	44.7	41.5	879	6.97
152	x 76	x 6.0	RHS	19.4	376	188	125	94.0	75.2	62.7	53.7	47.0	41.8	37.6	34.2	31.3	28.9	26.9	778	5.12
			RHS	16.4	323	162	108	80.8	64.7	53.9	46.2	40.4	35.9	32.3	29.4	26.9	24.9	23.1	657	5.20
			RHS	16.4	323	162	108	80.8	64.7	53.9	46.2	40.4	35.9	32.3	29.4	26.9	24.9	23.1	657	5.20
150	x 100	x 10.0	RHS	33.4	645	323	215	161	129	108	92.2	80.7	71.7	64.5	58.7	53.8	49.6	46.1	1220	8.44
			RHS	30.6	599	299	200	150	120	99.8	85.5	74.8	66.5	59.9	54.4	49.9	46.0	42.8	1120	8.55
			RHS	27.7	548	274	183	137	110	91.3	78.3	68.5	60.9	54.8	49.8	45.7	42.2	39.1	1010	8.66
			RHS	21.4	435	218	145	109	87.1	72.5	62.2	54.4	48.4	43.5	39.6	36.3	33.5	31.1	779	8.88
			RHS	18.2	373	186	124	93.2	74.6	62.2	53.3	46.6	41.4	37.3	33.9	31.1	28.7	26.6	658	8.99
150	x 50	x 6.0	RHS	16.7	295	148	98.4	73.8	59.1	49.2	42.2	36.9	32.8	29.5	26.8	24.6	22.7	21.1	749	2.23
			RHS	14.2	256	128	85.2	63.9	51.1	42.6	36.5	31.9	28.4	25.6	23.2	21.3	19.7	18.3	633	2.28
			RHS	11.6	212	106	70.7	53.0	42.4	35.3	30.3	26.5	23.6	21.2	19.3	17.7	16.3	15.1	514	2.33
			RHS	8.96	167	83.3	55.5	41.7	33.3	27.8	23.8	20.8	18.5	16.7	15.1	13.9	12.8	11.9	391	2.39
			RHS	7.53	141	70.5	47.0	35.3	28.2	23.5	20.1	17.6	15.7	14.1	12.8	11.8	10.8	10.1	328	2.41
127	x 51	x 6.0	RHS	14.7	223	112	74.5	55.8	44.7	37.2	31.9	27.9	24.8	22.3	20.3	18.6	17.2	16.0	631	2.70
			RHS	12.5	194	97.1	64.7	48.5	38.8	32.4	27.7	24.3	21.6	19.4	17.7	16.2	14.9	13.9	535	2.76
			RHS	9.07	144	72.2	48.2	36.1	28.9	24.1	20.6	18.1	16.1	14.4	13.1	12.0	11.1	10.3	384	2.86
125	x 75	x 6.0	RHS	16.7	273	136	91.0	68.2	54.6	45.5	39.0	34.1	30.3	27.3	24.8	22.7	21.0	19.5	634	5.93
			RHS	14.2	236	118	78.6	58.9	47.1	39.3	33.7	29.5	26.2	23.6	21.4	19.6	18.1	16.8	538	6.02
			RHS	11.6	195	97.6	65.1	48.8	39.1	32.5	27.9	24.4	21.7	19.5	17.8	16.3	15.0	13.9	438	6.12
			RHS	8.96	151	75.4	50.3	37.7	30.2	25.1	21.5	18.8	16.8	15.1	13.7	12.6	11.6	10.8	334	6.23
			RHS	7.53	113	56.3	37.5	28.1	22.5	18.8	16.1	14.1	12.5	11.3	10.2	9.38	8.66	8.04	281	6.27
102	x 76	x 6.0	RHS	14.7	200	100	66.8	50.1	40.1	33.4	28.6	25.1	22.3	20.0	18.2	16.7	15.4	14.3	511	7.26
			RHS	12.5	174	87.0	58.0	43.5	34.8	29.0	24.9	21.7	19.3	17.4	15.8	14.5	13.4	12.4	435	7.38
			RHS	9.07	129	64.6	43.1	32.3	25.8	21.5	18.5	16.1	14.4	12.9	11.7	10.8	9.94	9.23	315	7.56

**Notes:**

1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the availability of listed sections and associated finishes. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3.  $W_{L1}^*$  = Maximum Design Load based on Design Moment Capacity.
4.  $W_{L2}^*$  = Maximum Design Load based on Design Shear Capacity.
5. Maximum Design Load  $W_L^*$  is LESSER of  $W_{L1}^*$  and  $W_{L2}^*$ .
6. FLR – segment length for Full Lateral Restraint (Clause 5.3.2.4 of AS 4100) based on transverse load case with  $\beta_m = -0.8$ .

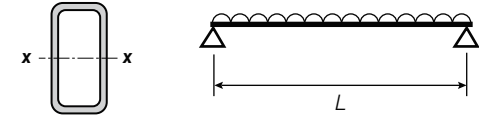
TABLE 5.1-4(2)(B)

# Rectangular Hollow Sections C450PLUS<sup>®</sup> – designed as AS/NZS 1163 Grade C450L0

## **SERVICEABILITY** LIMIT STATE MAXIMUM DESIGN LOADS FOR SIMPLY SUPPORTED BEAMS

*bending about x-axis*

- 1 RHS
- 2 C450PLUS<sup>®</sup>
- 3 Finish



Designation			Mass per m	W <sub>s</sub> <sup>*</sup> (kN)														
d	b	t		Span of Beam (L) in metres														
mm	mm	mm	kg/m	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	
200 x 100 x	10.0	6.0	RHS	41.3	880	375	167	93.9	60.1	41.7	30.6	23.5	18.5	15.0	12.4	10.4	8.89	7.66
		9.0	RHS	37.7	819	350	155	87.4	55.9	38.8	28.5	21.8	17.3	14.0	11.6	9.71	8.27	7.13
		8.0	RHS	33.9	753	321	143	80.3	51.4	35.7	26.2	20.1	15.9	12.8	10.6	8.92	7.60	6.55
		6.0	RHS	26.2	602	257	114	64.2	41.1	28.5	21.0	16.1	12.7	10.3	8.49	7.13	6.08	5.24
		5.0	RHS	22.1	518	221	98.1	55.2	35.3	24.5	18.0	13.8	10.9	8.83	7.30	6.13	5.23	4.51
		4.0	RHS	17.9	427	182	81.0	45.5	29.1	20.2	14.9	11.4	9.00	7.29	6.02	5.06	4.31	3.72
152 x 76 x	6.0	6.0	RHS	19.4	327	106	47.2	26.5	17.0	11.8	8.66	6.63	5.24	4.24	3.51	2.95	2.51	2.17
		5.0	RHS	16.4	284	92.3	41.0	23.1	14.8	10.3	7.53	5.77	4.56	3.69	3.05	2.56	2.18	1.88
150 x 100 x	10.0	6.0	RHS	33.4	558	178	79.3	44.6	28.5	19.8	14.6	11.2	8.81	7.14	5.90	4.96	4.22	3.64
		9.0	RHS	30.6	523	167	74.4	41.8	26.8	18.6	13.7	10.5	8.26	6.69	5.53	4.65	3.96	3.42
		8.0	RHS	27.7	484	155	68.8	38.7	24.8	17.2	12.6	9.68	7.65	6.19	5.12	4.30	3.67	3.16
		6.0	RHS	21.4	392	126	55.8	31.4	20.1	13.9	10.2	7.84	6.20	5.02	4.15	3.49	2.97	2.56
		5.0	RHS	18.2	339	109	48.3	27.2	17.4	12.1	8.87	6.79	5.36	4.34	3.59	3.02	2.57	2.22
		4.0	RHS	14.8	282	90.1	40.1	22.5	14.4	10.0	7.36	5.63	4.45	3.61	2.98	2.50	2.13	1.84
150 x 50 x	6.0	6.0	RHS	16.7	243	77.7	34.5	19.4	12.4	8.63	6.34	4.86	3.84	3.11	2.57	2.16	1.84	1.59
		5.0	RHS	14.2	213	68.2	30.3	17.1	10.9	7.58	5.57	4.26	3.37	2.73	2.26	1.89	1.61	1.39
		4.0	RHS	11.6	179	57.4	25.5	14.3	9.18	6.38	4.68	3.59	2.83	2.30	1.90	1.59	1.36	1.17
		3.0	RHS	8.96	143	45.9	20.4	11.5	7.34	5.10	3.74	2.87	2.26	1.83	1.52	1.27	1.09	0.936
		2.5	RHS	7.53	122	39.0	17.3	9.76	6.24	4.34	3.19	2.44	1.93	1.56	1.29	1.08	0.924	0.796
		2.0	RHS	6.07	99.6	31.9	14.2	7.97	5.10	3.54	2.60	1.99	1.57	1.28	1.05	0.885	0.754	0.651
127 x 51 x	6.0	6.0	RHS	14.7	186	50.3	22.4	12.6	8.05	5.59	4.11	3.15	2.49	2.01	1.66	1.40	1.19	1.03
		5.0	RHS	12.5	164	44.5	19.8	11.1	7.11	4.94	3.63	2.78	2.20	1.78	1.47	1.23	1.05	0.907
		3.5	RHS	9.07	125	33.8	15.0	8.46	5.41	3.76	2.76	2.11	1.67	1.35	1.12	0.940	0.801	0.690
125 x 75 x	6.0	6.0	RHS	16.7	240	63.9	28.4	16.0	10.2	7.10	5.22	3.99	3.16	2.56	2.11	1.78	1.51	1.30
		5.0	RHS	14.2	210	55.9	24.9	14.0	8.95	6.21	4.56	3.50	2.76	2.24	1.85	1.55	1.32	1.14
		4.0	RHS	11.6	176	46.9	20.8	11.7	7.50	5.21	3.83	2.93	2.32	1.88	1.55	1.30	1.11	0.957
		3.0	RHS	8.96	140	37.3	16.6	9.33	5.97	4.14	3.05	2.33	1.84	1.49	1.23	1.04	0.883	0.761
		2.5	RHS	7.53	119	31.7	14.1	7.93	5.08	3.52	2.59	1.98	1.57	1.27	1.05	0.881	0.751	0.647
		2.0	RHS	6.07	97.1	25.9	11.5	6.47	4.14	2.88	2.11	1.62	1.28	1.04	0.856	0.719	0.613	0.528
102 x 76 x	6.0	6.0	RHS	14.7	155	38.7	17.2	9.68	6.20	4.30	3.16	2.42	1.91	1.55	1.28	1.08	0.917	0.790
		5.0	RHS	12.5	136	34.1	15.2	8.53	5.46	3.79	2.78	2.13	1.68	1.36	1.13	0.948	0.807	0.696
		3.5	RHS	9.07	103	25.9	11.5	6.47	4.14	2.87	2.11	1.62	1.28	1.03	0.855	0.718	0.612	0.528

**Notes:**

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of f<sub>y</sub> = 450 MPa and f<sub>t</sub> = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- W<sub>s</sub><sup>\*</sup> = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250 or First Yield.
- Red shading indicates serviceability loads governed by yielding.

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**Design Capacity Tables for Structural Steel Hollow Sections**

AUGUST 2013

5-29

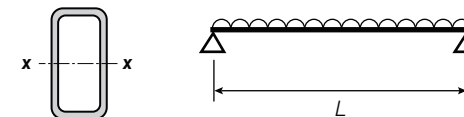
TABLE 5.1-4(3)(A)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

**STRENGTH** LIMIT STATE MAXIMUM DESIGN LOADS  
FOR SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT

*bending about x-axis*

- 1 RHS
- 2 C450PLUS®
- 3 Finish



d	Designation		Mass per m	W <sub>L1</sub> <sup>*</sup> (kN)															W <sub>L2</sub> <sup>*</sup>	FLR		
	b	t		Span of Beam (L) in metres																		
mm	mm	mm	kg/m	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	4.50	5.00	6.00	kN	m			
100	x	50	x	6.0	RHS	12.0	294	196	147	118	97.9	83.9	73.5	58.8	49.0	42.0	36.7	32.6	29.4	24.5	489	3.21
				5.0	RHS	10.3	258	172	129	103	85.9	73.6	64.4	51.5	42.9	36.8	32.2	28.6	25.8	21.5	417	3.29
				4.0	RHS	8.49	216	144	108	86.6	72.2	61.9	54.1	43.3	36.1	30.9	27.1	24.1	21.6	18.0	341	3.37
				3.5	RHS	7.53	194	129	97.0	77.6	64.7	55.4	48.5	38.8	32.3	27.7	24.2	21.6	19.4	16.2	301	3.40
				3.0	RHS	6.60	173	115	86.4	69.1	57.6	49.4	43.2	34.5	28.8	24.7	21.6	19.2	17.3	14.4	261	3.45
				2.5	RHS	5.56	147	97.9	73.5	58.8	49.0	42.0	36.7	29.4	24.5	21.0	18.4	16.3	14.7	12.2	220	3.49
				2.0	RHS	4.50	118	78.6	59.0	47.2	39.3	33.7	29.5	23.6	19.7	16.9	14.7	13.1	11.8	9.83	178	3.53
				1.6	RHS	3.64	80.8	53.9	40.4	32.3	26.9	23.1	20.2	16.2	13.5	11.5	10.1	8.98	8.08	6.73	143	3.56
76	x	38	x	4.0	RHS	6.23	117	78.3	58.7	47.0	39.2	33.6	29.4	23.5	19.6	16.8	14.7	13.1	11.7	9.79	252	2.48
				3.0	RHS	4.90	95.9	64.0	48.0	38.4	32.0	27.4	24.0	19.2	16.0	13.7	12.0	10.7	9.59	7.99	194	2.57
				2.5	RHS	4.15	82.2	54.8	41.1	32.9	27.4	23.5	20.5	16.4	13.7	11.7	10.3	9.13	8.22	6.85	164	2.61
75	x	50	x	6.0	RHS	9.67	182	121	90.9	72.7	60.6	52.0	45.5	36.4	30.3	26.0	22.7	20.2	18.2	15.2	356	4.11
				5.0	RHS	8.35	161	108	80.7	64.5	53.8	46.1	40.3	32.3	26.9	23.0	20.2	17.9	16.1	13.4	306	4.22
				4.0	RHS	6.92	137	91.3	68.5	54.8	45.7	39.1	34.3	27.4	22.8	19.6	17.1	15.2	13.7	11.4	252	4.33
				3.0	RHS	5.42	111	73.8	55.4	44.3	36.9	31.6	27.7	22.1	18.5	15.8	13.8	12.3	11.1	9.23	195	4.45
				2.5	RHS	4.58	94.6	63.0	47.3	37.8	31.5	27.0	23.6	18.9	15.8	13.5	11.8	10.5	9.46	7.88	165	4.51
				2.0	RHS	3.72	76.4	50.9	38.2	30.5	25.5	21.8	19.1	15.3	12.7	10.9	9.54	8.48	7.64	6.36	134	4.56
				1.6	RHS	3.01	53.5	35.7	26.8	21.4	17.8	15.3	13.4	10.7	8.92	7.65	6.69	5.95	5.35	4.46	108	4.60
75	x	25	x	2.5	RHS	3.60	65.2	43.5	32.6	26.1	21.7	18.6	16.3	13.0	10.9	9.31	8.15	7.24	6.52	5.43	158	1.14
				2.0	RHS	2.93	53.8	35.9	26.9	21.5	17.9	15.4	13.5	10.8	8.97	7.69	6.73	5.98	5.38	4.49	128	1.17
				1.6	RHS	2.38	44.2	29.4	22.1	17.7	14.7	12.6	11.0	8.83	7.36	6.31	5.52	4.91	4.42	3.68	104	1.19
65	x	35	x	4.0	RHS	5.35	86.0	57.4	43.0	34.4	28.7	24.6	21.5	17.2	14.3	12.3	10.8	9.56	8.60	7.17	212	2.41
				3.0	RHS	4.25	71.2	47.5	35.6	28.5	23.7	20.3	17.8	14.2	11.9	10.2	8.90	7.91	7.12	5.94	165	2.51
				2.5	RHS	3.60	61.3	40.8	30.6	24.5	20.4	17.5	15.3	12.3	10.2	8.75	7.66	6.81	6.13	5.10	139	2.55
				2.0	RHS	2.93	50.5	33.7	25.3	20.2	16.8	14.4	12.6	10.1	8.42	7.22	6.32	5.62	5.05	4.21	113	2.59
50	x	25	x	3.0	RHS	3.07	38.0	25.3	19.0	15.2	12.7	10.9	9.50	7.60	6.33	5.43	4.75	4.22	3.80	3.17	122	1.61
				2.5	RHS	2.62	33.1	22.1	16.5	13.2	11.0	9.45	8.27	6.62	5.51	4.73	4.14	3.68	3.31	2.76	104	1.65
				2.0	RHS	2.15	27.6	18.4	13.8	11.0	9.21	7.89	6.91	5.52	4.60	3.95	3.45	3.07	2.76	2.30	85.2	1.69
				1.6	RHS	1.75	22.8	15.2	11.4	9.14	7.61	6.53	5.71	4.57	3.81	3.26	2.86	2.54	2.28	1.90	69.3	1.72
50	x	20	x	3.0	RHS	2.88	38.4	22.3	16.7	13.4	11.1	9.55	8.36	6.68	5.57	4.77	4.18	3.71	3.34	2.79	121	1.02
				2.5	RHS	2.42	29.2	19.5	14.6	11.7	9.74	8.35	7.31	5.85	4.87	4.18	3.65	3.25	2.92	2.44	103	1.05
				2.0	RHS	1.99	24.5	16.3	12.3	9.80	8.17	7.00	6.13	4.90	4.08	3.50	3.06	2.72	2.45	2.04	84.1	1.08
				1.6	RHS	1.63	20.3	13.6	10.2	8.13	6.78	5.81	5.08	4.07	3.39	2.91	2.54	2.26	2.03	1.69	68.4	1.10

**Notes:**

- REFER to the Australian Tube Mills PRODUCT AVAILABILITY GUIDE (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- $W_{L1}^*$  = Maximum Design Load based on Design Moment Capacity.
- $W_{L2}^*$  = Maximum Design Load based on Design Shear Capacity.
- Maximum Design Load  $W_L$  is LESSER of  $W_{L1}^*$  and  $W_{L2}^*$ .
- FLR – segment length for Full Lateral Restraint (Clause 5.3.2.4 of AS 4100) based on transverse load case with  $\beta_m = -0.8$ .
- NOTE:** Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.

TABLE 5.1-4(3)(B)

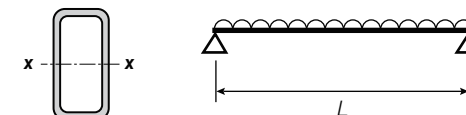
# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

**SERVICEABILITY** LIMIT STATE MAXIMUM DESIGN LOADS  
FOR SIMPLY SUPPORTED BEAMS

*bending about x-axis*

Designation				Mass per m	W <sub>s</sub> (kN) Span of Beam (L) in metres																
d	b	t			0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	4.50	5.00	6.00			
mm	mm	mm		kg/m																	
100	x	50	x	6.0	RHS	12.0	246	164	105	67.2	46.7	34.3	26.3	16.8	11.7	8.57	6.56	5.19	4.20	2.92	
				5.0	RHS	10.3	220	147	93.9	60.1	41.7	30.6	23.5	15.0	10.4	7.66	5.87	4.64	3.75	2.61	
				4.0	RHS	8.49	188	125	80.3	51.4	35.7	26.2	20.1	12.8	8.92	6.55	5.02	3.96	3.21	2.23	
				3.5	RHS	7.53	170	113	72.6	46.4	32.3	23.7	18.1	11.6	8.06	5.92	4.54	3.58	2.90	2.02	
				3.0	RHS	6.60	153	102	65.4	41.9	29.1	21.4	16.4	10.5	7.27	5.34	4.09	3.23	2.62	1.82	
				2.5	RHS	5.56	131	87.6	56.0	35.9	24.9	18.3	14.0	8.97	6.23	4.57	3.50	2.77	2.24	1.56	
				2.0	RHS	4.50	108	72.0	46.1	29.5	20.5	15.0	11.5	7.37	5.12	3.76	2.88	2.27	1.84	1.28	
				1.6	RHS	3.64	88.3	58.8	37.7	24.1	16.7	12.3	9.41	6.03	4.18	3.07	2.35	1.86	1.51	1.05	
76	x	38	x	4.0	RHS	6.23	99.8	57.6	32.4	20.7	14.4	10.6	8.09	5.18	3.60	2.64	2.02	1.60	1.29	0.899	
				3.0	RHS	4.90	83.9	48.4	27.2	17.4	12.1	8.89	6.80	4.35	3.02	2.22	1.70	1.34	1.09	0.756	
				2.5	RHS	4.15	72.6	41.9	23.5	15.1	10.5	7.69	5.89	3.77	2.62	1.92	1.47	1.16	0.942	0.654	
75	x	50	x	6.0	RHS	9.67	154	87.4	49.1	31.5	21.8	16.0	12.3	7.86	5.46	4.01	3.07	2.43	1.97	1.37	
				5.0	RHS	8.35	139	79.3	44.6	28.5	19.8	14.6	11.2	7.14	4.96	3.64	2.79	2.20	1.78	1.24	
				4.0	RHS	6.92	121	68.8	38.7	24.8	17.2	12.6	9.68	6.19	4.30	3.16	2.42	1.91	1.55	1.08	
				3.0	RHS	5.42	100	57.0	32.1	20.5	14.2	10.5	8.01	5.13	3.56	2.62	2.00	1.58	1.28	0.890	
				2.5	RHS	4.58	86.3	49.1	27.6	17.7	12.3	9.02	6.90	4.42	3.07	2.25	1.73	1.36	1.10	0.767	
				2.0	RHS	3.72	71.4	40.6	22.8	14.6	10.1	7.46	5.71	3.65	2.54	1.86	1.43	1.13	0.913	0.634	
				1.6	RHS	3.01	58.6	33.3	18.7	12.0	8.33	6.12	4.69	3.00	2.08	1.53	1.17	0.926	0.750	0.521	
75	x	25	x	2.5	RHS	3.60	54.8	31.1	17.5	11.2	7.79	5.72	4.38	2.80	1.95	1.43	1.10	0.865	0.701	0.487	
				2.0	RHS	2.93	45.8	26.0	14.6	9.37	6.51	4.78	3.66	2.34	1.63	1.20	0.915	0.723	0.586	0.407	
				1.6	RHS	2.38	37.9	21.6	12.1	7.76	5.39	3.96	3.03	1.94	1.35	0.990	0.758	0.599	0.485	0.337	
65	x	35	x	4.0	RHS	5.35	72.7	35.8	20.2	12.9	8.96	6.58	5.04	3.23	2.24	1.65	1.26	0.996	0.807	0.560	
				3.0	RHS	4.25	62.3	30.7	17.3	11.1	7.67	5.64	4.32	2.76	1.92	1.41	1.08	0.853	0.691	0.480	
				2.5	RHS	3.60	54.2	26.7	15.0	9.61	6.68	4.90	3.76	2.40	1.67	1.23	0.939	0.742	0.601	0.417	
				2.0	RHS	2.93	45.2	22.3	12.5	8.02	5.57	4.09	3.13	2.01	1.39	1.02	0.783	0.619	0.501	0.348	
50	x	25	x	3.0	RHS	3.07	27.5	12.2	6.86	4.39	3.05	2.24	1.72	1.10	0.763	0.560	0.429	0.339	0.275	0.191	
				2.5	RHS	2.62	24.3	10.8	6.07	3.89	2.70	1.98	1.52	0.972	0.675	0.496	0.380	0.300	0.243	0.169	
				2.0	RHS	2.15	20.6	9.16	5.15	3.30	2.29	1.68	1.29	0.824	0.572	0.420	0.322	0.254	0.206	0.143	
				1.6	RHS	1.75	17.2	7.67	4.31	2.76	1.92	1.41	1.08	0.690	0.479	0.352	0.269	0.213	0.172	0.120	
50	x	20	x	3.0	RHS	2.83	23.4	10.4	5.84	3.74	2.60	1.91	1.46	0.935	0.649	0.477	0.365	0.289	0.234	0.162	
				2.5	RHS	2.42	20.8	9.26	5.21	3.33	2.31	1.70	1.30	0.833	0.579	0.425	0.325	0.257	0.208	0.145	
				2.0	RHS	1.99	17.8	7.90	4.44	2.84	1.97	1.45	1.11	0.711	0.494	0.363	0.278	0.219	0.178	0.123	
				1.6	RHS	1.63	14.9	6.64	3.74	2.39	1.66	1.22	0.934	0.598	0.415	0.305	0.234	0.184	0.149	0.104	

- 1 RHS  
2 C450PLUS®  
3 Finish



### Notes:

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- $W_s^*$  = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250 or First Yield.
- Red shading indicates serviceability loads governed by yielding.
- NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**

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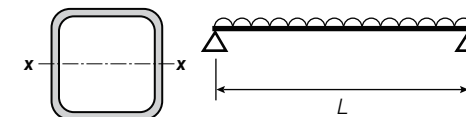
TABLE 5.1-5(A)

# Square Hollow Sections AS/NZS 1163 Grade C350L0

**STRENGTH** LIMIT STATE MAXIMUM DESIGN LOADS  
FOR SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT

*bending about x-axis*

- 1 SHS
- 2 C350L0
- 3 Finish



d	Designation		t	Mass per m	W <sub>L1</sub> (kN)														W <sub>L2</sub>		
	b				Span of Beam (L) in metres																
mm	mm	mm	mm	kg/m	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	4.50	5.00	6.00	kN		
50	x	50	x	6.0	SHS	7.32	73.2	48.8	36.6	29.3	24.4	20.9	18.3	14.6	12.2	10.5	9.16	8.14	7.32	6.10	170
				5.0	SHS	6.39	66.3	44.2	33.2	26.5	22.1	18.9	16.6	13.3	11.1	9.47	8.29	7.37	6.63	5.53	149
				4.0	SHS	5.35	57.4	38.2	28.7	22.9	19.1	16.4	14.3	11.5	9.56	8.19	7.17	6.37	5.74	4.78	125
				3.0	SHS	4.25	47.3	31.5	23.7	18.9	15.8	13.5	11.8	9.46	7.89	6.76	5.91	5.26	4.73	3.94	98.6
				2.5	SHS	3.60	40.7	27.1	20.3	16.3	13.6	11.6	10.2	8.14	6.78	5.81	5.09	4.52	4.07	3.39	84.0
				2.0	SHS	2.93	33.6	22.4	16.8	13.4	11.2	9.59	8.39	6.72	5.60	4.80	4.20	3.73	3.36	2.80	68.7
40	x	40	x	4.0	SHS	2.38	25.7	17.1	12.9	10.3	8.57	7.35	6.43	5.14	4.29	3.67	3.21	2.86	2.57	2.14	55.9
				4.0	SHS	4.09	33.9	22.6	17.0	13.6	11.3	9.70	8.49	6.79	5.66	4.85	4.24	3.77	3.39	2.83	95.6
				3.0	SHS	3.30	28.8	19.2	14.4	11.5	9.62	8.24	7.21	5.77	4.81	4.12	3.61	3.21	2.88	2.40	76.2
				2.5	SHS	2.82	25.0	16.7	12.5	10.0	8.34	7.15	6.26	5.01	4.17	3.58	3.13	2.78	2.50	2.09	65.3
				2.0	SHS	2.31	20.8	13.9	10.4	8.33	6.94	5.95	5.21	4.17	3.47	2.98	2.60	2.31	2.08	1.74	53.8
				1.6	SHS	1.88	17.2	11.5	8.60	6.88	5.73	4.91	4.30	3.44	2.87	2.46	2.15	1.91	1.72	1.43	44.0
35	x	35	x	3.0	SHS	2.83	21.3	14.2	10.7	8.53	7.10	6.09	5.33	4.26	3.55	3.04	2.66	2.37	2.13	1.78	65.0
				2.5	SHS	2.42	18.6	12.4	9.31	7.45	6.21	5.32	4.66	3.72	3.10	2.66	2.33	2.07	1.86	1.55	56.0
				2.0	SHS	1.99	15.6	10.4	7.80	6.24	5.20	4.46	3.90	3.12	2.60	2.23	1.95	1.73	1.56	1.30	46.3
				1.6	SHS	1.63	12.9	8.62	6.47	5.17	4.31	3.70	3.23	2.59	2.16	1.85	1.62	1.44	1.29	1.08	38.0
30	x	30	x	3.0	SHS	2.36	14.9	9.94	7.46	5.97	4.97	4.26	3.73	2.98	2.49	2.13	1.86	1.66	1.49	1.24	53.8
				2.5	SHS	2.03	13.2	8.77	6.58	5.26	4.38	3.76	3.29	2.63	2.19	1.88	1.64	1.46	1.32	1.10	46.7
				2.0	SHS	1.68	11.1	7.41	5.56	4.45	3.70	3.18	2.78	2.22	1.85	1.59	1.39	1.23	1.11	0.926	38.8
				1.6	SHS	1.38	9.28	6.19	4.64	3.71	3.09	2.65	2.32	1.86	1.55	1.33	1.16	1.03	0.928	0.773	32.0
25	x	25	x	3.0	SHS	1.89	9.65	6.43	4.83	3.86	3.22	2.76	2.41	1.93	1.61	1.38	1.21	1.07	0.965	0.804	42.6
				2.5	SHS	1.64	8.63	5.75	4.32	3.45	2.88	2.47	2.16	1.73	1.44	1.23	1.08	0.959	0.863	0.719	37.3
				2.0	SHS	1.36	7.39	4.93	3.69	2.96	2.46	2.11	1.85	1.48	1.23	1.06	0.924	0.821	0.739	0.616	31.4
				1.6	SHS	1.12	6.23	4.15	3.11	2.49	2.08	1.78	1.56	1.25	1.04	0.890	0.779	0.692	0.623	0.519	26.0
20	x	20	x	2.0	SHS	1.05	4.42	2.95	2.21	1.77	1.47	1.26	1.10	0.884	0.737	0.631	0.552	0.491	0.442	0.368	23.9
				1.6	SHS	0.873	3.78	2.52	1.89	1.51	1.26	1.08	0.946	0.757	0.631	0.540	0.473	0.420	0.378	0.315	20.1

**ADDITIONAL NOTES:**

(A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.

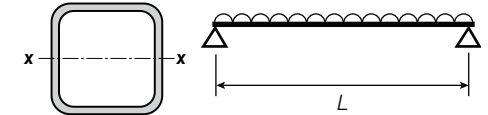
(B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.

TABLE 5.1-5(B)

# Square Hollow Sections AS/NZS 1163 Grade C350L0

**SERVICEABILITY** LIMIT STATE MAXIMUM DESIGN LOADS  
FOR SIMPLY SUPPORTED BEAMS  
*bending about x-axis*

- 1 SHS
- 2 C350L0
- 3 Finish



d	Designation			Mass per m	W <sub>s</sub> (kN)														
	b	t			Span of Beam (L) in metres														
mm	mm	mm		kg/m	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	4.50	5.00	6.00	
50	x	50	x	6.0 SHS	7.32	61.7	30.1	16.9	10.8	7.52	5.52	4.23	2.71	1.88	1.38	1.06	0.835	0.677	0.470
				5.0 SHS	6.39	57.6	28.1	15.8	10.1	7.02	5.15	3.95	2.53	1.75	1.29	0.987	0.780	0.631	0.438
				4.0 SHS	5.35	51.2	25.0	14.1	8.99	6.25	4.59	3.51	2.25	1.56	1.15	0.878	0.694	0.562	0.390
				3.0 SHS	4.25	43.6	21.3	12.0	7.65	5.32	3.91	2.99	1.91	1.33	0.976	0.748	0.591	0.478	0.332
				2.5 SHS	3.60	38.0	18.5	10.4	6.66	4.63	3.40	2.60	1.67	1.16	0.850	0.651	0.514	0.416	0.289
				2.0 SHS	2.93	31.7	15.5	8.69	5.56	3.86	2.84	2.17	1.39	0.966	0.710	0.543	0.429	0.348	0.241
40	x	40	x	4.0 SHS	4.09	25.9	11.5	6.47	4.14	2.87	2.11	1.62	1.03	0.718	0.528	0.404	0.319	0.259	0.180
				3.0 SHS	3.30	22.9	10.2	5.73	3.67	2.55	1.87	1.43	0.917	0.636	0.468	0.358	0.283	0.229	0.159
				2.5 SHS	2.82	20.2	8.97	5.05	3.23	2.24	1.65	1.26	0.808	0.561	0.412	0.315	0.249	0.202	0.140
				2.0 SHS	2.31	17.1	7.58	4.26	2.73	1.90	1.39	1.07	0.682	0.474	0.348	0.267	0.211	0.171	0.118
				1.6 SHS	1.88	14.2	6.33	3.56	2.28	1.58	1.16	0.890	0.570	0.396	0.291	0.223	0.176	0.142	0.0989
				35	x	35	x	3.0 SHS	2.83	14.6	6.50	3.65	2.34	1.62	1.19	0.914	0.585	0.406	0.298
2.5 SHS	2.42	13.0	5.78					3.25	2.08	1.44	1.06	0.812	0.520	0.361	0.265	0.203	0.160	0.130	0.0903
2.0 SHS	1.99	11.1	4.92					2.77	1.77	1.23	0.904	0.692	0.443	0.308	0.226	0.173	0.137	0.111	0.0769
1.6 SHS	1.63	9.31	4.14					2.33	1.49	1.03	0.760	0.582	0.372	0.259	0.190	0.145	0.115	0.0931	0.0647
30	x	30	x	3.0 SHS	2.36	8.61	3.83	2.15	1.38	0.957	0.703	0.538	0.344	0.239	0.176	0.135	0.106	0.0861	0.0598
				2.5 SHS	2.03	7.76	3.45	1.94	1.24	0.862	0.633	0.485	0.310	0.215	0.158	0.121	0.0958	0.0776	0.0539
				2.0 SHS	1.68	6.69	2.97	1.67	1.07	0.743	0.546	0.418	0.268	0.186	0.137	0.105	0.0826	0.0669	0.0465
				1.6 SHS	1.38	5.67	2.52	1.42	0.908	0.630	0.463	0.355	0.227	0.158	0.116	0.0887	0.0701	0.0567	0.0394
25	x	25	x	3.0 SHS	1.89	4.52	2.01	1.13	0.724	0.503	0.369	0.283	0.181	0.126	0.0923	0.0707	0.0559	0.0452	0.0314
				2.5 SHS	1.64	4.15	1.85	1.04	0.664	0.461	0.339	0.260	0.166	0.115	0.0848	0.0649	0.0513	0.0415	0.0288
				2.0 SHS	1.36	3.65	1.62	0.911	0.583	0.405	0.298	0.228	0.146	0.101	0.0744	0.0570	0.0450	0.0365	0.0253
				1.6 SHS	1.12	3.13	1.39	0.783	0.501	0.348	0.256	0.196	0.125	0.0870	0.0640	0.0490	0.0387	0.0313	0.0218
20	x	20	x	2.0 SHS	1.05	1.70	0.756	0.425	0.272	0.189	0.139	0.106	0.0680	0.0473	0.0347	0.0266	0.0210		
				1.6 SHS	0.873	1.49	0.664	0.373	0.239	0.166	0.122	0.0933	0.0597	0.0415	0.0305	0.0233			

- Notes:**
- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
  - W<sub>s</sub>\* = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250 or First Yield.
  - Red shading indicates serviceability loads governed by yielding.

**ADDITIONAL NOTES:**

- (A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.
- (B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.





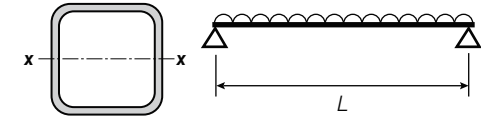
TABLE 5.1-6(1)(A)

# Square Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

**STRENGTH** LIMIT STATE MAXIMUM DESIGN LOADS  
FOR SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT

*bending about x-axis*

- 1 SHS
- 2 C450PLUS®
- 3 Finish



d	Designation		t	Mass per m	$W_{L1}^*$ (kN)														$W_{L2}^*$		
	b				Span of Beam (L) in metres																
mm	mm	mm	mm	kg/m	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	kN		
400	x	400	x	16.0	SHS	186	10800	5380	3590	2690	2150	1790	1540	1350	1200	1080	979	897	828	769	5650
				12.5	SHS	148	7490	3750	2500	1870	1500	1250	1070	937	832	749	681	624	576	535	4500
				10.0	SHS	120	5360	2680	1790	1340	1070	894	766	670	596	536	487	447	412	383	3650
350	x	350	x	16.0	SHS	161	8190	4090	2730	2050	1640	1360	1170	1020	910	819	744	682	630	585	4880
				12.5	SHS	128	6140	3070	2050	1540	1230	1020	878	768	683	614	558	512	473	439	3900
				10.0	SHS	104	4380	2190	1460	1100	877	731	626	548	487	438	399	365	337	313	3170
				8.0	SHS	84.2	3150	1570	1050	787	630	525	450	393	350	315	286	262	242	225	2570
300	x	300	x	16.0	SHS	136	5860	2930	1950	1460	1170	976	837	732	651	586	532	488	451	418	4120
				12.5	SHS	109	4770	2380	1590	1190	953	794	681	596	530	477	433	397	367	340	3300
				10.0	SHS	88.4	3490	1750	1160	873	698	582	499	436	388	349	317	291	269	249	2690
				8.0	SHS	71.6	2490	1240	830	622	498	415	356	311	277	249	226	207	192	178	2180
250	x	250	x	16.0	SHS	111	3910	1960	1300	979	783	652	559	489	435	391	356	326	301	280	3350
				12.5	SHS	89.0	3220	1610	1070	804	643	536	459	402	357	322	292	268	247	230	2700
				10.0	SHS	72.7	2630	1310	876	657	526	438	375	329	292	263	239	219	202	188	2210
				9.0	SHS	65.9	2260	1130	755	566	453	377	324	283	252	226	206	189	174	162	2000
				8.0	SHS	59.1	1900	949	633	474	380	316	271	237	211	190	173	158	146	136	1800
				6.0	SHS	45.0	1230	616	411	308	246	205	176	154	137	123	112	103	94.8	88.0	1370
200	x	200	x	16.0	SHS	85.5	2360	1180	787	590	472	393	337	295	262	236	215	197	182	169	2580
				12.5	SHS	69.4	1970	984	656	492	394	328	281	246	219	197	179	164	151	141	2100
				10.0	SHS	57.0	1650	823	549	412	329	274	235	206	183	165	150	137	127	118	1730
				9.0	SHS	51.8	1510	754	503	377	302	251	215	188	168	151	137	126	116	108	1570
				8.0	SHS	46.5	1350	673	449	336	269	224	192	168	150	135	122	112	104	96.1	1410
				6.0	SHS	35.6	880	440	293	220	176	147	126	110	97.8	88.0	80.0	73.4	67.7	62.9	1080
				5.0	SHS	29.9	670	335	223	168	134	112	95.7	83.8	74.5	67.0	60.9	55.9	51.6	47.9	912
150	x	150	x	10.0	SHS	41.3	872	436	291	218	174	145	125	109	96.9	87.2	79.3	72.7	67.1	62.3	1250
				9.0	SHS	37.7	804	402	268	201	161	134	115	101	89.4	80.4	73.1	67.0	61.9	57.4	1140
				8.0	SHS	33.9	732	366	244	183	146	122	105	91.5	81.3	73.2	66.6	61.0	56.3	52.3	1030
				6.0	SHS	26.2	568	284	189	142	114	94.6	81.1	71.0	63.1	56.8	51.6	47.3	43.7	40.6	795
				5.0	SHS	22.1	436	218	145	109	87.3	72.7	62.3	54.6	48.5	43.6	39.7	36.4	33.6	31.2	672

**Notes:**

1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3.  $W_{L1}^*$  = Maximum Design Load based on Design Moment Capacity.
4.  $W_{L2}^*$  = Maximum Design Load based on Design Shear Capacity.
5. Maximum Design Load  $W_{L1}^*$  is LESSER of  $W_{L1}^*$  and  $W_{L2}^*$ .

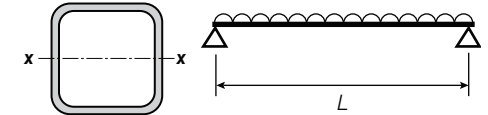
TABLE 5.1-6(1)(B)

# Square Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

**SERVICEABILITY** LIMIT STATE MAXIMUM DESIGN LOADS  
FOR SIMPLY SUPPORTED BEAMS

*bending about x-axis*

- 1 SHS
- 2 C450PLUS®
- 3 Finish



Designation				Mass per m	W <sub>s</sub> <sup>*</sup> (kN)															
d	b	t			Span of Beam (L) in metres															
mm	mm	mm		kg/m	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0		
400	x	400	x	16.0	SHS	186	10300	5140	3420	2190	1400	974	715	548	433	351	290	243	207	179
				12.5	SHS	148	8360	4180	2790	1780	1140	792	582	446	352	285	236	198	169	146
				10.0	SHS	120	6880	3440	2290	1470	939	652	479	367	290	235	194	163	139	120
350	x	350	x	16.0	SHS	161	7650	3830	2540	1430	914	635	467	357	282	229	189	159	135	117
				12.5	SHS	128	6270	3130	2080	1170	749	520	382	292	231	187	155	130	111	95.5
				10.0	SHS	104	5180	2590	1720	967	619	430	316	242	191	155	128	107	91.6	79.0
				8.0	SHS	84.2	4250	2130	1410	794	508	353	259	199	157	127	105	88.2	75.2	64.8
300	x	300	x	16.0	SHS	136	5420	2710	1540	867	555	386	283	217	171	139	115	96.4	82.1	70.8
				12.5	SHS	109	4480	2240	1270	717	459	318	234	179	142	115	94.7	79.6	67.8	58.5
				10.0	SHS	88.4	3720	1860	1060	596	381	265	195	149	118	95.4	78.8	66.2	56.4	48.6
				8.0	SHS	71.6	3070	1540	874	492	315	218	161	123	97.1	78.6	65.0	54.6	46.5	40.1
250	x	250	x	16.0	SHS	111	3570	1790	847	476	305	212	156	119	94.1	76.2	63.0	52.9	45.1	38.9
				12.5	SHS	89.0	2990	1490	709	399	255	177	130	99.6	78.7	63.8	52.7	44.3	37.7	32.5
				10.0	SHS	72.7	2510	1250	594	334	214	149	109	83.6	66.0	53.5	44.2	37.1	31.7	27.3
				9.0	SHS	65.9	2300	1150	545	307	196	136	100	76.6	60.6	49.1	40.5	34.1	29.0	25.0
				8.0	SHS	59.1	2080	1040	494	278	178	123	90.6	69.4	54.8	44.4	36.7	30.8	26.3	22.7
				6.0	SHS	45.0	1620	810	384	216	138	96.0	70.5	54.0	42.7	34.6	28.6	24.0	20.4	17.6
200	x	200	x	16.0	SHS	85.5	2110	899	400	225	144	99.9	73.4	56.2	44.4	36.0	29.7	25.0	21.3	18.4
				12.5	SHS	69.4	1800	768	341	192	123	85.3	62.7	48.0	37.9	30.7	25.4	21.3	18.2	15.7
				10.0	SHS	57.0	1530	653	290	163	104	72.6	53.3	40.8	32.2	26.1	21.6	18.1	15.5	13.3
				9.0	SHS	51.8	1410	602	267	150	96.3	66.9	49.1	37.6	29.7	24.1	19.9	16.7	14.2	12.3
				8.0	SHS	46.5	1280	548	243	137	87.6	60.9	44.7	34.2	27.1	21.9	18.1	15.2	13.0	11.2
				6.0	SHS	35.6	1010	430	191	108	68.9	47.8	35.1	26.9	21.3	17.2	14.2	12.0	10.2	8.78
				5.0	SHS	29.9	860	367	163	91.7	58.7	40.8	29.9	22.9	18.1	14.7	12.1	10.2	8.68	7.49
150	x	150	x	10.0	SHS	41.3	793	254	113	63.5	40.6	28.2	20.7	15.9	12.5	10.2	8.39	7.05	6.01	5.18
				9.0	SHS	37.7	738	236	105	59.0	37.8	26.2	19.3	14.8	11.7	9.45	7.81	6.56	5.59	4.82
				8.0	SHS	33.9	678	217	96.4	54.2	34.7	24.1	17.7	13.6	10.7	8.67	7.17	6.02	5.13	4.43
				6.0	SHS	26.2	542	173	77.0	43.3	27.7	19.3	14.1	10.8	8.56	6.93	5.73	4.81	4.10	3.54
				5.0	SHS	22.1	466	149	66.2	37.2	23.8	16.6	12.2	9.31	7.36	5.96	4.93	4.14	3.53	3.04

**Notes:**

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- $W_s^*$  = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250 or First Yield.
- Red shading indicates serviceability loads governed by yielding.

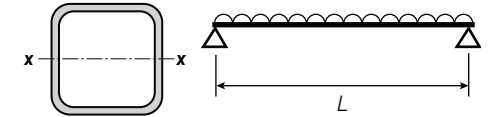
TABLE 5.1-6(2)(A)

# Square Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

**STRENGTH** LIMIT STATE MAXIMUM DESIGN LOADS  
FOR SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT

*bending about x-axis*

- 1 SHS
- 2 C450PLUS®
- 3 Finish



d	Designation			Mass per m	$W_{L1}^*$ (kN)														$W_{L2}^*$		
	b	t			Span of Beam (L) in metres																
mm	mm	mm		kg/m	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	kN		
125	x	125	x	10.0	SHS	33.4	576	288	192	144	115	96.0	82.3	72.0	64.0	57.6	52.4	48.0	44.3	41.2	1010
				9.0	SHS	30.6	534	267	178	134	107	89.1	76.3	66.8	59.4	53.4	48.6	44.5	41.1	38.2	924
				8.0	SHS	27.7	489	245	163	122	97.9	81.5	69.9	61.2	54.4	48.9	44.5	40.8	37.6	34.9	837
				6.0	SHS	21.4	389	194	130	97.1	77.7	64.8	55.5	48.6	43.2	38.9	35.3	32.4	29.9	27.8	651
				5.0	SHS	18.2	329	164	110	82.1	65.7	54.8	46.9	41.1	36.5	32.9	29.9	27.4	25.3	23.5	552
				4.0	SHS	14.8	237	119	79.1	59.3	47.4	39.5	33.9	29.7	26.4	23.7	21.6	19.8	18.2	16.9	449
100	x	100	x	10.0	SHS	25.6	341	171	114	85.3	68.2	56.8	48.7	42.6	37.9	34.1	31.0	28.4	26.2	24.4	768
				9.0	SHS	23.5	319	160	106	79.8	63.9	53.2	45.6	39.9	35.5	31.9	29.0	26.6	24.6	22.8	708
				8.0	SHS	21.4	295	148	98.3	73.8	59.0	49.2	42.1	36.9	32.8	29.5	26.8	24.6	22.7	21.1	645
				6.0	SHS	16.7	238	119	79.4	59.6	47.7	39.7	34.0	29.8	26.5	23.8	21.7	19.9	18.3	17.0	507
				5.0	SHS	14.2	206	103	68.6	51.4	41.2	34.3	29.4	25.7	22.9	20.6	18.7	17.1	15.8	14.7	432
				4.0	SHS	11.6	168	84.1	56.1	42.1	33.6	28.0	24.0	21.0	18.7	16.8	15.3	14.0	12.9	12.0	353
				3.0	SHS	8.96	111	55.7	37.1	27.8	22.3	18.6	15.9	13.9	12.4	11.1	10.1	9.28	8.56	7.95	271
				2.5	SHS	7.53	84.6	42.3	28.2	21.2	16.9	14.1	12.1	10.6	9.40	8.46	7.69	7.05	6.51	6.05	228
				2.0	SHS	6.07	61.0	30.5	20.3	15.3	12.2	10.2	8.72	7.63	6.78	6.10	5.55	5.08	4.69	4.36	184
90	x	90	x	2.5	SHS	6.74	72.2	36.1	24.1	18.1	14.4	12.0	10.3	9.03	8.03	7.22	6.57	6.02	5.56	5.16	204
				2.0	SHS	5.45	51.8	25.9	17.3	13.0	10.4	8.64	7.41	6.48	5.76	5.18	4.71	4.32	3.99	3.70	165
89	x	89	x	6.0	SHS	14.7	184	91.9	61.2	45.9	36.7	30.6	26.2	23.0	20.4	18.4	16.7	15.3	14.1	13.1	444
				5.0	SHS	12.5	159	79.7	53.2	39.9	31.9	26.6	22.8	19.9	17.7	15.9	14.5	13.3	12.3	11.4	379
				3.5	SHS	9.07	116	57.9	38.6	29.0	23.2	19.3	16.5	14.5	12.9	11.6	10.5	9.65	8.91	8.27	276
				2.0	SHS	5.38	51.0	25.5	17.0	12.7	10.2	8.49	7.28	6.37	5.66	5.10	4.63	4.25	3.92	3.64	163
75	x	75	x	6.0	SHS	12.0	124	62.2	41.5	31.1	24.9	20.7	17.8	15.6	13.8	12.4	11.3	10.4	9.57	8.89	363
				5.0	SHS	10.3	109	54.5	36.3	27.3	21.8	18.2	15.6	13.6	12.1	10.9	9.91	9.08	8.39	7.79	312
				4.0	SHS	8.49	91.5	45.8	30.5	22.9	18.3	15.3	13.1	11.4	10.2	9.15	8.32	7.63	7.04	6.54	257
				3.5	SHS	7.53	82.0	41.0	27.3	20.5	16.4	13.7	11.7	10.2	9.11	8.20	7.45	6.83	6.31	5.86	228
				3.0	SHS	6.60	71.9	36.0	24.0	18.0	14.4	12.0	10.3	8.99	7.99	7.19	6.54	5.99	5.53	5.14	199
				2.5	SHS	5.56	55.2	27.6	18.4	13.8	11.0	9.20	7.89	6.90	6.13	5.52	5.02	4.60	4.25	3.94	168
				2.0	SHS	4.50	39.3	19.7	13.1	9.83	7.86	6.55	5.62	4.91	4.37	3.93	3.57	3.28	3.02	2.81	136
				65	x	65	x	6.0	SHS	10.1	89.1	44.6	29.7	22.3	17.8	14.9	12.7	11.1	9.90	8.91	8.10
5.0	SHS	8.75	78.8					39.4	26.3	19.7	15.8	13.1	11.3	9.85	8.76	7.88	7.16	6.57	6.06	5.63	264
4.0	SHS	7.23	66.7					33.4	22.2	16.7	13.3	11.1	9.53	8.34	7.42	6.67	6.07	5.56	5.13	4.77	219
3.0	SHS	5.66	53.7					26.8	17.9	13.4	10.7	8.95	7.67	6.71	5.97	5.37	4.88	4.47	4.13	3.84	170
2.5	SHS	4.78	44.3					22.2	14.8	11.1	8.86	7.39	6.33	5.54	4.92	4.43	4.03	3.69	3.41	3.17	144
2.0	SHS	3.88	31.8					15.9	10.6	7.94	6.35	5.29	4.54	3.97	3.53	3.18	2.89	2.65	2.44	2.27	117
				1.6	SHS	3.13	22.7	11.4	7.57	5.68	4.54	3.79	3.24	2.84	2.52	2.27	2.06	1.89	1.75	1.62	94.9

**Notes:**

1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3.  $W_{L1}^*$  = Maximum Design Load based on Design Moment Capacity.
4.  $W_{L2}^*$  = Maximum Design Load based on Design Shear Capacity.
5. Maximum Design Load  $W_{L1}^*$  is LESSER of  $W_{L1}^*$  and  $W_{L2}^*$ .

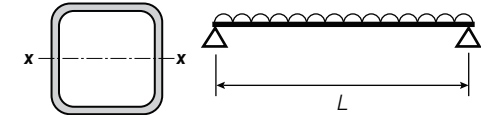
TABLE 5.1-6(2)(B)

# Square Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

**SERVICEABILITY** LIMIT STATE MAXIMUM DESIGN LOADS  
FOR SIMPLY SUPPORTED BEAMS

*bending about x-axis*

- 1 SHS
- 2 C450PLUS®
- 3 Finish



Designation				Mass per m	$W_s^*$ (kN)																
d	b	t			Span of Beam (L) in metres																
mm	mm	mm		kg/m	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0			
125	x 125	x 10.0	SHS	33.4	515	137	61.0	34.3	22.0	15.2	11.2	8.58	6.78	5.49	4.54	3.81	3.25	2.80			
			SHS	30.6	483	129	57.2	32.2	20.6	14.3	10.5	8.04	6.36	5.15	4.25	3.57	3.05	2.63			
			SHS	27.7	447	119	52.9	29.8	19.1	13.2	9.72	7.44	5.88	4.76	3.94	3.31	2.82	2.43			
			SHS	21.4	362	96.6	42.9	24.1	15.5	10.7	7.88	6.04	4.77	3.86	3.19	2.68	2.29	1.97			
			SHS	18.2	313	83.6	37.1	20.9	13.4	9.29	6.82	5.22	4.13	3.34	2.76	2.32	1.98	1.71			
100	x 100	x 10.0	SHS	25.6	253	63.1	28.1	15.8	10.1	7.02	5.15	3.95	3.12	2.53	2.09	1.75	1.49	1.29			
			SHS	23.5	240	60.0	26.7	15.0	9.60	6.67	4.90	3.75	2.96	2.40	1.98	1.67	1.42	1.22			
			SHS	21.4	225	56.2	25.0	14.1	8.99	6.25	4.59	3.51	2.78	2.25	1.86	1.56	1.33	1.15			
			SHS	16.7	187	46.6	20.7	11.7	7.46	5.18	3.81	2.92	2.30	1.87	1.54	1.30	1.10	0.952			
			SHS	14.2	163	40.8	18.1	10.2	6.53	4.53	3.33	2.55	2.02	1.63	1.35	1.13	0.966	0.833			
100	x 100	x 8.0	SHS	11.6	137	34.2	15.2	8.56	5.48	3.80	2.79	2.14	1.69	1.37	1.13	0.951	0.810	0.699			
			SHS	8.96	109	27.2	12.1	6.80	4.35	3.02	2.22	1.70	1.34	1.09	0.899	0.755	0.644	0.555			
			SHS	7.53	92.5	23.1	10.3	5.78	3.70	2.57	1.89	1.45	1.14	0.925	0.765	0.643	0.548	0.472			
			SHS	6.07	75.6	18.9	8.40	4.72	3.02	2.10	1.54	1.18	0.933	0.756	0.625	0.525	0.447	0.386			
			90	x 90	x 2.5	SHS	6.74	66.7	16.7	7.41	4.17	2.67	1.85	1.36	1.04	0.823	0.667	0.551	0.463	0.395	0.340
SHS	5.45	54.6				13.6	6.07	3.41	2.18	1.52	1.11	0.853	0.674	0.546	0.451	0.379	0.323	0.279			
89	x 89	x 6.0				SHS	14.7	127	31.7	14.1	7.92	5.07	3.52	2.59	1.98	1.57	1.27	1.05	0.880	0.750	0.647
						SHS	12.5	112	27.9	12.4	6.98	4.47	3.10	2.28	1.75	1.38	1.12	0.923	0.776	0.661	0.570
						SHS	9.07	84.7	21.2	9.42	5.30	3.39	2.35	1.73	1.32	1.05	0.847	0.700	0.588	0.501	0.432
75	x 75	x 6.0	SHS	5.38	52.7	13.2	5.86	3.30	2.11	1.47	1.08	0.824	0.651	0.527	0.436	0.366	0.312	0.269			
			SHS	12.0	71.1	17.8	7.90	4.45	2.85	1.98	1.45	1.11	0.878	0.711	0.588	0.494	0.421	0.363			
			SHS	10.3	63.5	15.9	7.05	3.97	2.54	1.76	1.30	0.992	0.783	0.635	0.524	0.441	0.375	0.324			
			SHS	8.49	54.2	13.6	6.02	3.39	2.17	1.51	1.11	0.847	0.669	0.542	0.448	0.376	0.321	0.277			
			SHS	7.53	49.0	12.2	5.44	3.06	1.96	1.36	1.00	0.765	0.605	0.490	0.405	0.340	0.290	0.250			
75	x 75	x 4.0	SHS	6.60	44.0	11.0	4.89	2.75	1.76	1.22	0.898	0.688	0.543	0.440	0.364	0.306	0.260	0.225			
			SHS	5.56	37.7	9.43	4.19	2.36	1.51	1.05	0.770	0.589	0.466	0.377	0.312	0.262	0.223	0.192			
			SHS	4.50	31.0	7.76	3.45	1.94	1.24	0.862	0.633	0.485	0.383	0.310	0.256	0.215	0.184	0.158			
			65	x 65	x 6.0	SHS	10.1	43.4	10.8	4.82	2.71	1.74	1.21	0.886	0.678	0.536	0.434	0.359	0.301	0.257	0.221
						SHS	8.75	39.2	9.80	4.36	2.45	1.57	1.09	0.800	0.613	0.484	0.392	0.324	0.272	0.232	0.200
SHS	7.23	33.9				8.48	3.77	2.12	1.36	0.942	0.692	0.530	0.419	0.339	0.280	0.235	0.201	0.173			
65	x 65	x 4.0	SHS	5.66	27.9	6.98	3.10	1.74	1.12	0.775	0.569	0.436	0.344	0.279	0.231	0.194	0.165	0.142			
			SHS	4.78	24.0	6.01	2.67	1.50	0.961	0.667	0.490	0.375	0.297	0.240	0.199	0.167	0.142	0.123			
			SHS	3.88	19.9	4.96	2.21	1.24	0.794	0.551	0.405	0.310	0.245	0.199	0.164	0.138	0.117	0.101			
			SHS	3.13	16.3	4.07	1.81	1.02	0.652	0.453	0.332	0.255	0.201	0.163	0.135	0.113	0.0964	0.0831			

**Notes:**

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- $W_s^*$  = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250 or First Yield.
- Red shading indicates serviceability loads governed by yielding.

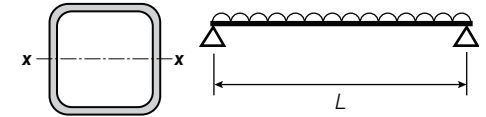
TABLE 5.1-6(3)(A)

# Square Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

**STRENGTH** LIMIT STATE MAXIMUM DESIGN LOADS  
FOR SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT

*bending about x-axis*

- 1 SHS
- 2 C450PLUS®
- 3 Finish



d	Designation			Mass per m	$W_{L1}^*$ (kN)														$W_{L2}^*$	
	b	t			Span of Beam (L) in metres															
mm	mm	mm		kg/m	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	4.50	5.00	6.00	kN	
50	x	50	x	6.0 SHS	7.32	94.2	62.8	47.1	37.7	31.4	26.9	23.5	18.8	15.7	13.5	11.8	10.5	9.42	7.85	219
				5.0 SHS	6.39	85.3	56.8	42.6	34.1	28.4	24.4	21.3	17.1	14.2	12.2	10.7	9.47	8.53	7.10	192
				4.0 SHS	5.35	73.8	49.2	36.9	29.5	24.6	21.1	18.4	14.8	12.3	10.5	9.22	8.19	7.38	6.15	161
				3.0 SHS	4.25	60.8	40.6	30.4	24.3	20.3	17.4	15.2	12.2	10.1	8.69	7.60	6.76	6.08	5.07	127
				2.5 SHS	3.60	52.3	34.9	26.2	20.9	17.4	14.9	13.1	10.5	8.72	7.47	6.54	5.81	5.23	4.36	108
				2.0 SHS	2.93	42.6	28.4	21.3	17.0	14.2	12.2	10.7	8.52	7.10	6.09	5.33	4.73	4.26	3.55	88.3
40	x	40	x	4.0 SHS	2.38	30.7	20.5	15.4	12.3	10.2	8.78	7.68	6.14	5.12	4.39	3.84	3.41	3.07	2.56	71.9
				3.0 SHS	4.09	43.6	29.1	21.8	17.5	14.5	12.5	10.9	8.73	7.27	6.24	5.46	4.85	4.36	3.64	123
				2.5 SHS	3.30	37.1	24.7	18.5	14.8	12.4	10.6	9.27	7.42	6.18	5.30	4.64	4.12	3.71	3.09	97.9
				2.0 SHS	2.82	32.2	21.5	16.1	12.9	10.7	9.20	8.05	6.44	5.36	4.60	4.02	3.58	3.22	2.68	84.0
				2.0 SHS	2.31	26.8	17.9	13.4	10.7	8.93	7.65	6.70	5.36	4.46	3.83	3.35	2.98	2.68	2.23	69.1
				1.6 SHS	1.88	21.8	14.5	10.9	8.73	7.27	6.23	5.45	4.36	3.64	3.12	2.73	2.42	2.18	1.82	56.5
35	x	35	x	3.0 SHS	2.83	27.4	18.3	13.7	11.0	9.13	7.83	6.85	5.48	4.57	3.91	3.43	3.04	2.74	2.28	83.5
				2.5 SHS	2.42	23.9	16.0	12.0	9.58	7.98	6.84	5.99	4.79	3.99	3.42	2.99	2.66	2.39	2.00	72.0
				2.0 SHS	1.99	20.1	13.4	10.0	8.02	6.68	5.73	5.01	4.01	3.34	2.86	2.51	2.23	2.01	1.67	59.5
				1.6 SHS	1.63	16.6	11.1	8.31	6.65	5.54	4.75	4.16	3.33	2.77	2.38	2.08	1.85	1.66	1.39	48.8
30	x	30	x	3.0 SHS	2.36	19.2	12.8	9.59	7.67	6.39	5.48	4.79	3.84	3.20	2.74	2.40	2.13	1.92	1.60	69.1
				2.5 SHS	2.03	16.9	11.3	8.46	6.76	5.64	4.83	4.23	3.38	2.82	2.42	2.11	1.88	1.69	1.41	60.0
				2.0 SHS	1.68	14.3	9.53	7.15	5.72	4.76	4.08	3.57	2.86	2.38	2.04	1.79	1.59	1.43	1.19	49.9
				1.6 SHS	1.38	11.9	7.95	5.96	4.77	3.98	3.41	2.98	2.39	1.99	1.70	1.49	1.33	1.19	0.994	41.2
25	x	25	x	3.0 SHS	1.89	12.4	8.27	6.20	4.96	4.14	3.55	3.10	2.48	2.07	1.77	1.55	1.38	1.24	1.03	54.7
				2.5 SHS	1.64	11.1	7.40	5.55	4.44	3.70	3.17	2.77	2.22	1.85	1.59	1.39	1.23	1.11	0.925	48.0
				2.0 SHS	1.36	9.50	6.33	4.75	3.80	3.17	2.71	2.38	1.90	1.58	1.36	1.19	1.06	0.950	0.792	40.3
				1.6 SHS	1.12	8.01	5.34	4.00	3.20	2.67	2.29	2.00	1.60	1.33	1.14	1.00	0.890	0.801	0.667	33.5
20	x	20	x	2.0 SHS	1.05	5.68	3.79	2.84	2.27	1.89	1.62	1.42	1.14	0.947	0.812	0.710	0.631	0.568	0.474	30.7
				1.6 SHS	0.873	4.86	3.24	2.43	1.95	1.62	1.39	1.22	0.973	0.811	0.695	0.608	0.540	0.486	0.405	25.8

**Notes:**

1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the availability of listed sections and associated finishes. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3.  $W_{L1}^*$  = Maximum Design Load based on Design Moment Capacity.
4.  $W_{L2}^*$  = Maximum Design Load based on Design Shear Capacity.
5. Maximum Design Load  $W_{L1}^*$  is LESSER of  $W_{L1}^*$  and  $W_{L2}^*$ .
6. **NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**

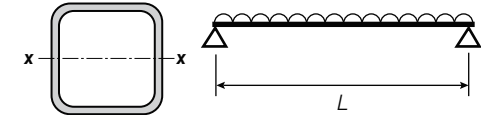
TABLE 5.1-6(3)(B)

# Square Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

**SERVICEABILITY** LIMIT STATE MAXIMUM DESIGN LOADS  
FOR SIMPLY SUPPORTED BEAMS

*bending about x-axis*

- 1 SHS
- 2 C450PLUS®
- 3 Finish



d	Designation		t	Mass per m	W <sub>s</sub> * (kN)															
	b				Span of Beam (L) in metres															
mm	mm	mm	kg/m	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	4.50	5.00	6.00			
50	x	50	x	6.0	SHS	7.32	67.7	30.1	16.9	10.8	7.52	5.52	4.23	2.71	1.88	1.38	1.06	0.835	0.677	0.470
				5.0	SHS	6.39	63.1	28.1	15.8	10.1	7.02	5.15	3.95	2.53	1.75	1.29	0.987	0.780	0.631	0.438
				4.0	SHS	5.35	56.2	25.0	14.1	8.99	6.25	4.59	3.51	2.25	1.56	1.15	0.878	0.694	0.562	0.390
				3.0	SHS	4.25	47.8	21.3	12.0	7.65	5.32	3.91	2.99	1.91	1.33	0.976	0.748	0.591	0.478	0.332
				2.5	SHS	3.60	41.6	18.5	10.4	6.66	4.63	3.40	2.60	1.67	1.16	0.850	0.651	0.514	0.416	0.289
				2.0	SHS	2.93	34.8	15.5	8.69	5.56	3.86	2.84	2.17	1.39	0.966	0.710	0.543	0.429	0.348	0.241
40	x	40	x	4.0	SHS	4.09	25.9	11.5	6.47	4.14	2.87	2.11	1.62	1.03	0.718	0.528	0.404	0.319	0.259	0.180
				3.0	SHS	3.30	22.9	10.2	5.73	3.67	2.55	1.87	1.43	0.917	0.636	0.468	0.358	0.283	0.229	0.159
				2.5	SHS	2.82	20.2	8.97	5.05	3.23	2.24	1.65	1.26	0.808	0.561	0.412	0.315	0.249	0.202	0.140
				2.0	SHS	2.31	17.1	7.58	4.26	2.73	1.90	1.39	1.07	0.682	0.474	0.348	0.267	0.211	0.171	0.118
				1.6	SHS	1.88	14.2	6.33	3.56	2.28	1.58	1.16	0.890	0.570	0.396	0.291	0.223	0.176	0.142	0.0989
35	x	35	x	3.0	SHS	2.83	14.6	6.50	3.65	2.34	1.62	1.19	0.914	0.585	0.406	0.298	0.228	0.180	0.146	0.102
				2.5	SHS	2.42	13.0	5.78	3.25	2.08	1.44	1.06	0.812	0.520	0.361	0.265	0.203	0.160	0.130	0.0903
				2.0	SHS	1.99	11.1	4.92	2.77	1.77	1.23	0.904	0.692	0.443	0.308	0.226	0.173	0.137	0.111	0.0769
				1.6	SHS	1.63	9.31	4.14	2.33	1.49	1.03	0.760	0.582	0.372	0.259	0.190	0.145	0.115	0.0931	0.0647
30	x	30	x	3.0	SHS	2.36	8.61	3.83	2.15	1.38	0.957	0.703	0.538	0.344	0.239	0.176	0.135	0.106	0.0861	0.0598
				2.5	SHS	2.03	7.76	3.45	1.94	1.24	0.862	0.633	0.485	0.310	0.215	0.158	0.121	0.0958	0.0776	0.0539
				2.0	SHS	1.68	6.69	2.97	1.67	1.07	0.743	0.546	0.418	0.268	0.186	0.137	0.105	0.0826	0.0669	0.0465
				1.6	SHS	1.38	5.67	2.52	1.42	0.908	0.630	0.463	0.355	0.227	0.158	0.116	0.0887	0.0701	0.0567	0.0394
25	x	25	x	3.0	SHS	1.89	4.52	2.01	1.13	0.724	0.503	0.369	0.283	0.181	0.126	0.0923	0.0707	0.0559	0.0452	0.0314
				2.5	SHS	1.64	4.15	1.85	1.04	0.664	0.461	0.339	0.260	0.166	0.115	0.0848	0.0649	0.0513	0.0415	0.0288
				2.0	SHS	1.36	3.65	1.62	0.911	0.583	0.405	0.298	0.228	0.146	0.101	0.0744	0.0570	0.0450	0.0365	0.0253
				1.6	SHS	1.12	3.13	1.39	0.783	0.501	0.348	0.256	0.196	0.125	0.0870	0.0640	0.0490	0.0387	0.0313	0.0218
20	x	20	x	2.0	SHS	1.05	1.70	0.756	0.425	0.272	0.189	0.139	0.106	0.0680	0.0473	0.0347	0.0266	0.0210		
				1.6	SHS	0.873	1.49	0.664	0.373	0.239	0.166	0.122	0.0933	0.0597	0.0415	0.0305	0.0233			

**Notes:**

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- $W_s^*$  = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250 or First Yield.
- Red shading indicates serviceability loads governed by yielding.
- NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**

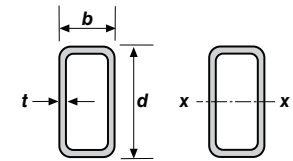
TABLE 5.2-1(A)

# Rectangular Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN SECTION MOMENT AND WEB CAPACITIES

about x-axis

- 1 RHS
- 2 C350L0
- 3 Finish



Designation			Mass per m	Design Section Moment Capacities			Design Web Capacities											
				About x-axis		Torsion	Shear	Interior Bearing					End Bearing					
d	b	t		$\phi M_{sx}$	FLR	$\phi M_z$	$\phi V_v$	$\frac{\phi R_{by}}{b_b}$	$\frac{\phi R_{bb}}{b_b}$	$5r_{ext}$	$b_{bw}$	$\frac{L_e}{r}$	$\frac{\phi R_{by}}{b_b}$	$\frac{\phi R_{bb}}{b_b}$	$2.5r_{ext}$	$b_{bw}$	$\frac{L_e}{r}$	
mm	mm	mm	kg/m	kNm	m	kNm	kN	kN/mm	kN/mm	mm	mm		kN/mm	kN/mm	mm	mm		
75	x 25	2.5	RHS	3.60	3.17	0.736	1.35	61.5	<b>0.519</b>	0.697	25.0	32.5	91.0	<b>0.499</b>	0.625	12.5	32.5	98.8
		2.0	RHS	2.93	2.62	0.751	1.14	49.9	0.411	<b>0.389</b>	20.0	33.5	117	0.399	<b>0.342</b>	10.0	33.5	127
		1.6	RHS	2.38	2.15	0.764	0.954	40.4	0.326	<b>0.208</b>	16.0	34.3	150	0.319	<b>0.181</b>	8.00	34.3	163
65	x 35	4.0	RHS	5.35	4.18	1.55	2.37	82.4	<b>0.704</b>	2.09	50.0	22.5	39.4	<b>0.611</b>	2.03	25.0	22.5	42.8
		3.0	RHS	4.25	3.46	1.61	1.97	64.0	<b>0.635</b>	1.24	30.0	26.5	61.8	<b>0.598</b>	1.16	15.0	26.5	67.1
		2.5	RHS	3.60	2.98	1.64	1.72	54.2	<b>0.523</b>	0.850	25.0	27.5	77.0	<b>0.499</b>	0.775	12.5	27.5	83.6
		2.0	RHS	2.93	2.46	1.66	1.44	44.1	<b>0.413</b>	0.493	20.0	28.5	99.8	<b>0.399</b>	0.438	10.0	28.5	108
50	x 25	3.0	RHS	3.07	1.85	1.04	0.979	47.5	<b>0.650</b>	1.50	30.0	19.0	44.3	<b>0.598</b>	1.45	15.0	19.0	48.1
		2.5	RHS	2.62	1.61	1.06	0.869	40.5	<b>0.533</b>	1.11	25.0	20.0	56.0	<b>0.499</b>	1.05	12.5	20.0	60.8
		2.0	RHS	2.15	1.34	1.09	0.741	33.1	<b>0.419</b>	0.713	20.0	21.0	73.5	<b>0.399</b>	0.654	10.0	21.0	79.8
		1.6	RHS	1.75	1.11	1.10	0.623	27.0	<b>0.331</b>	0.420	16.0	21.8	95.4	<b>0.319</b>	0.374	8.00	21.8	104
50	x 20	3.0	RHS	2.83	1.62	0.657	0.733	46.9	<b>0.650</b>	1.50	30.0	19.0	44.3	<b>0.598</b>	1.45	15.0	19.0	48.1
		2.5	RHS	2.42	1.42	0.676	0.659	40.0	<b>0.533</b>	1.11	25.0	20.0	56.0	<b>0.499</b>	1.05	12.5	20.0	60.8
		2.0	RHS	1.99	1.19	0.695	0.568	32.7	<b>0.419</b>	0.713	20.0	21.0	73.5	<b>0.399</b>	0.654	10.0	21.0	79.8
		1.6	RHS	1.63	0.989	0.710	0.482	26.6	<b>0.331</b>	0.420	16.0	21.8	95.4	<b>0.319</b>	0.374	8.00	21.8	104

**Notes:**

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- FLR based on most conservative case ( $\beta_m = -1$ ).
- Bold** listings in the table note whether design web bearing yielding or buckling is critical for either Interior or End Bearing.

**ADDITIONAL NOTES:**

- THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.
- SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.

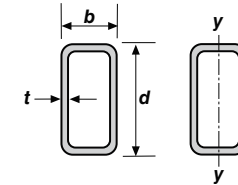
TABLE 5.2-1(B)

# Rectangular Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN SECTION MOMENT AND WEB CAPACITIES

about y-axis

- 1 RHS
- 2 C350L0
- 3 Finish



Designation	Mass per m	Design Section Moment Capacity	Design Web Capacities													
			Shear $\phi V_v$	Interior Bearing					End Bearing							
d	b	t	$\phi M_{sy}$	$\phi V_v$	$\frac{\phi R_{by}}{b_b}$	$\frac{\phi R_{bb}}{b_b}$	$5r_{ext}$	$b_{bw}$	$\frac{L_e}{r}$	$\frac{\phi R_{by}}{b_b}$	$\frac{\phi R_{bb}}{b_b}$	$2.5r_{ext}$	$b_{bw}$	$\frac{L_e}{r}$		
mm	mm	mm	kg/m	kN	kN/mm	kN/mm	mm	mm		kN/mm	kN/mm	mm	mm			
75 x 25	x	2.5	RHS	3.60	1.36	18.9	<b>0.587</b>	1.49	25.0	7.50	21.0	<b>0.499</b>	1.47	12.5	7.50	22.8
		2.0	RHS	2.93	1.00	15.9	<b>0.450</b>	1.12	20.0	8.50	29.8	<b>0.399</b>	1.10	10.0	8.50	32.3
		1.6	RHS	2.38	0.699	13.2	<b>0.349</b>	0.825	16.0	9.30	40.7	<b>0.319</b>	0.801	8.00	9.30	44.2
65 x 35	x	4.0	RHS	5.35	2.70	40.8	<b>0.866</b>	2.49	50.0	7.50	13.1	<b>0.611</b>	2.48	25.0	7.50	14.3
		3.0	RHS	4.25	2.24	32.9	<b>0.683</b>	1.72	30.0	11.5	26.8	<b>0.598</b>	1.69	15.0	11.5	29.1
		2.5	RHS	3.60	1.93	28.4	<b>0.553</b>	1.35	25.0	12.5	35.0	<b>0.499</b>	1.32	12.5	12.5	38.0
		2.0	RHS	2.93	1.48	23.4	<b>0.431</b>	0.973	20.0	13.5	47.3	<b>0.399</b>	0.935	10.0	13.5	51.3
50 x 25	x	3.0	RHS	3.07	1.12	21.5	<b>0.738</b>	1.85	30.0	6.50	15.2	<b>0.598</b>	1.83	15.0	6.50	16.5
		2.5	RHS	2.62	0.982	18.9	<b>0.587</b>	1.49	25.0	7.50	21.0	<b>0.499</b>	1.47	12.5	7.50	22.8
		2.0	RHS	2.15	0.824	15.9	<b>0.450</b>	1.12	20.0	8.50	29.8	<b>0.399</b>	1.10	10.0	8.50	32.3
		1.6	RHS	1.75	0.644	13.2	<b>0.349</b>	0.825	16.0	9.30	40.7	<b>0.319</b>	0.801	8.00	9.30	44.2
50 x 20	x	3.0	RHS	2.83	0.827	15.9	<b>0.797</b>	1.91	30.0	4.00	9.33	<b>0.598</b>	1.90	15.0	4.00	10.1
		2.5	RHS	2.42	0.729	14.2	<b>0.623</b>	1.55	25.0	5.00	14.0	<b>0.499</b>	1.54	12.5	5.00	15.2
		2.0	RHS	1.99	0.616	12.1	<b>0.469</b>	1.19	20.0	6.00	21.0	<b>0.399</b>	1.17	10.0	6.00	22.8
		1.6	RHS	1.63	0.484	10.2	<b>0.360</b>	0.897	16.0	6.80	29.8	<b>0.319</b>	0.881	8.00	6.80	32.3

**Notes:**

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Bold** listings in the table note whether design web bearing yielding or buckling is critical for either Interior or End Bearing.

**ADDITIONAL NOTES:**

- (A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.
- (B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.



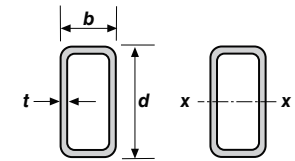
TABLE 5.2-2(1)(A)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION MOMENT AND WEB CAPACITIES

about x-axis

- 1 RHS
- 2 C450PLUS®
- 3 Finish



Designation			Mass per m	Design Section Moment Capacities				Design Web Capacities										
				About x-axis		Torsion	Shear	Interior Bearing					End Bearing					
d	b	t		$\phi M_{sx}$	FLR	$\phi M_z$	$\phi V_v$	$\frac{\phi R_{by}}{b_b}$	$\frac{\phi R_{bb}}{b_b}$	$5r_{ext}$	$b_{bw}$	$\frac{L_e}{r}$	$\frac{\phi R_{by}}{b_b}$	$\frac{\phi R_{bb}}{b_b}$	$2.5r_{ext}$	$b_{bw}$	$\frac{L_e}{r}$	
mm	mm	mm	kg/m	kNm	m	kNm	kN	kN/mm	kN/mm	mm	mm		kN/mm	kN/mm	mm	mm		
400 x 300 x	16.0	RHS	161	1110	14.9	771	2790	<b>3.42</b>	6.76	200	160	70.0	<b>3.14</b>	6.15	100	160	76.0	
		12.5	RHS	128	901	15.1	628	2220	<b>2.61</b>	3.58	156	169	94.5	<b>2.46</b>	3.16	78.1	169	103
		10.0	RHS	104	649	15.2	518	1800	2.06	<b>1.91</b>	125	175	123	1.97	<b>1.66</b>	62.5	175	133
		8.0	RHS	84.2	463	15.4	425	1450	1.63	<b>0.990</b>	100	180	158	1.57	<b>0.855</b>	50.0	180	171
400 x 200 x	16.0	RHS	136	866	6.73	485	2730	<b>3.42</b>	6.76	200	160	70.0	<b>3.14</b>	6.15	100	160	76.0	
		12.5	RHS	109	705	6.87	401	2170	<b>2.61</b>	3.58	156	169	94.5	<b>2.46</b>	3.16	78.1	169	103
		10.0	RHS	88.4	581	6.97	334	1760	2.06	<b>1.91</b>	125	175	123	1.97	<b>1.66</b>	62.5	175	133
		8.0	RHS	71.6	467	7.04	275	1420	1.63	<b>0.990</b>	100	180	158	1.57	<b>0.855</b>	50.0	180	171
350 x 250 x	16.0	RHS	136	807	11.7	543	2400	<b>3.47</b>	8.00	200	135	59.1	<b>3.14</b>	7.42	100	135	64.1	
		12.5	RHS	109	657	11.9	446	1920	<b>2.64</b>	4.47	156	144	80.5	<b>2.46</b>	4.00	78.1	144	87.4
		10.0	RHS	88.4	533	12.1	370	1560	<b>2.08</b>	2.44	125	150	105	<b>1.97</b>	2.14	62.5	150	114
		8.0	RHS	71.6	376	12.2	304	1260	1.64	<b>1.28</b>	100	155	136	1.57	<b>1.11</b>	50.0	155	147
300 x 200 x	16.0	RHS	111	548	8.66	354	2020	<b>3.54</b>	9.28	200	110	48.1	<b>3.14</b>	8.80	100	110	52.3	
		12.5	RHS	89.0	450	8.85	294	1620	<b>2.68</b>	5.58	156	119	66.5	<b>2.46</b>	5.10	78.1	119	72.2
		10.0	RHS	72.7	373	8.99	246	1320	<b>2.10</b>	3.19	125	125	87.5	<b>1.97</b>	2.84	62.5	125	95.0
		8.0	RHS	59.1	302	9.10	204	1070	<b>1.66</b>	1.72	100	130	114	1.57	<b>1.50</b>	50.0	130	124
		6.0	RHS	45.0	192	9.20	158	813	1.22	<b>0.743</b>	75.0	135	158	1.18	<b>0.641</b>	37.5	135	171
		250 x 150 x	16.0	RHS	85.5	338	5.73	203	1630	<b>3.65</b>	10.5	200	85.0	37.2	<b>3.14</b>	10.1	100	85.0
12.5	RHS	69.4		282	5.90	173	1320	<b>2.74</b>	6.86	156	93.8	52.5	<b>2.46</b>	6.44	78.1	93.8	57.0	
10.0	RHS	57.0		236	6.02	146	1080	<b>2.14</b>	4.23	125	100	70.0	<b>1.97</b>	3.84	62.5	100	76.0	
9.0	RHS	51.8		216	6.07	135	976	<b>1.90</b>	3.26	113	103	79.7	<b>1.77</b>	2.92	56.3	103	86.6	
8.0	RHS	46.5		195	6.12	122	875	<b>1.68</b>	2.39	100	105	91.9	<b>1.57</b>	2.11	50.0	105	99.8	
6.0	RHS	35.6		149	6.22	96.0	668	1.23	<b>1.06</b>	75.0	110	128	1.18	<b>0.920</b>	37.5	110	139	
250 x 150 x	5.0	RHS	29.9	111	6.26	81.8	561	1.02	<b>0.619</b>	62.5	113	158	0.983	<b>0.534</b>	31.3	113	171	

**Notes:**

1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. FLR based on most conservative case ( $\beta_m = -1$ ).
4. **Bold** listings in the table note whether design web bearing yielding or buckling is critical for either Interior or End Bearing.

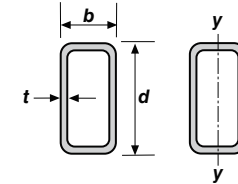
TABLE 5.2-2(1)(B)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION MOMENT AND WEB CAPACITIES

about y-axis

- 1 RHS
- 2 C450PLUS®
- 3 Finish



Designation	Mass per m	Design Section Moment Capacity	Design Web Capacities													
			Shear $\phi V_v$	Interior Bearing					End Bearing							
				$\frac{\phi R_{by}}{b_b}$	$\frac{\phi R_{bb}}{b_b}$	$5r_{ext}$	$b_{bw}$	$\frac{L_e}{r}$	$\frac{\phi R_{by}}{b_b}$	$\frac{\phi R_{bb}}{b_b}$	$2.5r_{ext}$	$b_{bw}$	$\frac{L_e}{r}$			
mm	mm	mm	kg/m	$\phi M_{sy}$	kN	kN/mm	mm	mm		kN/mm	kN/mm	mm	mm			
400 x 300 x 16.0 RHS	161	905	2080	<b>3.54</b>	9.28	200	110	48.1	<b>3.14</b>	8.80	100	110	52.3			
	128	641	1670	<b>2.68</b>	5.58	156	119	66.5	<b>2.46</b>	5.10	78.1	119	72.2			
	104	454	1360	<b>2.10</b>	3.19	125	125	87.5	<b>1.97</b>	2.84	62.5	125	95.0			
	84.2	324	1100	<b>1.66</b>	1.72	100	130	114	1.57	<b>1.50</b>	50.0	130	124			
400 x 200 x 16.0 RHS	136	527	1310	<b>3.85</b>	11.5	200	60.0	26.3	<b>3.14</b>	11.3	100	60.0	28.5			
	109	379	1060	<b>2.84</b>	8.08	156	68.8	38.5	<b>2.46</b>	7.81	78.1	68.8	41.8			
	88.4	266	875	<b>2.19</b>	5.48	125	75.0	52.5	<b>1.97</b>	5.15	62.5	75.0	57.0			
	71.6	188	715	<b>1.71</b>	3.38	100	80.0	70.0	<b>1.57</b>	3.07	50.0	80.0	76.0			
350 x 250 x 16.0 RHS	136	641	1700	<b>3.65</b>	10.5	200	85.0	37.2	<b>3.14</b>	10.1	100	85.0	40.4			
	109	487	1370	<b>2.74</b>	6.86	156	93.8	52.5	<b>2.46</b>	6.44	78.1	93.8	57.0			
	88.4	350	1120	<b>2.14</b>	4.23	125	100	70.0	<b>1.97</b>	3.84	62.5	100	76.0			
	71.6	249	910	<b>1.68</b>	2.39	100	105	91.9	<b>1.57</b>	2.11	50.0	105	99.8			
300 x 200 x 16.0 RHS	111	414	1310	<b>3.85</b>	11.5	200	60.0	26.3	<b>3.14</b>	11.3	100	60.0	28.5			
	89.0	341	1060	<b>2.84</b>	8.08	156	68.8	38.5	<b>2.46</b>	7.81	78.1	68.8	41.8			
	72.7	254	875	<b>2.19</b>	5.48	125	75.0	52.5	<b>1.97</b>	5.15	62.5	75.0	57.0			
	59.1	181	715	<b>1.71</b>	3.38	100	80.0	70.0	<b>1.57</b>	3.07	50.0	80.0	76.0			
250 x 150 x 16.0 RHS	45.0	116	548	<b>1.25</b>	1.60	75.0	85.0	99.2	<b>1.18</b>	1.41	37.5	85.0	108			
	85.5	236	918	<b>4.29</b>	12.5	200	35.0	15.3	<b>3.14</b>	12.4	100	35.0	16.6			
	69.4	198	759	<b>3.04</b>	9.14	156	43.8	24.5	<b>2.46</b>	8.99	78.1	43.8	26.6			
	57.0	164	632	<b>2.30</b>	6.69	125	50.0	35.0	<b>1.97</b>	6.50	62.5	50.0	38.0			
250 x 150 x 10.0 RHS	51.8	143	577	<b>2.03</b>	5.68	113	52.5	40.8	<b>1.77</b>	5.46	56.3	52.5	44.3			
	46.5	121	521	<b>1.77</b>	4.64	100	55.0	48.1	<b>1.57</b>	4.40	50.0	55.0	52.3			
	35.6	77.5	402	<b>1.28</b>	2.54	75.0	60.0	70.0	<b>1.18</b>	2.30	37.5	60.0	76.0			
	29.9	58.5	340	<b>1.05</b>	1.60	62.5	62.5	87.5	<b>0.983</b>	1.42	31.3	62.5	95.0			

**Notes:**

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- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- Bold** listings in the table note whether design web bearing yielding or buckling is critical for either Interior or End Bearing.

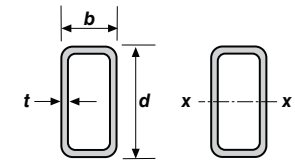
TABLE 5.2-2(2)(A)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION MOMENT AND WEB CAPACITIES

about x-axis

- 1 RHS
- 2 C450PLUS®
- 3 Finish



Designation			Mass per m	Design Section Moment Capacities			Design Web Capacities										
				About x-axis		Torsion	Shear	Interior Bearing					End Bearing				
d	b	t		$\phi M_{sx}$	FLR	$\phi M_z$	$\phi V_v$	$\frac{\phi R_{by}}{b_b}$	$\frac{\phi R_{bb}}{b_b}$	$5r_{ext}$	$b_{bw}$	$\frac{L_e}{r}$	$\frac{\phi R_{by}}{b_b}$	$\frac{\phi R_{bb}}{b_b}$	$2.5r_{ext}$	$b_{bw}$	$\frac{L_e}{r}$
mm	mm	mm	kg/m	kNm	m	kNm	kN	kN/mm	kN/mm	mm	mm		kN/mm	kN/mm	mm	mm	
200 x 100	x 10.0	RHS	41.3	129	3.29	71.0	833	<b>2.19</b>	5.48	125	75.0	52.5	<b>1.97</b>	5.15	62.5	75.0	57.0
		RHS	37.7	119	3.33	66.0	758	<b>1.95</b>	4.42	113	77.5	60.3	<b>1.77</b>	4.09	56.3	77.5	65.4
		RHS	33.9	108	3.37	60.7	681	<b>1.71</b>	3.38	100	80.0	70.0	<b>1.57</b>	3.07	50.0	80.0	76.0
		RHS	26.2	85.1	3.44	48.5	522	<b>1.25</b>	1.60	75.0	85.0	99.2	<b>1.18</b>	1.41	37.5	85.0	108
		RHS	22.1	72.6	3.48	41.7	440	1.03	<b>0.953</b>	62.5	87.5	123	0.983	<b>0.830</b>	31.3	87.5	133
		RHS	17.9	58.4	3.52	34.4	355	0.816	<b>0.495</b>	50.0	90.0	158	0.786	<b>0.428</b>	25.0	90.0	171
152 x 76	x 6.0	RHS	19.4	47.0	2.56	26.4	389	<b>1.28</b>	2.49	75.0	61.0	71.2	<b>1.18</b>	2.26	37.5	61.0	77.3
		RHS	16.4	40.4	2.60	22.9	329	<b>1.05</b>	1.56	62.5	63.5	88.9	<b>0.983</b>	1.39	31.3	63.5	96.5
150 x 100	x 10.0	RHS	33.4	80.7	4.22	51.3	611	<b>2.30</b>	6.69	125	50.0	35.0	<b>1.97</b>	6.50	62.5	50.0	38.0
		RHS	30.6	74.8	4.28	47.9	559	<b>2.03</b>	5.68	113	52.5	40.8	<b>1.77</b>	5.46	56.3	52.5	44.3
		RHS	27.7	68.5	4.33	44.2	504	<b>1.77</b>	4.64	100	55.0	48.1	<b>1.57</b>	4.40	50.0	55.0	52.3
		RHS	21.4	54.4	4.44	35.6	389	<b>1.28</b>	2.54	75.0	60.0	70.0	<b>1.18</b>	2.30	37.5	60.0	76.0
		RHS	18.2	46.6	4.49	30.7	329	<b>1.05</b>	1.60	62.5	62.5	87.5	<b>0.983</b>	1.42	31.3	62.5	95.0
		RHS	14.8	37.8	4.55	25.5	267	<b>0.828</b>	0.860	50.0	65.0	114	0.786	<b>0.752</b>	25.0	65.0	124
150 x 50	x 6.0	RHS	16.7	36.9	1.12	15.6	374	<b>1.28</b>	2.54	75.0	60.0	70.0	<b>1.18</b>	2.30	37.5	60.0	76.0
		RHS	14.2	31.9	1.14	13.8	316	<b>1.05</b>	1.60	62.5	62.5	87.5	<b>0.983</b>	1.42	31.3	62.5	95.0
		RHS	11.6	26.5	1.17	11.7	257	<b>0.828</b>	0.860	50.0	65.0	114	0.786	<b>0.752</b>	25.0	65.0	124
		RHS	8.96	20.8	1.19	9.30	195	0.785	<b>0.357</b>	30.0	69.0	161	0.769	<b>0.308</b>	15.0	69.0	175
		RHS	7.53	17.6	1.21	7.97	164	0.651	<b>0.208</b>	25.0	70.0	196	0.641	<b>0.179</b>	12.5	70.0	213
		RHS	6.07	12.8	1.22	6.55	132	0.519	<b>0.107</b>	20.0	71.0	249	0.513	<b>0.0918</b>	10.0	71.0	270
		RHS	14.7	27.9	1.35	13.3	315	<b>1.31</b>	3.11	75.0	48.5	56.6	<b>1.18</b>	2.90	37.5	48.5	61.4
127 x 51	x 6.0	RHS	12.5	24.3	1.38	11.8	267	<b>1.07</b>	2.07	62.5	51.0	71.4	<b>0.983</b>	1.87	31.3	51.0	77.5
		RHS	9.07	18.1	1.43	9.04	192	<b>0.726</b>	0.800	43.8	54.8	110	<b>0.688</b>	0.701	21.9	54.8	119
		RHS	16.7	34.1	2.96	21.0	317	<b>1.31</b>	3.16	75.0	47.5	55.4	<b>1.18</b>	2.95	37.5	47.5	60.2
		RHS	14.2	29.5	3.01	18.3	269	<b>1.07</b>	2.11	62.5	50.0	70.0	<b>0.983</b>	1.92	31.3	50.0	76.0
		RHS	11.6	24.4	3.06	15.3	219	<b>0.838</b>	1.19	50.0	52.5	91.9	<b>0.786</b>	1.06	25.0	52.5	99.8
125 x 75	x 3.0	RHS	8.96	18.8	3.11	12.0	167	0.790	<b>0.506</b>	30.0	56.5	132	0.769	<b>0.439</b>	15.0	56.5	143
		RHS	7.53	14.1	3.14	10.2	140	0.654	<b>0.298</b>	25.0	57.5	161	0.641	<b>0.257</b>	12.5	57.5	175
		RHS	6.07	10.0	3.16	8.36	113	0.521	<b>0.154</b>	20.0	58.5	205	0.513	<b>0.132</b>	10.0	58.5	222
		RHS	14.7	25.1	3.63	17.0	255	<b>1.35</b>	3.74	75.0	36.0	42.0	<b>1.18</b>	3.59	37.5	36.0	45.6
		RHS	12.5	21.7	3.69	14.9	218	<b>1.09</b>	2.69	62.5	38.5	53.9	<b>0.983</b>	2.52	31.3	38.5	58.5
102 x 76	x 3.5	RHS	9.07	16.1	3.78	11.2	157	<b>0.737</b>	1.17	43.8	42.3	84.5	<b>0.688</b>	1.05	21.9	42.3	91.7

Notes:

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- FLR based on most conservative case ( $\beta_m = 1$ ).
- Bold** listings in the table note whether design web bearing yielding or buckling is critical for either Interior or End Bearing.

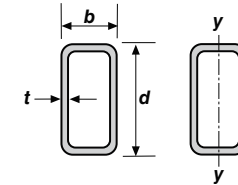
TABLE 5.2-2(2)(B)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION MOMENT AND WEB CAPACITIES

about y-axis

- 1 RHS
- 2 C450PLUS®
- 3 Finish



Designation				Mass per m	Design Section Moment Capacity	Design Web Capacities										
						Shear	Interior Bearing					End Bearing				
d	b	t				$\phi V_v$	$\frac{\phi R_{by}}{b_b}$	$\frac{\phi R_{bb}}{b_b}$	$5r_{ext}$	$b_{bw}$	$\frac{L_e}{r}$	$\frac{\phi R_{by}}{b_b}$	$\frac{\phi R_{bb}}{b_b}$	$2.5r_{ext}$	$b_{bw}$	$\frac{L_e}{r}$
mm	mm	mm		kg/m	$\phi M_{sy}$	kN	kN/mm	kN/mm	mm	mm		kN/mm	kN/mm	mm	mm	
200 x 100 x 10.0	RHS	41.3	79.1	389	<b>2.60</b>	7.69	125	25.0	17.5	<b>1.97</b>	7.61	62.5	25.0	19.0		
	RHS	37.7	73.1	359	<b>2.25</b>	6.73	113	27.5	21.4	<b>1.77</b>	6.64	56.3	27.5	23.2		
	RHS	33.9	65.9	327	<b>1.92</b>	5.77	100	30.0	26.3	<b>1.57</b>	5.66	50.0	30.0	28.5		
	RHS	26.2	44.4	257	<b>1.35</b>	3.79	75.0	35.0	40.8	<b>1.18</b>	3.64	37.5	35.0	44.3		
	RHS	22.1	33.3	219	<b>1.10</b>	2.74	62.5	37.5	52.5	<b>0.983</b>	2.58	31.3	37.5	57.0		
152 x 76 x 6.0	RHS	19.4	28.4	187	<b>1.44</b>	4.31	75.0	23.0	26.8	<b>1.18</b>	4.23	37.5	23.0	29.1		
	RHS	16.4	22.3	160	<b>1.15</b>	3.32	62.5	25.5	35.7	<b>0.983</b>	3.22	31.3	25.5	38.8		
150 x 100 x 10.0	RHS	33.4	60.9	389	<b>2.60</b>	7.69	125	25.0	17.5	<b>1.97</b>	7.61	62.5	25.0	19.0		
	RHS	30.6	56.5	359	<b>2.25</b>	6.73	113	27.5	21.4	<b>1.77</b>	6.64	56.3	27.5	23.2		
	RHS	27.7	51.8	327	<b>1.92</b>	5.77	100	30.0	26.3	<b>1.57</b>	5.66	50.0	30.0	28.5		
	RHS	21.4	40.7	257	<b>1.35</b>	3.79	75.0	35.0	40.8	<b>1.18</b>	3.64	37.5	35.0	44.3		
	RHS	18.2	31.8	219	<b>1.10</b>	2.74	62.5	37.5	52.5	<b>0.983</b>	2.58	31.3	37.5	57.0		
150 x 50 x 6.0	RHS	14.8	22.6	179	<b>0.854</b>	1.69	50.0	40.0	70.0	<b>0.786</b>	1.54	25.0	40.0	76.0		
	RHS	16.7	16.4	111	<b>1.72</b>	4.81	75.0	10.0	11.7	<b>1.18</b>	4.77	37.5	10.0	12.7		
	RHS	14.2	12.9	97.2	<b>1.30</b>	3.85	62.5	12.5	17.5	<b>0.983</b>	3.81	31.3	12.5	19.0		
	RHS	11.6	9.19	81.6	<b>0.962</b>	2.88	50.0	15.0	26.3	<b>0.786</b>	2.83	25.0	15.0	28.5		
	RHS	8.96	5.89	64.2	<b>0.836</b>	1.82	30.0	19.0	44.3	<b>0.769</b>	1.74	15.0	19.0	48.1		
	RHS	7.53	4.40	54.7	<b>0.685</b>	1.31	25.0	20.0	56.0	<b>0.641</b>	1.22	12.5	20.0	60.8		
	RHS	6.07	3.10	44.7	<b>0.539</b>	0.800	20.0	21.0	73.5	<b>0.513</b>	0.723	10.0	21.0	79.8		
127 x 51 x 6.0	RHS	14.7	14.5	114	<b>1.70</b>	4.79	75.0	10.5	12.3	<b>1.18</b>	4.75	37.5	10.5	13.3		
	RHS	12.5	12.4	99.6	<b>1.29</b>	3.83	62.5	13.0	18.2	<b>0.983</b>	3.79	31.3	13.0	19.8		
	RHS	9.07	7.49	74.8	<b>0.810</b>	2.37	43.8	16.8	33.5	<b>0.688</b>	2.31	21.9	16.8	36.4		
125 x 75 x 6.0	RHS	16.7	23.9	184	<b>1.44</b>	4.33	75.0	22.5	26.3	<b>1.18</b>	4.25	37.5	22.5	28.5		
	RHS	14.2	20.5	158	<b>1.15</b>	3.34	62.5	25.0	35.0	<b>0.983</b>	3.25	31.3	25.0	38.0		
	RHS	11.6	15.1	130	<b>0.884</b>	2.32	50.0	27.5	48.1	<b>0.786</b>	2.20	25.0	27.5	52.3		
	RHS	8.96	9.80	101	<b>0.809</b>	1.20	30.0	31.5	73.5	<b>0.769</b>	1.08	15.0	31.5	79.8		
	RHS	7.53	7.39	85.1	<b>0.667</b>	0.756	25.0	32.5	91.0	<b>0.641</b>	0.670	12.5	32.5	98.8		
	RHS	6.07	5.27	69.0	<b>0.528</b>	0.410	20.0	33.5	117	<b>0.513</b>	0.358	10.0	33.5	127		
102 x 76 x 6.0	RHS	14.7	20.5	187	<b>1.44</b>	4.31	75.0	23.0	26.8	<b>1.18</b>	4.23	37.5	23.0	29.1		
	RHS	12.5	17.8	160	<b>1.15</b>	3.32	62.5	25.5	35.7	<b>0.983</b>	3.22	31.3	25.5	38.8		
	RHS	9.07	12.1	117	<b>0.759</b>	1.76	43.8	29.3	58.5	<b>0.688</b>	1.64	21.9	29.3	63.5		

Notes:

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- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- Bold** listings in the table note whether design web bearing yielding or buckling is critical for either Interior or End Bearing.

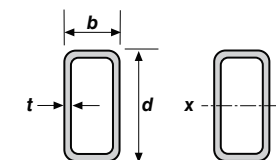
TABLE 5.2-2(3)(A)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION MOMENT AND WEB CAPACITIES

about x-axis

1 RHS  
2 C450PLUS®  
3 Finish



Designation			Mass per m	Design Section Moment Capacities				Design Web Capacities										
d	b	t		φM <sub>ex</sub>	FLR	Torsion φM <sub>z</sub>	Shear φV <sub>v</sub>	Interior Bearing					End Bearing					
mm	mm	mm	kg/m	kNm	m	kNm	kN	φR <sub>by</sub> b <sub>b</sub>	φR <sub>bb</sub> b <sub>b</sub>	5r <sub>ext</sub>	b <sub>bw</sub>	L <sub>e</sub> r	φR <sub>by</sub> b <sub>b</sub>	φR <sub>bb</sub> b <sub>b</sub>	2.5r <sub>ext</sub>	b <sub>bw</sub>	L <sub>e</sub> r	
100 x 50	x	6.0	RHS	12.0	18.4	1.60	9.94	244	<b>1.35</b>	3.79	75.0	35.0	40.8	<b>1.18</b>	3.64	37.5	35.0	44.3
		5.0	RHS	10.3	16.1	1.64	8.87	208	<b>1.10</b>	2.74	62.5	37.5	52.5	<b>0.983</b>	2.58	31.3	37.5	57.0
		4.0	RHS	8.49	13.5	1.68	7.58	170	<b>0.854</b>	1.69	50.0	40.0	70.0	<b>0.786</b>	1.54	25.0	40.0	76.0
		3.5	RHS	7.53	12.1	1.70	6.85	151	<b>0.738</b>	1.21	43.8	41.3	82.5	<b>0.688</b>	1.08	21.9	41.3	89.6
		3.0	RHS	6.60	10.8	1.73	6.08	131	0.797	<b>0.758</b>	30.0	44.0	103	0.769	<b>0.667</b>	15.0	44.0	111
		2.5	RHS	5.56	9.18	1.74	5.22	110	0.659	<b>0.455</b>	25.0	45.0	126	0.641	<b>0.396</b>	12.5	45.0	137
		2.0	RHS	4.50	7.37	1.76	4.31	88.9	0.524	<b>0.238</b>	20.0	46.0	161	0.513	<b>0.205</b>	10.0	46.0	175
		1.6	RHS	3.64	5.05	1.78	3.53	71.7	0.417	<b>0.123</b>	16.0	46.8	205	0.410	<b>0.106</b>	8.00	46.8	222
76 x 38	x	4.0	RHS	6.23	7.34	1.24	4.03	126	<b>0.883</b>	2.30	50.0	28.0	49.0	<b>0.786</b>	2.17	25.0	28.0	53.2
		3.0	RHS	4.90	6.00	1.28	3.31	97.2	<b>0.808</b>	1.18	30.0	32.0	74.7	<b>0.769</b>	1.06	15.0	32.0	81.1
		2.5	RHS	4.15	5.14	1.30	2.87	82.2	<b>0.667</b>	0.739	25.0	33.0	92.4	<b>0.641</b>	0.655	12.5	33.0	100
75 x 50	x	6.0	RHS	9.67	11.4	2.05	7.11	178	<b>1.44</b>	4.33	75.0	22.5	26.3	<b>1.18</b>	4.25	37.5	22.5	28.5
		5.0	RHS	8.35	10.1	2.11	6.41	153	<b>1.15</b>	3.34	62.5	25.0	35.0	<b>0.983</b>	3.25	31.3	25.0	38.0
		4.0	RHS	6.92	8.56	2.17	5.52	126	<b>0.884</b>	2.32	50.0	27.5	48.1	<b>0.786</b>	2.20	25.0	27.5	52.3
		3.0	RHS	5.42	6.92	2.23	4.47	97.4	<b>0.809</b>	1.20	30.0	31.5	73.5	<b>0.769</b>	1.08	15.0	31.5	79.8
		2.5	RHS	4.58	5.91	2.25	3.85	82.3	<b>0.667</b>	0.756	25.0	32.5	91.0	<b>0.641</b>	0.670	12.5	32.5	98.8
		2.0	RHS	3.72	4.77	2.28	3.19	66.8	0.528	<b>0.410</b>	20.0	33.5	117	0.513	<b>0.358</b>	10.0	33.5	127
		1.6	RHS	3.01	3.34	2.30	2.62	54.0	0.420	<b>0.216</b>	16.0	34.3	150	0.410	<b>0.186</b>	8.00	34.3	163
75 x 25	x	2.5	RHS	3.60	4.07	0.572	1.73	79.1	<b>0.667</b>	0.756	25.0	32.5	91.0	<b>0.641</b>	0.670	12.5	32.5	98.8
		2.0	RHS	2.93	3.36	0.584	1.47	64.2	0.528	<b>0.410</b>	20.0	33.5	117	0.513	<b>0.358</b>	10.0	33.5	127
		1.6	RHS	2.38	2.76	0.594	1.23	51.9	0.420	<b>0.216</b>	16.0	34.3	150	0.410	<b>0.186</b>	8.00	34.3	163
65 x 35	x	4.0	RHS	5.35	5.38	1.21	3.05	106	<b>0.906</b>	2.56	50.0	22.5	39.4	<b>0.786</b>	2.47	25.0	22.5	42.8
		3.0	RHS	4.25	4.45	1.25	2.54	82.3	<b>0.817</b>	1.44	30.0	26.5	61.8	<b>0.769</b>	1.39	15.0	26.5	67.1
		2.5	RHS	3.60	3.83	1.27	2.21	69.7	<b>0.672</b>	0.945	25.0	27.5	77.0	<b>0.641</b>	0.850	12.5	27.5	83.6
		2.0	RHS	2.93	3.16	1.29	1.85	56.7	0.532	<b>0.528</b>	20.0	28.5	99.8	0.513	<b>0.465</b>	10.0	28.5	108
50 x 25	x	3.0	RHS	3.07	2.37	0.807	1.26	61.1	<b>0.836</b>	1.82	30.0	19.0	44.3	<b>0.769</b>	1.74	15.0	19.0	48.1
		2.5	RHS	2.62	2.07	0.826	1.12	52.1	<b>0.685</b>	1.31	25.0	20.0	56.0	<b>0.641</b>	1.22	12.5	20.0	60.8
		2.0	RHS	2.15	1.73	0.844	0.952	42.6	<b>0.539</b>	0.800	20.0	21.0	73.5	<b>0.513</b>	0.723	10.0	21.0	79.8
		1.6	RHS	1.75	1.43	0.859	0.800	34.7	<b>0.426</b>	0.452	16.0	21.8	95.4	0.410	<b>0.399</b>	8.00	21.8	104
50 x 20	x	3.0	RHS	2.83	2.09	0.511	0.942	60.3	<b>0.836</b>	1.82	30.0	19.0	44.3	<b>0.769</b>	1.74	15.0	19.0	48.1
		2.5	RHS	2.42	1.83	0.526	0.847	51.4	<b>0.685</b>	1.31	25.0	20.0	56.0	<b>0.641</b>	1.22	12.5	20.0	60.8
		2.0	RHS	1.99	1.53	0.541	0.730	42.0	<b>0.539</b>	0.800	20.0	21.0	73.5	<b>0.513</b>	0.723	10.0	21.0	79.8
		1.6	RHS	1.63	1.27	0.552	0.619	34.2	<b>0.426</b>	0.452	16.0	21.8	95.4	0.410	<b>0.399</b>	8.00	21.8	104

Notes:

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- FLR based on most conservative case ( $\beta_m = 1$ ).
- Bold** listings in the table note whether design web bearing yielding or buckling is critical for either Interior or End Bearing.
- NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**

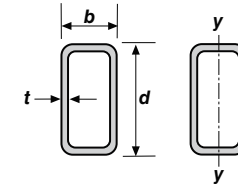
TABLE 5.2-2(3)(B)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION MOMENT AND WEB CAPACITIES

about y-axis

- 1 RHS
- 2 C450PLUS®
- 3 Finish



Designation			Mass per m	Design Section Moment Capacity	Design Web Capacities										
					Shear	Interior Bearing				End Bearing					
d	b	t		$\phi V_v$	$\frac{\phi R_{by}}{b_b}$	$\frac{\phi R_{bb}}{b_b}$	$5r_{ext}$	$b_{bw}$	$\frac{L_e}{r}$	$\frac{\phi R_{by}}{b_b}$	$\frac{\phi R_{bb}}{b_b}$	$2.5r_{ext}$	$b_{bw}$	$\frac{L_e}{r}$	
mm	mm	mm	kg/m	$\phi M_{sy}$	kN	kN/mm	kN/mm	mm	mm		kN/mm	kN/mm	mm	mm	
100 x 50	x 6.0	RHS	12.0	11.2	111	<b>1.72</b>	4.81	75.0	10.0	11.7	<b>1.18</b>	4.77	37.5	10.0	12.7
		RHS	10.3	9.88	97.2	<b>1.30</b>	3.85	62.5	12.5	17.5	<b>0.983</b>	3.81	31.3	12.5	19.0
		RHS	8.49	8.23	81.6	<b>0.962</b>	2.88	50.0	15.0	26.3	<b>0.786</b>	2.83	25.0	15.0	28.5
		RHS	7.53	6.92	73.1	<b>0.814</b>	2.39	43.8	16.3	32.5	<b>0.688</b>	2.33	21.9	16.3	35.3
		RHS	6.60	5.63	64.2	<b>0.836</b>	1.82	30.0	19.0	44.3	<b>0.769</b>	1.74	15.0	19.0	48.1
		RHS	5.56	4.22	54.7	<b>0.685</b>	1.31	25.0	20.0	56.0	<b>0.641</b>	1.22	12.5	20.0	60.8
		RHS	4.50	2.97	44.7	<b>0.539</b>	0.800	20.0	21.0	73.5	<b>0.513</b>	0.723	10.0	21.0	79.8
		RHS	3.64	2.10	36.4	<b>0.426</b>	0.452	16.0	21.8	95.4	0.410	<b>0.399</b>	8.00	21.8	104
76 x 38	x 4.0	RHS	6.23	4.50	58.3	<b>1.07</b>	3.12	50.0	9.00	15.8	<b>0.786</b>	3.09	25.0	9.00	17.1
		RHS	4.90	3.61	46.7	<b>0.866</b>	2.09	30.0	13.0	30.3	<b>0.769</b>	2.04	15.0	13.0	32.9
		RHS	4.15	2.83	40.1	<b>0.704</b>	1.60	25.0	14.0	39.2	<b>0.641</b>	1.55	12.5	14.0	42.6
75 x 50	x 6.0	RHS	9.67	8.56	111	<b>1.72</b>	4.81	75.0	10.0	11.7	<b>1.18</b>	4.77	37.5	10.0	12.7
		RHS	8.35	7.61	97.2	<b>1.30</b>	3.85	62.5	12.5	17.5	<b>0.983</b>	3.81	31.3	12.5	19.0
		RHS	6.92	6.47	81.6	<b>0.962</b>	2.88	50.0	15.0	26.3	<b>0.786</b>	2.83	25.0	15.0	28.5
		RHS	5.42	5.17	64.2	<b>0.836</b>	1.82	30.0	19.0	44.3	<b>0.769</b>	1.74	15.0	19.0	48.1
		RHS	4.58	4.03	54.7	<b>0.685</b>	1.31	25.0	20.0	56.0	<b>0.641</b>	1.22	12.5	20.0	60.8
		RHS	3.72	2.86	44.7	<b>0.539</b>	0.800	20.0	21.0	73.5	<b>0.513</b>	0.723	10.0	21.0	79.8
		RHS	3.01	2.03	36.4	<b>0.426</b>	0.452	16.0	21.8	95.4	0.410	<b>0.399</b>	8.00	21.8	104
		RHS	3.60	1.64	24.3	<b>0.754</b>	1.88	25.0	7.50	21.0	<b>0.641</b>	1.85	12.5	7.50	22.8
75 x 25	x 2.5	RHS	2.93	1.17	20.4	<b>0.578</b>	1.40	20.0	8.50	29.8	<b>0.513</b>	1.37	10.0	8.50	32.3
		RHS	2.38	0.816	17.0	<b>0.449</b>	1.01	16.0	9.30	40.7	<b>0.410</b>	0.973	8.00	9.30	44.2
		RHS	5.35	3.48	52.5	<b>1.11</b>	3.17	50.0	7.50	13.1	<b>0.786</b>	3.15	25.0	7.50	14.3
65 x 35	x 4.0	RHS	4.25	2.88	42.3	<b>0.878</b>	2.15	30.0	11.5	26.8	<b>0.769</b>	2.11	15.0	11.5	29.1
		RHS	3.60	2.41	36.5	<b>0.711</b>	1.67	25.0	12.5	35.0	<b>0.641</b>	1.62	12.5	12.5	38.0
		RHS	2.93	1.77	30.1	<b>0.554</b>	1.17	20.0	13.5	47.3	<b>0.513</b>	1.11	10.0	13.5	51.3
		RHS	3.07	1.44	27.7	<b>0.949</b>	2.35	30.0	6.50	15.2	<b>0.769</b>	2.33	15.0	6.50	16.5
50 x 25	x 3.0	RHS	2.62	1.26	24.3	<b>0.754</b>	1.88	25.0	7.50	21.0	<b>0.641</b>	1.85	12.5	7.50	22.8
		RHS	2.15	1.05	20.4	<b>0.578</b>	1.40	20.0	8.50	29.8	<b>0.513</b>	1.37	10.0	8.50	32.3
		RHS	1.75	0.777	17.0	<b>0.449</b>	1.01	16.0	9.30	40.7	<b>0.410</b>	0.973	8.00	9.30	44.2
		RHS	2.83	1.06	20.4	<b>1.02</b>	2.44	30.0	4.00	9.33	<b>0.769</b>	2.43	15.0	4.00	10.1
50 x 20	x 2.5	RHS	2.42	0.938	18.2	<b>0.801</b>	1.97	25.0	5.00	14.0	<b>0.641</b>	1.95	12.5	5.00	15.2
		RHS	1.99	0.783	15.6	<b>0.603</b>	1.50	20.0	6.00	21.0	<b>0.513</b>	1.48	10.0	6.00	22.8
		RHS	1.63	0.582	13.1	<b>0.463</b>	1.12	16.0	6.80	29.8	<b>0.410</b>	1.10	8.00	6.80	32.3
		RHS	1.63	0.582	13.1	<b>0.463</b>	1.12	16.0	6.80	29.8	<b>0.410</b>	1.10	8.00	6.80	32.3

Notes:

- REFER to the Australian Tube Mills PRODUCT AVAILABILITY GUIDE (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- Bold** listings in the table note whether design web bearing yielding or buckling is critical for either Interior or End Bearing.
- NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**

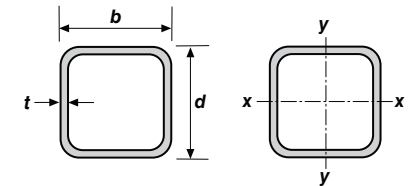
TABLE 5.2-3

# Square Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN SECTION MOMENT AND WEB CAPACITIES

about x- and y-axis

- 1 SHS
- 2 C350L0
- 3 Finish



Designation			Mass per m	Design Section Moment Capacities			Design Web Capacities										
				Moment $\phi M_{sx}$	Torsion $\phi M_z$	Shear $\phi V_v$	Interior Bearing					End Bearing					
d	b	t					$\frac{\phi R_{by}}{b_b}$	$\frac{\phi R_{bb}}{b_b}$	$5r_{ext}$	$b_{bw}$	$\frac{L_e}{r}$	$\frac{\phi R_{by}}{b_b}$	$\frac{\phi R_{bb}}{b_b}$	$2.5r_{ext}$	$b_{bw}$	$\frac{L_e}{r}$	
mm	mm	mm	kg/m	kNm	kNm	kN	kN/mm	kN/mm	mm	mm		kN/mm	kN/mm	mm	mm		
50	x 50	x 6.0	SHS	7.32	4.58	3.34	85.1	<b>1.34</b>	3.77	75.0	10.0	11.7	<b>0.917</b>	3.75	37.5	10.0	12.7
			SHS	6.39	4.14	3.07	74.7	<b>1.01</b>	3.04	62.5	12.5	17.5	<b>0.764</b>	3.01	31.3	12.5	19.0
			SHS	5.35	3.59	2.70	62.7	<b>0.748</b>	2.30	50.0	15.0	26.3	<b>0.611</b>	2.26	25.0	15.0	28.5
			SHS	4.25	2.96	2.22	49.3	<b>0.650</b>	1.50	30.0	19.0	44.3	<b>0.598</b>	1.45	15.0	19.0	48.1
			SHS	3.60	2.54	1.93	42.0	<b>0.533</b>	1.11	25.0	20.0	56.0	<b>0.499</b>	1.05	12.5	20.0	60.8
			SHS	2.93	2.10	1.61	34.3	<b>0.419</b>	0.713	20.0	21.0	73.5	<b>0.399</b>	0.654	10.0	21.0	79.8
40	x 40	x 4.0	SHS	2.38	1.61	1.33	28.0	<b>0.331</b>	0.420	16.0	21.8	95.4	<b>0.319</b>	0.374	8.00	21.8	104
			SHS	4.09	2.12	1.57	47.8	<b>0.810</b>	2.43	50.0	10.0	17.5	<b>0.611</b>	2.41	25.0	10.0	19.0
			SHS	3.30	1.80	1.34	38.1	<b>0.668</b>	1.65	30.0	14.0	32.7	<b>0.598</b>	1.61	15.0	14.0	35.5
			SHS	2.82	1.56	1.17	32.7	<b>0.544</b>	1.28	25.0	15.0	42.0	<b>0.499</b>	1.24	12.5	15.0	45.6
			SHS	2.31	1.30	0.989	26.9	<b>0.426</b>	0.888	20.0	16.0	56.0	<b>0.399</b>	0.840	10.0	16.0	60.8
35	x 35	x 3.0	SHS	1.88	1.07	0.824	22.0	<b>0.335</b>	0.571	16.0	16.8	73.5	<b>0.319</b>	0.523	8.00	16.8	79.8
			SHS	2.83	1.33	0.978	32.5	<b>0.683</b>	1.72	30.0	11.5	26.8	<b>0.598</b>	1.69	15.0	11.5	29.1
			SHS	2.42	1.16	0.866	28.0	<b>0.553</b>	1.35	25.0	12.5	35.0	<b>0.499</b>	1.32	12.5	12.5	38.0
			SHS	1.99	0.975	0.735	23.1	<b>0.431</b>	0.973	20.0	13.5	47.3	<b>0.399</b>	0.935	10.0	13.5	51.3
30	x 30	x 2.5	SHS	1.63	0.808	0.616	19.0	<b>0.338</b>	0.658	16.0	14.3	62.6	<b>0.319</b>	0.615	8.00	14.3	67.9
			SHS	2.36	0.932	0.676	26.9	<b>0.704</b>	1.78	30.0	9.00	21.0	<b>0.598</b>	1.76	15.0	9.00	22.8
			SHS	2.03	0.822	0.605	23.3	<b>0.566</b>	1.42	25.0	10.0	28.0	<b>0.499</b>	1.40	12.5	10.0	30.4
			SHS	1.68	0.695	0.519	19.4	<b>0.439</b>	1.05	20.0	11.0	38.5	<b>0.399</b>	1.02	10.0	11.0	41.8
25	x 25	x 2.0	SHS	1.38	0.580	0.439	16.0	<b>0.343</b>	0.745	16.0	11.8	51.6	<b>0.319</b>	0.710	8.00	11.8	56.1
			SHS	1.89	0.603	0.430	21.3	<b>0.738</b>	1.85	30.0	6.50	15.2	<b>0.598</b>	1.83	15.0	6.50	16.5
			SHS	1.64	0.539	0.391	18.7	<b>0.587</b>	1.49	25.0	7.50	21.0	<b>0.499</b>	1.47	12.5	7.50	22.8
			SHS	1.36	0.462	0.341	15.7	<b>0.450</b>	1.12	20.0	8.50	29.8	<b>0.399</b>	1.10	10.0	8.50	32.3
20	x 20	x 1.6	SHS	1.12	0.389	0.292	13.0	<b>0.349</b>	0.825	16.0	9.30	40.7	<b>0.319</b>	0.801	8.00	9.30	44.2
			SHS	1.05	0.276	0.200	11.9	<b>0.469</b>	1.19	20.0	6.00	21.0	<b>0.399</b>	1.17	10.0	6.00	22.8
			SHS	0.873	0.236	0.175	10.0	<b>0.360</b>	0.897	16.0	6.80	29.8	<b>0.319</b>	0.881	8.00	6.80	32.3

**Notes:**

1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
2. **Bold** listings in the table note whether design web bearing yielding or buckling is critical for either Interior or End Bearing.

**ADDITIONAL NOTES:**

(A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.

(B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.

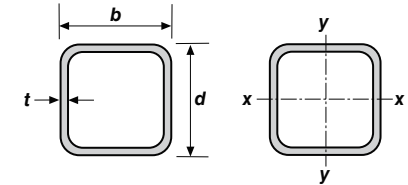
TABLE 5.2-4(1)

# Square Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION MOMENT AND WEB CAPACITIES

about x- and y-axis

- 1 SHS
- 2 C450PLUS®
- 3 Finish



Designation			Mass per m	Design Section Moment Capacities			Design Web Capacities									
				Moment $\phi M_{sx}$	Torsion $\phi M_z$	Shear $\phi V_v$	Interior Bearing			End Bearing						
d	b	t					$\frac{\phi R_{by}}{b_b}$	$\frac{\phi R_{ob}}{b_b}$	$5r_{ext}$	$b_{dw}$	$\frac{L_e}{r}$	$\frac{\phi R_{by}}{b_b}$	$\frac{\phi R_{ob}}{b_b}$	$2.5r_{ext}$	$b_{dw}$	$\frac{L_e}{r}$
mm	mm	mm	kg/m	kNm	kNm	kN	kN/mm	kN/mm	mm	mm		kN/mm	kN/mm	mm	mm	
400 x 400 x	400 x 400 x	16.0 SHS	186	1350	1060	2830	<b>3.42</b>	6.76	200	160	70.0	<b>3.14</b>	6.15	100	160	76.0
		12.5 SHS	148	937	856	2250	<b>2.61</b>	3.58	156	169	94.5	<b>2.46</b>	3.16	78.1	169	103
		10.0 SHS	120	670	703	1820	2.06	<b>1.91</b>	125	175	123	1.97	<b>1.66</b>	62.5	175	133
350 x 350 x	350 x 350 x	16.0 SHS	161	1020	790	2440	<b>3.47</b>	8.00	200	135	59.1	<b>3.14</b>	7.42	100	135	64.1
		12.5 SHS	128	768	644	1950	<b>2.64</b>	4.47	156	144	80.5	<b>2.46</b>	4.00	78.1	144	87.4
		10.0 SHS	104	548	530	1580	<b>2.08</b>	2.44	125	150	105	<b>1.97</b>	2.14	62.5	150	114
		8.0 SHS	84.2	393	434	1280	1.64	<b>1.28</b>	100	155	136	1.57	<b>1.11</b>	50.0	155	147
300 x 300 x	300 x 300 x	16.0 SHS	136	732	562	2060	<b>3.54</b>	9.28	200	110	48.1	<b>3.14</b>	8.80	100	110	52.3
		12.5 SHS	109	596	461	1650	<b>2.68</b>	5.58	156	119	66.5	<b>2.46</b>	5.10	78.1	119	72.2
		10.0 SHS	88.4	436	382	1340	<b>2.10</b>	3.19	125	125	87.5	<b>1.97</b>	2.84	62.5	125	95.0
		8.0 SHS	71.6	311	314	1090	<b>1.66</b>	1.72	100	130	114	1.57	<b>1.50</b>	50.0	130	124
250 x 250 x	250 x 250 x	16.0 SHS	111	489	373	1670	<b>3.65</b>	10.5	200	85.0	37.2	<b>3.14</b>	10.1	100	85.0	40.4
		12.5 SHS	89.0	402	309	1350	<b>2.74</b>	6.86	156	93.8	52.5	<b>2.46</b>	6.44	78.1	93.8	57.0
		10.0 SHS	72.7	329	258	1100	<b>2.14</b>	4.23	125	100	70.0	<b>1.97</b>	3.84	62.5	100	76.0
		9.0 SHS	65.9	283	236	1000	<b>1.90</b>	3.26	113	103	79.7	<b>1.77</b>	2.92	56.3	103	86.6
		8.0 SHS	59.1	237	213	899	<b>1.68</b>	2.39	100	105	91.9	<b>1.57</b>	2.11	50.0	105	99.8
		6.0 SHS	45.0	154	165	685	1.23	<b>1.06</b>	75.0	110	128	1.18	<b>0.920</b>	37.5	110	139
200 x 200 x	200 x 200 x	16.0 SHS	85.5	295	222	1290	<b>3.85</b>	11.5	200	60.0	26.3	<b>3.14</b>	11.3	100	60.0	28.5
		12.5 SHS	69.4	246	188	1050	<b>2.84</b>	8.08	156	68.8	38.5	<b>2.46</b>	7.81	78.1	68.8	41.8
		10.0 SHS	57.0	206	158	864	<b>2.19</b>	5.48	125	75.0	52.5	<b>1.97</b>	5.15	62.5	75.0	57.0
		9.0 SHS	51.8	188	146	786	<b>1.95</b>	4.42	113	77.5	60.3	<b>1.77</b>	4.09	56.3	77.5	65.4
		8.0 SHS	46.5	168	132	707	<b>1.71</b>	3.38	100	80.0	70.0	<b>1.57</b>	3.07	50.0	80.0	76.0
		6.0 SHS	35.6	110	103	541	<b>1.25</b>	1.60	75.0	85.0	99.2	<b>1.18</b>	1.41	37.5	85.0	108
150 x 150 x	150 x 150 x	10.0 SHS	29.9	83.8	87.9	456	1.03	<b>0.953</b>	62.5	87.5	123	<b>0.983</b>	<b>0.830</b>	31.3	87.5	133
		9.0 SHS	41.3	109	82.9	624	<b>2.30</b>	6.69	125	50.0	35.0	<b>1.97</b>	6.50	62.5	50.0	38.0
		8.0 SHS	37.7	101	76.8	570	<b>2.03</b>	5.68	113	52.5	40.8	<b>1.77</b>	5.46	56.3	52.5	44.3
		6.0 SHS	33.9	91.5	70.2	515	<b>1.77</b>	4.64	100	55.0	48.1	<b>1.57</b>	4.40	50.0	55.0	52.3
		5.0 SHS	26.2	71.0	55.7	397	<b>1.28</b>	2.54	75.0	60.0	70.0	<b>1.18</b>	2.30	37.5	60.0	76.0
5.0 SHS	22.1	54.6	47.8	336	<b>1.05</b>	1.60	62.5	62.5	87.5	<b>0.983</b>	1.42	31.3	62.5	95.0		

**Notes:**

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the availability of listed sections and associated finishes. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- Bold** listings in the table note whether design web bearing yielding or buckling is critical for either Interior or End Bearing.



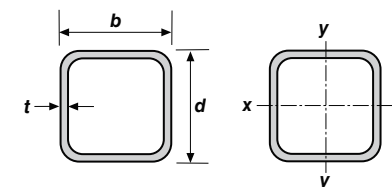
TABLE 5.2-4(2)

# Square Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION MOMENT AND WEB CAPACITIES

about x- and y-axis

- 1 SHS
- 2 C450PLUS®
- 3 Finish



Designation			Mass per m	Design Section Moment Capacities			Design Web Capacities										
d	b	t		Moment $\phi M_{sx}$	Torsion $\phi M_z$	Shear $\phi V_y$	Interior Bearing					End Bearing					
mm	mm	mm	kg/m	kNm	kNm	kN	$\frac{\phi R_{by}}{b_b}$	$\frac{\phi R_{bb}}{b_b}$	$5r_{ext}$	$b_{bw}$	$\frac{L_e}{r}$	$\frac{\phi R_{by}}{b_b}$	$\frac{\phi R_{bb}}{b_b}$	$2.5r_{ext}$	$b_{bw}$	$\frac{L_e}{r}$	
125 x 125 x		10.0	SHS	33.4	72.0	54.2	504	<b>2.41</b>	7.21	125	37.5	26.3	<b>1.97</b>	7.08	62.5	37.5	28.5
		9.0	SHS	30.6	66.8	50.6	462	<b>2.11</b>	6.23	113	40.0	31.1	<b>1.77</b>	6.09	56.3	40.0	33.8
		8.0	SHS	27.7	61.2	46.6	419	<b>1.83</b>	5.24	100	42.5	37.2	<b>1.57</b>	5.07	50.0	42.5	40.4
		6.0	SHS	21.4	48.6	37.4	325	<b>1.31</b>	3.16	75.0	47.5	55.4	<b>1.18</b>	2.95	37.5	47.5	60.2
		5.0	SHS	18.2	41.1	32.3	276	<b>1.07</b>	2.11	62.5	50.0	70.0	<b>0.983</b>	1.92	31.3	50.0	76.0
100 x 100 x		4.0	SHS	14.8	29.7	26.7	225	<b>0.838</b>	1.19	50.0	52.5	91.9	<b>0.786</b>	1.06	25.0	52.5	99.8
		10.0	SHS	25.6	42.6	31.6	384	<b>2.60</b>	7.69	125	25.0	17.5	<b>1.97</b>	7.61	62.5	25.0	19.0
		9.0	SHS	23.5	39.9	29.8	354	<b>2.25</b>	6.73	113	27.5	21.4	<b>1.77</b>	6.64	56.3	27.5	23.2
		8.0	SHS	21.4	36.9	27.8	323	<b>1.92</b>	5.77	100	30.0	26.3	<b>1.57</b>	5.66	50.0	30.0	28.5
		6.0	SHS	16.7	29.8	22.7	253	<b>1.35</b>	3.79	75.0	35.0	40.8	<b>1.18</b>	3.64	37.5	35.0	44.3
		5.0	SHS	14.2	25.7	19.8	216	<b>1.10</b>	2.74	62.5	37.5	52.5	<b>0.983</b>	2.58	31.3	37.5	57.0
		4.0	SHS	11.6	21.0	16.5	177	<b>0.854</b>	1.69	50.0	40.0	70.0	<b>0.786</b>	1.54	25.0	40.0	76.0
		3.0	SHS	8.96	13.9	12.9	135	<b>0.797</b>	<b>0.758</b>	30.0	44.0	103	<b>0.769</b>	<b>0.667</b>	15.0	44.0	111
90 x 90 x		2.5	SHS	7.53	10.6	11.0	114	0.659	<b>0.455</b>	25.0	45.0	126	0.641	<b>0.396</b>	12.5	45.0	137
		2.0	SHS	6.07	7.63	8.97	92.2	0.524	<b>0.238</b>	20.0	46.0	161	0.513	<b>0.205</b>	10.0	46.0	175
		2.5	SHS	6.74	9.03	8.80	102	0.662	<b>0.551</b>	25.0	40.0	112	0.641	<b>0.482</b>	12.5	40.0	122
89 x 89 x		2.0	SHS	5.45	6.48	7.20	82.6	0.525	<b>0.291</b>	20.0	41.0	144	0.513	<b>0.252</b>	10.0	41.0	156
		6.0	SHS	14.7	23.0	17.4	222	<b>1.38</b>	4.03	75.0	29.5	34.4	<b>1.18</b>	3.92	37.5	29.5	37.4
		5.0	SHS	12.5	19.9	15.3	190	<b>1.11</b>	3.02	62.5	32.0	44.8	<b>0.983</b>	2.88	31.3	32.0	48.6
		3.5	SHS	9.07	14.5	11.5	138	<b>0.746</b>	1.44	43.8	35.8	71.5	<b>0.688</b>	1.31	21.9	35.8	77.6
75 x 75 x		2.0	SHS	5.38	6.37	7.04	81.6	0.525	<b>0.298</b>	20.0	40.5	142	0.513	<b>0.258</b>	10.0	40.5	154
		6.0	SHS	12.0	15.6	11.7	181	<b>1.44</b>	4.33	75.0	22.5	26.3	<b>1.18</b>	4.25	37.5	22.5	28.5
		5.0	SHS	10.3	13.6	10.4	156	<b>1.15</b>	3.34	62.5	25.0	35.0	<b>0.983</b>	3.25	31.3	25.0	38.0
		4.0	SHS	8.49	11.4	8.78	129	<b>0.884</b>	2.32	50.0	27.5	48.1	<b>0.786</b>	2.20	25.0	27.5	52.3
		3.5	SHS	7.53	10.2	7.90	114	<b>0.760</b>	1.79	43.8	28.8	57.5	<b>0.688</b>	1.66	21.9	28.8	62.4
		3.0	SHS	6.60	8.99	6.98	99.4	<b>0.809</b>	1.20	30.0	31.5	73.5	<b>0.769</b>	1.08	15.0	31.5	79.8
		2.5	SHS	5.56	6.90	5.98	84.0	<b>0.667</b>	0.756	25.0	32.5	91.0	<b>0.641</b>	0.670	12.5	32.5	98.8
65 x 65 x		2.0	SHS	4.50	4.91	4.91	68.2	0.528	<b>0.410</b>	20.0	33.5	117	0.513	<b>0.358</b>	10.0	33.5	127
		6.0	SHS	10.1	11.1	8.31	153	<b>1.51</b>	4.52	75.0	17.5	20.4	<b>1.18</b>	4.46	37.5	17.5	22.2
		5.0	SHS	8.75	9.85	7.43	132	<b>1.19</b>	3.55	62.5	20.0	28.0	<b>0.983</b>	3.48	31.3	20.0	30.4
		4.0	SHS	7.23	8.34	6.36	109	<b>0.906</b>	2.56	50.0	22.5	39.4	<b>0.786</b>	2.47	25.0	22.5	42.8
		3.0	SHS	5.66	6.71	5.11	85.0	<b>0.817</b>	1.44	30.0	26.5	61.8	<b>0.769</b>	1.33	15.0	26.5	67.1
		2.5	SHS	4.78	5.54	4.40	72.0	<b>0.672</b>	0.945	25.0	27.5	77.0	<b>0.641</b>	0.850	12.5	27.5	83.6
		2.0	SHS	3.88	3.97	3.63	58.6	0.532	<b>0.528</b>	20.0	28.5	99.8	0.513	<b>0.465</b>	10.0	28.5	108
		1.6	SHS	3.13	2.84	2.98	47.5	0.422	<b>0.283</b>	16.0	29.3	128	0.410	<b>0.246</b>	8.00	29.3	139

Notes:

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- Bold** listings in the table note whether design web bearing yielding or buckling is critical for either Interior or End Bearing.

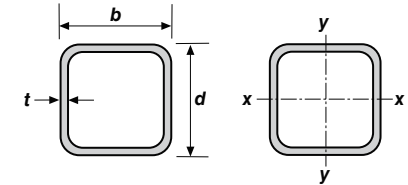
TABLE 5.2-4(3)

# Square Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION MOMENT AND WEB CAPACITIES

about x- and y-axis

- 1 SHS
- 2 C450PLUS®
- 3 Finish



Designation			Mass per m	Design Section Moment Capacities			Design Web Capacities										
				Moment $\phi M_{sx}$	Torsion $\phi M_z$	Shear $\phi V_v$	Interior Bearing				End Bearing						
d	b	t	kg/m	kNm	kNm	kN	$\frac{\phi R_{by}}{b_b}$	$\frac{\phi R_{ob}}{b_b}$	$5r_{ext}$	$b_{dw}$	$\frac{L_e}{r}$	$\frac{\phi R_{by}}{b_b}$	$\frac{\phi R_{ob}}{b_b}$	$2.5r_{ext}$	$b_{dw}$	$\frac{L_e}{r}$	
mm	mm	mm					kN/mm	kN/mm	mm	mm		kN/mm	kN/mm	mm	mm		
50	x 50	x	6.0 SHS	7.32	5.89	4.30	109	<b>1.72</b>	4.81	75.0	10.0	11.7	<b>1.18</b>	4.77	37.5	10.0	12.7
			5.0 SHS	6.39	5.33	3.95	96.0	<b>1.30</b>	3.85	62.5	12.5	17.5	<b>0.983</b>	3.81	31.8	12.5	19.0
			4.0 SHS	5.35	4.61	3.47	80.6	<b>0.962</b>	2.88	50.0	15.0	26.3	<b>0.786</b>	2.83	25.0	15.0	28.5
			3.0 SHS	4.25	3.80	2.86	63.4	<b>0.836</b>	1.82	30.0	19.0	44.3	<b>0.769</b>	1.74	15.0	19.0	48.1
			2.5 SHS	3.60	3.27	2.48	54.0	<b>0.685</b>	1.31	25.0	20.0	56.0	<b>0.641</b>	1.22	12.5	20.0	60.8
			2.0 SHS	2.93	2.66	2.07	44.2	<b>0.539</b>	0.800	20.0	21.0	73.5	<b>0.513</b>	0.723	10.0	21.0	79.8
			1.6 SHS	2.38	1.92	1.71	35.9	<b>0.426</b>	0.452	16.0	21.8	95.4	<b>0.410</b>	<b>0.399</b>	8.00	21.8	104
40	x 40	x	4.0 SHS	4.09	2.73	2.02	61.4	<b>1.04</b>	3.08	50.0	10.0	17.5	<b>0.786</b>	3.05	25.0	10.0	19.0
			3.0 SHS	3.30	2.32	1.72	49.0	<b>0.859</b>	2.05	30.0	14.0	32.7	<b>0.769</b>	2.00	15.0	14.0	35.5
			2.5 SHS	2.82	2.01	1.51	42.0	<b>0.700</b>	1.56	25.0	15.0	42.0	<b>0.641</b>	1.50	12.5	15.0	45.6
			2.0 SHS	2.31	1.67	1.27	34.6	<b>0.548</b>	1.05	20.0	16.0	56.0	<b>0.513</b>	0.975	10.0	16.0	60.8
			1.6 SHS	1.88	1.36	1.06	28.3	<b>0.431</b>	0.640	16.0	16.8	73.5	<b>0.410</b>	0.578	8.00	16.8	79.8
35	x 35	x	3.0 SHS	2.83	1.71	1.26	41.8	<b>0.878</b>	2.15	30.0	11.5	26.8	<b>0.769</b>	2.11	15.0	11.5	29.1
			2.5 SHS	2.42	1.50	1.11	36.0	<b>0.711</b>	1.67	25.0	12.5	35.0	<b>0.641</b>	1.62	12.5	12.5	38.0
			2.0 SHS	1.99	1.25	0.945	29.8	<b>0.554</b>	1.17	20.0	13.5	47.3	<b>0.513</b>	1.11	10.0	13.5	51.3
			1.6 SHS	1.63	1.04	0.792	24.4	<b>0.435</b>	0.760	16.0	14.3	62.6	<b>0.410</b>	0.699	8.00	14.3	67.9
30	x 30	x	3.0 SHS	2.36	1.20	0.869	34.6	<b>0.905</b>	2.25	30.0	9.00	21.0	<b>0.769</b>	2.22	15.0	9.00	22.8
			2.5 SHS	2.03	1.06	0.778	30.0	<b>0.728</b>	1.78	25.0	10.0	28.0	<b>0.641</b>	1.74	12.5	10.0	30.4
			2.0 SHS	1.68	0.893	0.667	25.0	<b>0.564</b>	1.29	20.0	11.0	38.5	<b>0.513</b>	1.25	10.0	11.0	41.8
			1.6 SHS	1.38	0.746	0.564	20.6	<b>0.441</b>	0.888	16.0	11.8	51.6	<b>0.410</b>	0.836	8.00	11.8	56.1
25	x 25	x	3.0 SHS	1.89	0.776	0.553	27.4	<b>0.949</b>	2.35	30.0	6.50	15.2	<b>0.769</b>	2.33	15.0	6.50	16.5
			2.5 SHS	1.64	0.694	0.503	24.0	<b>0.754</b>	1.88	25.0	7.50	21.0	<b>0.641</b>	1.85	12.5	7.50	22.8
			2.0 SHS	1.36	0.594	0.438	20.2	<b>0.578</b>	1.40	20.0	8.50	29.8	<b>0.513</b>	1.37	10.0	8.50	32.3
			1.6 SHS	1.12	0.500	0.375	16.7	<b>0.449</b>	1.01	16.0	9.30	40.7	<b>0.410</b>	0.973	8.00	9.30	44.2
20	x 20	x	2.0 SHS	1.05	0.355	0.258	15.4	<b>0.603</b>	1.50	20.0	6.00	21.0	<b>0.513</b>	1.48	10.0	6.00	22.8
			1.6 SHS	0.873	0.304	0.224	12.9	<b>0.463</b>	1.12	16.0	6.80	29.8	<b>0.410</b>	1.10	8.00	6.80	32.3

Notes:

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- Bold** listings in the table note whether design web bearing yielding or buckling is critical for either Interior or End Bearing.
- NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**

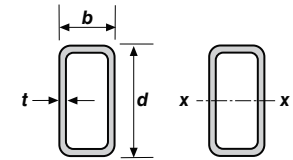
TABLE 5.3-1

# Rectangular Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN MOMENT CAPACITIES FOR MEMBERS WITHOUT FULL LATERAL RESTRAINT

### bending about x-axis

- 1 RHS
- 2 C350L0
- 3 Finish



Designation			Mass per m	$\phi M_{sx}$	$\phi V_v$	Design Member Moment Capacities, $\phi M_b$ (kNm)															FLR		
d	b	t				Effective Length ( $L_e$ ) in metres																	
mm	mm	mm	kg/m	kNm	kN	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	4.50	5.00	6.00	m			
75	x	25	x	2.5	RHS	3.60	3.17	61.5	3.17	3.15	3.10	3.05	3.01	2.96	2.92	2.83	2.74	2.66	2.58	2.51	2.44	2.30	0.736
		2.0	RHS	2.93	2.62	49.9	2.62	2.62	2.56	2.52	2.49	2.45	2.41	2.34	2.27	2.21	2.14	2.08	2.02	1.91	0.751		
		1.6	RHS	2.38	2.15	40.4	2.15	2.15	2.10	2.07	2.04	2.01	1.98	1.93	1.87	1.82	1.77	1.72	1.67	1.58	0.764		
65	x	35	x	4.0	RHS	5.35	4.18	82.4	4.18	4.18	4.18	4.18	4.18	4.10	4.06	3.99	3.93	3.86	3.80	3.73	3.67	3.55	1.55
		3.0	RHS	4.25	3.46	64.0	3.46	3.46	3.46	3.46	3.46	3.39	3.36	3.31	3.25	3.20	3.14	3.09	3.04	2.94	1.61		
		2.5	RHS	3.60	2.98	54.2	2.98	2.98	2.98	2.98	2.98	2.92	2.89	2.85	2.80	2.75	2.71	2.66	2.62	2.54	1.64		
		2.0	RHS	2.93	2.46	44.1	2.46	2.46	2.46	2.46	2.46	2.41	2.39	2.35	2.31	2.27	2.24	2.20	2.17	2.10	1.66		
50	x	25	x	3.0	RHS	3.07	1.85	47.5	1.85	1.85	1.85	1.80	1.78	1.76	1.74	1.69	1.65	1.61	1.57	1.53	1.50	1.43	1.04
		2.5	RHS	2.62	1.61	40.5	1.61	1.61	1.61	1.57	1.55	1.53	1.51	1.48	1.44	1.41	1.37	1.34	1.31	1.25	1.06		
		2.0	RHS	2.15	1.34	33.1	1.34	1.34	1.34	1.31	1.30	1.28	1.27	1.24	1.21	1.18	1.15	1.12	1.10	1.05	1.09		
		1.6	RHS	1.75	1.11	27.0	1.11	1.11	1.11	1.09	1.07	1.06	1.05	1.02	0.999	0.976	0.953	0.931	0.909	0.868	1.10		
50	x	20	x	3.0	RHS	2.83	1.62	46.9	1.62	1.60	1.57	1.54	1.52	1.49	1.46	1.41	1.36	1.31	1.27	1.23	1.19	1.11	0.657
		2.5	RHS	2.42	1.42	40.0	1.42	1.40	1.38	1.35	1.33	1.31	1.28	1.24	1.20	1.16	1.12	1.08	1.04	0.978	0.676		
		2.0	RHS	1.99	1.19	32.7	1.19	1.18	1.16	1.14	1.12	1.10	1.08	1.04	1.01	0.975	0.943	0.912	0.883	0.827	0.695		
		1.6	RHS	1.63	0.989	26.6	0.989	0.976	0.960	0.944	0.928	0.913	0.897	0.868	0.839	0.812	0.786	0.761	0.736	0.691	0.710		

Notes:

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Values of  $\phi M_b$  based on  $\alpha_m = 1.0$  (uniform moment over entire segment) in this Table.
- Values to the left of those of the solid line are for segment lengths with full lateral restraint based on the listed FLR and  $\phi M_b = \phi M_{sx}$ .
- FLR – segment length for Full Lateral Restraint (Clause 5.3.2.4 of AS 4100) with  $\beta_m = -1.0$ .
- For other moment distributions use the appropriate value of  $\alpha_m$  obtained from Clauses 5.6.1 or 5.6.2 of AS 4100 and use the minimum of  $\alpha_m \phi M_b$  and  $\phi M_{sx}$  given in this Table.

ADDITIONAL NOTES:

- (A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.
- (B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.

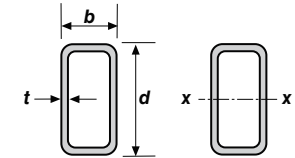
TABLE 5.3-2(1)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

DESIGN MOMENT CAPACITIES FOR MEMBERS  
WITHOUT FULL LATERAL RESTRAINT

*bending about x-axis*

- 1 RHS
- 2 C450PLUS®
- 3 Finish



Designation				Mass per m	$\phi M_{sx}$	$\phi V_v$	Design Member Moment Capacities, $\phi M_b$ (kNm)														FLR					
d	b	t					Effective Length ( $L_e$ ) in metres																			
mm	mm	mm		kg/m	kNm	kN	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	m					
400	x	300	x	16.0	RHS	161	1110	2790	1110	1110	1110	1110	1110	1110	1110	1110	1110	1110	1110	1110	1110	1110	14.9			
				12.5	RHS	128	901	2220	901	901	901	901	901	901	901	901	901	901	901	901	901	901	901	901	15.1	
				10.0	RHS	104	649	1800	649	649	649	649	649	649	649	649	649	649	649	649	649	649	649	649	649	15.2
				8.0	RHS	84.2	463	1450	463	463	463	463	463	463	463	463	463	463	463	463	463	463	463	463	463	15.4
400	x	200	x	16.0	RHS	136	866	2730	866	866	866	866	866	866	853	846	839	833	827	820	814	808	6.73			
				12.5	RHS	109	705	2170	705	705	705	705	705	705	705	695	689	684	679	674	669	664	659	6.87		
				10.0	RHS	88.4	581	1760	581	581	581	581	581	581	581	572	568	564	559	555	551	547	543	6.97		
				8.0	RHS	71.6	467	1420	467	467	467	467	467	467	467	467	458	454	451	448	444	441	438	7.04		
350	x	250	x	16.0	RHS	136	807	2400	807	807	807	807	807	807	807	807	807	807	787	783	778	11.7				
				12.5	RHS	109	657	1920	657	657	657	657	657	657	657	657	657	657	657	640	637	634	11.9			
				10.0	RHS	88.4	533	1560	533	533	533	533	533	533	533	533	533	533	533	533	533	533	517	12.1		
				8.0	RHS	71.6	376	1260	376	376	376	376	376	376	376	376	376	376	376	376	376	376	368	12.2		
300	x	200	x	16.0	RHS	111	548	2020	548	548	548	548	548	548	548	548	535	532	528	524	521	517	8.66			
				12.5	RHS	89.0	450	1620	450	450	450	450	450	450	450	440	437	434	431	428	425	8.85				
				10.0	RHS	72.7	373	1320	373	373	373	373	373	373	373	365	362	360	357	355	353	353	353	353	8.99	
				8.0	RHS	59.1	302	1070	302	302	302	302	302	302	302	302	302	294	292	290	288	286	286	9.10		
250	x	150	x	16.0	RHS	85.5	338	1630	338	338	338	338	338	338	331	328	325	322	318	315	312	309	306	5.73		
				12.5	RHS	69.4	282	1320	282	282	282	282	282	282	276	274	271	269	266	264	261	259	256	5.90		
				10.0	RHS	57.0	236	1080	236	236	236	236	236	236	236	229	229	227	225	223	221	219	217	215	6.02	
				9.0	RHS	51.8	216	976	216	216	216	216	216	216	216	210	208	206	204	202	200	199	197	197	6.07	
250	x	150	x	8.0	RHS	46.5	195	875	195	195	195	195	195	195	195	190	188	186	185	183	181	180	178	6.12		
				6.0	RHS	35.6	149	668	149	149	149	149	149	149	149	145	144	143	141	140	139	138	136	136	6.22	
250	x	150	x	5.0	RHS	29.9	111	561	111	111	111	111	111	111	111	109	109	108	107	106	105	104	103	6.26		

**Notes:**

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- Values of  $\phi M_b$  based on  $\alpha_m = 1.0$  (uniform moment over entire segment) in this Table.
- Values to the left of those of the solid line are for segment lengths with full lateral restraint based on the listed FLR and  $\phi M_b = \phi M_{sx}$ .
- FLR – segment length for Full Lateral Restraint (Clause 5.3.2.4 of AS 4100) with  $\beta_m = -1.0$ .
- For other moment distributions use the appropriate value of  $\alpha_m$  obtained from Clauses 5.6.1 or 5.6.2 of AS 4100 and use the minimum of  $\alpha_m \phi M_b$  and  $\phi M_{sx}$  given in this Table.

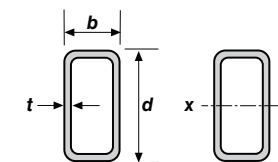
TABLE 5.3-2(2)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

DESIGN MOMENT CAPACITIES FOR MEMBERS  
WITHOUT FULL LATERAL RESTRAINT

*bending about x-axis*

- 1 RHS
- 2 C450PLUS®
- 3 Finish



Designation			Mass per m	$\phi M_{sx}$	$\phi V_v$	Design Member Moment Capacities, $\phi M_b$ (kNm)														FLR			
d	b	t				Effective Length ( $L_e$ ) in metres																	
mm	mm	mm	kg/m	kNm	kN	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	m			
200	x	100	x	10.0	RHS	41.3	129	833	129	129	129	126	124	122	120	118	116	115	113	111	109	108	3.29
				9.0	RHS	37.7	119	758	119	119	119	116	114	113	111	109	107	106	104	103	101	99.5	3.33
				8.0	RHS	33.9	108	681	108	108	108	106	104	103	101	99.4	97.9	96.4	95.0	93.5	92.1	90.7	3.37
				6.0	RHS	26.2	85.1	522	85.1	85.1	85.1	83.2	82.0	80.7	79.5	78.3	77.1	76.0	74.8	73.7	72.6	71.5	3.44
				5.0	RHS	22.1	72.6	440	72.6	72.6	72.6	71.0	69.9	68.9	67.8	66.8	65.8	64.8	63.9	62.9	62.0	61.1	3.48
152	x	76	x	6.0	RHS	19.4	47.0	389	47.0	47.0	46.0	45.0	44.1	43.3	42.4	41.5	40.7	39.9	39.1	38.4	37.6	36.9	2.56
				5.0	RHS	16.4	40.4	329	40.4	40.4	39.5	38.8	38.0	37.2	36.5	35.8	35.1	34.4	33.7	33.1	32.4	31.8	2.60
150	x	100	x	10.0	RHS	33.4	80.7	611	80.7	80.7	80.7	80.7	78.2	77.1	76.1	75.0	74.0	73.0	72.0	71.0	70.0	69.1	4.22
				9.0	RHS	30.6	74.8	559	74.8	74.8	74.8	74.8	72.6	71.6	70.6	69.6	68.7	67.7	66.8	65.9	65.0	64.1	4.28
				8.0	RHS	27.7	68.5	504	68.5	68.5	68.5	68.5	66.5	65.6	64.7	63.8	62.9	62.1	61.2	60.4	59.6	58.8	4.33
				6.0	RHS	21.4	54.4	389	54.4	54.4	54.4	54.4	52.8	52.1	51.4	50.7	50.0	49.4	48.7	48.0	47.4	46.8	4.44
				5.0	RHS	18.2	46.6	329	46.6	46.6	46.6	46.6	45.3	44.7	44.1	43.5	42.9	42.3	41.8	41.2	40.6	40.1	4.49
150	x	50	x	6.0	RHS	16.7	36.9	374	36.9	35.4	34.1	32.8	31.5	30.3	29.2	28.1	27.1	26.1	25.1	24.2	23.4	22.6	1.12
				5.0	RHS	14.2	31.9	316	31.9	30.7	29.5	28.4	27.4	26.3	25.4	24.4	23.6	22.7	21.9	21.1	20.4	19.7	1.14
				4.0	RHS	11.6	26.5	257	26.5	25.5	24.6	23.7	22.8	21.9	21.2	20.4	19.7	19.0	18.3	17.7	17.1	16.5	1.17
				3.0	RHS	8.96	20.8	195	20.8	20.1	19.3	18.6	17.9	17.3	16.7	16.1	15.5	15.0	14.4	13.9	13.5	13.0	1.19
				2.5	RHS	7.53	17.6	164	17.6	17.0	16.4	15.8	15.2	14.7	14.1	13.6	13.2	12.7	12.3	11.8	11.5	11.1	1.21
127	x	51	x	6.0	RHS	14.7	27.9	315	27.9	27.1	26.1	25.3	24.4	23.6	22.8	22.0	21.3	20.6	20.0	19.3	18.7	18.1	1.35
				5.0	RHS	12.5	24.3	267	24.3	23.6	22.8	22.0	21.3	20.6	19.9	19.2	18.6	18.0	17.5	16.9	16.4	15.9	1.38
				3.5	RHS	9.07	18.1	192	18.1	17.6	17.0	16.4	15.9	15.4	14.9	14.4	13.9	13.5	13.1	12.7	12.3	11.9	1.43
125	x	75	x	6.0	RHS	16.7	34.1	317	34.1	34.1	33.5	32.8	32.2	31.6	31.0	30.4	29.9	29.3	28.8	28.2	27.7	27.2	2.96
				5.0	RHS	14.2	29.5	269	29.5	29.5	29.5	28.4	27.9	27.3	26.8	26.3	25.8	25.4	24.9	24.4	24.0	23.6	3.01
				4.0	RHS	11.6	24.4	219	24.4	24.4	24.4	23.5	23.1	22.7	22.2	21.8	21.4	21.0	20.7	20.3	19.9	19.5	3.06
				3.0	RHS	8.96	18.8	167	18.8	18.8	18.8	18.2	17.9	17.5	17.2	16.9	16.6	16.3	16.0	15.7	15.4	15.1	3.11
				2.5	RHS	7.53	14.1	140	14.1	14.1	14.1	13.7	13.5	13.3	13.0	12.8	12.6	12.4	12.2	12.0	11.8	11.7	3.14
102	x	76	x	6.0	RHS	14.7	25.1	255	25.1	25.1	25.1	24.3	23.9	23.5	23.1	22.7	22.3	21.9	21.5	21.2	20.8	20.4	3.63
				5.0	RHS	12.5	21.7	218	21.7	21.7	21.7	21.1	20.7	20.4	20.0	19.7	19.3	19.0	18.7	18.4	18.1	17.8	3.69
				3.5	RHS	9.07	16.1	157	16.1	16.1	16.1	15.7	15.4	15.1	14.9	14.6	14.4	14.1	13.9	13.7	13.4	13.2	3.78

**Notes:**

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- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- Values of  $\phi M_b$  based on  $\alpha_m = 1.0$  (uniform moment over entire segment) in this Table.
- Values to the left of those of the solid line are for segment lengths with full lateral restraint based on the listed FLR and  $\phi M_b = \phi M_{sx}$ .
- FLR – segment length for Full Lateral Restraint (Clause 5.3.2.4 of AS 4100) with  $\beta_m = -1.0$ .
- For other moment distributions use the appropriate value of  $\alpha_m$  obtained from Clauses 5.6.1 or 5.6.2 of AS 4100 and use the minimum of  $\alpha_m \phi M_b$  and  $\phi M_{sx}$  given in this Table.



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# Part 6

## MEMBERS SUBJECT TO AXIAL COMPRESSION

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6.3 Design Member Capacity in Axial Compression	6-3
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Design Member Capacities in Axial Compression	6-6

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



# Part 6

## MEMBERS SUBJECT TO AXIAL COMPRESSION

### 6.1 General

Values of the design member capacity in compression ( $\phi N_c$ ) for buckling about each principal axes for a range of effective lengths ( $L_e$ ) are given in Tables 6-1 to 6-6. The design member capacities are determined from Section 6 of AS 4100. All the Tables for CHS, RHS and SHS are supplemented by graphs of  $\phi N_c$  versus  $L_e$  placed consecutively after the tables for each corresponding grade and section type. All loads are assumed to be applied through the centroid of the section. The column capacity is associated with flexural buckling as torsional buckling is not a common buckling mode for hollow sections in axial compression.

For RHS only, the Tables in this section have been grouped into two series:

- the (A) series for the member buckling about the x-axis, and
- the (B) series for the member buckling about the y-axis.

The (A) series tables and graphs for each group of sections are immediately followed by the (B) series of tables and graphs for the same group.

### 6.2 Design Section Capacity in Axial Compression

The design section capacity in compression ( $\phi N_s$ ) is obtained from Clause 6.2 of AS 4100 and is given by:

$$\phi N_s = \phi k_f A_n f_y$$

where

- $\phi = 0.9$  (Table 3.4 of AS 4100)
- $k_f =$  form factor (see Section 3.2.2.3)
- $A_n =$  net area of the cross section
- $= A_g$  assuming no penetrations or holes (see 3.1 series Tables in Part 3)
- $f_y =$  yield stress used in design

The design *section* capacity considers the behaviour of the cross-section only (as in a stub column test), and is affected by the element slenderness of each plate element in the cross-section. The form factor ( $k_f$ ) represents the proportion of the section that is effective in axial compression and is determined from considerations of element slenderness as affected by local buckling, using Clause 6.2.3 and 6.2.4 of AS 4100. See discussion in Section 3.2.2.3.

### 6.3 Design Member Capacity in Axial Compression

The design *member* capacity in axial compression accounts for the effect of overall member buckling for the effective length of the member (amongst other factors) and it is obtained from Clause 6.3 of AS 4100 and given by:

$$\phi N_c = \phi \alpha_c N_s \leq \phi N_s$$

where

- $\phi = 0.9$  (Table 3.4 of AS 4100)
- $\alpha_c =$  member slenderness reduction factor

The member slenderness reduction factor ( $\alpha_c$ ) depends on the modified member slenderness ( $\lambda_n$ ) and the member section constant ( $\alpha_b$ ). From Clause 6.3.3 of AS 4100:

$$\alpha_c = \xi \left\{ 1 - \sqrt{1 - \left( \frac{90}{\xi \lambda} \right)^2} \right\}$$

$$\xi = \frac{\left( \frac{\lambda}{90} \right)^2 + 1 + \eta}{2 \left( \frac{\lambda}{90} \right)^2}$$

where

$$\lambda_n = \left( \frac{L_e}{r} \right) \sqrt{(k_f) \frac{f_y}{250}}$$

$$\lambda = \lambda_n + \alpha_a \alpha_b$$

$$\alpha_a = \frac{2100 (\lambda_n - 13.5)}{\lambda_n^2 - 15.3 \lambda_n + 2050}$$

$$\eta = 0.00326 (\lambda - 13.5) \geq 0$$

# Part 6

## MEMBERS SUBJECT TO AXIAL COMPRESSION

$L_e$  = effective length of a compression member about the axis of buckling  
 $r$  = radius of gyration about the axis of buckling

For routine design the above equations need not be used. Table 6.3.3(3) of AS 4100 may be consulted to obtain the value of  $(\alpha_c)$  directly once  $\lambda_{r1}$  and  $\alpha_b$  are evaluated.

Note that the design member capacity equals the design section capacity (i.e.  $\phi N_c = \phi N_s$ ) when the effective length is zero (i.e.  $L_e = 0$ ).

Table T6.1 (which is extracted from Table 6.3.3 of AS 4100) lists values of  $\alpha_b$  for the sections considered in these Tables.

**Table T6.1: Values of Member Section Constant ( $\alpha_b$ ) for Compression Members**

Section	Residual Stresses	Yield Slenderness Limit $\lambda_{ey}$	$\alpha_b$	
			$k_r = 1.0$	$k_r < 1.0$
RHS, SHS	CF	40	-0.5	-0.5
CHS	CF	82	-0.5	-0.5

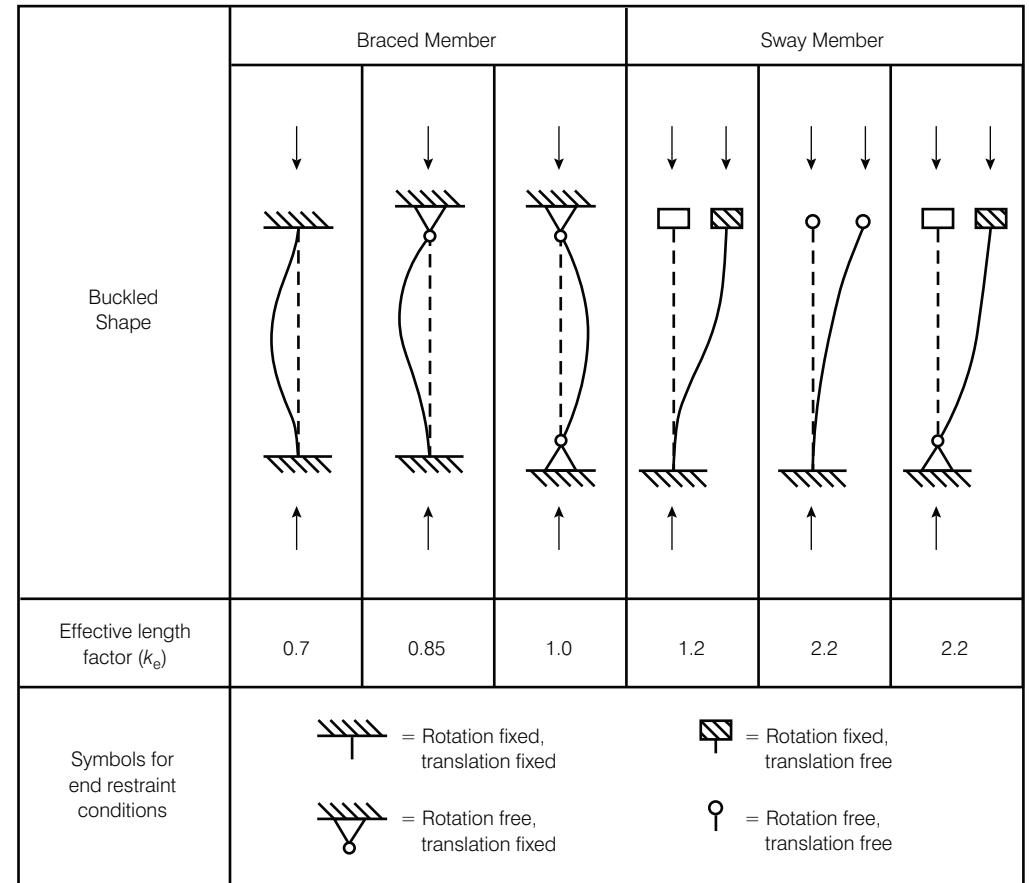
### 6.4 Effective Length

The values of  $\phi N_c$  are based on the *effective length* ( $L_e$ ) of the member. The effective length depends on the member length ( $L$ ), the rotational and translational restraints at the ends of the member and is determined from the following formula:

$$L_e = k_e L$$

The member effective length factor ( $k_e$ ) for use in Clause 6.3.2 of AS 4100 can be determined using Clause 4.6.3 of AS 4100 or by a rational frame buckling analysis (Clause 4.7 of AS 4100).

$k_e$  is given in Figure 6.1 for members with idealised end restraints (from Figure 4.6.3.2 of AS 4100). For braced or sway members in frames,  $k_e$  depends on the ratio ( $\gamma$ ) of the compression member stiffness to the end restraint stiffness, calculated at each end of the member. Example 2 of Section 4.3 in Ref [6.1] provides a sample calculation of  $k_e$  for columns in an unbraced plane frame.



**Figure 6.1: Effective Length Factors for Members with Idealised Conditions of End Restraint**

# Part 6

## MEMBERS SUBJECT TO AXIAL COMPRESSION

### 6.5 Example

Design a RHS column, with a length of 5.8 m, in Grade C450L0 (C450PLUS®) steel to resist a design axial force,  $N^* = 2400$  kN. Assume that for x-axis buckling both ends are pinned (rotation free, translation fixed), while for y-axis buckling one end is rotation free, translation fixed (pinned) and the other end is rotationally and translationally fixed.

#### Design Data:

$$N^* = 2400 \text{ kN}$$

#### Solution:

(i) Determine effective lengths

$$\text{For x-axis buckling } k_e = 1.0 \quad (\text{Figure 6.1})$$

$$\therefore L_{ex} = k_e L = 1.0 \times 5.8 = 5.8 \text{ m} \approx 6.0 \text{ m}$$

$$\text{For y-axis buckling } k_e = 0.85 \quad (\text{Figure 6.1})$$

$$\therefore L_{ey} = k_e L = 0.85 \times 5.8 = 4.93 \text{ m} \approx 5.0 \text{ m}$$

(ii) Select a member

When looking up Tables 6-4(1)(A) and 6-4(1)(B) from bottom to top there are various sections for which  $N^* < \phi N_c$ . As such there is the possibility that the first sections being sighted are uneconomical. In order to select a more optimal section it may be prudent to summarise a few of the initial listings for  $\phi N_{cx}$  and  $\phi N_{cy}$  based on their respective effective lengths. This is summarised in Table T6.2 for the example being considered.

**Table T6.2: Possible C450PLUS® RHS options to resist  $N^* = 2400$  kN compression.**

Buckling about x-axis with $L_{ex} = 6.0$ m						Buckling about y-axis with $L_{ey} = 5.0$ m					
Designation			Mass per m	$\phi N_{cx}$ (kN)		Designation			Mass per m	$\phi N_{cy}$ (kN)	
d	b	t		$L_e = 6.0\text{m}$		d	b	t		$L_e = 5.0\text{m}$	
mm	mm	mm	kg/m			mm	mm	mm	kg/m		
400	x 200	x 10.0	RHS	88.4	3500	400	x 200	x 10.0	RHS	88.4	3050
		8.0	RHS	71.6	2510			8.0	RHS	71.6	< $N^*$
350	x 250	x 16.0	RHS	136	5940	350	x 250	x 16.0	RHS	136	5750
		12.5	RHS	109	4780			12.5	RHS	109	4630
		10.0	RHS	88.4	3720			10.0	RHS	88.4	3620
		8.0	RHS	71.6	2720			8.0	RHS	71.6	2660
300	x 200	x 16.0	RHS	111	4440	300	x 200	x 16.0	RHS	111	4020
		12.5	RHS	89.0	3610			12.5	RHS	89.0	3290
		10.0	RHS	72.7	2970			10.0	RHS	72.7	2720
250	x 150	x 16.0	RHS	85.5	2850	250	x 150	x 16.0	RHS	85.5	< $N^*$

Note: shaded values indicate the lightest section in mass (kg/m).

$\therefore$  as noted in Table T6.2, adopt a 350 x 250 x 8.0 RHS in C450L0 (C450PLUS) as:

$$\phi N_{cx} = 2720 \text{ kN} \quad (L_{ex} = 6.0 \text{ m in Table 6-4(1)(A)})$$

$$> N^*$$

$$\phi N_{cy} = 2660 \text{ kN} \quad (L_{ey} = 5.0 \text{ m in Table 6-4(1)(B)})$$

$$> N^*$$

### 6.6 References

[6.1] ASI, "Design Capacity Tables for Structural Steel – Volume 1: Open Sections", fourth edition, Australian Steel Institute, 2009.

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

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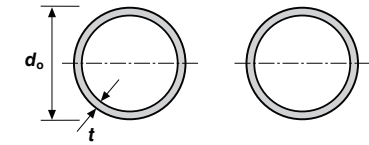
TABLE 6-1

# Circular Hollow Sections AS/NZS 1163 Grade C250L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

*buckling about any axis*

- 1 CHS
- 2 C250L0
- 3 Finish



Designation	t	Mass per m	$\phi N_s$ (kN)	Design Member Capacities in Axial Compression, $\phi N_c$ (kN)													
				Effective Length ( $L_e$ ) in metres													
$d_o$			$L_e = 0.00$	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	5.00	
mm	mm	kg/m															
165.1	x 5.4	CHS	21.3	610	610	610	605	600	595	589	581	565	544	520	490	418	
	5.0	CHS	19.7	566	566	566	562	557	552	546	540	524	506	483	456	389	
139.7	x 5.4	CHS	17.9	513	513	513	511	506	500	494	487	479	459	434	404	288	
	5.0	CHS	16.6	476	476	476	474	470	465	459	452	445	426	403	375	269	
114.3	x 5.4	CHS	14.5	416	416	416	411	406	400	392	383	373	348	316	278	170	
	4.5	CHS	12.2	349	349	349	346	341	336	330	323	314	293	267	235	144	
101.6	x 5.0	CHS	11.9	341	341	341	336	331	325	317	308	297	270	236	199	113	
	4.0	CHS	9.63	276	276	276	272	268	263	256	249	241	219	193	163	92.9	
88.9	x 5.9	CHS	12.1	346	346	344	339	331	323	312	299	284	246	203	163	86.9	
	5.0	CHS	10.3	297	297	295	290	284	277	268	257	244	213	176	141	75.9	
	4.0	CHS	8.38	240	240	239	235	230	224	217	209	199	174	144	117	62.7	
76.1	x 5.9	CHS	10.2	293	293	289	283	275	265	252	236	218	175	135	104	53.6	
	4.5	CHS	7.95	228	228	225	221	215	207	197	186	172	139	108	83.5	43.2	
	3.6	CHS	6.44	184	184	183	179	174	168	160	151	140	114	89.0	69.0	35.8	
60.3	x 5.4	CHS	7.31	210	210	205	198	189	176	161	142	122	87.2	63.3	47.5	24.0	
	4.5	CHS	6.19	177	177	174	168	160	150	137	122	105	75.7	55.0	41.4	20.9	
	3.6	CHS	5.03	144	144	141	137	131	123	113	100	87.1	63.0	46.0	34.6	17.5	
48.3	x 4.0	CHS	4.37	125	125	121	114	106	93.9	79.5	65.1	52.8	35.6	25.3	18.8	9.43	
	3.2	CHS	3.56	102	102	98.4	93.5	86.7	77.3	65.9	54.3	44.2	29.9	21.2	15.8	7.93	
42.4	x 4.0	CHS	3.79	109	108	103	96.1	85.7	72.0	57.5	45.2	35.8	23.7	16.7	12.4	6.20	
	3.2	CHS	3.09	88.7	88.0	84.4	78.9	70.7	59.9	48.2	38.0	30.2	20.0	14.2	10.5	5.25	
33.7	x 4.0	CHS	2.93	84.0	82.5	76.9	67.6	53.9	40.0	29.4	22.2	17.3	11.3	7.92	5.87	2.92	
	3.2	CHS	2.41	69.0	67.8	63.5	56.2	45.4	34.0	25.2	19.1	14.8	9.69	6.81	5.04	2.51	
26.9	x 4.0	CHS	2.26	64.7	62.6	55.6	43.1	29.3	20.0	14.2	10.6	8.19	5.31	3.72	2.75	1.37	
	3.2	CHS	1.87	53.6	51.9	46.4	36.7	25.4	17.4	12.4	9.27	7.17	4.65	3.26	2.41	1.20	
	2.6	CHS	1.56	44.7	43.3	38.9	31.2	21.9	15.1	10.8	8.05	6.22	4.04	2.83	2.09	1.04	

**Notes:**

1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
2. This product is also compliant with AS 1074 – Steel tubes and tubulars for ordinary service. Refer to the ATM Product Manual for details on AS 1074 sections.
3.  $\phi N_s = \phi N_c$  for  $L_e = 0.0$ .

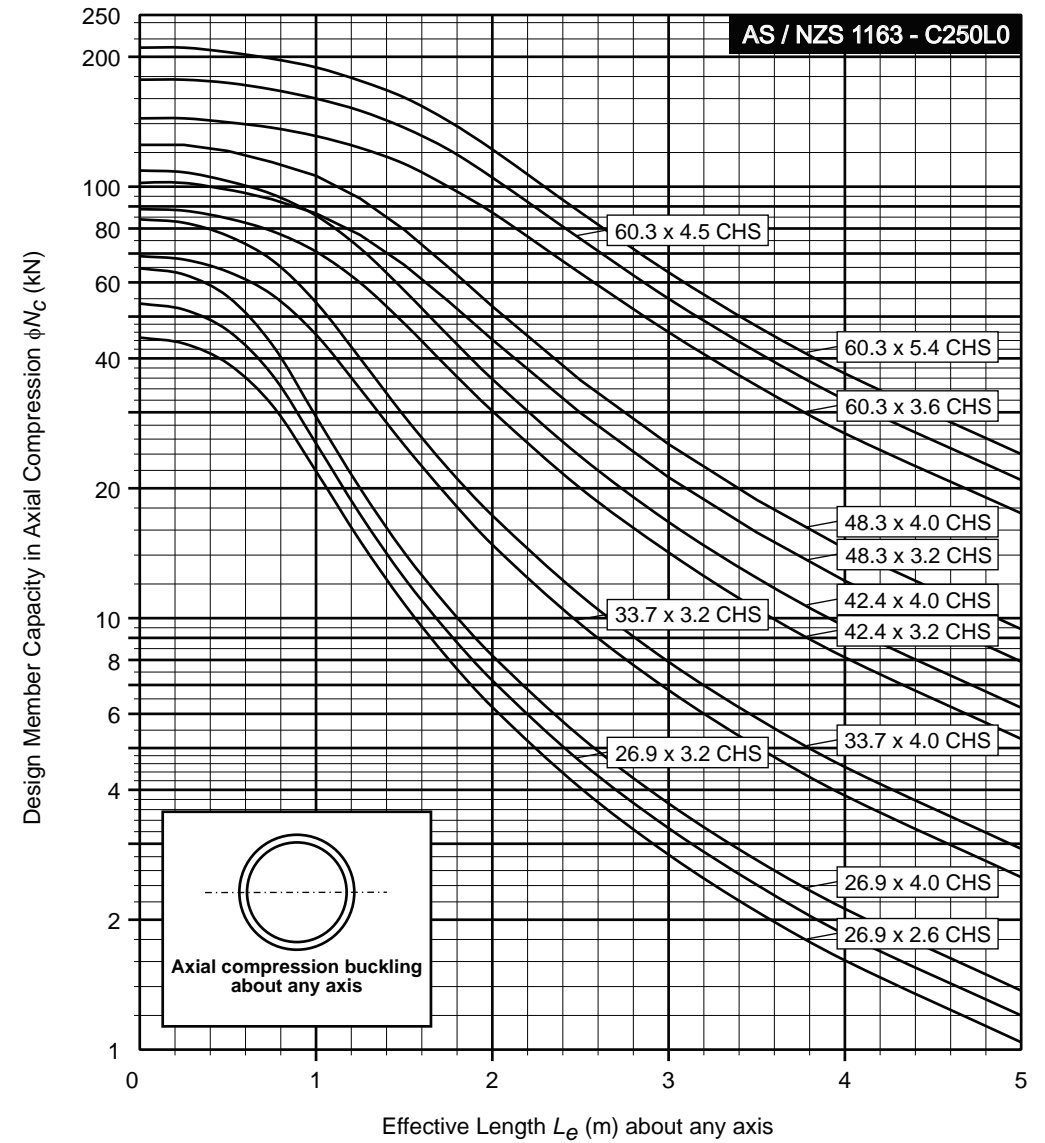
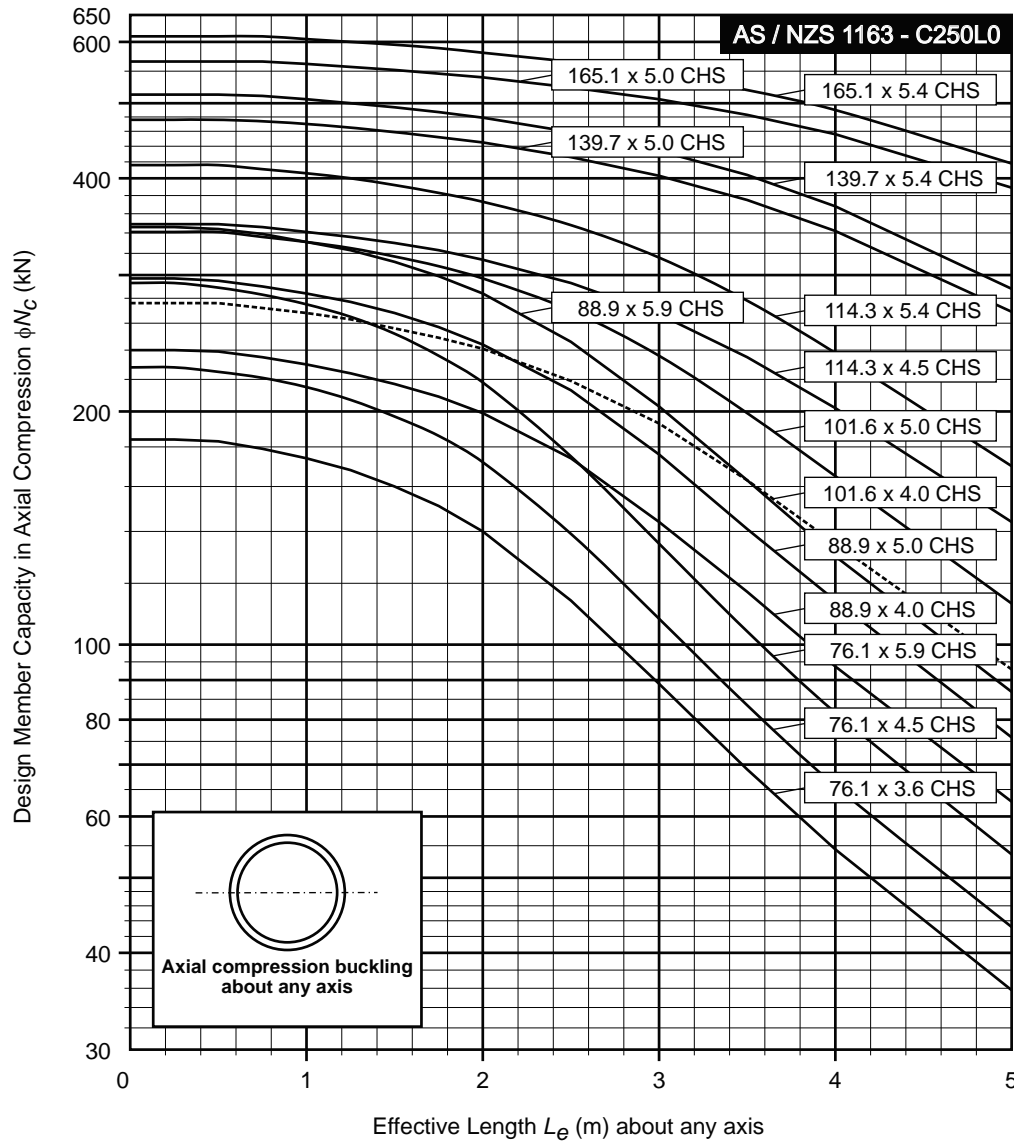
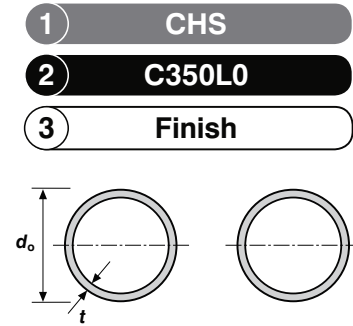


TABLE 6-2(1)

# Circular Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

*buckling about any axis*



Designation $d_o$ mm	t mm	Mass per m kg/m	$\phi N_s$ (kN) $L_e = 0.0$	Design Member Capacities in Axial Compression, $\phi N_c$ (kN) Effective Length ( $L_e$ ) in metres													
				1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	12.0	14.0	16.0	
508.0 x	12.7 CHS	155	6220	6220	6220	6150	6070	5960	5840	5700	5530	5340	5120	4600	3990	3370	
	9.5 CHS	117	4690	4690	4690	4630	4570	4490	4400	4300	4170	4030	3870	3480	3020	2560	
	6.4 CHS	79.2	2720	2720	2720	2700	2670	2630	2580	2530	2470	2400	2320	2140	1910	1660	
457.0 x	12.7 CHS	139	5580	5580	5570	5490	5400	5290	5150	4990	4810	4590	4340	3750	3130	2570	
	9.5 CHS	105	4210	4210	4200	4140	4070	3990	3890	3770	3630	3470	3280	2850	2380	1960	
	6.4 CHS	71.1	2580	2580	2550	2510	2460	2410	2340	2270	2180	2080	1840	1570	1310		
406.4 x	12.7 CHS	123	4950	4950	4920	4840	4740	4610	4460	4280	4060	3810	3520	2900	2320	1860	
	9.5 CHS	93.0	3730	3730	3710	3650	3580	3480	3370	3230	3070	2890	2670	2210	1770	1420	
	6.4 CHS	63.1	2430	2430	2420	2380	2340	2280	2210	2130	2030	1910	1780	1490	1210	973	
355.6 x	12.7 CHS	107	4310	4310	4270	4180	4070	3920	3750	3530	3270	2980	2670	2080	1610	1270	
	9.5 CHS	81.1	3250	3250	3220	3160	3070	2970	2840	2680	2490	2270	2030	1590	1230	973	
	6.4 CHS	55.1	2210	2210	2190	2150	2090	2020	1930	1830	1700	1550	1400	1090	852	672	
323.9 x	12.7 CHS	97.5	3910	3910	3860	3760	3640	3480	3280	3040	2750	2440	2140	1610	1230	961	
	9.5 CHS	73.7	2960	2960	2920	2850	2750	2640	2490	2310	2100	1870	1640	1240	946	740	
	6.4 CHS	50.1	2010	2010	1980	1940	1880	1800	1700	1580	1440	1280	1130	856	655	512	
273.1 x	12.7 CHS	81.6	3270	3270	3200	3090	2950	2750	2510	2210	1900	1610	1360	985	740	574	
	9.3 CHS	60.5	2430	2430	2380	2300	2190	2050	1870	1660	1430	1220	1030	748	562	436	
	6.4 CHS	42.1	1690	1690	1650	1600	1530	1430	1310	1170	1010	859	728	530	399	310	
	4.8 CHS	31.8	1270	1270	1250	1210	1150	1080	994	885	767	654	555	404	304	236	
219.1 x	8.2 CHS	42.6	1710	1700	1650	1570	1450	1290	1090	893	724	591	489	347	259	200	
	6.4 CHS	33.6	1350	1340	1300	1230	1140	1020	865	711	578	472	391	278	207	160	
	4.8 CHS	25.4	1020	1010	982	934	865	773	659	543	442	362	299	213	158	122	
168.3 x	7.1 CHS	28.2	1130	1120	1060	964	822	649	495	380	297	238	195	137	102	78.4	
	6.4 CHS	25.6	1030	1010	960	874	746	591	451	346	271	217	178	125	92.8	71.6	
	4.8 CHS	19.4	777	767	728	664	570	453	347	267	209	168	137	96.6	71.6	55.2	

**Notes:**

1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
2.  $\phi N_s = \phi N_c$  for  $L_e = 0.0$ .

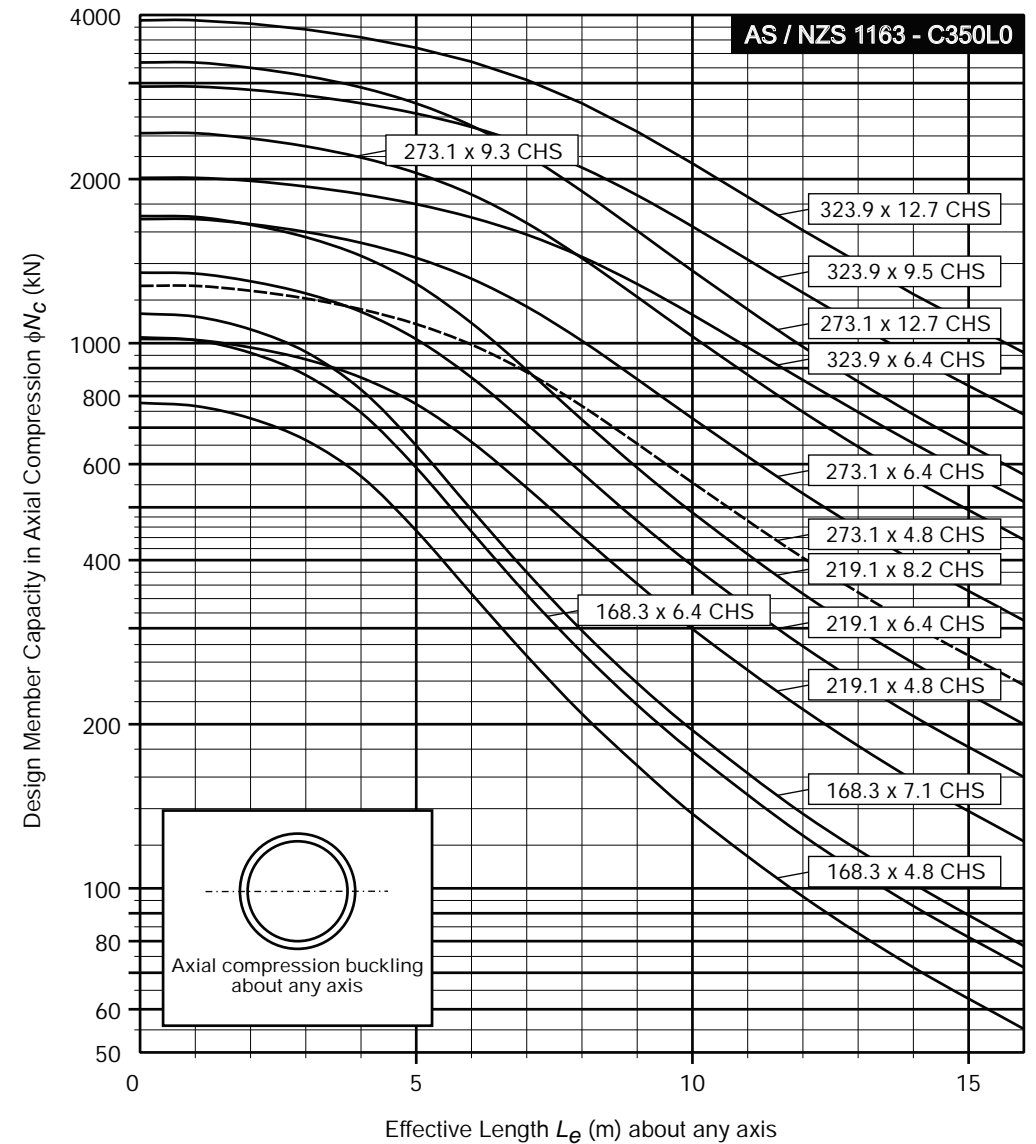
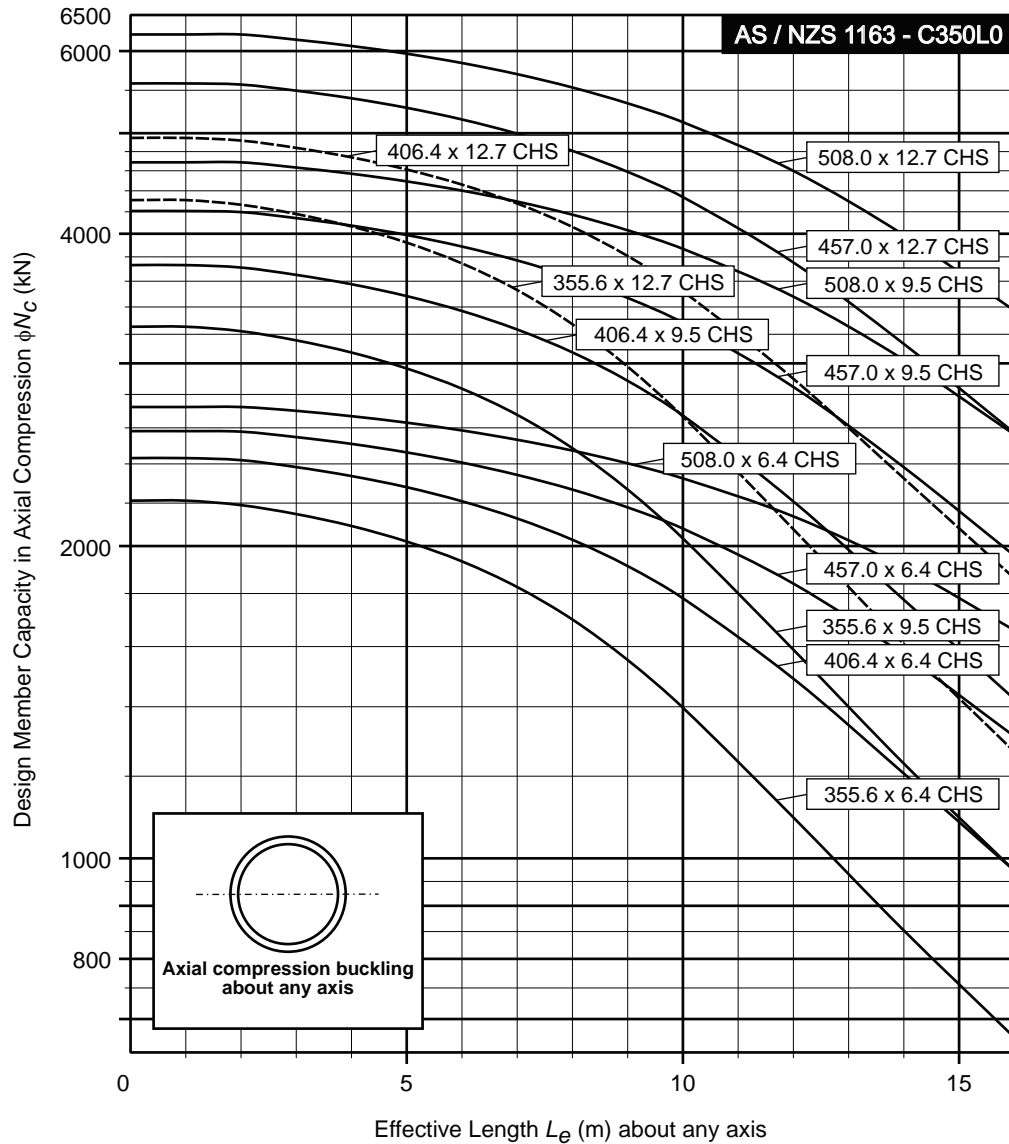




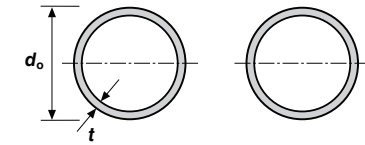
TABLE 6-2(2)

# Circular Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

*buckling about any axis*

- 1 CHS
- 2 C350L0
- 3 Finish



Designation $d_o$ mm	t mm	Mass per m kg/m	$\phi N_s$ (kN)	Design Member Capacities in Axial Compression, $\phi N_c$ (kN)													
				Effective Length ( $L_e$ ) in metres													
				$L_e = 0.00$	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	5.00
165.1 x	3.5 CHS	13.9	560	560	560	558	553	547	540	533	524	503	477	445	407	322	
	3.0 CHS	12.0	481	481	481	480	475	470	465	458	451	433	410	383	351	278	
139.7 x	3.5 CHS	11.8	472	472	472	468	462	456	448	439	429	403	371	332	289	211	
	3.0 CHS	10.1	406	406	406	403	398	392	386	378	369	348	320	287	250	182	
114.3 x	3.6 CHS	9.83	394	394	393	388	381	373	364	352	339	306	264	220	181	123	
	3.2 CHS	8.77	352	352	351	346	340	333	325	315	303	273	237	197	162	110	
101.6 x	3.2 CHS	7.77	312	312	310	305	298	290	281	269	256	222	183	146	117	78.2	
	2.6 CHS	6.35	255	255	253	249	244	238	230	221	210	182	150	121	96.8	64.7	
88.9 x	3.2 CHS	6.76	271	271	269	263	256	247	236	222	206	168	131	101	79.8	52.5	
	2.6 CHS	5.53	222	222	220	215	210	202	193	182	169	138	108	83.9	66.1	43.5	
76.1 x	3.2 CHS	5.75	231	231	227	221	213	202	188	172	153	115	85.1	64.5	50.2	32.8	
	2.3 CHS	4.19	168	168	165	161	155	147	138	126	113	85.0	63.2	47.9	37.4	24.4	
60.3 x	2.9 CHS	4.11	165	164	160	153	143	131	114	96.6	80.0	54.9	39.3	29.3	22.7	14.7	
	2.3 CHS	3.29	132	132	128	123	115	105	92.5	78.4	65.1	44.8	32.1	23.9	18.5	12.0	
48.3 x	2.9 CHS	3.25	130	129	124	115	103	86.0	68.5	53.8	42.6	28.2	19.9	14.8	11.4	7.38	
	2.3 CHS	2.61	105	104	99.6	92.9	83.1	70.0	56.1	44.1	35.0	23.2	16.4	12.2	9.38	6.07	
42.4 x	2.6 CHS	2.55	102	101	95.6	86.8	73.6	57.8	43.9	33.6	26.3	17.2	12.1	9.00	6.93	4.48	
	2.0 CHS	1.99	80.0	79.0	74.8	68.1	58.1	46.0	35.1	26.9	21.1	13.8	9.74	7.22	5.56	3.60	
33.7 x	2.6 CHS	1.99	80.0	78.0	71.3	59.5	43.8	30.9	22.3	16.7	12.9	8.39	5.89	4.36	3.35	2.16	
	2.0 CHS	1.56	62.7	61.3	56.1	47.2	35.2	24.9	18.0	13.5	10.5	6.81	4.78	3.53	2.72	1.76	
26.9 x	2.3 CHS	1.40	56.0	53.6	46.0	33.0	21.2	14.2	10.0	7.45	5.75	3.73	2.61	1.93	1.48	0.956	
	2.0 CHS	1.23	49.3	47.3	40.7	29.4	19.0	12.7	9.01	6.70	5.17	3.35	2.35	1.73	1.33	0.860	

**Notes:**

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections** and associated **finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- $\phi N_s = \phi N_c$  for  $L_e = 0.0$ .

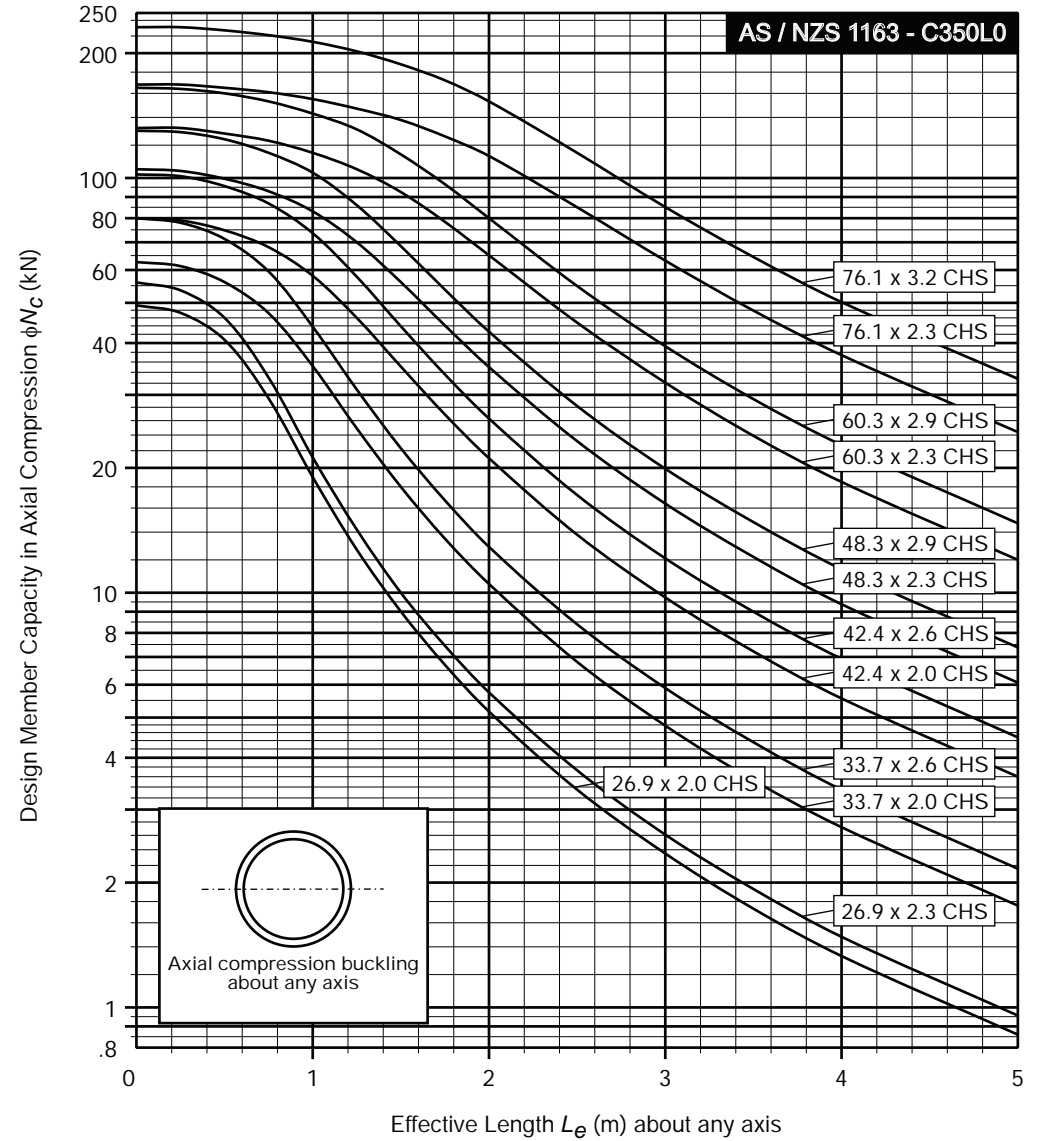
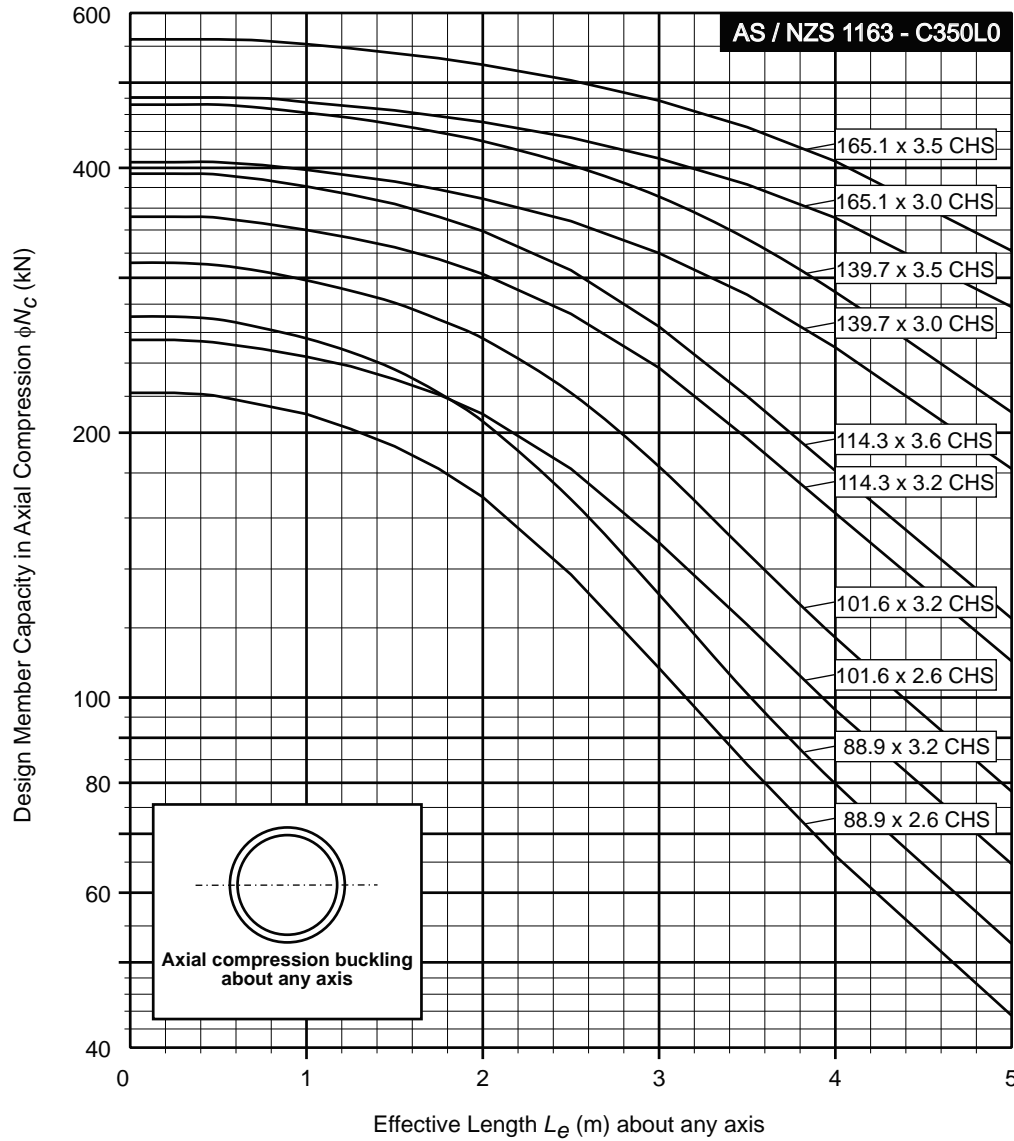


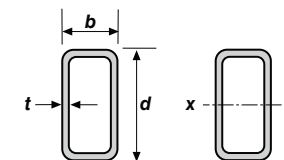
TABLE 6-3(A)

# Rectangular Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

### buckling about x-axis

- 1 RHS
- 2 C350L0
- 3 Finish



d	Designation			Mass per m	$\phi N_c$ (kN)	Design Member Capacities in Axial Compression, $\phi N_c$ (kN)														
	b	t				Effective Length ( $L_e$ ) in metres														
mm	mm	mm		kg/m	$L_e = 0.00$	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	5.00		
75	x	25	x	2.5	RHS	3.60	145	145	142	138	132	125	116	105	92.2	68.2	50.2	37.9	29.5	19.2
				2.0	RHS	2.93	113	113	112	108	104	99.1	92.5	84.3	74.9	56.2	41.6	31.5	24.5	16.0
				1.6	RHS	2.38	77.6	77.6	76.7	74.9	72.6	69.6	65.9	61.4	56.0	44.0	33.5	25.6	20.1	13.2
65	x	35	x	4.0	RHS	5.35	215	215	209	201	191	177	159	138	117	82.0	59.1	44.3	34.3	22.3
				3.0	RHS	4.25	170	170	166	161	153	143	130	114	97.5	69.4	50.3	37.7	29.3	19.0
				2.5	RHS	3.60	145	145	141	137	130	122	111	97.9	84.1	60.2	43.7	32.8	25.4	16.5
50	x	25	x	3.0	RHS	3.07	123	122	118	110	99.6	85.4	69.4	55.2	44.0	29.3	20.7	15.4	11.9	7.68
				2.5	RHS	2.62	105	105	101	94.6	85.9	74.1	60.7	48.5	38.8	25.9	18.3	13.6	10.5	6.79
				2.0	RHS	2.15	86.2	85.7	82.6	77.8	70.9	61.6	50.9	40.8	32.7	21.9	15.5	11.5	8.89	5.76
				1.6	RHS	1.75	70.3	69.9	67.4	63.6	58.2	50.8	42.2	34.0	27.3	18.3	13.0	9.63	7.44	4.82
50	x	20	x	3.0	RHS	2.83	114	113	108	101	90.0	75.8	60.6	47.7	37.8	25.0	17.7	13.1	10.1	6.56
				2.5	RHS	2.42	97.3	96.6	92.7	86.7	77.9	66.2	53.4	42.2	33.6	22.3	15.7	11.7	9.02	5.84
				2.0	RHS	1.99	79.9	79.4	76.3	71.5	64.6	55.3	45.0	35.7	28.5	19.0	13.4	9.96	7.68	4.97
				1.6	RHS	1.63	65.3	64.9	62.4	58.6	53.2	45.8	37.5	29.9	23.9	15.9	11.3	8.37	6.46	4.18

**Notes:**

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections** and associated **finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- $\phi N_c = \phi N_c$  for  $L_e = 0.0$ .

**ADDITIONAL NOTES:**

- THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.
- SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.

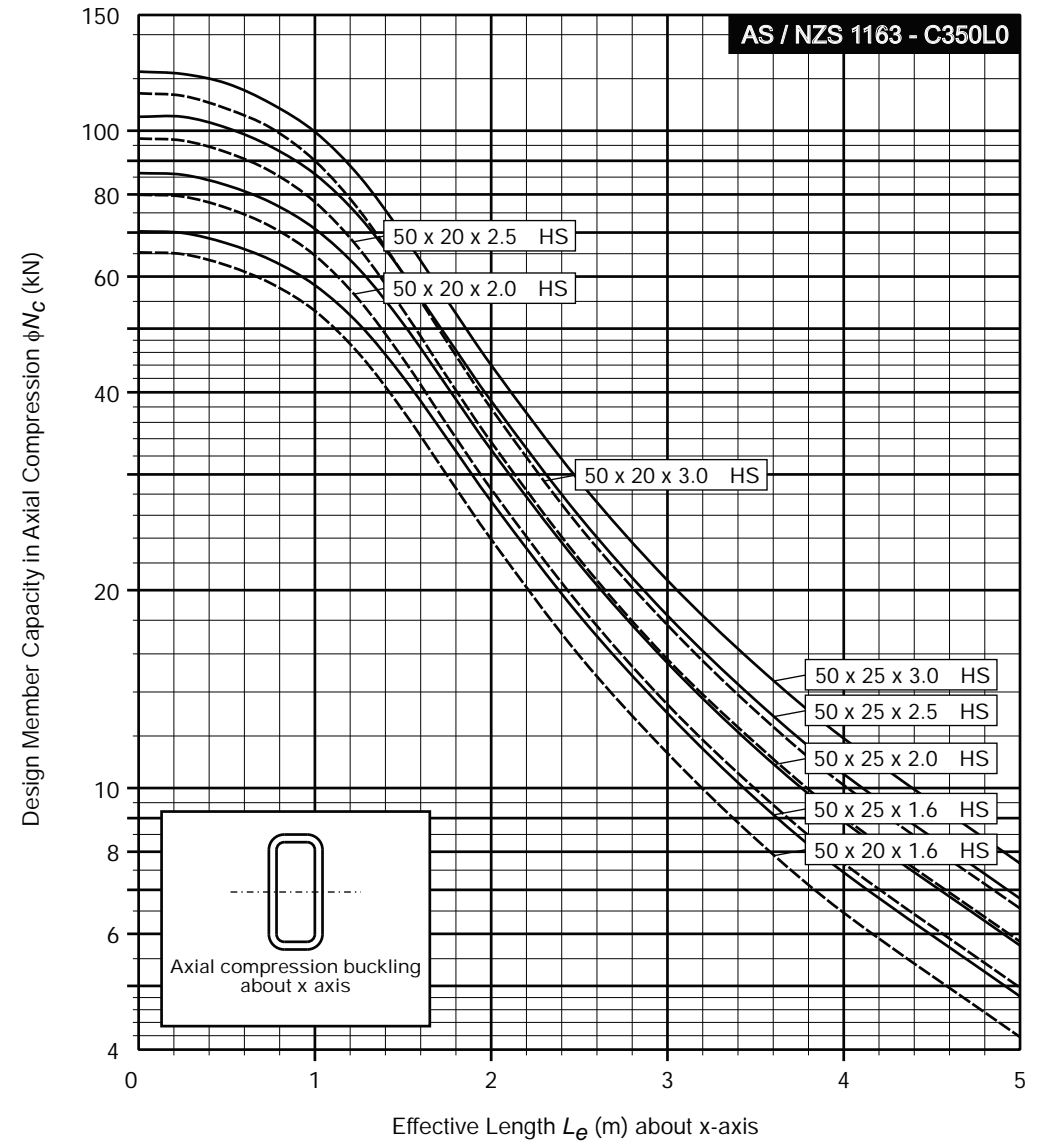
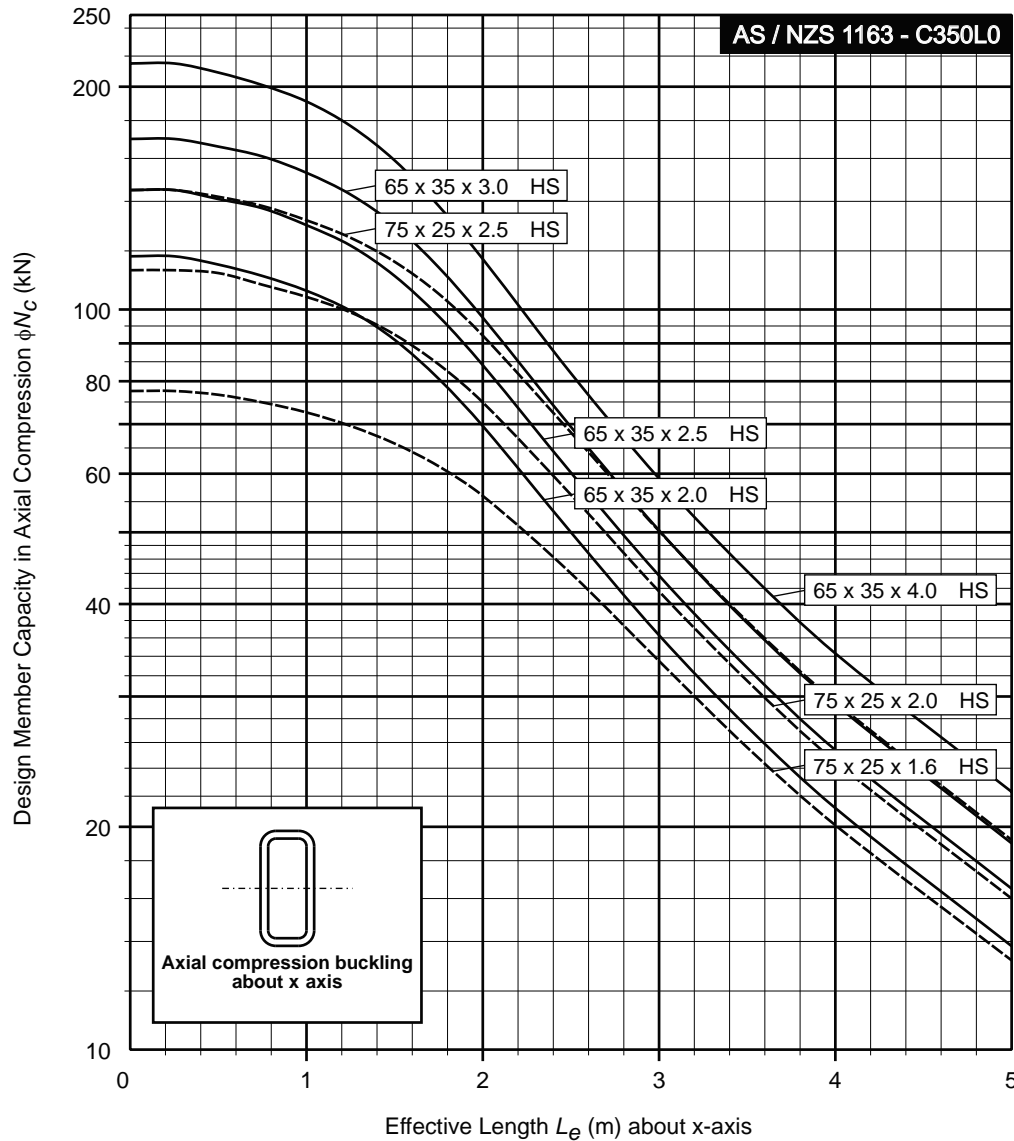


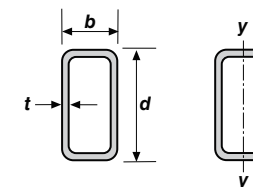
TABLE 6-3(B)

# Rectangular Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

### buckling about y-axis

- 1 RHS
- 2 C350L0
- 3 Finish



d	Designation			Mass per m	$\phi N_c$ (kN)	Design Member Capacities in Axial Compression, $\phi N_c$ (kN)														
	b	t				Effective Length ( $L_e$ ) in metres														
mm	mm	mm		kg/m	$L_e = 0.00$	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	5.00		
75	x	25	x	2.5	RHS	3.60	145	140	126	102	71.6	49.4	35.4	26.4	20.4	13.3	9.29	6.87	5.29	3.41
				2.0	RHS	2.93	113	110	100	82.4	59.6	41.6	29.9	22.4	17.3	11.2	7.88	5.83	4.49	2.90
				1.6	RHS	2.38	77.6	76.0	70.3	60.6	46.8	33.8	24.7	18.5	14.4	9.37	6.58	4.87	3.75	2.42
65	x	35	x	4.0	RHS	5.35	215	211	199	178	148	113	84.9	64.6	50.4	33.0	23.2	17.2	13.2	8.55
				3.0	RHS	4.25	170	168	159	144	122	95.1	72.0	55.1	43.1	28.2	19.9	14.7	11.3	7.33
				2.5	RHS	3.60	145	143	135	123	105	82.4	62.7	48.1	37.7	24.7	17.4	12.9	9.93	6.42
50	x	25	x	3.0	RHS	3.07	123	119	105	81.6	55.4	37.7	26.8	20.0	15.5	10.0	7.02	5.19	4.00	2.58
				2.5	RHS	2.62	105	102	90.8	71.3	49.1	33.5	23.9	17.8	13.8	8.95	6.27	4.64	3.57	2.30
				2.0	RHS	2.15	86.2	83.6	75.0	59.7	41.7	28.6	20.5	15.3	11.8	7.66	5.37	3.97	3.06	1.97
50	x	20	x	3.0	RHS	1.75	70.3	68.3	61.5	49.5	34.9	24.1	17.2	12.9	9.96	6.46	4.53	3.35	2.58	1.66
				2.5	RHS	2.83	114	107	87.0	55.7	34.1	22.5	15.9	11.8	9.07	5.87	4.10	3.03	2.33	1.50
				2.0	RHS	2.42	97.3	92.2	75.8	49.8	30.8	20.3	14.3	10.6	8.20	5.31	3.71	2.74	2.11	1.36
50	x	20	x	2.0	RHS	1.99	79.9	76.0	63.3	42.5	26.5	17.6	12.4	9.21	7.11	4.60	3.22	2.38	1.83	1.18
				1.6	RHS	1.63	65.3	62.2	52.3	35.8	22.5	14.9	10.6	7.84	6.05	3.92	2.74	2.03	1.56	1.00

**Notes:**

- REFER to the Australian Tube Mills QUICK REFERENCE PRODUCT AVAILABILITY GUIDE (QRPAG) for information on the availability of listed sections and associated finishes. The QRPAG is found at the beginning of this publication.
- $\phi N_c = \phi N_c$  for  $L_e = 0.0$ .

**ADDITIONAL NOTES:**

- THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.
- SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.

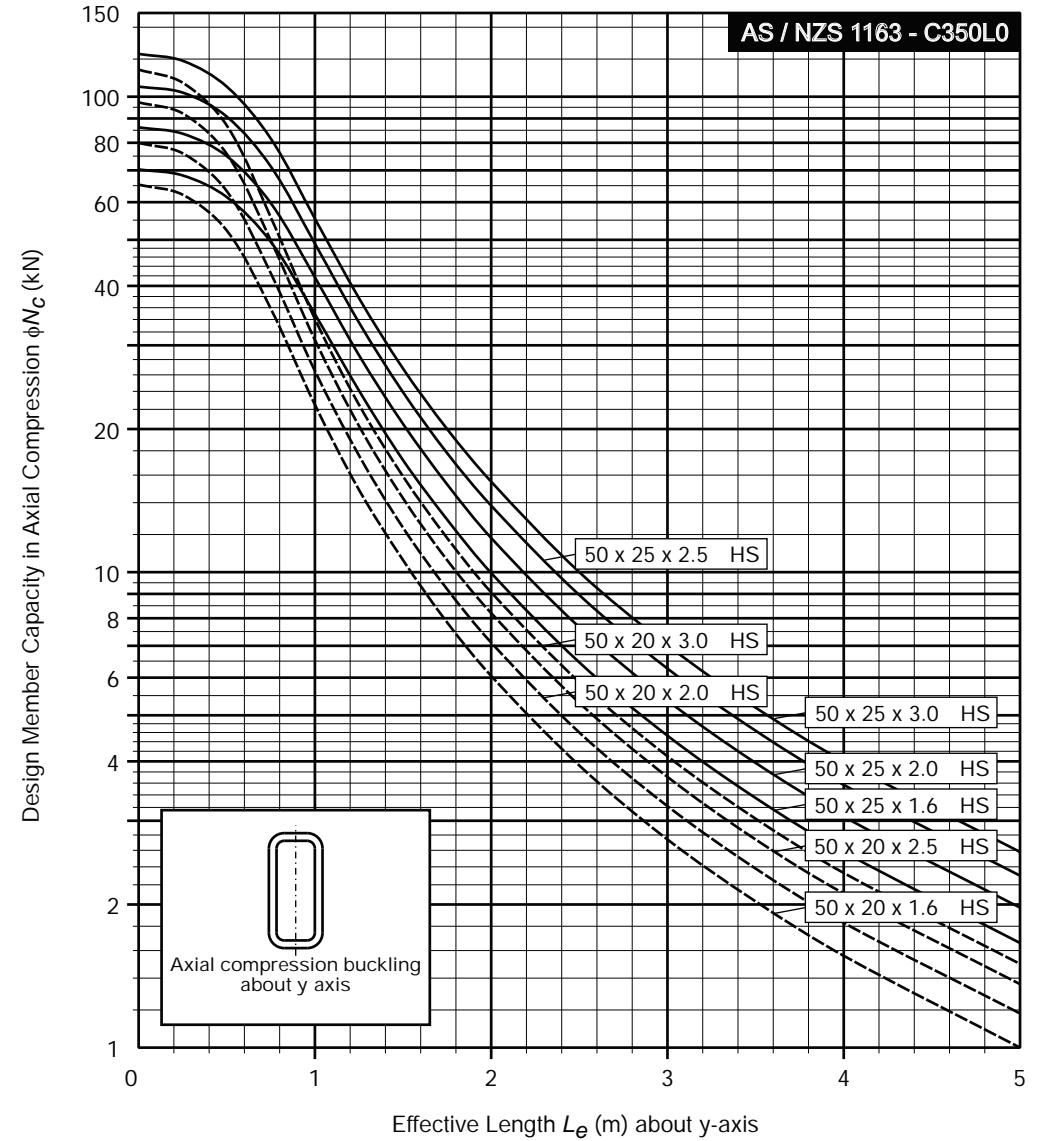
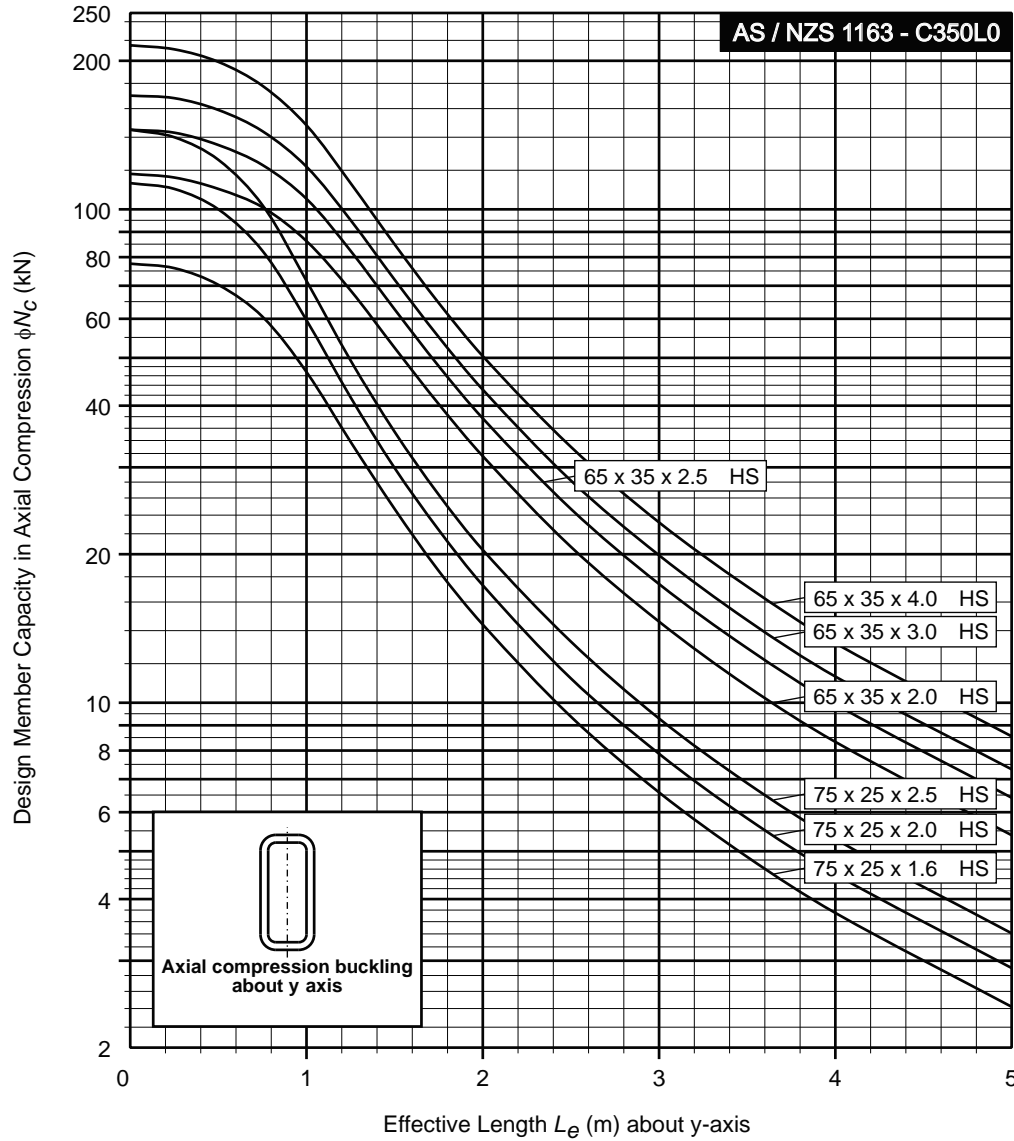


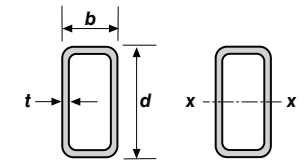
TABLE 6-4(1)(A)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

### buckling about x-axis

- 1 RHS
- 2 C450PLUS®
- 3 Finish



d	Designation			Mass per m	$\phi N_s$ (kN)	Design Member Capacities in Axial Compression, $\phi N_c$ (kN)														
	b	t				Effective Length ( $L_e$ ) in metres														
mm	mm	mm		kg/m	$L_e = 0.0$	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	12.0	14.0	16.0		
400	x	300	x	16.0	RHS	161	8300	8300	8240	8090	7900	7660	7370	7020	6610	6120	5580	4480	3530	2810
				12.5	RHS	128	6590	6590	6550	6430	6290	6100	5880	5610	5290	4920	4500	3640	2880	2290
				10.0	RHS	104	4710	4710	4680	4610	4520	4400	4270	4100	3910	3680	3420	2850	2310	1860
				8.0	RHS	84.2	3110	3110	3100	3060	3010	2950	2870	2790	2690	2570	2440	2120	1780	1470
400	x	200	x	16.0	RHS	136	7010	7010	6940	6800	6620	6390	6110	5770	5360	4890	4390	3430	2670	2100
				12.5	RHS	109	5580	5580	5530	5420	5280	5110	4890	4630	4320	3960	3570	2810	2190	1730
				10.0	RHS	88.4	3900	3900	3870	3810	3720	3620	3500	3340	3170	2960	2720	2220	1770	1410
				8.0	RHS	71.6	2750	2750	2740	2700	2650	2590	2510	2420	2310	2190	2050	1730	1410	1140
350	x	250	x	16.0	RHS	136	7010	7010	6910	6750	6540	6270	5940	5520	5030	4500	3950	3000	2300	1800
				12.5	RHS	109	5600	5600	5540	5410	5250	5040	4780	4460	4080	3660	3230	2460	1890	1480
				10.0	RHS	88.4	4300	4300	4250	4160	4050	3900	3720	3490	3230	2920	2610	2020	1560	1220
				8.0	RHS	71.6	3080	3080	3050	2990	2920	2830	2720	2580	2420	2230	2020	1610	1260	997
300	x	200	x	16.0	RHS	111	5710	5710	5590	5410	5170	4850	4440	3940	3410	2910	2460	1790	1350	1050
				12.5	RHS	89.0	4590	4590	4500	4360	4170	3930	3610	3230	2810	2400	2040	1490	1130	874
				10.0	RHS	72.7	3750	3750	3680	3570	3410	3220	2970	2670	2330	2000	1710	1250	942	732
				8.0	RHS	59.1	2750	2750	2710	2630	2540	2410	2250	2060	1830	1600	1380	1020	775	604
				6.0	RHS	45.0	1750	1750	1730	1690	1640	1570	1490	1390	1270	1140	1010	770	591	463
250	x	150	x	16.0	RHS	85.5	4410	4400	4260	4050	3750	3350	2850	2350	1910	1560	1290	919	685	529
				12.5	RHS	69.4	3580	3570	3460	3300	3070	2760	2380	1980	1620	1330	1100	783	584	451
				10.0	RHS	57.0	2940	2930	2840	2720	2540	2290	1990	1660	1370	1120	932	665	496	383
				9.0	RHS	51.8	2670	2670	2590	2470	2310	2090	1820	1520	1250	1030	858	612	457	353
				8.0	RHS	46.5	2400	2390	2320	2220	2080	1890	1640	1380	1140	938	779	557	415	321
				6.0	RHS	35.6	1550	1550	1510	1450	1380	1280	1150	1000	849	712	598	431	323	250
				5.0	RHS	29.9	1180	1180	1150	1110	1060	995	910	807	696	592	501	364	274	212

**Notes:**

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- $\phi N_s = \phi N_c$  for  $L_e = 0.0$ .

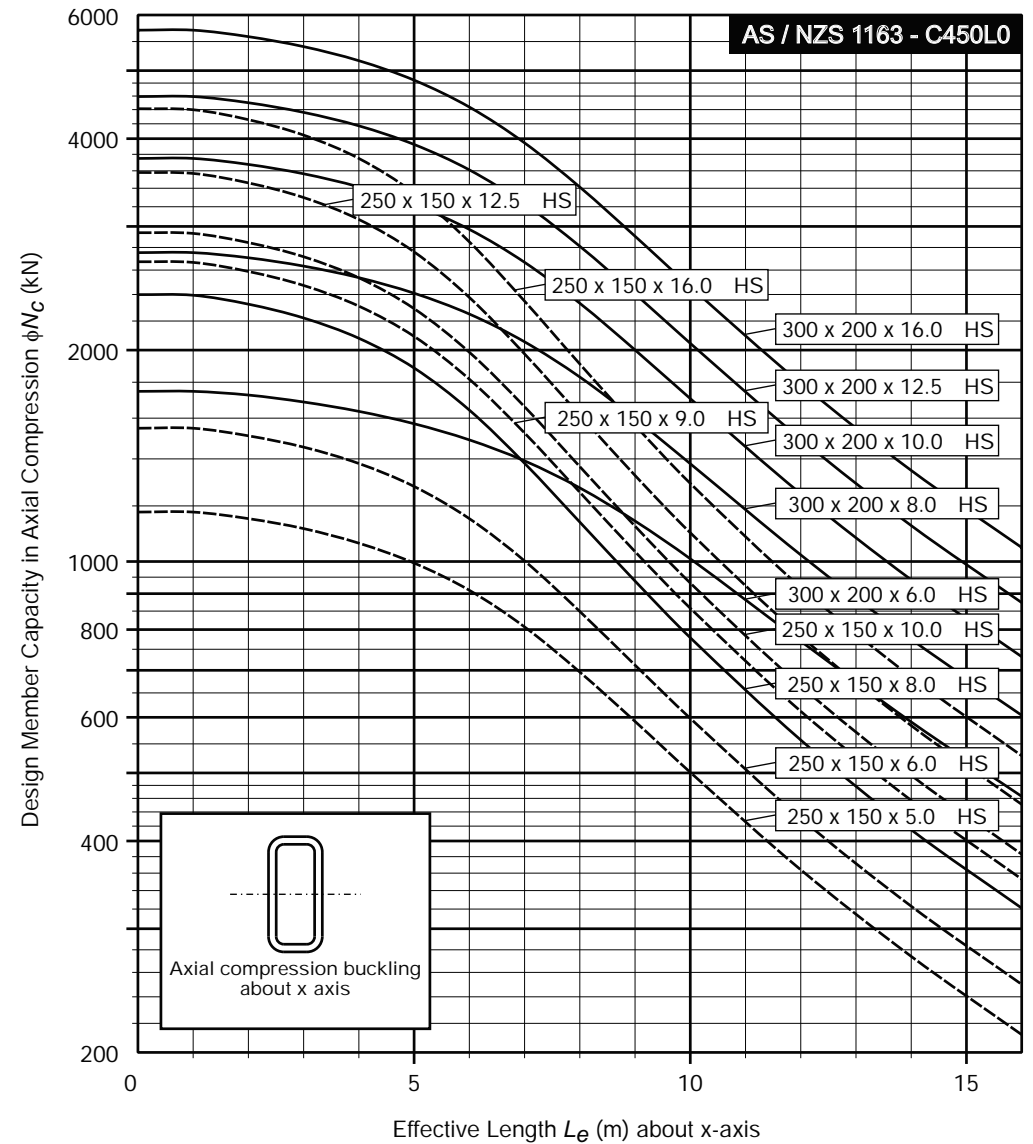
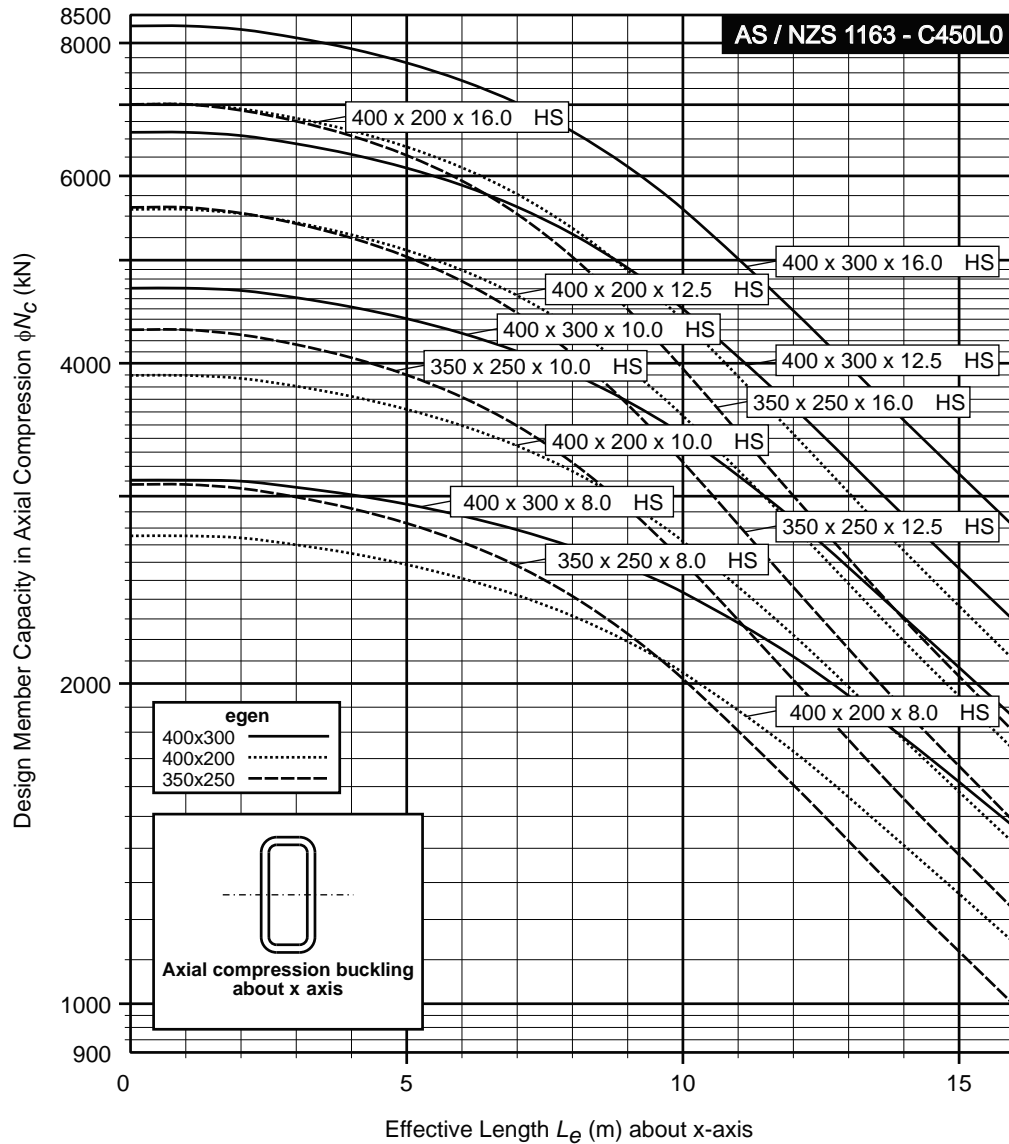




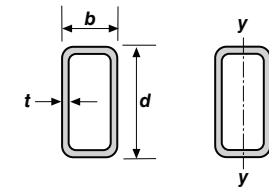
TABLE 6-4(1)(B)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

### buckling about y-axis

- 1 RHS
- 2 C450PLUS®
- 3 Finish



**Notes:**

1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3.  $\phi N_s = \phi N_c$  for  $L_e = 0.0$ .

d	Designation			Mass per m	$\phi N_s$ (kN)	Design Member Capacities in Axial Compression, $\phi N_c$ (kN)														
	b	t				Effective Length ( $L_e$ ) in metres														
mm	mm	mm		kg/m	$L_e = 0.0$	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	12.0	14.0	16.0		
400	x	300	x	16.0	RHS	161	8300	8300	8170	7950	7670	7300	6830	6260	5590	4900	4230	3150	2390	1870
				12.5	RHS	128	6590	6590	6490	6330	6110	5820	5460	5020	4510	3970	3440	2570	1960	1530
				10.0	RHS	104	4710	4710	4650	4540	4410	4230	4020	3750	3430	3080	2720	2080	1600	1250
				8.0	RHS	84.2	3110	3110	3080	3020	2950	2860	2740	2610	2440	2250	2040	1630	1280	1010
400	x	200	x	16.0	RHS	136	7010	6970	6720	6350	5810	5080	4220	3410	2740	2230	1840	1300	968	747
				12.5	RHS	109	5580	5560	5370	5080	4670	4120	3460	2810	2270	1850	1520	1080	805	622
				10.0	RHS	88.4	3900	3890	3770	3610	3370	3050	2660	2230	1840	1510	1260	896	669	517
				8.0	RHS	71.6	2750	2750	2680	2580	2440	2250	2010	1740	1460	1220	1020	735	550	426
350	x	250	x	16.0	RHS	136	7010	7000	6830	6570	6210	5750	5140	4450	3750	3140	2630	1890	1420	1100
				12.5	RHS	109	5600	5600	5470	5270	4990	4630	4170	3630	3080	2580	2170	1560	1170	907
				10.0	RHS	88.4	4300	4300	4200	4060	3870	3620	3290	2910	2500	2110	1780	1290	971	754
				8.0	RHS	71.6	3080	3080	3020	2930	2810	2660	2460	2220	1950	1680	1430	1050	795	618
300	x	200	x	16.0	RHS	111	5710	5670	5460	5130	4660	4020	3290	2630	2100	1700	1400	991	737	569
				12.5	RHS	89.0	4590	4570	4400	4150	3780	3290	2720	2190	1760	1420	1170	831	618	477
				10.0	RHS	72.7	3750	3730	3600	3400	3110	2720	2260	1830	1470	1200	985	698	519	401
				8.0	RHS	59.1	2750	2740	2660	2530	2340	2090	1790	1470	1200	982	812	578	430	333
	6.0	RHS	45.0	1750	1750	1700	1630	1540	1410	1250	1070	894	743	620	445	333	257			
250	x	150	x	16.0	RHS	85.5	4410	4340	4050	3570	2860	2130	1570	1190	924	738	602	423	313	241
				12.5	RHS	69.4	3580	3520	3300	2930	2390	1800	1340	1020	792	633	517	363	269	207
				10.0	RHS	57.0	2940	2890	2720	2430	2000	1530	1140	866	676	540	441	310	230	177
				9.0	RHS	51.8	2670	2630	2480	2220	1840	1400	1050	799	623	499	407	286	212	164
				8.0	RHS	46.5	2400	2360	2230	2000	1660	1270	956	728	568	454	371	261	193	149
				6.0	RHS	35.6	1550	1530	1460	1340	1160	940	727	562	442	355	291	205	152	117
	5.0	RHS	29.9	1180	1170	1120	1040	918	763	604	473	374	301	247	174	129	99.7			

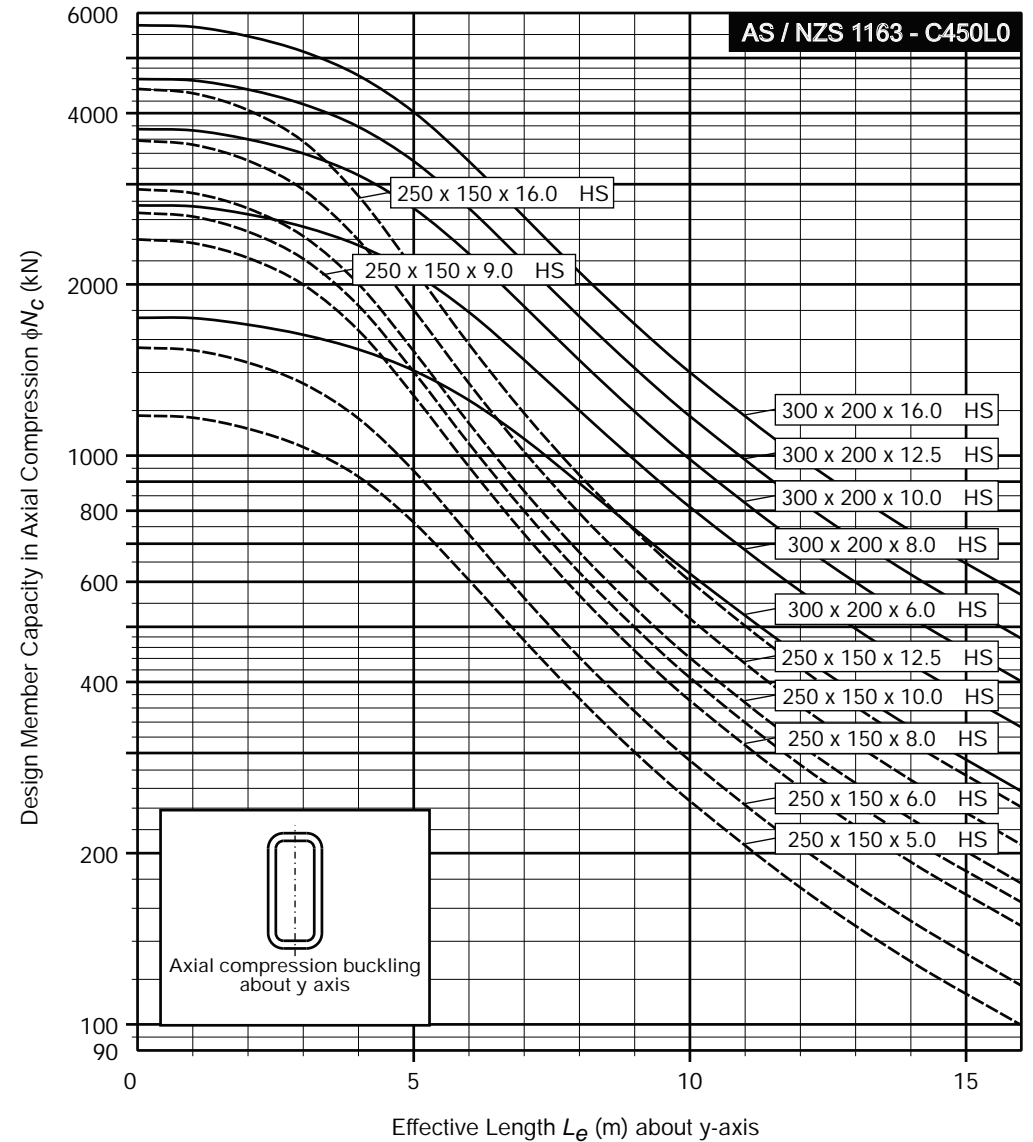
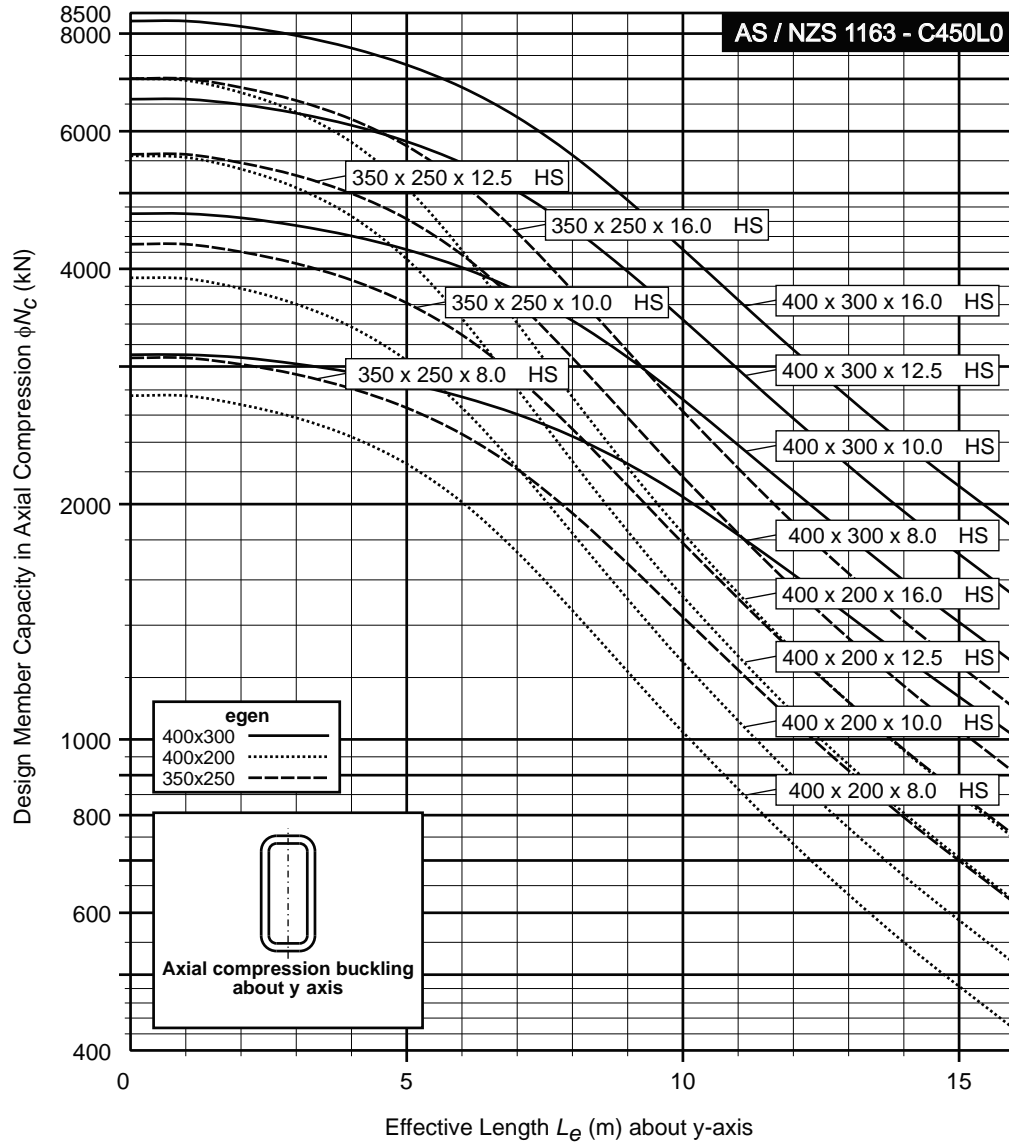


TABLE 6-4(2)(A)

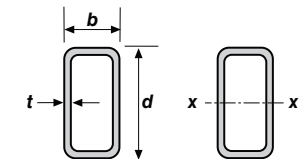
# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

### buckling about x-axis

d	Designation			Mass per m	$\phi N_s$ (kN)	Design Member Capacities in Axial Compression, $\phi N_c$ (kN)														
	b	t				Effective Length ( $L_e$ ) in metres														
mm	mm	mm		kg/m	$L_e = 0.0$	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	10.0	12.0		
200	x	100	x	10.0	RHS	41.3	2130	2110	2060	2010	1930	1850	1740	1610	1300	1010	783	616	405	286
				9.0	RHS	37.7	1940	1920	1880	1830	1770	1690	1590	1480	1200	938	727	573	377	266
				8.0	RHS	33.9	1750	1730	1700	1650	1600	1530	1440	1340	1100	858	667	525	346	244
				6.0	RHS	26.2	1310	1290	1270	1240	1200	1150	1090	1020	850	674	528	417	276	195
				5.0	RHS	22.1	974	968	952	931	905	874	836	791	680	555	443	353	235	166
152	x	76	x	6.0	RHS	19.4	1000	978	946	902	845	772	684	589	423	308	231	179	117	81.9
				5.0	RHS	16.4	848	830	804	768	720	660	587	508	367	267	201	156	101	71.2
150	x	100	x	10.0	RHS	33.4	1720	1690	1630	1550	1450	1320	1160	1000	715	519	390	302	197	138
				9.0	RHS	30.6	1580	1540	1490	1420	1330	1220	1080	930	668	486	365	283	184	129
				8.0	RHS	27.7	1430	1400	1350	1290	1210	1110	986	853	616	448	337	262	170	120
				6.0	RHS	21.4	1110	1080	1050	1010	947	872	780	680	495	362	273	212	138	96.8
				5.0	RHS	18.2	937	919	891	854	805	743	667	583	426	312	235	183	119	83.7
150	x	50	x	6.0	RHS	16.7	864	841	808	764	704	629	542	455	318	228	171	132	85.9	60.3
				5.0	RHS	14.2	735	716	689	653	604	541	469	396	278	200	150	116	75.4	52.9
				4.0	RHS	11.6	526	515	499	476	447	410	364	316	228	166	125	97.0	63.1	44.3
				3.0	RHS	8.96	329	324	316	305	291	273	251	226	172	129	98.1	76.5	50.0	35.1
				2.5	RHS	7.53	246	243	237	230	221	209	195	178	141	107	82.4	64.6	42.3	29.8
				2.0	RHS	6.07	173	172	168	164	158	151	143	133	109	85.1	66.1	52.1	34.3	24.2
127	x	51	x	6.0	RHS	14.7	757	729	691	637	564	476	389	315	212	151	112	86.6	56.1	39.3
				5.0	RHS	12.5	646	623	591	547	487	414	340	277	187	133	98.9	76.4	49.5	34.7
				3.5	RHS	9.07	423	411	393	368	335	293	247	204	140	100	74.8	57.9	37.5	26.3
125	x	75	x	6.0	RHS	16.7	864	835	796	741	668	576	479	392	267	190	142	110	71.1	49.8
				5.0	RHS	14.2	735	711	679	634	573	497	415	341	233	166	124	95.8	62.1	43.5
				4.0	RHS	11.6	600	581	556	520	471	411	345	285	195	139	104	80.3	52.1	36.5
				3.0	RHS	8.96	390	381	367	348	323	291	253	215	151	109	81.8	63.4	41.2	28.9
				2.5	RHS	7.53	296	290	280	268	251	229	203	176	126	91.9	69.1	53.6	34.9	24.5
102	x	76	x	6.0	RHS	14.7	757	719	670	599	503	402	316	251	166	117	87.0	67.1	43.4	30.4
				5.0	RHS	12.5	646	615	574	515	436	351	277	220	146	103	76.6	59.1	38.2	26.8
				3.5	RHS	9.07	468	446	418	378	323	262	208	166	110	78.0	58.0	44.7	29.0	20.3

- 1 RHS
- 2 C450PLUS®
- 3 Finish



### Notes:

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- $\phi N_s = \phi N_c$  for  $L_e = 0.0$ .

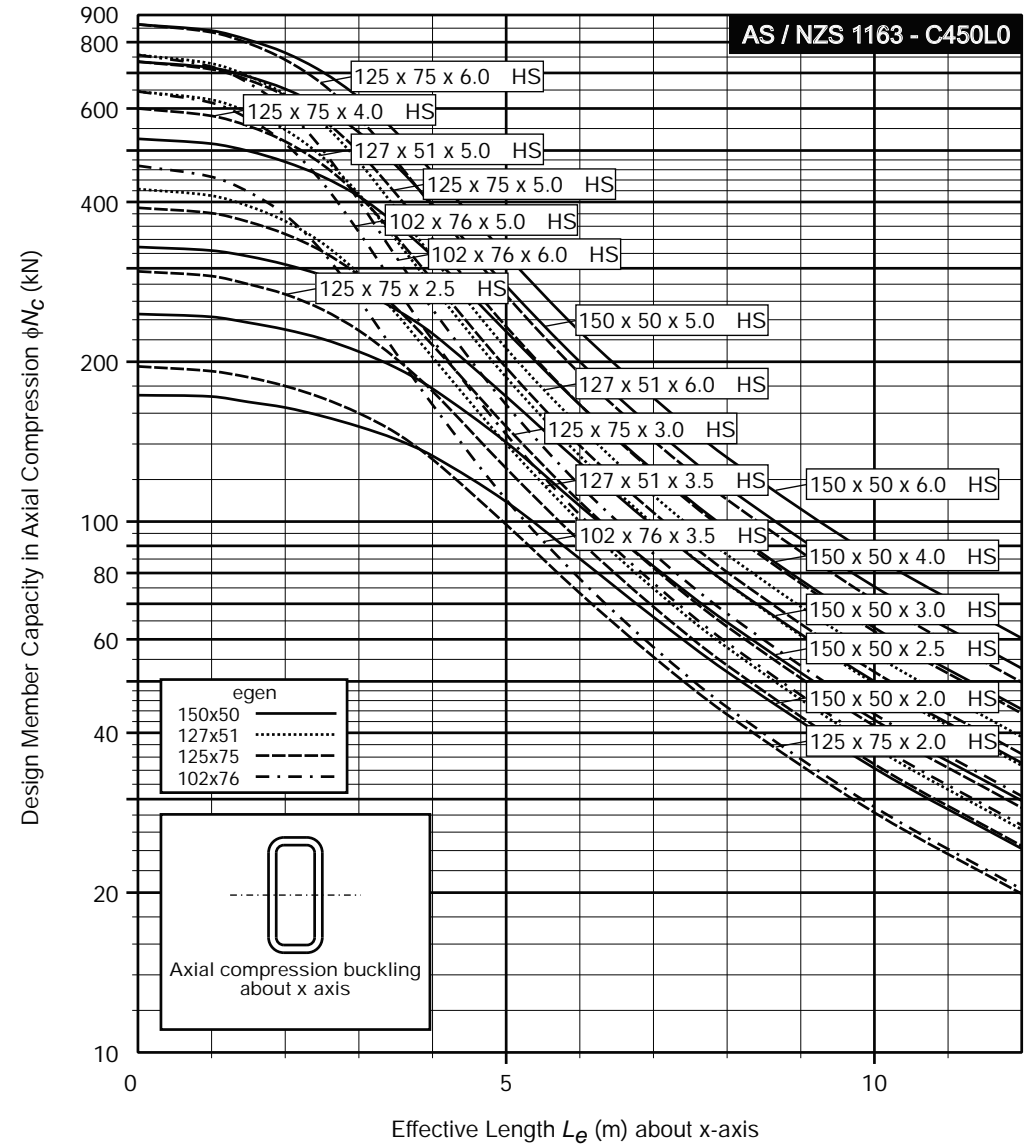
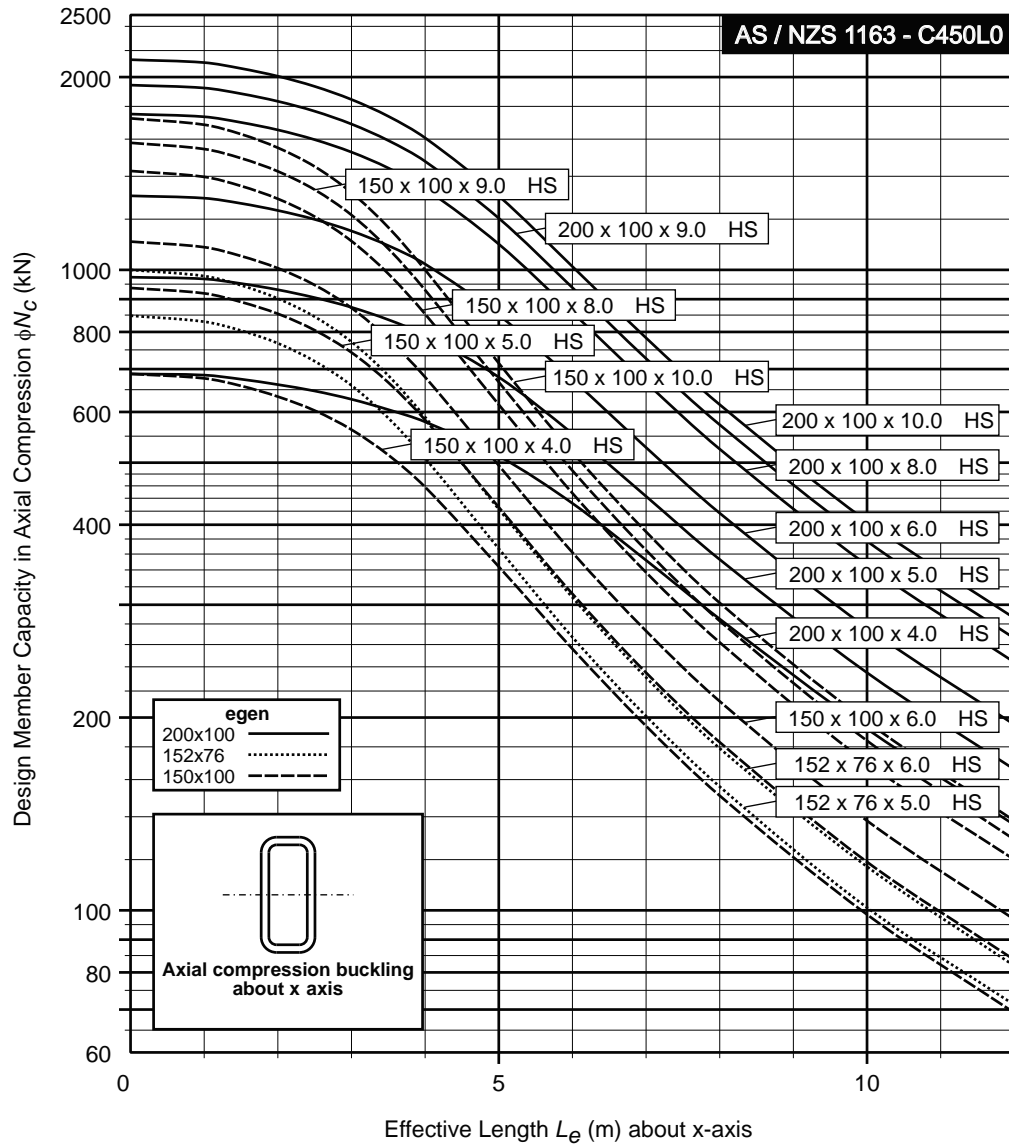


TABLE 6-4(2)(B)

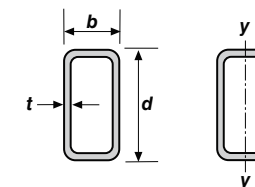
# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

### buckling about y-axis

d	Designation			Mass per m	$\phi N_s$ (kN)	Design Member Capacities in Axial Compression, $\phi N_c$ (kN)														
	b	t				Effective Length ( $L_e$ ) in metres														
mm	mm	mm		kg/m	$L_e = 0.0$	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	10.0		
200	x	100	x	10.0	RHS	41.3	2130	2120	2040	1920	1750	1510	1250	999	800	534	378	281	217	140
				9.0	RHS	37.7	1940	1930	1860	1760	1600	1400	1150	929	745	498	353	262	203	131
				8.0	RHS	33.9	1750	1740	1680	1590	1450	1270	1060	852	686	459	325	242	187	121
				6.0	RHS	26.2	1310	1300	1260	1190	1100	975	825	674	546	368	262	195	150	97.4
				5.0	RHS	22.1	974	972	943	901	843	764	664	557	459	314	224	167	129	83.8
152	x	76	x	6.0	RHS	19.4	1000	985	928	834	694	534	401	306	239	156	110	81.3	62.6	40.5
				5.0	RHS	16.4	848	836	789	712	597	463	349	266	208	136	95.8	71.0	54.7	35.4
150	x	100	x	10.0	RHS	33.4	1720	1710	1640	1540	1390	1190	960	762	607	403	285	212	163	106
				9.0	RHS	30.6	1580	1570	1510	1410	1280	1100	895	712	568	378	267	199	153	99.3
				8.0	RHS	27.7	1430	1420	1370	1280	1160	1000	823	657	526	350	248	184	142	92.0
				6.0	RHS	21.4	1110	1100	1060	1000	913	795	659	530	425	284	201	150	116	74.9
				5.0	RHS	18.2	937	932	900	849	778	680	566	457	368	246	175	130	100	64.9
150	x	50	x	6.0	RHS	16.7	864	828	714	517	335	224	159	118	91.1	59.0	41.3	30.5	23.5	15.1
				5.0	RHS	14.2	735	706	614	452	296	199	141	105	81.0	52.5	36.7	27.2	20.9	13.5
				4.0	RHS	11.6	526	509	454	356	245	167	119	88.9	68.7	44.6	31.2	23.1	17.8	11.5
				3.0	RHS	8.96	329	322	295	248	185	131	94.5	70.8	54.9	35.7	25.0	18.5	14.3	9.20
				2.5	RHS	7.53	246	241	223	193	151	110	80.0	60.3	46.8	30.5	21.4	15.8	12.2	7.88
				2.0	RHS	6.07	173	171	160	142	116	87.2	64.8	49.1	38.3	25.0	17.5	13.0	10.0	6.47
127	x	51	x	6.0	RHS	14.7	757	726	627	456	296	198	140	104	80.6	52.2	36.5	27.0	20.8	13.4
				5.0	RHS	12.5	646	621	540	400	262	176	125	93.0	71.9	46.6	32.6	24.1	18.5	12.0
				3.5	RHS	9.07	423	410	365	287	197	135	96.0	71.6	55.3	35.9	25.1	18.6	14.3	9.23
125	x	75	x	6.0	RHS	16.7	864	850	797	709	579	438	326	247	193	126	88.3	65.4	50.4	32.6
				5.0	RHS	14.2	735	723	680	608	501	382	285	217	169	110	77.5	57.5	44.3	28.6
				4.0	RHS	11.6	600	591	556	500	415	319	239	182	142	92.8	65.3	48.4	37.3	24.1
				3.0	RHS	8.96	390	386	367	337	293	237	184	142	112	73.4	51.7	38.3	29.6	19.1
				2.5	RHS	7.53	296	294	281	261	231	192	152	119	94.2	62.2	43.9	32.6	25.1	16.3
102	x	76	x	6.0	RHS	14.7	757	744	697	617	500	375	278	211	164	107	75.2	55.7	42.9	27.7
				5.0	RHS	12.5	646	635	596	531	434	329	245	186	145	94.4	66.4	49.2	37.9	24.5
				3.5	RHS	9.07	468	461	434	389	322	247	185	141	110	71.7	50.4	37.4	28.8	18.6

- 1 RHS
- 2 C450PLUS®
- 3 Finish



### Notes:

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- $\phi N_s = \phi N_c$  for  $L_e = 0.0$ .

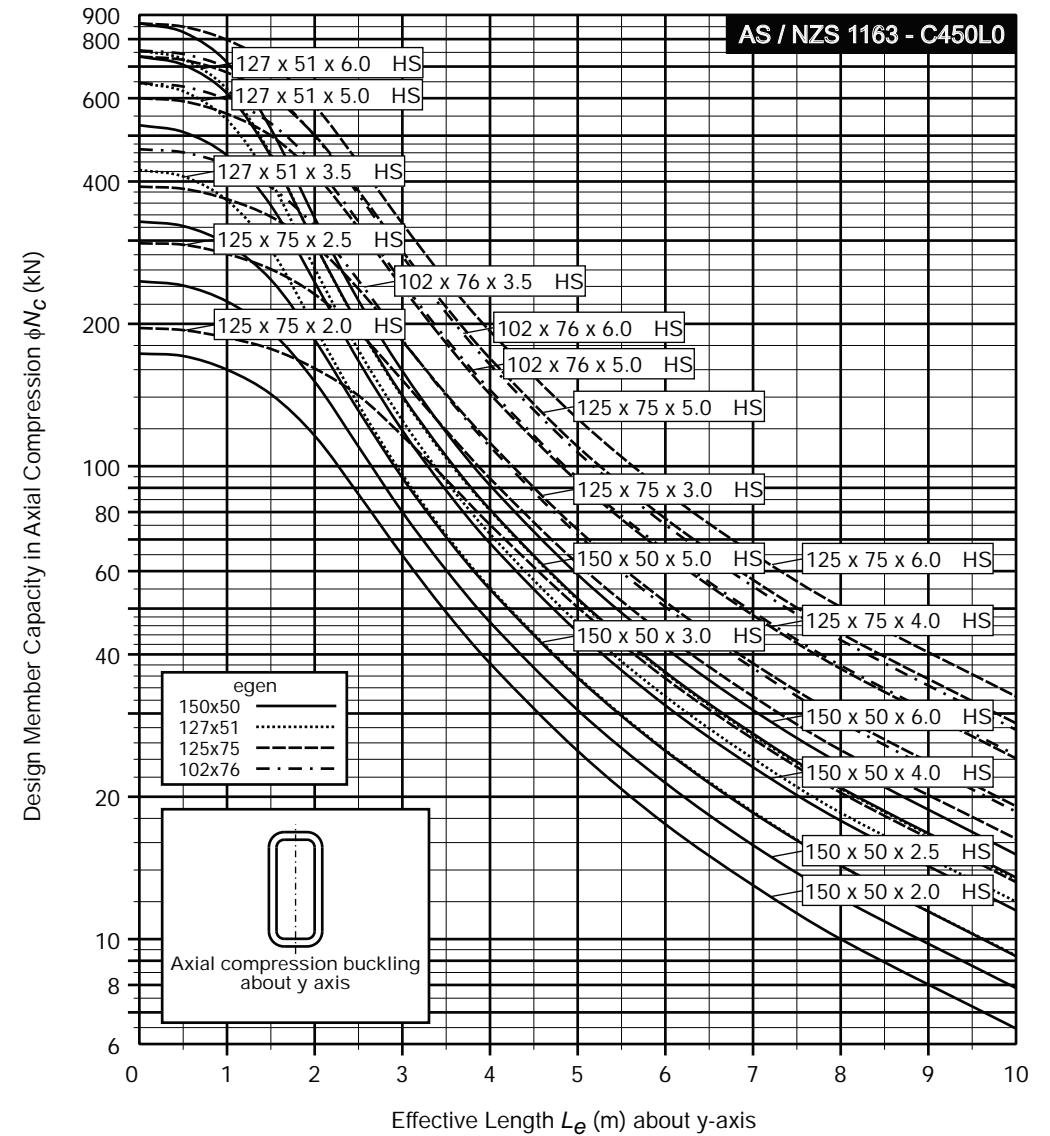
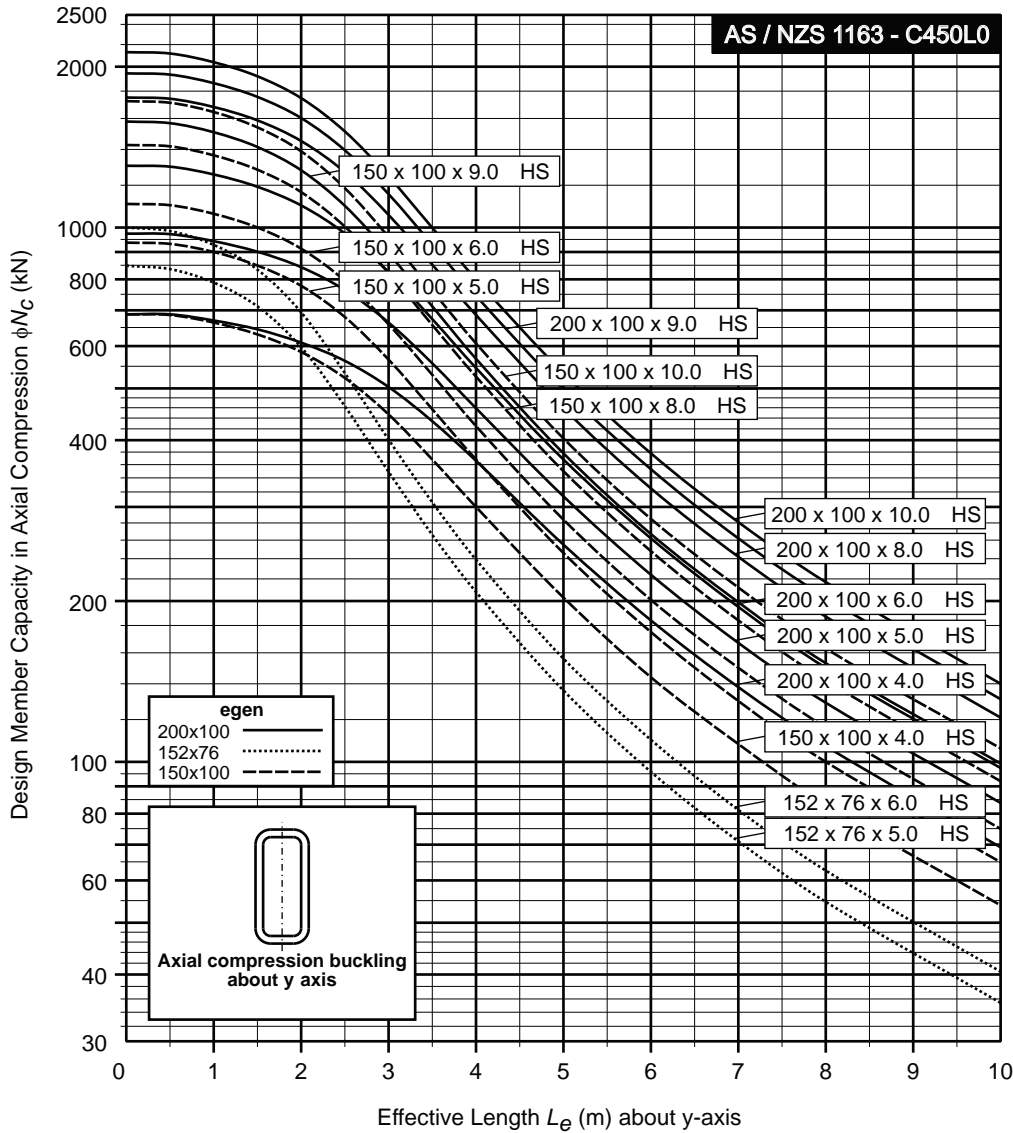


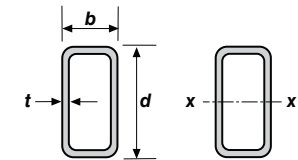
TABLE 6-4(3)(A)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

### buckling about x-axis

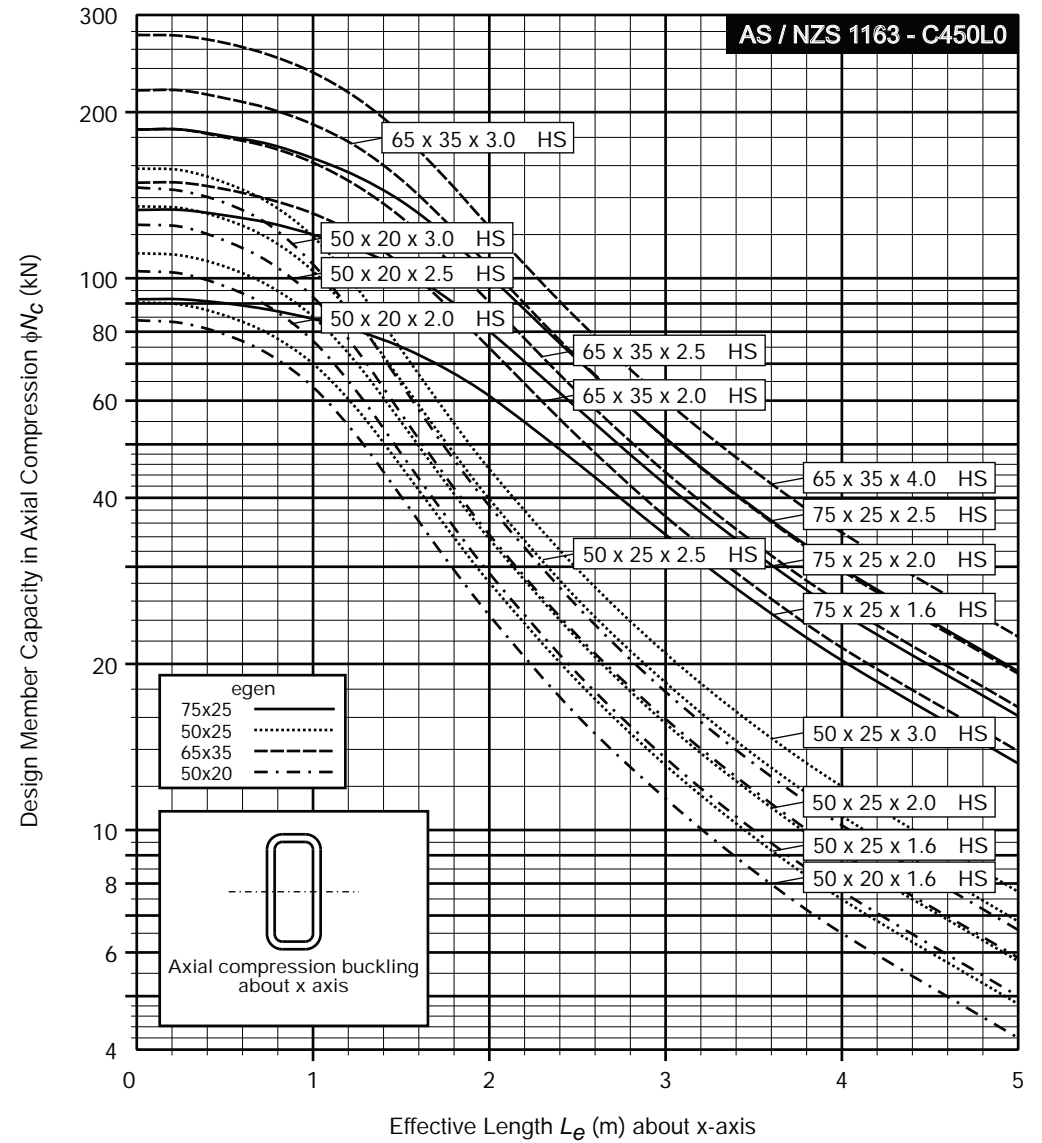
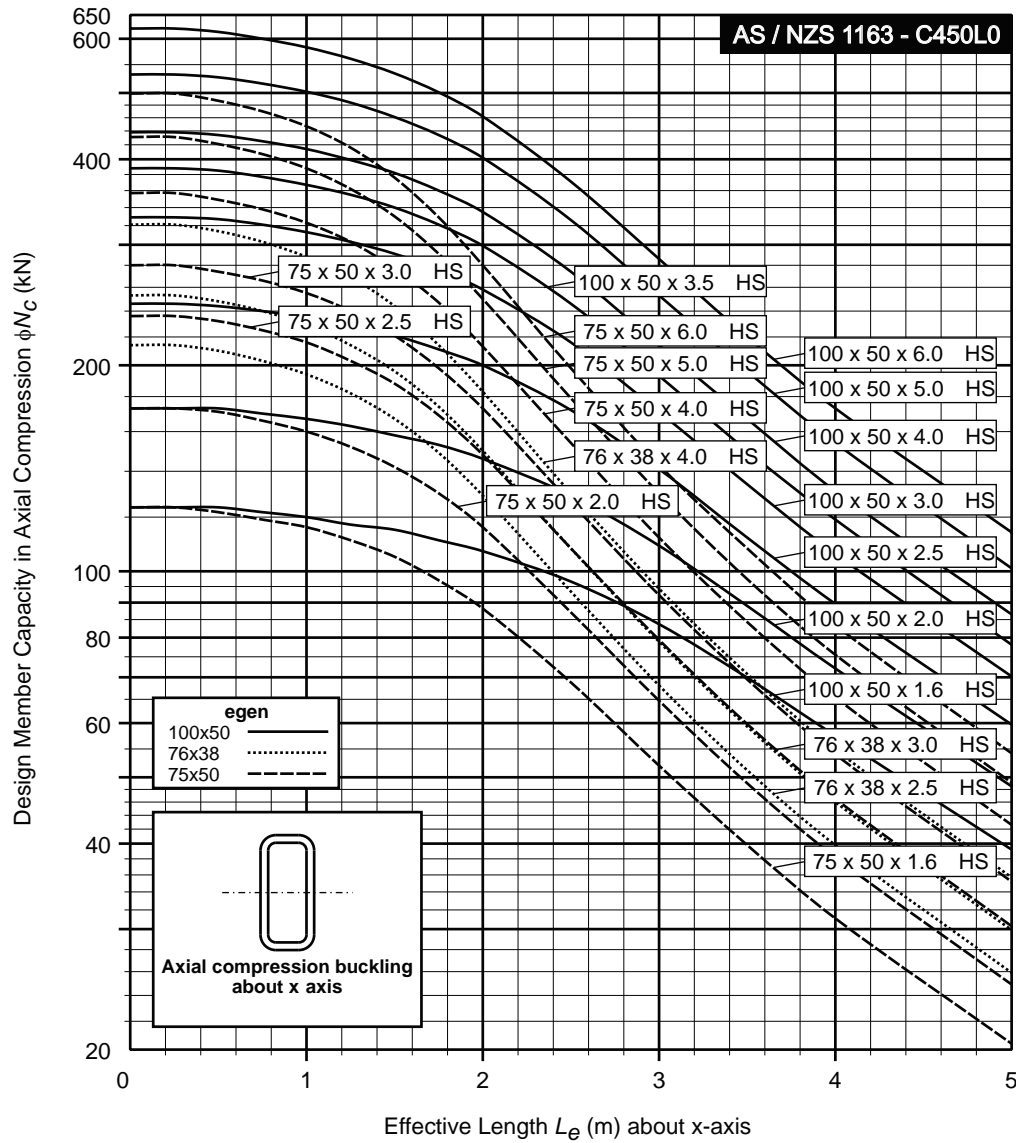
- 1 RHS
- 2 C450PLUS®
- 3 Finish



d	Designation			Mass per m	$\phi N_s$ (kN)	Design Member Capacities in Axial Compression, $\phi N_c$ (kN)														
	b	t				Effective Length ( $L_e$ ) in metres														
mm	mm	mm		kg/m	$L_e = 0.00$	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	5.00		
100	x	50	x	6.0	RHS	12.0	621	621	614	600	583	561	534	501	462	371	286	220	173	114
				5.0	RHS	10.3	532	532	527	516	502	484	461	434	402	326	253	196	154	101
				4.0	RHS	8.49	438	438	434	425	414	399	382	360	335	274	214	167	131	86.5
				3.5	RHS	7.53	388	388	385	377	367	355	340	321	299	246	193	150	119	78.1
				3.0	RHS	6.60	329	329	327	321	313	303	291	276	258	216	171	134	106	70.2
				2.5	RHS	5.56	246	246	244	240	235	228	221	211	200	172	141	112	89.6	59.7
				2.0	RHS	4.50	173	173	173	170	167	163	158	153	146	129	109	89.0	72.1	48.5
1.6	RHS	3.64	124	124	124	122	120	117	115	111	107	96.6	83.7	69.9	57.5	39.2				
76	x	38	x	4.0	RHS	6.23	321	321	314	303	288	269	244	214	183	130	94.3	70.8	54.9	35.7
				3.0	RHS	4.90	253	253	248	240	229	214	196	174	150	108	78.9	59.3	46.0	29.9
				2.5	RHS	4.15	214	214	210	203	194	182	167	149	129	93.4	68.1	51.2	39.8	25.9
75	x	50	x	6.0	RHS	9.67	499	499	487	470	447	416	376	329	280	198	143	108	83.4	54.2
				5.0	RHS	8.35	431	431	421	407	388	362	330	291	250	179	130	97.4	75.5	49.1
				4.0	RHS	6.92	357	357	349	338	323	303	277	247	213	154	112	84.3	65.4	42.6
				3.0	RHS	5.42	280	280	274	266	255	240	221	198	173	126	92.3	69.5	54.0	35.2
				2.5	RHS	4.58	236	236	232	225	216	203	188	169	148	108	79.4	59.8	46.5	30.3
				2.0	RHS	3.72	173	173	171	166	160	152	142	130	116	87.1	64.7	49.0	38.2	24.9
				1.6	RHS	3.01	124	124	122	119	116	111	105	97.0	88.2	68.8	52.0	39.8	31.1	20.4
75	x	25	x	2.5	RHS	3.60	186	186	181	175	165	153	138	120	101	71.2	51.3	38.4	29.8	19.4
				2.0	RHS	2.93	133	133	130	126	120	113	104	92.5	80.2	58.1	42.8	31.9	24.7	16.1
				1.6	RHS	2.38	91.6	91.6	90.1	87.7	84.4	80.3	75.1	68.6	61.2	46.2	34.3	26.0	20.3	13.2
65	x	35	x	4.0	RHS	5.35	276	276	267	254	236	212	183	152	124	84.3	60.0	44.8	34.6	22.4
				3.0	RHS	4.25	219	219	212	203	190	173	151	127	105	71.7	51.2	38.2	29.5	19.2
				2.5	RHS	3.60	186	186	180	173	162	147	129	109	90.3	62.2	44.5	33.2	25.7	16.7
				2.0	RHS	2.93	149	149	145	139	131	120	106	89.8	74.8	51.7	37.0	27.7	21.4	13.9
50	x	25	x	3.0	RHS	3.07	158	157	149	137	119	96.0	74.3	57.4	45.1	29.7	20.9	15.5	12.0	7.73
				2.5	RHS	2.62	135	134	128	118	103	83.7	65.2	50.6	39.8	26.2	18.5	13.7	10.6	6.83
				2.0	RHS	2.15	111	110	105	96.9	85.2	70.0	54.9	42.7	33.7	22.2	15.6	11.6	8.95	5.79
				1.6	RHS	1.75	90.4	89.6	85.6	79.3	70.0	57.9	45.6	35.6	28.1	18.6	13.1	9.71	7.49	4.84
50	x	20	x	3.0	RHS	2.83	146	144	137	125	106	84.2	64.3	49.3	38.7	25.4	17.8	13.2	10.2	6.59
				2.5	RHS	2.42	125	124	117	107	92.5	74.0	56.8	43.8	34.3	22.5	15.9	11.8	9.08	5.87
				2.0	RHS	1.99	103	102	96.7	88.8	77.0	62.2	48.1	37.2	29.2	19.2	13.5	10.0	7.74	5.00
				1.6	RHS	1.63	83.9	83.0	79.1	72.8	63.5	51.7	40.2	31.1	24.5	16.1	11.4	8.43	6.50	4.20

### Notes:

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- $\phi N_s = \phi N_c$  for  $L_e = 0.0$ .
- NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**



Refer previous table for notes on steel grade.



TABLE 6-4(3)(B)

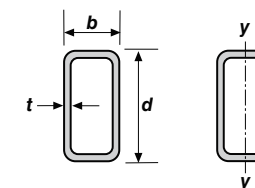
# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

### buckling about y-axis

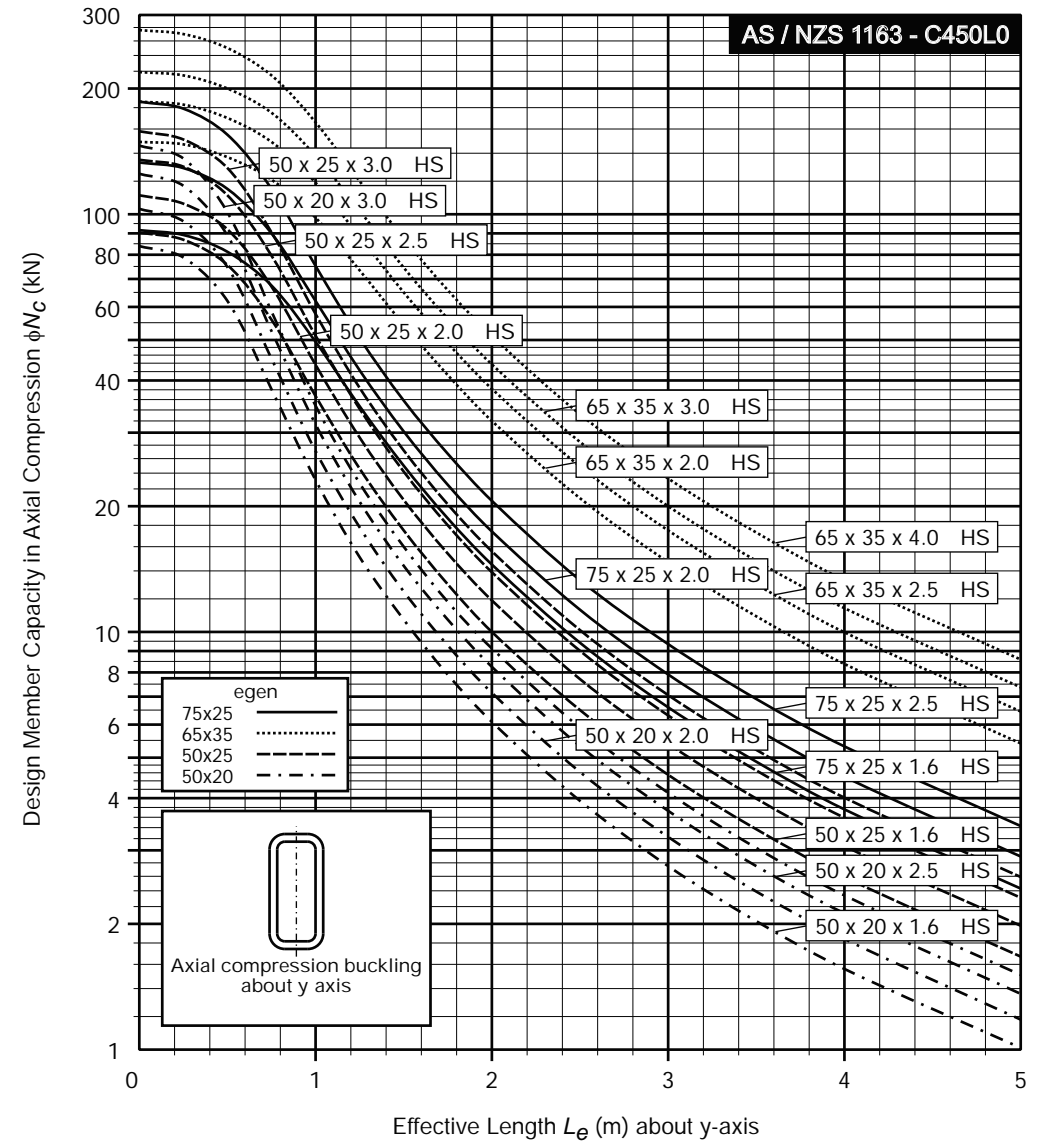
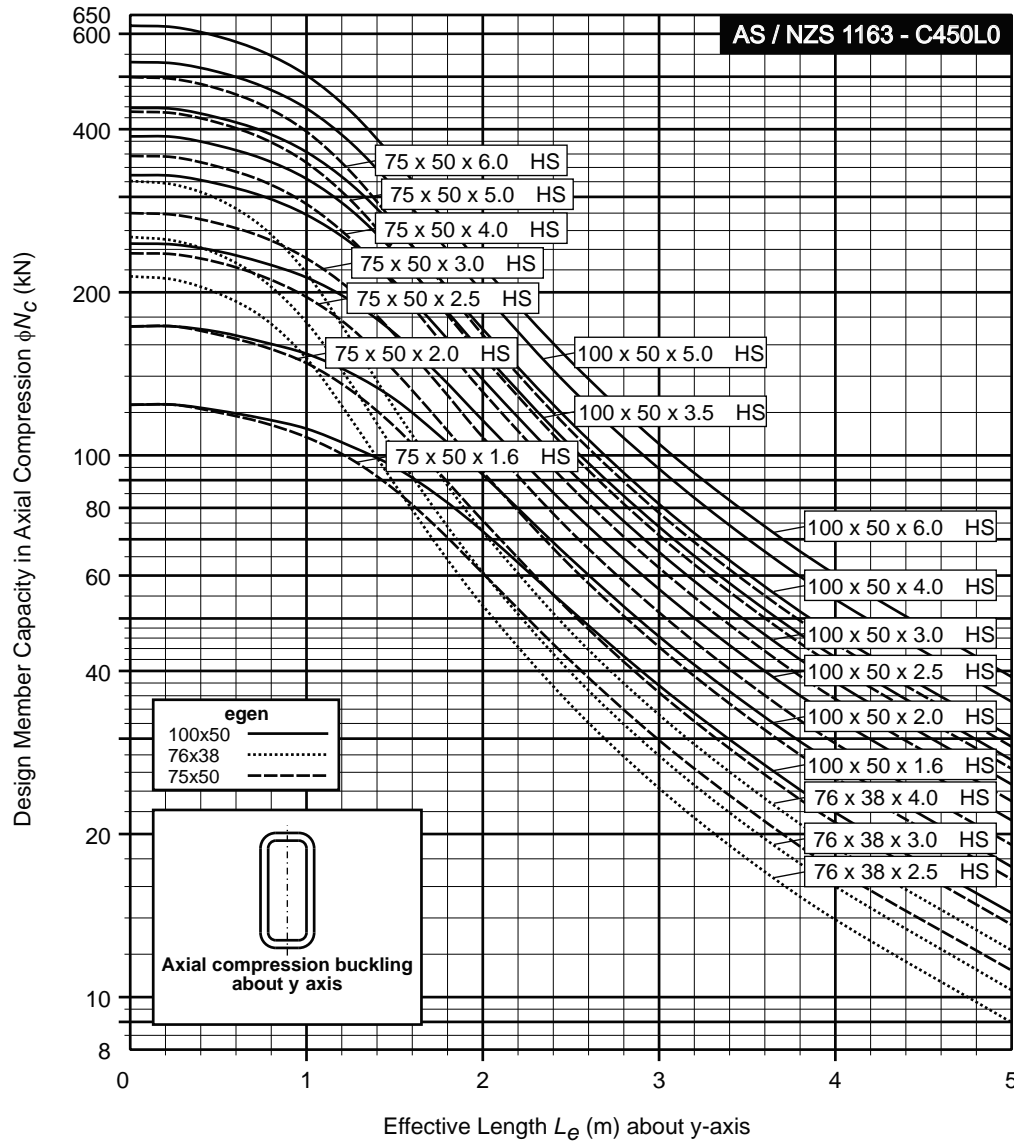
Designation			Mass per m	$\phi N_s$ (kN)	Design Member Capacities in Axial Compression, $\phi N_c$ (kN)															
d	b	t			Effective Length ( $L_e$ ) in metres															
mm	mm	mm	kg/m	$L_e = 0.00$	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	5.00			
100	x	50	x	6.0	RHS	12.0	621	617	593	556	503	432	352	280	223	149	105	78.1	60.3	39.0
				5.0	RHS	10.3	532	529	510	480	437	378	311	250	200	133	94.5	70.2	54.2	35.1
				4.0	RHS	8.49	438	436	420	397	363	317	264	213	171	115	81.3	60.5	46.7	30.2
				3.5	RHS	7.53	388	387	373	353	324	284	237	192	155	104	73.8	54.9	42.4	27.4
				3.0	RHS	6.60	329	328	317	301	278	247	209	171	138	93.3	66.3	49.3	38.1	24.7
				2.5	RHS	5.56	246	245	238	227	213	193	168	141	116	79.3	56.6	42.2	32.7	21.2
				2.0	RHS	4.50	173	173	169	162	154	142	127	109	92.1	64.4	46.3	34.7	26.9	17.4
				1.6	RHS	3.64	124	124	121	117	112	104	95.2	84.1	72.4	51.8	37.6	28.3	21.9	14.3
76	x	38	x	4.0	RHS	6.23	321	316	297	264	217	164	122	92.7	72.3	47.2	33.2	24.6	18.9	12.2
				3.0	RHS	4.90	253	249	235	211	176	136	102	77.8	60.8	39.7	27.9	20.7	16.0	10.3
				2.5	RHS	4.15	214	211	199	180	151	117	88.5	67.6	52.8	34.6	24.3	18.0	13.9	8.98
75	x	50	x	6.0	RHS	9.67	499	495	475	443	396	334	268	211	167	111	78.3	58.2	44.9	29.0
				5.0	RHS	8.35	431	428	411	385	347	296	240	190	152	101	71.2	52.9	40.8	26.4
				4.0	RHS	6.92	357	355	341	321	291	251	206	164	131	87.5	62.0	46.0	35.5	23.0
				3.0	RHS	5.42	280	278	268	253	231	202	167	135	108	72.3	51.3	38.1	29.4	19.1
				2.5	RHS	4.58	236	235	227	214	196	172	143	116	93.2	62.4	44.3	32.9	25.4	16.5
				2.0	RHS	3.72	173	173	167	159	148	132	113	93.0	75.8	51.3	36.5	27.2	21.0	13.6
				1.6	RHS	3.01	124	124	120	115	108	98.5	86.4	73.1	60.6	41.7	29.8	22.3	17.2	11.2
75	x	25	x	2.5	RHS	3.60	186	179	155	115	75.2	50.5	35.8	26.7	20.6	13.3	9.35	6.91	5.32	3.43
				2.0	RHS	2.93	133	129	115	90.0	62.0	42.3	30.2	22.5	17.4	11.3	7.91	5.85	4.50	2.90
				1.6	RHS	2.38	91.6	89.2	81.3	67.5	49.5	34.7	25.0	18.7	14.5	9.42	6.60	4.89	3.76	2.43
65	x	35	x	4.0	RHS	5.35	276	270	250	215	166	120	87.5	65.8	51.1	33.2	23.3	17.3	13.3	8.59
				3.0	RHS	4.25	219	215	200	175	138	102	74.5	56.2	43.7	28.5	20.0	14.8	11.4	7.37
				2.5	RHS	3.60	186	183	170	149	119	88.3	65.0	49.1	38.2	24.9	17.5	13.0	9.98	6.45
				2.0	RHS	2.93	149	147	137	121	98.1	73.4	54.4	41.2	32.0	20.9	14.7	10.9	8.38	5.41
50	x	25	x	3.0	RHS	3.07	158	151	129	90.5	57.7	38.4	27.2	20.2	15.6	10.1	7.06	5.22	4.01	2.59
				2.5	RHS	2.62	135	130	111	79.6	51.2	34.2	24.2	18.0	13.9	9.01	6.31	4.66	3.59	2.31
				2.0	RHS	2.15	111	106	92.0	67.1	43.6	29.2	20.7	15.4	11.9	7.71	5.40	3.99	3.07	1.98
				1.6	RHS	1.75	90.4	86.9	75.6	55.9	36.7	24.6	17.5	13.0	10.0	6.50	4.55	3.37	2.59	1.67
50	x	20	x	3.0	RHS	2.83	146	136	101	58.5	34.8	22.7	16.0	11.8	9.13	5.90	4.12	3.04	2.34	1.51
				2.5	RHS	2.42	125	117	88.9	52.5	31.4	20.5	14.4	10.7	8.25	5.33	3.73	2.75	2.12	1.36
				2.0	RHS	1.99	103	96.2	74.7	45.1	27.1	17.8	12.5	9.28	7.15	4.62	3.23	2.39	1.84	1.18
				1.6	RHS	1.63	83.9	78.8	62.0	38.1	23.1	15.1	10.7	7.90	6.09	3.94	2.75	2.03	1.56	1.01

- 1 RHS
- 2 C450PLUS®
- 3 Finish



### Notes:

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- $\phi N_s = \phi N_c$  for  $L_e = 0.0$ .
- NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**



Refer previous table for notes on steel grade.

TABLE 6-5

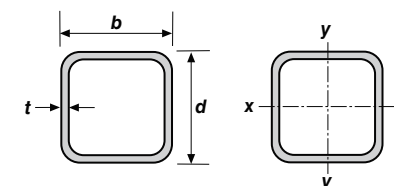
# Square Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

### buckling about x- and y-axis

d	Designation			Mass per m	$\phi N_s$ (kN)	Design Member Capacities in Axial Compression, $\phi N_c$ (kN)														
	b	t				Effective Length ( $L_e$ ) in metres														
mm	mm	mm	mm	kg/m	$L_e = 0.00$	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	5.00		
50	x	50	x	6.0	SHS	7.32	294	292	281	264	240	207	169	135	108	72.0	50.9	37.9	29.2	18.9
				5.0	SHS	6.39	256	255	246	232	212	186	154	124	100	66.9	47.4	35.3	27.2	17.6
				4.0	SHS	5.35	215	214	206	196	180	159	134	109	88.1	59.3	42.1	31.3	24.2	15.7
				3.0	SHS	4.25	170	170	164	156	145	129	110	91.0	74.1	50.2	35.7	26.6	20.5	13.3
				2.5	SHS	3.60	145	144	140	133	124	111	95.0	78.7	64.2	43.6	31.0	23.1	17.9	11.6
				2.0	SHS	2.93	118	117	114	108	101	90.9	78.4	65.2	53.4	36.3	25.9	19.3	14.9	9.66
40	x	40	x	4.0	SHS	4.09	164	162	153	140	119	93.6	71.3	54.7	42.8	28.1	19.7	14.6	11.3	7.29
				3.0	SHS	3.30	133	131	125	115	99.4	80.2	62.0	47.9	37.7	24.8	17.4	12.9	9.97	6.45
				2.5	SHS	2.82	113	112	107	98.2	85.7	69.8	54.3	42.1	33.1	21.8	15.4	11.4	8.78	5.68
				2.0	SHS	2.31	92.5	91.6	87.4	80.7	70.9	58.1	45.5	35.4	27.9	18.4	13.0	9.61	7.41	4.79
				1.6	SHS	1.88	75.3	74.6	71.3	66.0	58.2	48.0	37.8	29.4	23.2	15.3	10.8	8.02	6.19	4.00
35	x	35	x	3.0	SHS	2.83	114	112	105	92.5	74.9	56.1	41.5	31.5	24.5	16.0	11.2	8.32	6.41	4.14
				2.5	SHS	2.42	97.3	95.7	89.8	79.9	65.4	49.4	36.8	27.9	21.7	14.2	9.97	7.39	5.69	3.68
				2.0	SHS	1.99	79.9	78.7	74.0	66.2	54.7	41.7	31.2	23.7	18.5	12.1	8.49	6.29	4.85	3.13
				1.6	SHS	1.63	65.3	64.3	60.6	54.4	45.2	34.8	26.1	19.9	15.5	10.1	7.13	5.28	4.07	2.63
30	x	30	x	3.0	SHS	2.36	94.8	92.3	83.9	69.2	50.3	35.2	25.3	18.9	14.7	9.52	6.68	4.94	3.80	2.45
				2.5	SHS	2.03	81.6	79.5	72.7	60.6	44.7	31.5	22.7	17.0	13.2	8.56	6.01	4.44	3.42	2.21
				2.0	SHS	1.68	67.3	65.7	60.3	50.8	38.0	27.0	19.5	14.6	11.3	7.38	5.17	3.83	2.95	1.90
				1.6	SHS	1.38	55.2	53.9	49.6	42.2	31.9	22.8	16.5	12.4	9.61	6.25	4.38	3.25	2.50	1.61
25	x	25	x	3.0	SHS	1.89	75.9	72.7	62.4	44.7	28.8	19.2	13.6	10.1	7.81	5.06	3.54	2.62	2.01	1.30
				2.5	SHS	1.64	65.8	63.2	54.8	40.2	26.2	17.6	12.5	9.27	7.16	4.64	3.25	2.40	1.85	1.19
				2.0	SHS	1.36	54.7	52.7	46.1	34.5	22.8	15.4	10.9	8.12	6.27	4.06	2.85	2.10	1.62	1.04
				1.6	SHS	1.12	45.1	43.5	38.3	29.1	19.5	13.2	9.36	6.97	5.38	3.49	2.44	1.81	1.39	0.897
20	x	20	x	2.0	SHS	1.05	42.1	39.5	30.8	18.7	11.2	7.38	5.19	3.85	2.97	1.92	1.34	0.991	0.762	0.490
				1.6	SHS	0.873	35.0	32.9	26.1	16.2	9.83	6.46	4.55	3.37	2.60	1.68	1.18	0.869	0.668	0.430

- 1 SHS
- 2 C350L0
- 3 Finish



**Notes:**

1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
2.  $\phi N_s = \phi N_c$  for  $L_e = 0.0$ .

**ADDITIONAL NOTES:**

- (A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.
- (B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.

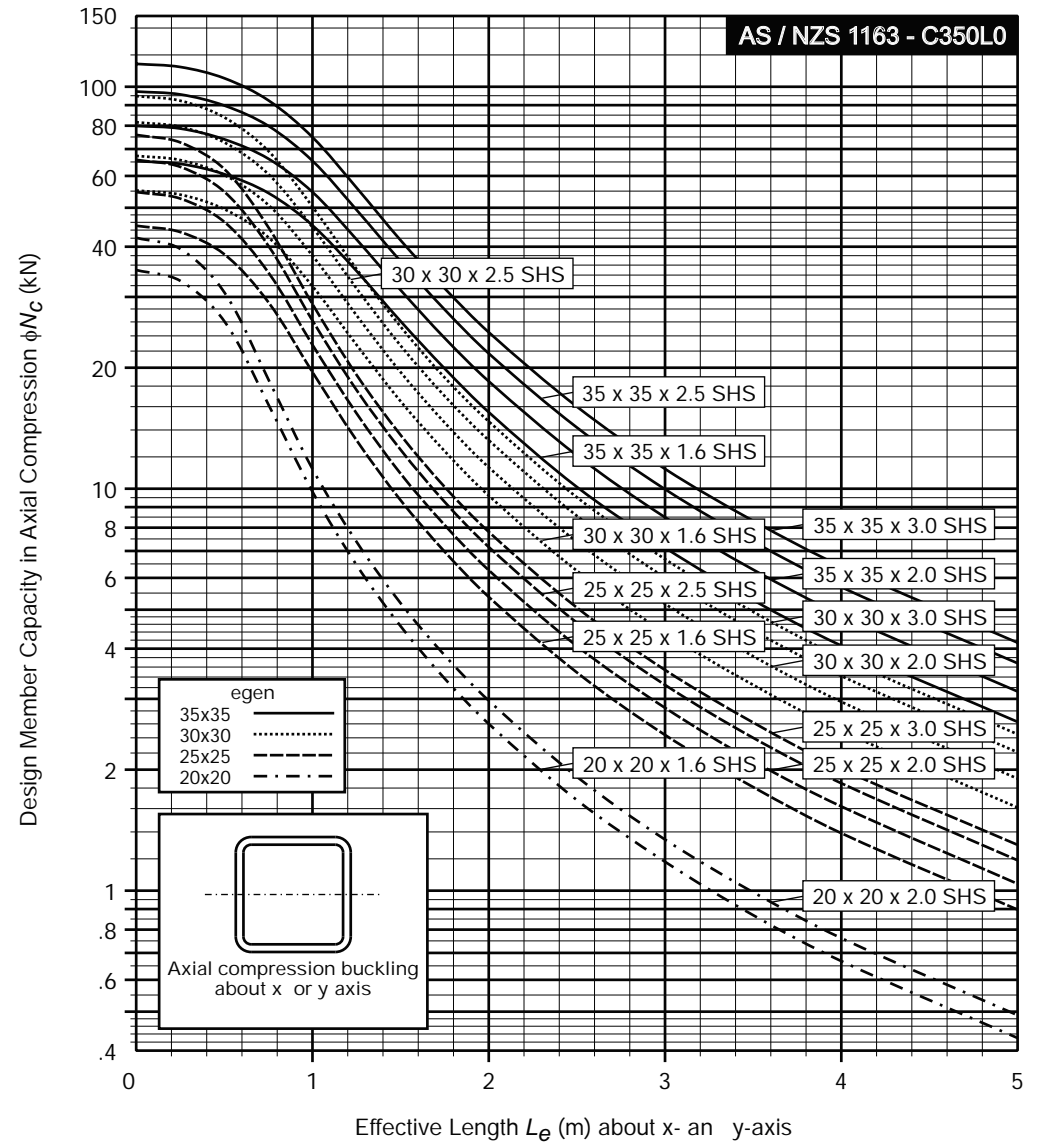
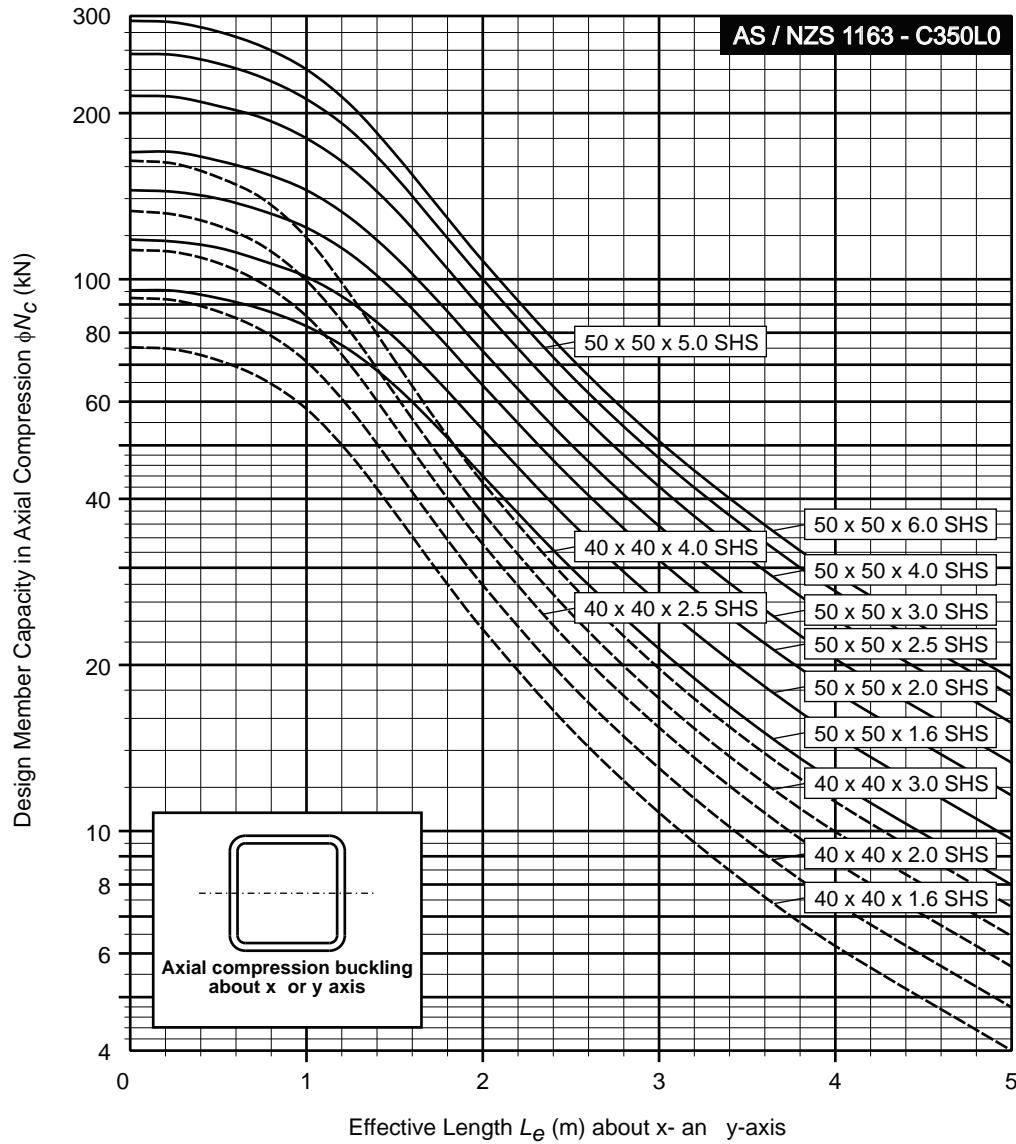


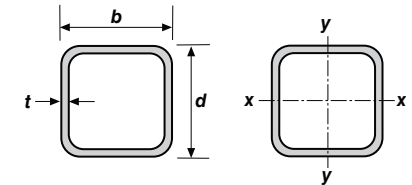
TABLE 6-6(1)

# Square Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

*buckling about x- and y-axis*

- 1 SHS
- 2 C450PLUS®
- 3 Finish



d mm	Designation			Mass per m kg/m	$\phi N_s$ (kN) $L_e = 0.0$	Design Member Capacities in Axial Compression, $\phi N_c$ (kN) Effective Length ( $L_e$ ) in metres														
	b mm	x	t mm			1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	10.0	12.0		
400	x	400	x	16.0	SHS	186	9600	9600	9600	9540	9460	9380	9280	9180	8920	8620	8250	7810	6720	5500
				12.5	SHS	148	7580	7580	7580	7540	7480	7420	7340	7260	7070	6830	6550	6220	5380	4430
				10.0	SHS	120	4850	4850	4850	4840	4810	4780	4740	4700	4600	4480	4340	4180	3780	3270
350	x	350	x	16.0	SHS	161	8300	8300	8280	8210	8130	8040	7930	7810	7520	7170	6730	6210	5010	3870
				12.5	SHS	128	6620	6620	6600	6550	6480	6410	6330	6240	6010	5740	5400	5000	4060	3150
				10.0	SHS	104	4850	4850	4850	4810	4770	4720	4670	4610	4460	4280	4070	3810	3180	2530
				8.0	SHS	84.2	3110	3110	3110	3090	3070	3040	3020	2990	2910	2820	2720	2590	2280	1910
300	x	300	x	16.0	SHS	136	7010	7010	6960	6880	6790	6690	6560	6420	6080	5650	5120	4520	3360	2480
				12.5	SHS	109	5600	5600	5570	5510	5440	5360	5260	5150	4890	4560	4150	3680	2750	2040
				10.0	SHS	88.4	4560	4560	4530	4480	4430	4360	4290	4200	3990	3730	3400	3030	2280	1690
				8.0	SHS	71.6	3110	3110	3100	3070	3030	3000	2950	2910	2790	2640	2460	2250	1780	1350
250	x	250	x	16.0	SHS	111	5710	5700	5630	5540	5440	5310	5170	5000	4570	4030	3420	2850	1970	1410
				12.5	SHS	89.0	4590	4590	4530	4470	4380	4290	4170	4040	3710	3290	2820	2360	1640	1170
				10.0	SHS	72.7	3750	3750	3700	3650	3580	3510	3420	3310	3050	2720	2340	1960	1370	984
				9.0	SHS	65.9	3400	3400	3360	3310	3250	3180	3100	3010	2780	2480	2130	1800	1250	901
				8.0	SHS	59.1	3050	3050	3010	2970	2920	2860	2780	2700	2490	2230	1920	1620	1130	815
				6.0	SHS	45.0	1750	1750	1740	1720	1690	1670	1640	1600	1520	1410	1280	1130	836	617
200	x	200	x	16.0	SHS	85.5	4410	4380	4300	4190	4070	3910	3720	3490	2930	2340	1840	1460	964	681
				12.5	SHS	69.4	3580	3550	3490	3410	3310	3190	3040	2870	2440	1970	1560	1240	821	580
				10.0	SHS	57.0	2940	2920	2870	2810	2730	2630	2510	2380	2030	1650	1310	1050	696	492
				9.0	SHS	51.8	2670	2650	2610	2550	2480	2400	2290	2170	1860	1520	1210	964	641	454
				8.0	SHS	46.5	2400	2380	2340	2290	2230	2150	2060	1950	1680	1370	1100	876	583	413
				6.0	SHS	35.6	1750	1740	1710	1680	1630	1580	1520	1450	1260	1050	847	681	456	323
				5.0	SHS	29.9	1210	1210	1190	1170	1150	1120	1090	1050	944	817	682	561	382	273
150	x	150	x	10.0	SHS	41.3	2130	2090	2030	1940	1840	1700	1530	1350	991	728	549	427	278	195
				9.0	SHS	37.7	1940	1910	1850	1780	1680	1560	1410	1240	918	676	510	397	259	182
				8.0	SHS	33.9	1750	1720	1670	1610	1520	1410	1280	1130	840	619	468	364	237	167
				6.0	SHS	26.2	1350	1330	1290	1240	1180	1100	1000	888	665	493	373	291	190	133
				5.0	SHS	22.1	1140	1120	1090	1050	998	932	850	757	570	423	320	249	163	114

**Notes:**

- REFER to the Australian Tube Mills PRODUCT AVAILABILITY GUIDE (PAG) for information on the availability of listed sections and associated finishes. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).**
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- $\phi N_s = \phi N_c$  for  $L_e = 0.0$ .

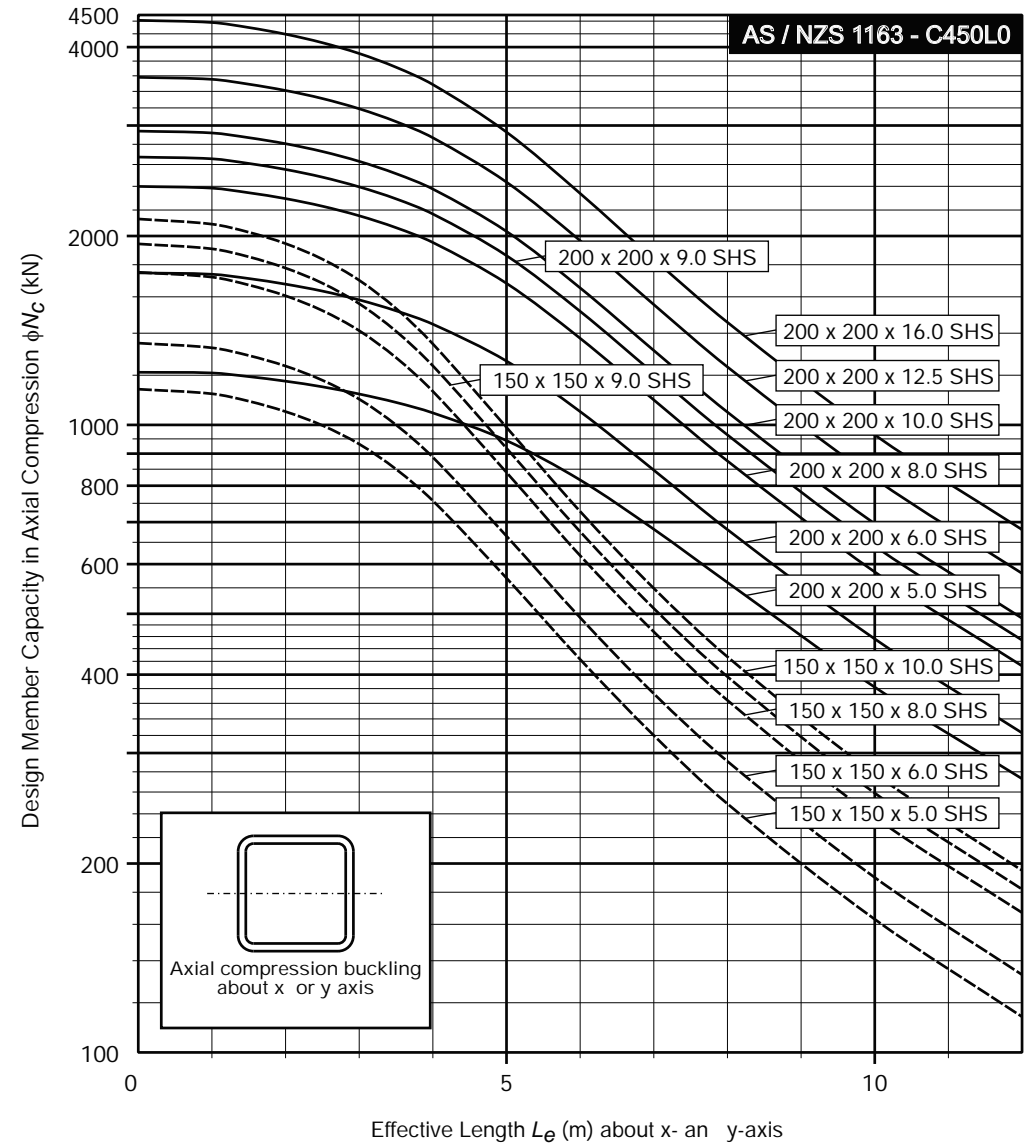
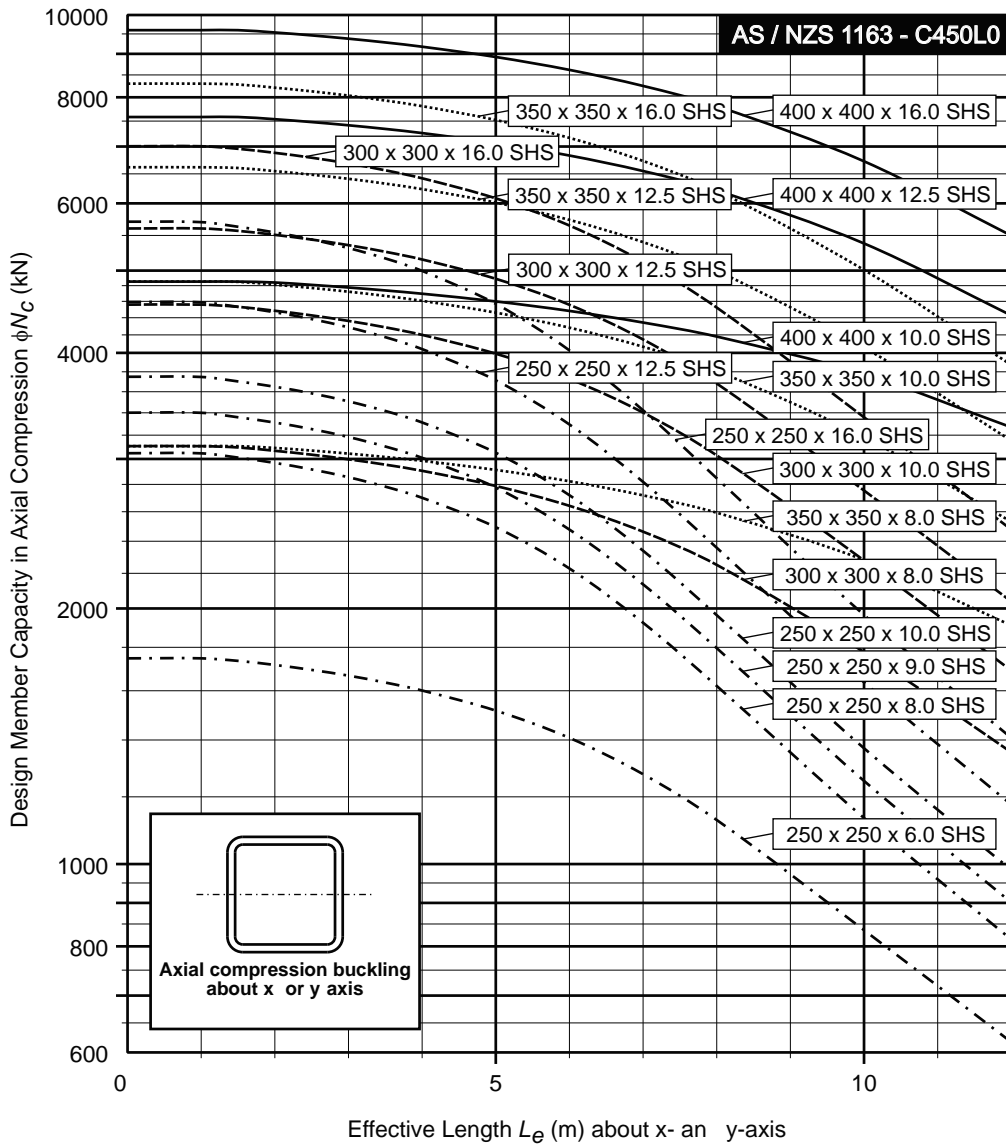


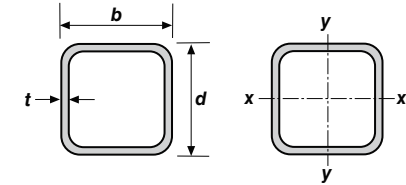
TABLE 6-6(2)

# Square Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

buckling about x- and y-axis

- 1 SHS
- 2 C450PLUS®
- 3 Finish



d	Designation			Mass per m	φN <sub>s</sub> (kN)	Design Member Capacities in Axial Compression, φN <sub>c</sub> (kN)															
	b	t				Effective Length (L <sub>e</sub> ) in metres															
mm	mm	mm		kg/m	L <sub>e</sub> = 0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0			
125	x	125	x	10.0	SHS	33.4	1720	1720	1670	1600	1500	1360	1190	1000	829	684	569	407	303	235	
				9.0	SHS	30.6	1580	1580	1530	1470	1380	1260	1100	933	774	640	532	381	284	220	
				8.0	SHS	27.7	1430	1430	1390	1330	1250	1140	1010	856	712	590	491	352	263	203	
				6.0	SHS	21.4	1110	1110	1080	1030	975	896	796	682	571	475	396	285	213	165	
				5.0	SHS	18.2	937	937	912	877	828	763	680	585	491	409	342	246	184	142	
				4.0	SHS	14.8	762	762	742	714	675	623	557	481	405	338	283	204	153	118	
100	x	100	x	10.0	SHS	25.6	1320	1310	1250	1160	1020	847	668	521	412	331	272	192	142	110	
				9.0	SHS	23.5	1210	1200	1150	1070	951	793	629	493	390	314	258	182	135	104	
				8.0	SHS	21.4	1100	1090	1050	977	872	732	584	459	364	294	241	170	126	97.5	
				6.0	SHS	16.7	864	857	823	770	693	590	477	377	300	243	199	141	105	80.7	
				5.0	SHS	14.2	735	730	701	658	594	508	413	328	262	212	174	123	91.5	70.6	
				4.0	SHS	11.6	600	596	573	539	488	420	344	274	219	177	146	103	76.7	59.2	
				3.0	SHS	8.96	440	438	422	399	365	319	265	214	172	140	115	81.7	60.7	46.9	
				2.5	SHS	7.53	305	305	296	282	263	238	206	172	141	116	96.4	68.8	51.3	39.6	
90	x	90	x	2.5	SHS	6.74	305	303	291	273	246	210	170	135	107	86.7	71.2	50.3	37.4	28.9	
				2.0	SHS	5.45	196	195	189	179	166	148	126	104	84.7	69.3	57.3	40.7	30.3	23.4	
89	x	89	x	6.0	SHS	14.7	757	748	711	650	561	449	345	266	209	168	137	96.6	71.6	55.2	
				5.0	SHS	12.5	646	639	608	558	484	391	302	234	184	147	121	85.0	63.1	48.6	
				3.5	SHS	9.07	468	463	441	407	356	291	227	176	139	112	91.4	64.4	47.8	36.8	
				2.0	SHS	5.38	196	195	188	179	165	146	124	102	82.3	67.2	55.5	39.4	29.4	22.7	
75	x	75	x	6.0	SHS	12.0	621	608	565	490	384	280	205	154	120	95.7	78.1	54.8	40.6	31.3	
				5.0	SHS	10.3	532	522	486	425	337	248	182	137	107	85.2	69.6	48.8	36.2	27.9	
				4.0	SHS	8.49	438	430	401	353	283	210	155	117	91.0	72.7	59.4	41.7	30.9	23.8	
				3.5	SHS	7.53	388	382	357	315	253	189	140	106	82.2	65.6	53.6	37.6	27.9	21.5	
				3.0	SHS	6.60	341	335	313	278	225	169	125	94.7	73.7	58.9	48.1	33.8	25.0	19.3	
				2.5	SHS	5.56	287	282	265	235	191	144	107	81.0	63.1	50.5	41.2	29.0	21.4	16.5	
				2.0	SHS	4.50	196	193	183	166	142	112	85.4	65.5	51.3	41.1	33.6	23.7	17.6	13.5	
65	x	65	x	6.0	SHS	10.1	523	508	458	368	260	179	128	95.8	74.1	59.0	48.1	33.7	24.9	19.2	
				5.0	SHS	8.75	451	439	397	324	232	161	116	86.4	66.9	53.3	43.4	30.4	22.5	17.3	
				4.0	SHS	7.23	373	363	330	273	198	138	99.6	74.5	57.7	46.0	37.5	26.3	19.4	15.0	
				3.0	SHS	5.66	292	285	260	217	161	113	81.7	61.2	47.4	37.8	30.8	21.6	16.0	12.3	
				2.5	SHS	4.78	247	241	220	185	137	97.2	70.2	52.6	40.8	32.5	26.5	18.6	13.8	10.6	
				2.0	SHS	3.88	196	191	176	149	112	79.8	57.8	43.4	33.6	26.8	21.9	15.3	11.4	8.75	
				1.6	SHS	3.13	125	123	115	102	83.0	62.3	46.2	35.0	27.3	21.8	17.8	12.5	9.27	7.14	

**Notes:**

1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the availability of listed sections and associated finishes. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of f<sub>y</sub> = 450 MPa and f<sub>t</sub> = 500 MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. φN<sub>s</sub> = φN<sub>c</sub> for L<sub>e</sub> = 0.0.

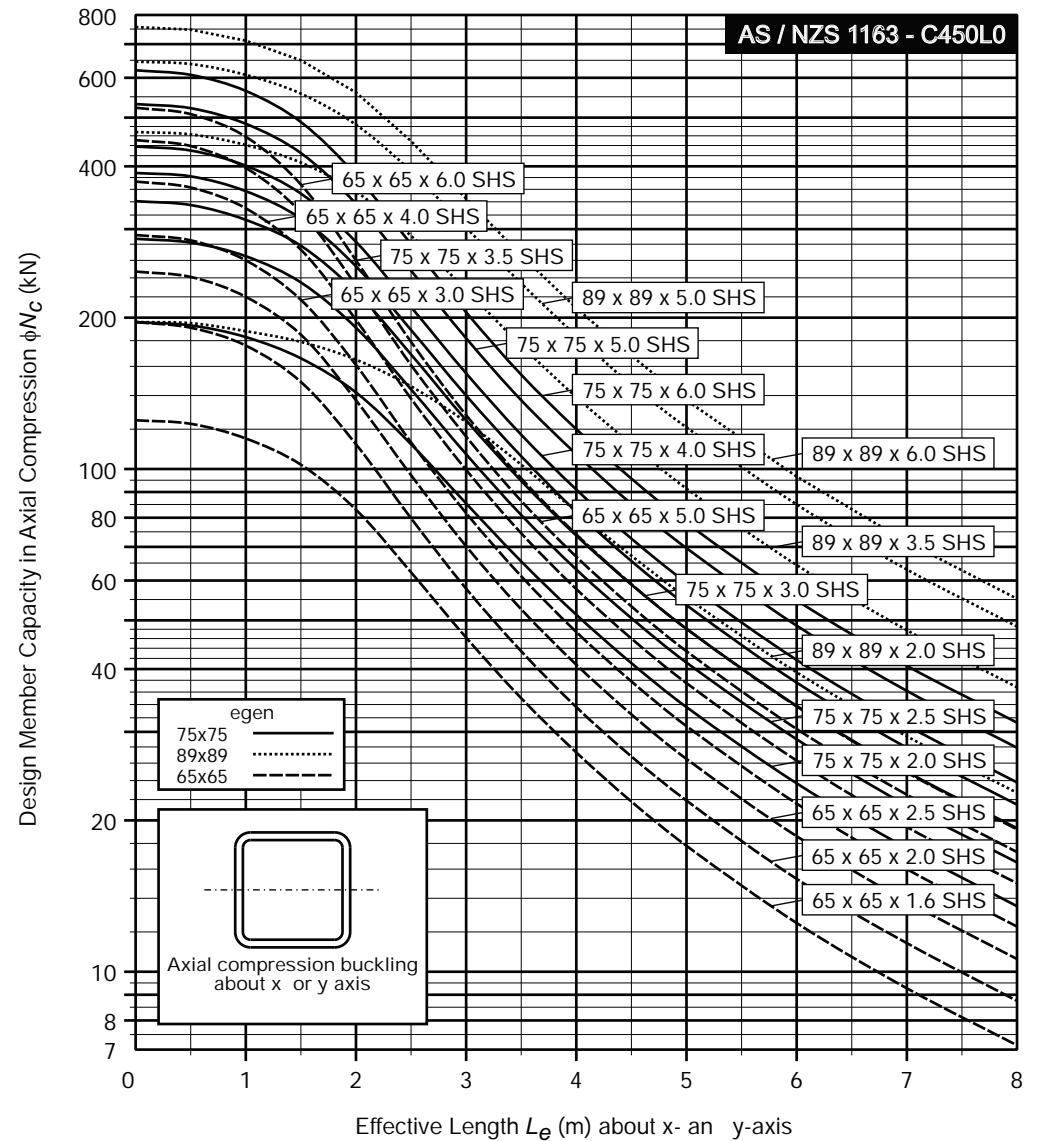
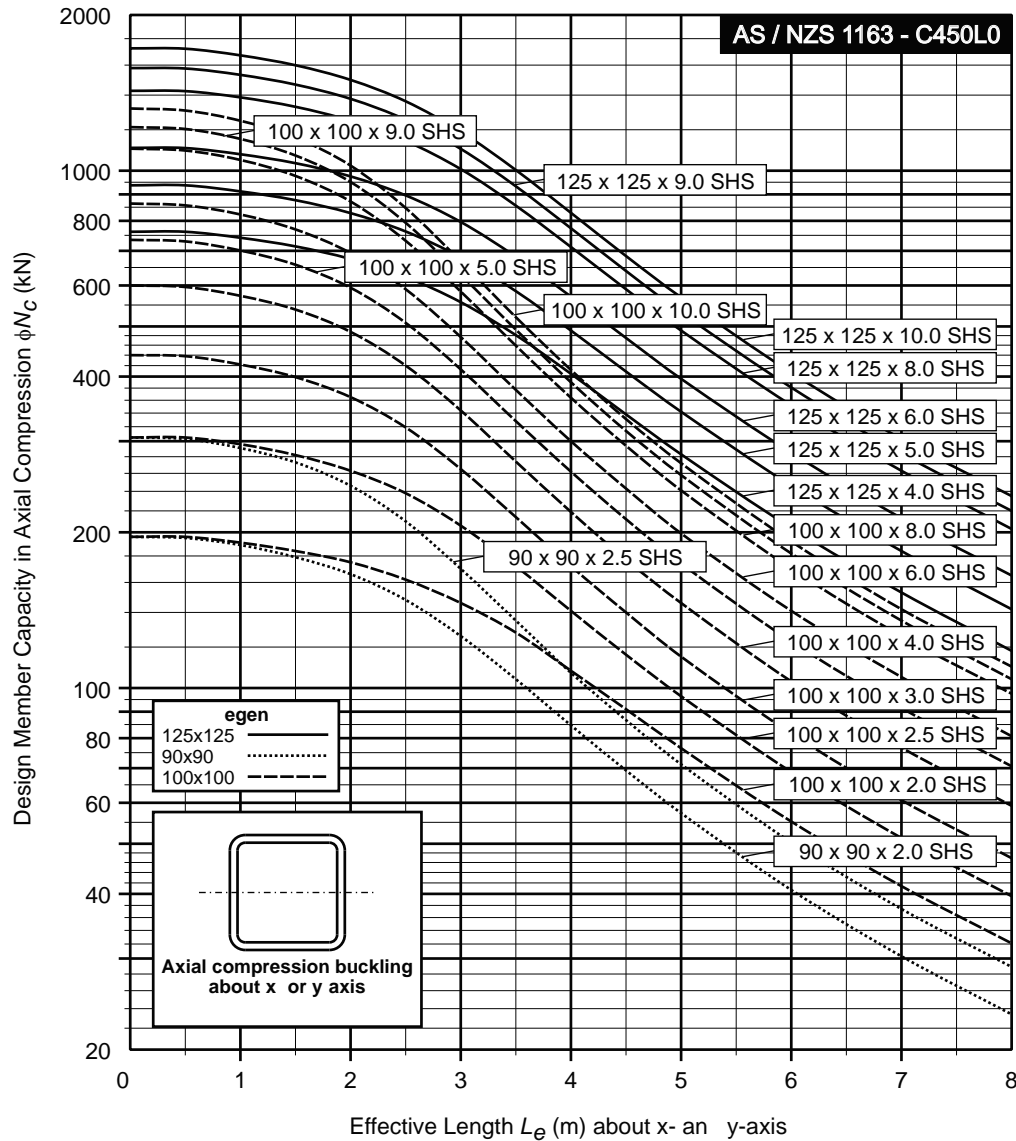




TABLE 6-6(3)

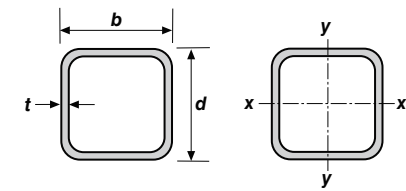
# Square Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN MEMBER CAPACITIES IN AXIAL COMPRESSION

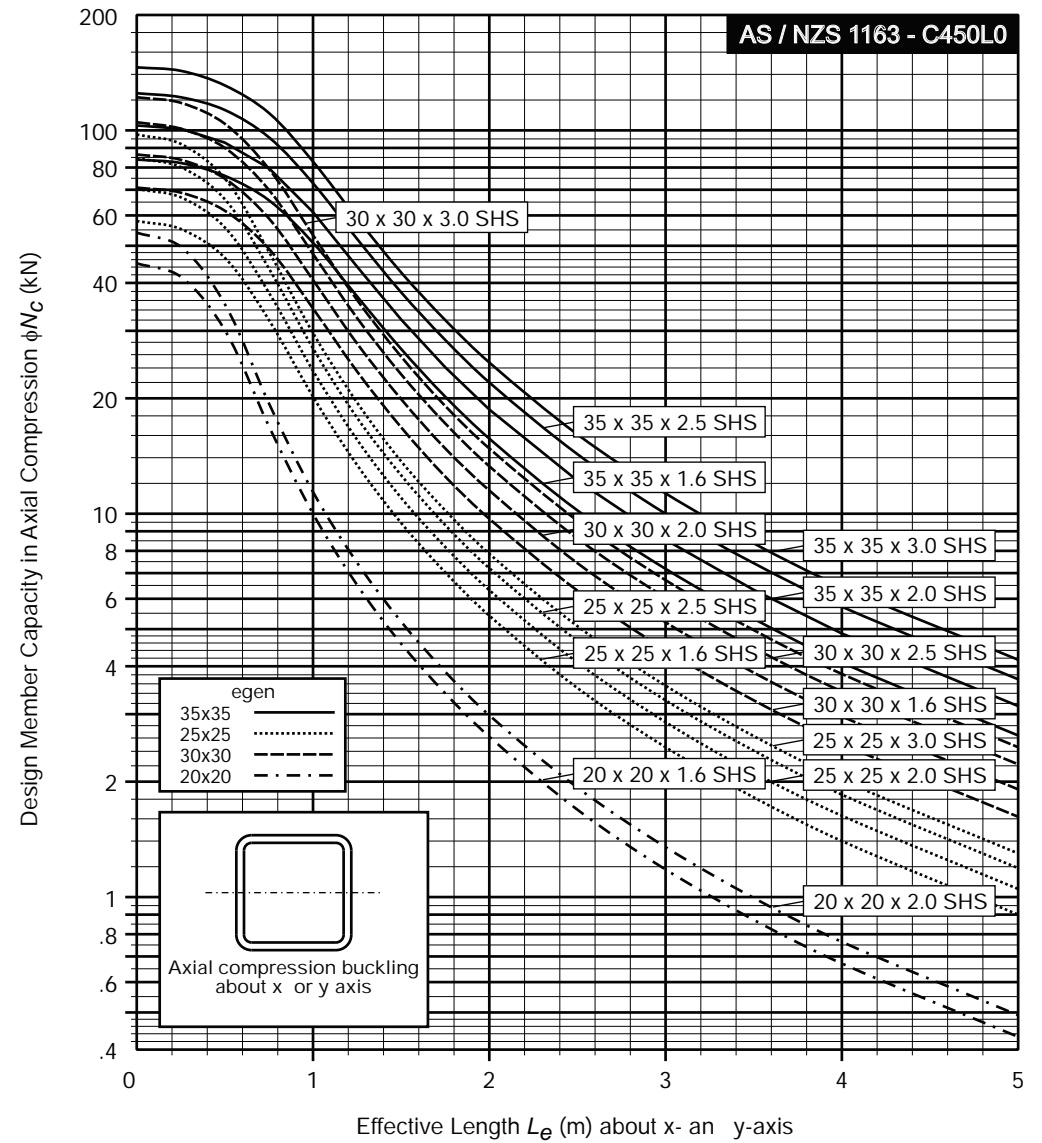
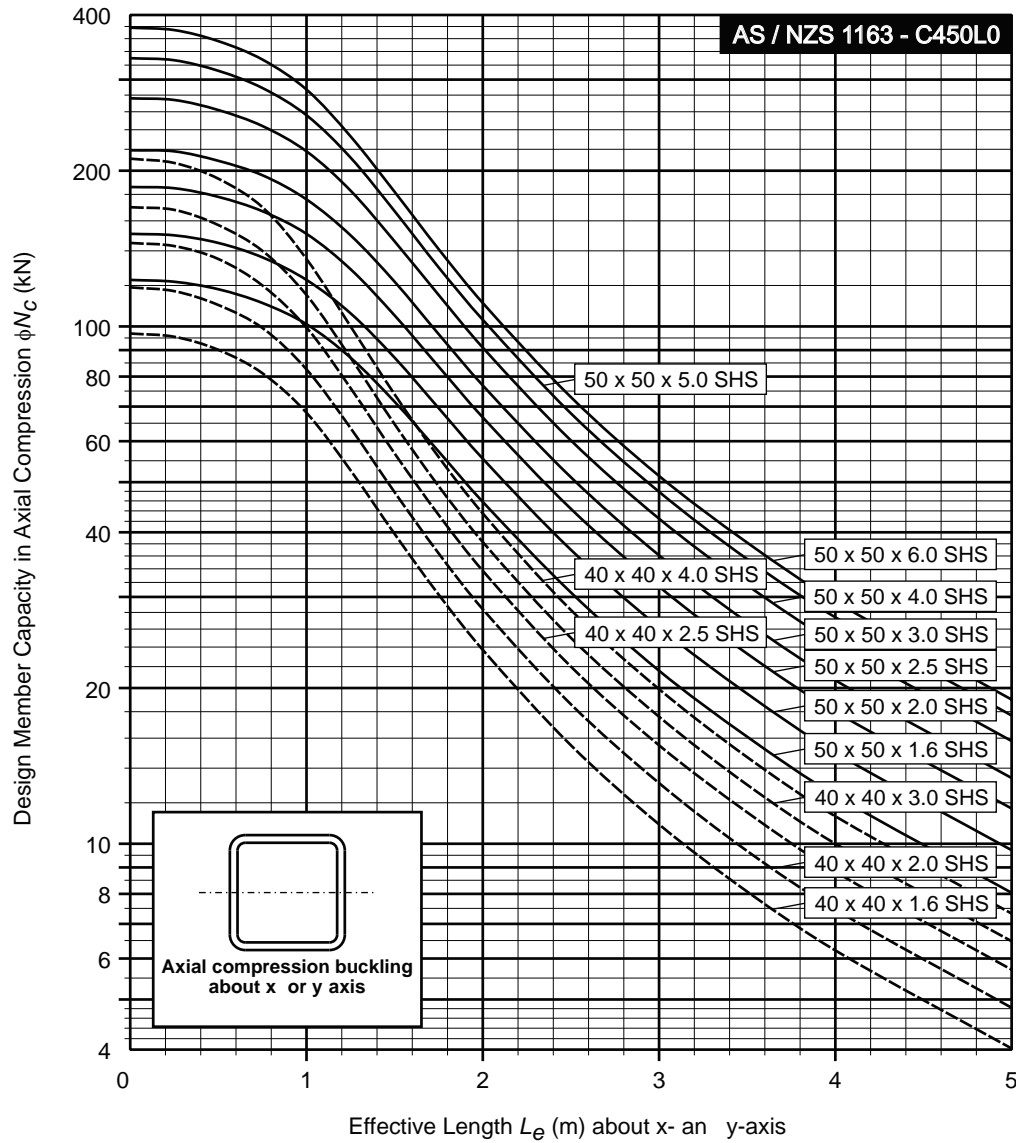
### buckling about x- and y-axis

d	Designation			Mass per m	$\phi N_s$ (kN)	Design Member Capacities in Axial Compression, $\phi N_c$ (kN)														
	b	t				Effective Length ( $L_e$ ) in metres														
mm	mm	mm	mm	kg/m	$L_e = 0.00$	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	5.00		
50	x	50	x	6.0	SHS	7.32	378	374	356	328	287	233	182	141	111	73.0	51.4	38.2	29.4	19.0
				5.0	SHS	6.39	330	327	312	289	256	212	167	130	103	67.9	47.9	35.5	27.4	17.7
				4.0	SHS	5.35	276	274	262	244	218	183	146	115	91.0	60.2	42.5	31.6	24.4	15.8
				3.0	SHS	4.25	219	218	209	196	176	150	122	96.6	76.9	51.1	36.1	26.8	20.7	13.4
				2.5	SHS	3.60	186	185	178	167	151	129	105	83.6	66.7	44.4	31.4	23.3	18.0	11.7
				2.0	SHS	2.93	151	150	145	136	123	106	87.0	69.5	55.5	37.0	26.2	19.5	15.0	9.72
40	x	40	x	4.0	SHS	2.38	123	122	118	111	101	87.0	71.5	57.3	45.8	30.6	21.6	16.1	12.4	8.04
				3.0	SHS	4.09	211	207	193	170	135	100	73.9	55.9	43.5	28.3	19.9	14.7	11.3	7.33
				2.5	SHS	3.30	170	168	157	140	115	87.0	64.7	49.1	38.3	25.0	17.6	13.0	10.0	6.48
				2.0	SHS	2.82	145	143	135	120	99.5	76.0	56.8	43.2	33.7	22.0	15.5	11.5	8.83	5.71
				1.6	SHS	2.31	119	117	110	99.3	82.6	63.6	47.8	36.4	28.4	18.6	13.1	9.68	7.46	4.82
35	x	35	x	3.0	SHS	1.88	96.9	95.5	90.1	81.2	68.1	52.7	39.7	30.3	23.7	15.5	10.9	8.08	6.22	4.02
				2.5	SHS	2.83	146	143	131	111	82.9	58.9	42.6	32.0	24.8	16.1	11.3	8.37	6.44	4.16
				2.0	SHS	2.42	125	122	113	95.9	72.8	52.1	37.8	28.4	22.0	14.3	10.0	7.43	5.72	3.70
				1.6	SHS	1.99	103	101	92.9	79.7	61.2	44.1	32.1	24.1	18.7	12.2	8.55	6.33	4.87	3.15
30	x	30	x	3.0	SHS	1.63	83.9	82.2	76.1	65.7	50.9	36.9	26.9	20.2	15.7	10.2	7.18	5.32	4.09	2.64
				2.5	SHS	2.36	122	118	104	79.3	53.3	36.1	25.7	19.1	14.8	9.59	6.71	4.97	3.82	2.46
				2.0	SHS	2.03	105	101	90.0	69.9	47.6	32.4	23.1	17.2	13.3	8.62	6.04	4.47	3.44	2.22
				1.6	SHS	1.68	86.5	83.8	74.8	58.9	40.7	27.8	19.9	14.8	11.5	7.43	5.21	3.85	2.96	1.91
25	x	25	x	3.0	SHS	1.38	70.9	68.8	61.7	49.1	34.3	23.5	16.8	12.5	9.70	6.30	4.41	3.26	2.51	1.62
				2.5	SHS	1.89	97.5	92.2	74.9	48.2	29.6	19.5	13.7	10.2	7.86	5.09	3.56	2.63	2.02	1.30
				2.0	SHS	1.64	84.6	80.2	66.1	43.6	27.0	17.8	12.6	9.34	7.21	4.66	3.26	2.41	1.85	1.19
				1.6	SHS	1.36	70.3	66.9	55.8	37.7	23.6	15.6	11.0	8.19	6.32	4.09	2.86	2.11	1.63	1.05
20	x	20	x	2.0	SHS	1.12	58.0	55.3	46.5	32.0	20.2	13.4	9.46	7.03	5.42	3.51	2.46	1.82	1.40	0.900
				1.6	SHS	1.05	54.1	49.7	35.2	19.4	11.4	7.45	5.23	3.87	2.98	1.93	1.35	0.995	0.764	0.492
						0.873	45.0	41.5	30.1	16.9	9.99	6.52	4.58	3.40	2.62	1.69	1.18	0.872	0.671	0.432

- 1 SHS
- 2 C450PLUS®
- 3 Finish



- Notes:**
- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
  - Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
  - $\phi N_s = \phi N_c$  for  $L_e = 0.0$ .
  - NOTE:** Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.



Refer previous table for notes on steel grade.

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# Part 7

## MEMBERS SUBJECT TO AXIAL TENSION

Section	Page
7.1 General	7-2
7.2 Design Section Capacity in Axial Tension	7-2
7.3 Example	7-2
7.4 References	7-2

Table	Page
Tables 7-1 to 7-6 Design Section Capacities in Axial Tension	7-3

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

# Part 7

## MEMBERS SUBJECT TO AXIAL TENSION

### 7.1 General

Tables 7-1 to 7-6 give values of design section capacity in axial tension. Section 7 of AS 4100 has been used to determine these values.

The Tables list the design section capacity in tension for Australian Tube Mills structural steel hollow sections. It further assumes that there are no eccentricity, shear lag or stress concentration effects such that there is a uniform stress distribution along the cross-section (e.g. as in full perimeter welded connections to uniformly stiff supports - see Clause C7.3.1 of Ref. [7.1]).

### 7.2 Design Section Capacity in Axial Tension

The design section capacity in axial tension ( $\phi N_t$ ) listed in the Tables has been determined from Clause 7.2 of AS 4100 and is taken as the *lesser* of:

$$\phi N_t = \phi A_g f_y \quad (\text{yielding of the gross section})$$

$$\phi N_t = \phi(0.85)k_t A_n f_u \quad (\text{fracture of the net section})$$

where  $\phi = 0.9$  (Table 3.4 of AS 4100)

$f_y =$  yield stress used in design

$f_u =$  ultimate tensile strength used in design

$A_g =$  gross area of the cross-section

$A_n =$  net area of the cross-section

$= A_g$  (e.g. for full perimeter welded connections to uniformly stiff supports)

$k_t = 1.0$  (Clause 7.3.1 of AS 4100)

The *lesser* value of  $\phi N_t(1) = \phi A_g f_y$  and  $\phi N_t(2) = \phi(0.85)A_g f_u$  is **highlighted in bold type** in the Tables.

Note: For AS/NZS 1163 Grade C250L0 and C350L0 CHS,  $\phi N_t = \phi A_g f_y$  is always less than  $\phi N_t = \phi(0.85)A_g f_u$  though for RHS/SHS to AS/NZS 1163 Grade C450L0  $\phi N_t = \phi(0.85)A_g f_u$  is the *lesser* value of  $\phi N_t$ .

For sections reduced by penetrations or holes, the value of  $\phi N_t$  can be determined from the Tables as the *lesser* value of:

$$\phi N_t = \phi A_g f_y$$

and  $\phi N_t = \phi(0.85)k_t A_g f_u (A_n/A_g)$

where  $A_n =$  net area of the cross-section

$k_t =$  tension correction factor (Clause 7.3.1 of AS 4100)

Values of  $A_g$  are tabulated in Tables 7-1 to 7-6. Note that all the values in Tables 7-1 to 7-6 assume  $k_t = 1.0$ .

### 7.3 Example

1. A tension member with a full perimeter welded connection to a uniformly stiff support is subjected to an axial tension force of 150 kN. Design a suitable RHS tension member.

#### Design Data:

$$N^* = 150 \text{ kN}$$

$$k_t = 1.0 \text{ (for a full perimeter welded connection)}$$

#### Solution:

Select a suitable RHS member from Tables 7-4(2). The alternatives are:

$$76 \times 38 \times 4.0 \text{ RHS - Grade C450L0 (C450PLUS) (6.23 kg/m) } \phi N_t = 303 \text{ kN} > N^*$$

$$100 \times 50 \times 3.0 \text{ RHS - Grade C450L0 (C450PLUS) (6.60 kg/m) } \phi N_t = 322 \text{ kN} > N^*$$

Both these options are suitable for the design as their mass is somewhat similar. The final choice of section may be influenced by other constraints (geometric, availability etc.).

### 7.4 References

- [7.1] Standards Australia, AS 4100 Supplement 1-1999: "Steel Structures Commentary" (Supplement to AS 4100-1998), Standards Australia, 1999.

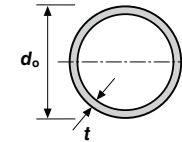
**See Section 1.1.2 for details on reference Standards.**

TABLE 7-1

# Circular Hollow Sections AS/NZS 1163 Grade C250L0

## DESIGN SECTION CAPACITIES IN AXIAL TENSION

- 1 CHS
- 2 C250L0
- 3 Finish



Designation		Mass per m	Axial Tension, $\phi N_t$		Gross Section Area $A_g$	
$d_o$	t		$\phi N_t$ (1)	$\phi N_t$ (2)		
mm	mm	kg/m	kN	kN	mm <sup>2</sup>	
165.1	x 5.4	CHS	21.3	<b>610</b>	663	2710
	5.0	CHS	19.7	<b>566</b>	616	2510
139.7	x 5.4	CHS	17.9	<b>513</b>	558	2280
	5.0	CHS	16.6	<b>476</b>	518	2120
114.3	x 5.4	CHS	14.5	<b>416</b>	452	1850
	4.5	CHS	12.2	<b>349</b>	380	1550
101.6	x 5.0	CHS	11.9	<b>341</b>	371	1520
	4.0	CHS	9.63	<b>276</b>	300	1230
88.9	x 5.9	CHS	12.1	<b>346</b>	377	1540
	5.0	CHS	10.3	<b>297</b>	323	1320
	4.0	CHS	8.38	<b>240</b>	261	1070
76.1	x 5.9	CHS	10.2	<b>293</b>	319	1300
	4.5	CHS	7.95	<b>228</b>	248	1010
	3.6	CHS	6.44	<b>184</b>	201	820
60.3	x 5.4	CHS	7.31	<b>210</b>	228	931
	4.5	CHS	6.19	<b>177</b>	193	789
	3.6	CHS	5.03	<b>144</b>	157	641
48.3	x 4.0	CHS	4.37	<b>125</b>	136	557
	3.2	CHS	3.56	<b>102</b>	111	453
42.4	x 4.0	CHS	3.79	<b>109</b>	118	483
	3.2	CHS	3.09	<b>88.7</b>	96.5	394
33.7	x 4.0	CHS	2.93	<b>84.0</b>	91.4	373
	3.2	CHS	2.41	<b>69.0</b>	75.1	307
26.9	x 4.0	CHS	2.26	<b>64.7</b>	70.4	288
	3.2	CHS	1.87	<b>53.6</b>	58.3	238
	2.6	CHS	1.56	<b>44.7</b>	48.6	198

**Notes:**

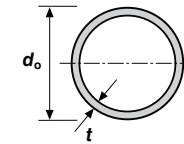
1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
2. The lesser (governing) value of  $\phi N_t(1)$  and  $\phi N_t(2)$  is highlighted in **bold** type. These terms are defined in Section 7.2.
3. This product is also compliant with AS 1074 – Steel tubes and tubulars for ordinary service. Refer to the ATM Product Manual for details on AS 1074 sections.

TABLE 7-2

# Circular Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN SECTION CAPACITIES IN AXIAL TENSION

- 1 CHS  
2 C350L0  
3 Finish



Designation d <sub>o</sub>	t	Mass per m kg/m	Axial Tension, φN <sub>t</sub>		Gross Section Area A <sub>g</sub> mm <sup>2</sup>
			φN <sub>t</sub> (1) kN	φN <sub>t</sub> (2) kN	
508.0 x	12.7 CHS	155	<b>6220</b>	6500	19800
	9.5 CHS	117	<b>4690</b>	4890	14900
	6.4 CHS	79.2	<b>3180</b>	3320	10100
457.0 x	12.7 CHS	139	<b>5580</b>	5830	17700
	9.5 CHS	105	<b>4210</b>	4390	13400
	6.4 CHS	71.1	<b>2850</b>	2980	9060
406.4 x	12.7 CHS	123	<b>4950</b>	5170	15700
	9.5 CHS	93.0	<b>3730</b>	3900	11800
	6.4 CHS	63.1	<b>2530</b>	2650	8040
355.6 x	12.7 CHS	107	<b>4310</b>	4500	13700
	9.5 CHS	81.1	<b>3250</b>	3400	10300
	6.4 CHS	55.1	<b>2210</b>	2310	7020
323.9 x	12.7 CHS	97.5	<b>3910</b>	4080	12400
	9.5 CHS	73.7	<b>2960</b>	3090	9380
	6.4 CHS	50.1	<b>2010</b>	2100	6380
273.1 x	12.7 CHS	81.6	<b>3270</b>	3420	10400
	9.3 CHS	60.5	<b>2430</b>	2540	7710
	6.4 CHS	42.1	<b>1690</b>	1760	5360
	4.8 CHS	31.8	<b>1270</b>	1330	4050
219.1 x	8.2 CHS	42.6	<b>1710</b>	1790	5430
	6.4 CHS	33.6	<b>1350</b>	1410	4280
	4.8 CHS	25.4	<b>1020</b>	1060	3230
168.3 x	7.1 CHS	28.2	<b>1130</b>	1180	3600
	6.4 CHS	25.6	<b>1030</b>	1070	3260
	4.8 CHS	19.4	<b>777</b>	811	2470

Designation d <sub>o</sub>	t	Mass per m kg/m	Axial Tension, φN <sub>t</sub>		Gross Section Area A <sub>g</sub> mm <sup>2</sup>
			φN <sub>t</sub> (1) kN	φN <sub>t</sub> (2) kN	
165.1 x	3.5 CHS	13.9	<b>560</b>	585	1780
	3.0 CHS	12.0	<b>481</b>	503	1530
139.7 x	3.5 CHS	11.8	<b>472</b>	493	1500
	3.0 CHS	10.1	<b>406</b>	424	1290
114.3 x	3.6 CHS	9.83	<b>394</b>	412	1250
	3.2 CHS	8.77	<b>352</b>	367	1120
101.6 x	3.2 CHS	7.77	<b>312</b>	325	989
	2.6 CHS	6.35	<b>255</b>	266	809
88.9 x	3.2 CHS	6.76	<b>271</b>	283	862
	2.6 CHS	5.53	<b>222</b>	232	705
76.1 x	3.2 CHS	5.75	<b>231</b>	241	733
	2.3 CHS	4.19	<b>168</b>	175	533
60.3 x	2.9 CHS	4.11	<b>165</b>	172	523
	2.3 CHS	3.29	<b>132</b>	138	419
48.3 x	2.9 CHS	3.25	<b>130</b>	136	414
	2.3 CHS	2.61	<b>105</b>	109	332
42.4 x	2.6 CHS	2.55	<b>102</b>	107	325
	2.0 CHS	1.99	<b>80.0</b>	83.5	254
33.7 x	2.6 CHS	1.99	<b>80.0</b>	83.6	254
	2.0 CHS	1.56	<b>62.7</b>	65.5	199
26.9 x	2.3 CHS	1.40	<b>56.0</b>	58.5	178
	2.0 CHS	1.23	<b>49.3</b>	51.5	156

### Notes:

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- The lesser (governing) value of φN<sub>t</sub>(1) and φN<sub>t</sub>(2) is highlighted in **bold** type. These terms are defined in Section 7.2.

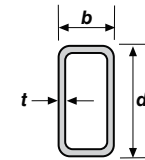
TABLE 7-3

# Rectangular Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN SECTION CAPACITIES IN AXIAL TENSION

Designation			Mass per m	Axial Tension, $\phi N_t$		Gross Section Area $A_g$	
d	b	t		$\phi N_t$ (1)	$\phi N_t$ (2)		
mm	mm	mm	kg/m	kN	kN	mm <sup>2</sup>	
75 x 25	x	2.5	RHS	3.60	<b>145</b>	151	459
		2.0	RHS	2.93	<b>118</b>	123	374
		1.6	RHS	2.38	<b>95.5</b>	99.7	303
65 x 35	x	4.0	RHS	5.35	<b>215</b>	224	681
		3.0	RHS	4.25	<b>170</b>	178	541
		2.5	RHS	3.60	<b>145</b>	151	459
		2.0	RHS	2.93	<b>118</b>	123	374
50 x 25	x	3.0	RHS	3.07	<b>123</b>	129	391
		2.5	RHS	2.62	<b>105</b>	110	334
		2.0	RHS	2.15	<b>86.2</b>	90.0	274
		1.6	RHS	1.75	<b>70.3</b>	73.4	223
50 x 20	x	3.0	RHS	2.83	<b>114</b>	119	361
		2.5	RHS	2.42	<b>97.3</b>	102	309
		2.0	RHS	1.99	<b>79.9</b>	83.5	254
		1.6	RHS	1.63	<b>65.3</b>	68.1	207

- 1 RHS
- 2 C350L0
- 3 Finish



**Notes:**

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- The lesser (governing) value of  $\phi N_t(1)$  and  $\phi N_t(2)$  is highlighted in **bold** type. These terms are defined in Section 7.2.

**ADDITIONAL NOTES:**

- (A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.
- (B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.

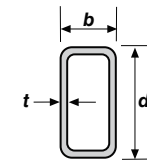


TABLE 7-4(1)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION CAPACITIES IN AXIAL TENSION

- 1 RHS
- 2 C450PLUS®
- 3 Finish



Designation			Mass per m kg/m	Axial Tension, $\phi N_t$		Gross Section Area $A_g$ mm <sup>2</sup>
d mm	b mm	t mm		$\phi N_t(1)$ kN	$\phi N_t(2)$ kN	
400 x 300 x	RHS	16.0	161	8300	<b>7840</b>	20500
		12.5	128	6620	<b>6250</b>	16300
		10.0	104	5370	<b>5070</b>	13300
		8.0	84.2	4340	<b>4100</b>	10700
400 x 200 x	RHS	16.0	136	7010	<b>6620</b>	17300
		12.5	109	5600	<b>5290</b>	13800
		10.0	88.4	4560	<b>4310</b>	11300
		8.0	71.6	3700	<b>3490</b>	9120
350 x 250 x	RHS	16.0	136	7010	<b>6620</b>	17300
		12.5	109	5600	<b>5290</b>	13800
		10.0	88.4	4560	<b>4310</b>	11300
		8.0	71.6	3700	<b>3490</b>	9120
300 x 200 x	RHS	16.0	111	5710	<b>5390</b>	14100
		12.5	89.0	4590	<b>4340</b>	11300
		10.0	72.7	3750	<b>3540</b>	9260
		8.0	59.1	3050	<b>2880</b>	7520
		6.0	45.0	2320	<b>2190</b>	5730
250 x 150 x	RHS	16.0	85.5	4410	<b>4170</b>	10900
		12.5	69.4	3580	<b>3380</b>	8840
		10.0	57.0	2940	<b>2780</b>	7260
		9.0	51.8	2670	<b>2520</b>	6600
		8.0	46.5	2400	<b>2270</b>	5920
		6.0	35.6	1840	<b>1730</b>	4530
		5.0	29.9	1540	<b>1460</b>	3810

Designation			Mass per m kg/m	Axial Tension, $\phi N_t$		Gross Section Area $A_g$ mm <sup>2</sup>
d mm	b mm	t mm		$\phi N_t(1)$ kN	$\phi N_t(2)$ kN	
200 x 100 x	RHS	10.0	41.3	2130	<b>2010</b>	5260
		9.0	37.7	1940	<b>1840</b>	4800
		8.0	33.9	1750	<b>1650</b>	4320
		6.0	26.2	1350	<b>1270</b>	3330
		5.0	22.1	1140	<b>1080</b>	2810
		4.0	17.9	924	<b>873</b>	2280
152 x 76 x	RHS	6.0	19.4	1000	<b>944</b>	2470
		5.0	16.4	848	<b>801</b>	2090
150 x 100 x	RHS	10.0	33.4	1720	<b>1630</b>	4260
		9.0	30.6	1580	<b>1490</b>	3900
		8.0	27.7	1430	<b>1350</b>	3520
		6.0	21.4	1110	<b>1050</b>	2730
		5.0	18.2	937	<b>885</b>	2310
		4.0	14.8	762	<b>720</b>	1880
150 x 50 x	RHS	6.0	16.7	864	<b>816</b>	2130
		5.0	14.2	735	<b>694</b>	1810
		4.0	11.6	600	<b>567</b>	1480
		3.0	8.96	462	<b>436</b>	1140
		2.5	7.53	388	<b>367</b>	959
		2.0	6.07	313	<b>296</b>	774
127 x 51 x	RHS	6.0	14.7	757	<b>715</b>	1870
		5.0	12.5	646	<b>610</b>	1590
		3.5	9.07	468	<b>442</b>	1150
125 x 75 x	RHS	6.0	16.7	864	<b>816</b>	2130
		5.0	14.2	735	<b>694</b>	1810
		4.0	11.6	600	<b>567</b>	1480
		3.0	8.96	462	<b>436</b>	1140
		2.5	7.53	388	<b>367</b>	959
		2.0	6.07	313	<b>296</b>	774
102 x 76 x	RHS	6.0	14.7	757	<b>715</b>	1870
		5.0	12.5	646	<b>610</b>	1590
		3.5	9.07	468	<b>442</b>	1150

**Notes:**

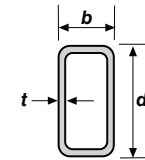
1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. The lesser (governing) value of  $\phi N_t(1)$  and  $\phi N_t(2)$  is highlighted in **bold** type. These terms are defined in Section 7.2.

TABLE 7-4(2)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION CAPACITIES IN AXIAL TENSION

- 1 RHS
- 2 C450PLUS®
- 3 Finish



Designation			Mass per m kg/m	Axial Tension, $\phi N_t$		Gross Section Area $A_g$ mm <sup>2</sup>
d mm	b mm	t mm		$\phi N_t$ (1) kN	$\phi N_t$ (2) kN	
100	50	6.0 RHS	12.0	621	<b>586</b>	1530
		5.0 RHS	10.3	532	<b>503</b>	1310
		4.0 RHS	8.49	438	<b>414</b>	1080
		3.5 RHS	7.53	388	<b>367</b>	959
		3.0 RHS	6.60	341	<b>322</b>	841
		2.5 RHS	5.56	287	<b>271</b>	709
		2.0 RHS	4.50	232	<b>219</b>	574
		1.6 RHS	3.64	188	<b>177</b>	463
76	38	4.0 RHS	6.23	321	<b>303</b>	793
		3.0 RHS	4.90	253	<b>239</b>	625
		2.5 RHS	4.15	214	<b>202</b>	529
75	50	6.0 RHS	9.67	499	<b>471</b>	1230
		5.0 RHS	8.35	431	<b>407</b>	1060
		4.0 RHS	6.92	357	<b>337</b>	881
		3.0 RHS	5.42	280	<b>264</b>	691
		2.5 RHS	4.58	236	<b>223</b>	584
		2.0 RHS	3.72	192	<b>181</b>	474
		1.6 RHS	3.01	155	<b>147</b>	383
75	25	2.5 RHS	3.60	186	<b>176</b>	459
		2.0 RHS	2.93	151	<b>143</b>	374
		1.6 RHS	2.38	123	<b>116</b>	303
65	35	4.0 RHS	5.35	276	<b>261</b>	681
		3.0 RHS	4.25	219	<b>207</b>	541
		2.5 RHS	3.60	186	<b>176</b>	459
		2.0 RHS	2.93	151	<b>143</b>	374
50	25	3.0 RHS	3.07	158	<b>149</b>	391
		2.5 RHS	2.62	135	<b>128</b>	334
		2.0 RHS	2.15	111	<b>105</b>	274
		1.6 RHS	1.75	90.4	<b>85.4</b>	223
		1.6 RHS	1.75	90.4	<b>85.4</b>	223
50	20	3.0 RHS	2.83	146	<b>138</b>	361
		2.5 RHS	2.42	125	<b>118</b>	309
		2.0 RHS	1.99	103	<b>97.0</b>	254
		1.6 RHS	1.63	83.9	<b>79.2</b>	207

**Notes:**

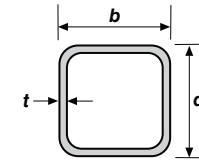
- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) **and** C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- The lesser (governing) value of  $\phi N_t(1)$  and  $\phi N_t(2)$  is highlighted in **bold** type. These terms are defined in Section 7.2.
- NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**

TABLE 7-5

# Square Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN SECTION CAPACITIES IN AXIAL TENSION

- 1 SHS
- 2 C350L0
- 3 Finish



Designation			Mass per m	Axial Tension, $\phi N_t$		Gross Section Area $A_g$	
d	b	t		$\phi N_t(1)$	$\phi N_t(2)$		
mm	mm	mm	kg/m	kN	kN	mm <sup>2</sup>	
50 x 50	50	6.0	SHS	7.32	<b>294</b>	307	932
		5.0	SHS	6.39	<b>256</b>	268	814
		4.0	SHS	5.35	<b>215</b>	224	681
		3.0	SHS	4.25	<b>170</b>	178	541
		2.5	SHS	3.60	<b>145</b>	151	459
		2.0	SHS	2.93	<b>118</b>	123	374
		1.6	SHS	2.38	<b>95.5</b>	99.7	303
40 x 40	40	4.0	SHS	4.09	<b>164</b>	171	521
		3.0	SHS	3.30	<b>133</b>	138	421
		2.5	SHS	2.82	<b>113</b>	118	359
		2.0	SHS	2.31	<b>92.5</b>	96.6	294
		1.6	SHS	1.88	<b>75.3</b>	78.7	239
35 x 35	35	3.0	SHS	2.83	<b>114</b>	119	361
		2.5	SHS	2.42	<b>97.3</b>	102	309
		2.0	SHS	1.99	<b>79.9</b>	83.5	254
		1.6	SHS	1.63	<b>65.3</b>	68.1	207
30 x 30	30	3.0	SHS	2.36	<b>94.8</b>	99.0	301
		2.5	SHS	2.03	<b>81.6</b>	85.2	259
		2.0	SHS	1.68	<b>67.3</b>	70.3	214
		1.6	SHS	1.38	<b>55.2</b>	57.6	175
25 x 25	25	3.0	SHS	1.89	<b>75.9</b>	79.2	241
		2.5	SHS	1.64	<b>65.8</b>	68.7	209
		2.0	SHS	1.36	<b>54.7</b>	57.1	174
		1.6	SHS	1.12	<b>45.1</b>	47.1	143
20 x 20	20	2.0	SHS	1.05	<b>42.1</b>	44.0	134
		1.6	SHS	0.873	<b>35.0</b>	36.6	111

### ADDITIONAL NOTES:

(A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.

(B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.

### Notes:

1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
2. The lesser (governing) value of  $\phi N_t(1)$  and  $\phi N_t(2)$  is highlighted in **bold** type. These terms are defined in Section 7.2.

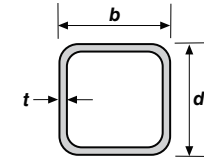
Australian Tube Mills A.B.N. 21 123 666 679. PO Box 246 Sunnybank, Queensland 4109 Australia Telephone +61 7 3909 6600 Facsimile +61 7 3909 6660 E-mail [info@austubemills.com](mailto:info@austubemills.com) Internet [www.austubemills.com](http://www.austubemills.com)

TABLE 7-6(1)

# Square Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION CAPACITIES IN AXIAL TENSION

- 1 SHS
- 2 C450PLUS®
- 3 Finish



Designation			Mass per m kg/m	Axial Tension, $\phi N_t$		Gross Section Area $A_g$ mm <sup>2</sup>
d	b	t		$\phi N_t(1)$ kN	$\phi N_t(2)$ kN	
mm	mm	mm				
400 x 400	x	16.0 SHS	186	9600	<b>9060</b>	23700
		12.5 SHS	148	7630	<b>7210</b>	18800
		10.0 SHS	120	6180	<b>5840</b>	15300
350 x 350	x	16.0 SHS	161	8300	<b>7840</b>	20500
		12.5 SHS	128	6620	<b>6250</b>	16300
		10.0 SHS	104	5370	<b>5070</b>	13300
		8.0 SHS	84.2	4340	<b>4100</b>	10700
300 x 300	x	16.0 SHS	136	7010	<b>6620</b>	17300
		12.5 SHS	109	5600	<b>5290</b>	13800
		10.0 SHS	88.4	4560	<b>4310</b>	11300
		8.0 SHS	71.6	3700	<b>3490</b>	9120
250 x 250	x	16.0 SHS	111	5710	<b>5390</b>	14100
		12.5 SHS	89.0	4590	<b>4340</b>	11300
		10.0 SHS	72.7	3750	<b>3540</b>	9260
		9.0 SHS	65.9	3400	<b>3210</b>	8400
		8.0 SHS	59.1	3050	<b>2880</b>	7520
		6.0 SHS	45.0	2320	<b>2190</b>	5730
200 x 200	x	16.0 SHS	85.5	4410	<b>4170</b>	10900
		12.5 SHS	69.4	3580	<b>3380</b>	8840
		10.0 SHS	57.0	2940	<b>2780</b>	7260
		9.0 SHS	51.8	2670	<b>2520</b>	6600
		8.0 SHS	46.5	2400	<b>2270</b>	5920
		6.0 SHS	35.6	1840	<b>1730</b>	4530
		5.0 SHS	29.9	1540	<b>1460</b>	3810
150 x 150	x	10.0 SHS	41.3	2130	<b>2010</b>	5260
		9.0 SHS	37.7	1940	<b>1840</b>	4800
		8.0 SHS	33.9	1750	<b>1650</b>	4320
		6.0 SHS	26.2	1350	<b>1270</b>	3330
		5.0 SHS	22.1	1140	<b>1080</b>	2810

Designation			Mass per m kg/m	Axial Tension, $\phi N_t$		Gross Section Area $A_g$ mm <sup>2</sup>
d	b	t		$\phi N_t(1)$ kN	$\phi N_t(2)$ kN	
mm	mm	mm				
125 x 125	x	10.0 SHS	33.4	1720	<b>1630</b>	4260
		9.0 SHS	30.6	1580	<b>1490</b>	3900
		8.0 SHS	27.7	1430	<b>1350</b>	3520
		6.0 SHS	21.4	1110	<b>1050</b>	2730
		5.0 SHS	18.2	937	<b>885</b>	2310
100 x 100	x	4.0 SHS	14.8	762	<b>720</b>	1880
		10.0 SHS	25.6	1320	<b>1250</b>	3260
		9.0 SHS	23.5	1210	<b>1150</b>	3000
		8.0 SHS	21.4	1100	<b>1040</b>	2720
		6.0 SHS	16.7	864	<b>816</b>	2130
		5.0 SHS	14.2	735	<b>694</b>	1810
90 x 90	x	4.0 SHS	11.6	600	<b>567</b>	1480
		3.0 SHS	8.96	462	<b>436</b>	1140
		2.5 SHS	7.53	388	<b>367</b>	959
		2.0 SHS	6.07	313	<b>296</b>	774
		2.5 SHS	6.74	348	<b>329</b>	859
89 x 89	x	2.0 SHS	5.45	281	<b>265</b>	694
		6.0 SHS	14.7	757	<b>715</b>	1870
89 x 89	x	5.0 SHS	12.5	646	<b>610</b>	1590
		3.5 SHS	9.07	468	<b>442</b>	1150
		2.0 SHS	5.38	278	<b>262</b>	686
		6.0 SHS	12.0	621	<b>586</b>	1530
		5.0 SHS	10.3	532	<b>503</b>	1310
75 x 75	x	4.0 SHS	8.49	438	<b>414</b>	1080
		3.5 SHS	7.53	388	<b>367</b>	959
		3.0 SHS	6.60	341	<b>322</b>	841
		2.5 SHS	5.56	287	<b>271</b>	709
		2.0 SHS	4.50	232	<b>219</b>	574
		6.0 SHS	10.1	523	<b>494</b>	1290
65 x 65	x	5.0 SHS	8.75	451	<b>426</b>	1110
		4.0 SHS	7.23	373	<b>352</b>	921
		3.0 SHS	5.66	292	<b>276</b>	721
		2.5 SHS	4.78	247	<b>233</b>	609
		2.0 SHS	3.88	200	<b>189</b>	494
		1.6 SHS	3.13	162	<b>153</b>	399

**Notes:**

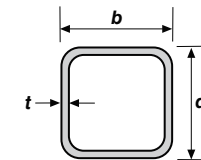
- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- The lesser (governing) value of  $\phi N_t(1)$  and  $\phi N_t(2)$  is highlighted in **bold** type. These terms are defined in Section 7.2.

TABLE 7-6(2)

# Square Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION CAPACITIES IN AXIAL TENSION

- 1 SHS
- 2 C450PLUS®
- 3 Finish



Designation			Mass per m kg/m	Axial Tension, $\phi N_t$		Gross Section Area $A_g$ mm <sup>2</sup>	
d	b	t		$\phi N_t(1)$ kN	$\phi N_t(2)$ kN		
mm	mm	mm					
50	x 50	6.0	SHS	7.32	378	<b>357</b>	932
		5.0	SHS	6.39	330	<b>311</b>	814
		4.0	SHS	5.35	276	<b>261</b>	681
		3.0	SHS	4.25	219	<b>207</b>	541
		2.5	SHS	3.60	186	<b>176</b>	459
		2.0	SHS	2.93	151	<b>143</b>	374
		1.6	SHS	2.38	123	<b>116</b>	303
40	x 40	4.0	SHS	4.09	211	<b>199</b>	521
		3.0	SHS	3.30	170	<b>161</b>	421
		2.5	SHS	2.82	145	<b>137</b>	359
		2.0	SHS	2.31	119	<b>112</b>	294
		1.6	SHS	1.88	96.9	<b>91.5</b>	239
35	x 35	3.0	SHS	2.83	146	<b>138</b>	361
		2.5	SHS	2.42	125	<b>118</b>	309
		2.0	SHS	1.99	103	<b>97.0</b>	254
		1.6	SHS	1.63	83.9	<b>79.2</b>	207
30	x 30	3.0	SHS	2.36	122	<b>115</b>	301
		2.5	SHS	2.03	105	<b>99.0</b>	259
		2.0	SHS	1.68	86.5	<b>81.7</b>	214
		1.6	SHS	1.38	70.9	<b>67.0</b>	175
25	x 25	3.0	SHS	1.89	97.5	<b>92.1</b>	241
		2.5	SHS	1.64	84.6	<b>79.9</b>	209
		2.0	SHS	1.36	70.3	<b>66.4</b>	174
		1.6	SHS	1.12	58.0	<b>54.8</b>	143
20	x 20	2.0	SHS	1.05	54.1	<b>51.1</b>	134
		1.6	SHS	0.873	45.0	<b>42.5</b>	111

### Notes:

1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3. The lesser (governing) value of  $\phi N_t(1)$  and  $\phi N_t(2)$  is highlighted in **bold** type. These terms are defined in Section 7.2.
4. **NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**

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# Part 8

## MEMBERS SUBJECT TO COMBINED ACTIONS

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**Tables 8-1 to 8-6 provide the information required to design members for combined actions. All relevant design section capacities in bending, compression, tension and shear are given as well as reduced design section moment capacities. These tables also provide reference to the appropriate tables in Sections 5, 6 and 7 to determine design member capacities in bending, axial compression and axial tension.**

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

# Part 8

## MEMBERS SUBJECT TO COMBINED ACTIONS

### 8.1 General

This part of the Tables contains design capacities and other parameters which are used to design members subject to combined actions in accordance with Section 8 of AS 4100. Tables 8-1 to 8-6 list design section capacities and references to other tables for checking interaction effects on member capacities.

The design capacities considered in the 8 Series Tables include:

Design Capacity	Definition	Described in Section No.
$\phi N_s$	design section capacity in axial compression	6.2
$\phi N_t$	design section capacity in axial tension	7.2
$\phi M_s$	design section moment capacity (CHS/SHS)	5.2.2.1
$\phi M_{sx}, \phi M_{sy}$	$\phi M_s$ about x- and y-axis (RHS)	5.2.2.1
$\phi M_r$	$\phi M_s$ reduced by axial force (CHS)	8.3.1.1, 8.4.1.1
$\phi M_{rx}$ (comp)	$\phi M_{sx}$ reduced by axial compression force (RHS)	8.3.1.1
$\phi M_{rx}$ (tens)	$\phi M_{sx}$ reduced by axial tension force (RHS)	8.4.1.1
$\phi M_{ry}$	$\phi M_{sy}$ reduced by axial force (RHS)	8.3.2.1, 8.4.2.1
$\phi M_r$ (comp) $\phi M_r$ (tens)	$\phi M_s$ about a principal axis reduced by axial compression and tension force (SHS)	8.3.1.1, 8.4.1.1
$\phi V_v$	design shear capacity of a web (CHS/SHS)	5.2.2.4
$\phi V_{vx}$	$\phi V_v$ for bending about x-axis (RHS)	5.2.2.4
$\phi V_{vy}$	$\phi V_v$ for bending about y-axis (RHS)	5.2.2.4
$\phi M_z$	design torsional section moment capacity	5.2.2.3

Note: The above description on direction of shear force on RHS is important - i.e.  $\phi V_{vx}$  and  $\phi V_{vy}$ .

### 8.2 Design for Combined Actions

Sections 8.3 and 8.4 explain the relevant equations from AS 4100 for combined bending and axial compression and combined bending and axial tension respectively. Each of these sections consider uniaxial bending about the major principal x-axis, uniaxial bending about the minor principal y-axis and biaxial bending. Section 8.5 gives the interaction formulae for biaxial bending without axial forces.

In every case both the section capacity and the member capacity must be checked.

**For all cases of combined bending and axial force the designer should first ensure that the appropriate design axial capacity (compression or tension) is greater than the design axial force (i.e.  $\phi N \geq N^*$ ) – see part 6 or 7 as appropriate.**

### 8.3 Combined Bending and Axial Compression

In this section:

- $\phi$  = 0.9 (Table 3.4 of AS 4100)
- $\phi M_{sx}$  = design section moment capacity for bending about the major principal x-axis
- $\phi M_{sy}$  = design section moment capacity for bending about the minor principal y-axis
- $N^*$  = design axial compressive force
- $\phi N_s$  = design section capacity in compression
- $\phi N_{cx}$  = design member capacity in compression, for buckling about the x-axis
- $\phi N_{cy}$  = design member capacity in compression, for buckling about the y-axis

#### 8.3.1 Compression and Uniaxial Bending – about the major principal x-axis

For a member subject to uniaxial bending about the major principal x-axis and axial compression, the following condition must be satisfied:

$$M_x^* \leq \min. [\phi M_{rx}; \phi M_{ix}; \phi M_{ox}]$$

where  $\phi$  = 0.9 (Table 3.4 of AS 4100)

- $M_x^*$  = design bending moment about the major principal x-axis
- $\phi M_{rx}$  = design section moment capacity ( $\phi M_{sx}$ ) for bending about the major principal x-axis reduced by axial force (see Section 8.3.1.1)
- $\phi M_{ix}$  = design in-plane member moment capacity ( $\phi M_i$ ) for bending about the major principal x-axis (see Section 8.3.1.2(a))
- $\phi M_{ox}$  = design out-of-plane member moment capacity ( $\phi M_o$ ) for bending about the major principal x-axis (see Section 8.3.1.2(b))

#### 8.3.1.1 Section Capacity

The value of  $\phi M_{rx}$  must be determined at all points along the member and the minimum value used to satisfy the inequality in Section 8.3.1.

$$\phi M_{rx} = \phi M_{sx} \left( 1 - \frac{N^*}{\phi N_s} \right) \quad \text{(Clause 8.3.2 of AS 4100)}$$

# Part 8

## MEMBERS SUBJECT TO COMBINED ACTIONS

Alternatively, for RHS and SHS to AS/NZS 1163, which are compact about the x-axis with  $k_f = 1.0$  and are subject to bending and compression

$$\phi M_{rx} = 1.18 \phi M_{sx} \left( 1 - \frac{N^*}{\phi N_s} \right) \leq \phi M_{sx} \quad (\text{Clause 8.3.2 of AS 4100})$$

For RHS and SHS to AS/NZS 1163, which are compact about the x-axis with  $k_f < 1.0$  and are subject to bending and compression

$$\phi M_{rx} = \phi M_{sx} \left( 1 - \frac{N^*}{\phi N_s} \right) \left[ 1 + 0.18 \left( \frac{82 - \lambda_w}{82 - \lambda_{wy}} \right) \right] \leq \phi M_{sx} \quad (\text{Clause 8.3.2 of AS 4100})$$

where  $\lambda_w$  = the element slenderness of the web (Clause 6.2.3 of AS 4100)

$$= \frac{d - 2t}{t} \sqrt{\frac{f_y}{250}}$$

$\lambda_{wy}$  = the web yield slenderness limit (Table 6.2.4 of AS 4100)  
= 40 for RHS and SHS considered in this publication.

### 8.3.1.2 Member Capacity

This section only applies to members analysed using an elastic method of analysis. Where there is sufficient restraint to prevent lateral buckling, only the in-plane requirements of this Section (Section 8.3.1.2) needs to be satisfied. If there is insufficient restraint to prevent lateral buckling, then both the in-plane and out-of-plane requirements of this Section needs to be satisfied.

#### (a) In-plane capacity

$$\phi M_{ix} = \phi M_{sx} \left( 1 - \frac{N^*}{\phi N_{cx}} \right) \quad (\text{Clause 8.4.2.2 of AS 4100})$$

For braced and sway members, the above value of  $\phi N_{cx}$  is calculated using an effective length factor ( $k_{ex}$ ) equal to 1.0 (i.e.  $L_{ex} = L$ ), unless a lower value of  $k_{ex}$  has been calculated for a braced member, provided that  $N^* \leq \phi N_{cx}$  where the value of  $\phi N_{cx}$  in this inequality is calculated using the value of  $k_{ex}$  as calculated from Clauses 4.6.3.2, 4.6.3.3 or 4.6.3.5 of AS 4100.

#### (b) Out-of-plane capacity

$$\phi M_{ox} = \phi M_{bx} \left( 1 - \frac{N^*}{\phi N_{cy}} \right) \quad (\text{Clause 8.4.4.1 of AS 4100})$$

where  $\phi M_{bx}$  = design member moment capacity for bending about the major principal x-axis for a member without full lateral restraint.

Clauses 8.4.2.2 and 8.4.4.1 of AS 4100 also provides a higher tier method for evaluating  $M_{ix}$  and  $M_{ox}$  which is dependent on the ratio of the member's end bending moments. Due to the variable nature of these end bending moments, the further consideration of this higher tier method is beyond the scope of this publication.

### 8.3.1.3 Tables

For CHS, Tables 8-1 to 8-2 list  $\phi N_s$ ,  $\phi M_s$  and the relationship to  $\phi M_r$  (i.e. the design section moment capacity reduced by compression) as listed in Notes 2 and 3 in those Tables to comply with Clause 8.3.2 of AS 4100. For RHS and SHS, Tables 8-3 to 8-6 list  $\phi M_{sx}$ ,  $\phi N_s$  and  $\phi M_{rx}$  (comp) – the latter parameter refers to  $\phi M_{rx}$  a function of  $n$  to comply with Section 8.3.1.1. Designers should evaluate  $n = N^*/\phi N_s$ , then use it to calculate the value of  $\phi M_{rx}$  and ensure that it is **less than or equal to** the design section capacity  $\phi M_{sx}$ . For specific hollow sections, the 8 Series Tables also provide references to other Tables (e.g.  $\phi M_b$  (for RHS only),  $\phi N_{cx}$  and  $\phi N_{cy}$ ) to evaluate  $\phi M_{ix}$  and  $\phi M_{ox}$ .

### 8.3.2 Compression and Uniaxial Bending – about the minor principal y-axis

For a member subject to uniaxial bending about the minor principal y-axis and axial compression, the following condition must be satisfied:

$$M_y^* \leq \min. [\phi M_{ry}; \phi M_{iy}]$$

where  $\phi = 0.9$  (Table 3.4 of AS 4100)

$M_y^*$  = design bending moment about the minor principal y-axis

$\phi M_{ry}$  = design section moment capacity ( $\phi M_s$ ) for bending about the minor principal y-axis reduced by axial force (see Section 8.3.2.1)

$\phi M_{iy}$  = design in-plane member moment capacity ( $\phi M_i$ ) for bending about the minor principal y-axis (see Section 8.3.2.2)

CHS and SHS are not required to be assessed in this instance as this would be covered by the interaction check of Section 8.3.1.



## Part 8

### MEMBERS SUBJECT TO COMBINED ACTIONS

#### 8.3.2.1 Section Capacity

The value of  $\phi M_{ry}$  must be determined at all points along the member and the minimum value is used to satisfy the inequality in Section 8.3.2:

$$\phi M_{ry} = \phi M_{sy} \left( 1 - \frac{N^*}{\phi N_s} \right) \quad (\text{Clause 8.3.3 of AS 4100})$$

Alternatively, for RHS and SHS to AS/NZS 1163, which are compact about the y-axis and are subject to bending and compression:

$$\phi M_{ry} = 1.18 \phi M_{sy} \left( 1 - \frac{N^*}{\phi N_s} \right) \leq \phi M_{sy} \quad (\text{Clause 8.3.3 of AS 4100})$$

#### 8.3.2.2 Member Capacity

This section only applies to members analysed using an elastic method of analysis. For bending about the minor principal y-axis only the in-plane requirements need to be satisfied.

##### (a) In-plane capacity

$$\phi M_{iy} = \phi M_{sy} \left( 1 - \frac{N^*}{\phi N_{cy}} \right) \quad (\text{Clause 8.4.2.2 of AS 4100})$$

For braced and sway members, the above value of  $\phi N_{cy}$  is calculated using an effective length factor ( $k_{ey}$ ) equal to 1.0 (i.e.  $L_{ey} = L$ ), unless a lower value of  $k_{ey}$  has been calculated for a braced member, provided that  $N^* \leq \phi N_{cy}$  where the value of  $\phi N_{cy}$  in this inequality is calculated using the value of  $k_{ey}$  as calculated from Clauses 4.6.3.2, 4.6.3.3 or 4.6.3.5 of AS 4100.

Clause 8.4.2.2 of AS 4100 also provides a higher tier method for evaluating  $M_{iy}$  which is dependent on the ratio of the member's end bending moments. Due to the variable nature of these end bending moments, the further consideration of this higher tier method is beyond the scope of this publication.

#### 8.3.2.3 Tables

For RHS, Tables 8-3 to 8-4 list  $\phi M_{sy}$ ,  $\phi N_s$  and  $\phi M_{ry}$  – the latter parameter uses a function of  $n$  to comply with Section 8.3.2.1. Designers should evaluate  $n = N^*/\phi N_s$ , then use it to calculate the value of  $\phi M_{ry}$  and ensure that it is **less than or equal to** the design section capacity  $\phi M_{sy}$ . For specific hollow sections, the 8 Series tables also provide references to other tables (e.g.  $\phi N_{cy}$ ) to evaluate  $\phi M_{iy}$ .

#### 8.3.3 Compression and Biaxial Bending

For a member subject to biaxial bending and axial compression, both the conditions defined in Sections 8.3.3.1 and 8.3.3.2 must be satisfied.

##### 8.3.3.1 Section Capacity

$$\frac{N^*}{\phi N_s} + \frac{M_x^*}{\phi M_{sx}} + \frac{M_y^*}{\phi M_{sy}} \leq 1.0 \quad (\text{Clause 8.3.4 of AS 4100})$$

Alternatively, for RHS and SHS to AS/NZS 1163, which are compact about both the x- and y-axes, sections at all points along the member shall satisfy:

$$\left( \frac{M_x^*}{\phi M_{rx}} \right)^\gamma + \left( \frac{M_y^*}{\phi M_{ry}} \right)^\gamma \leq 1.0 \quad (\text{Clause 8.3.4 of AS 4100})$$

$$\text{where } \gamma = 1.4 + \frac{N^*}{\phi N_s} \leq 2.0$$

$\phi M_{rx}$  and  $\phi M_{ry}$  are calculated using the alternatives presented in Sections 8.3.1.1 and 8.3.2.1.

##### 8.3.3.2 Member Capacity

$$\left( \frac{M_x^*}{\phi M_{cx}} \right)^{1.4} + \left( \frac{M_y^*}{\phi M_{cy}} \right)^{1.4} \leq 1.0 \quad (\text{Clause 8.4.5.1 of AS 4100})$$

where  $\phi M_{cx} =$  lesser of  $\phi M_{ix}$  and  $\phi M_{ox}$  (see Section 8.3.1.2) and  $\phi M_{iy}$  is calculated using the method presented in Section 8.3.2.2.

# Part 8

## MEMBERS SUBJECT TO COMBINED ACTIONS

### 8.3.3.3 Tables

For CHS, Table 8-1 and 8-2 list these parameters as  $\phi N_s$  and  $\phi M_s$ . For RHS and SHS, Tables 8-3 to 8-6 list  $\phi N_s$ ,  $\phi M_{sx}$  and  $\phi M_{sy}$ . As noted in Sections 8.3.1.3 and 8.3.2.3, the parameters  $\phi M_{rx}$ ,  $\phi M_{ry}$ ,  $\phi M_{ix}$ ,  $\phi M_{iy}$  and  $\phi M_{ox}$  can also be calculated from these and other referenced tables.

### 8.4 Combined Bending and Axial Tension

In this section:

- $\phi$  = 0.9 (Table 3.4 of AS 4100)
- $\phi M_{sx}$  = design section moment capacity for bending about the major principal x-axis
- $\phi M_{sy}$  = design section moment capacity for bending about the minor principal y-axis
- $N^*$  = design axial tension force
- $\phi N_t$  = design section capacity in axial tension

#### 8.4.1 Tension and Uniaxial Bending – about the major principal x-axis

For a member subject to uniaxial bending about the major principal x-axis and axial tension, the following conditions must be satisfied:

$$M_x^* \leq \min. [\phi M_{rx}; \phi M_{ox}]$$

where  $\phi$  = 0.9 (Table 3.4 of AS 4100)

- $M_x^*$  = design bending moment about the major principal x-axis
- $\phi M_{rx}$  = design section moment capacity ( $\phi M_s$ ) for bending about the major principal x-axis reduced by axial force (see Section 8.4.1.1)
- $\phi M_{ox}$  = design out-of-plane member moment capacity ( $\phi M_o$ ) for bending about the major principal x-axis reduced by axial force (see Section 8.4.1.2(a))

##### 8.4.1.1 Section Capacity

The value of  $\phi M_{rx}$  must be determined at all points along the member and the minimum value used to satisfy the inequality in Section 8.4.1.

$$\phi M_{rx} = \phi M_{sx} \left( 1 - \frac{N^*}{\phi N_t} \right) \quad \text{(Clause 8.3.2 of AS 4100)}$$

Alternatively, for RHS and SHS to AS/NZS 1163, which are compact about the x-axis and are subject to bending and tension

$$\phi M_{rx} = 1.18 \phi M_{sx} \left( 1 - \frac{N^*}{\phi N_t} \right) \leq \phi M_{sx} \quad \text{(Clause 8.3.2 of AS 4100)}$$

#### 8.4.1.2 Member Capacity

This section only applies to members analysed using an elastic method of analysis. Only the out-of-plane capacity needs to be considered.

##### (a) Out-of-plane capacity

$$\phi M_{ox} = \phi M_{bx} \left( 1 + \frac{N^*}{\phi N_t} \right) \leq \phi M_{rx} \quad \text{(Clause 8.4.4.2 of AS 4100)}$$

where  $\phi M_{bx}$  = design member moment capacity for bending about the major principal x-axis and  $\phi M_{rx}$  is calculated using the method presented in Section 8.4.1.1.

#### 8.4.1.3 Tables

For CHS, Tables 8-1 to 8-2 list  $\phi N_t$ ,  $\phi M_s$  and the relationship to  $\phi M_r$  (i.e. the design section moment capacity reduced by tension) as listed in Notes 2 and 3 in those Tables to comply with Clause 8.3.2 of AS 4100. For RHS and SHS, Tables 8-3 to 8-6 list  $\phi M_{sx}$ ,  $\phi N_t$  and  $\phi M_{rx}$  (tens) – the latter parameter refers to  $\phi M_{rx}$  as a function of  $n$  to comply with Section 8.3.1.1. Designers should evaluate  $n = N^*/\phi N_t$ , then use it to calculate the value of  $\phi M_{rx}$  and ensure that it is **less than or equal to** the design section capacity  $\phi M_{sx}$ . For specific hollow sections, the 8 Series Tables also provide references to other Tables – e.g.  $\phi M_b$  for RHS (whereas  $\phi M_b = \phi M_s$  generally for CHS/SHS) – to evaluate  $\phi M_{ox}$ .

#### 8.4.2 Tension and Uniaxial Bending – about the minor principal y-axis

For a member subject to uniaxial bending about the minor principal y-axis and axial tension, the following condition must be satisfied:

$$M_y^* \leq \phi M_{ry}$$

where  $\phi$  = 0.9 (Table 3.4 of AS 4100)

- $M_y^*$  = design bending moment about the minor principal y-axis
- $\phi M_{ry}$  = design section moment capacity ( $\phi M_s$ ) for bending about the minor principal y-axis reduced by axial force (see Section 8.3.2.1).

CHS and SHS are not required to be assessed in this instance as this would be covered by the interaction check of Section 8.4.1.

# Part 8

## MEMBERS SUBJECT TO COMBINED ACTIONS

### 8.4.2.1 Section Capacity

The value of  $\phi M_{ry}$  must be determined at all points along the member and the minimum value is used to satisfy the inequality in Section 8.4.2:

$$\phi M_{ry} = \phi M_{sy} \left( 1 - \frac{N^*}{\phi N_t} \right) \quad (\text{Clause 8.3.3 of AS 4100})$$

Alternatively, for RHS and SHS to AS/NZS 1163, which are compact about the y-axis and are subject to bending and compression:

$$\phi M_{ry} = 1.18 \phi M_{sy} \left( 1 - \frac{N^*}{\phi N_t} \right) \leq \phi M_{sy} \quad (\text{Clause 8.3.3 of AS 4100})$$

### 8.4.2.2 Tables

For RHS, Tables 8-3 and 8-4 list  $\phi M_{sy}$ ,  $\phi N_t$  and  $\phi M_{ry}$  – the latter parameter uses a function of  $n$  to comply with Section 8.3.2.1. Designers should evaluate  $n = N^*/\phi N_t$ , then use it to calculate the value of  $\phi M_{ry}$  and ensure that it is **less than or equal to** the design section capacity  $\phi M_{sy}$ .

### 8.4.3 Tension and Biaxial Bending

For a member subject to biaxial bending and axial tension, both the conditions defined in Sections 8.4.3.1 and 8.4.3.2 must be satisfied.

#### 8.4.3.1 Section Capacity

$$\frac{N^*}{\phi N_t} + \frac{M_x^*}{\phi M_{sx}} + \frac{M_y^*}{\phi M_{sy}} \leq 1.0 \quad (\text{Clause 8.3.4 of AS 4100})$$

Alternatively, for RHS and SHS to AS/NZS 1163, which are compact about both the x- and y-axes, sections at all points along the member shall satisfy:

$$\left( \frac{M_x^*}{\phi M_{rx}} \right)^\gamma + \left( \frac{M_y^*}{\phi M_{ry}} \right)^\gamma \leq 1.0 \quad (\text{Clause 8.3.4 of AS 4100})$$

where  $\gamma = 1.4 + \left( \frac{N^*}{\phi N_t} \right) \leq 2.0$

$\phi M_{rx}$  and  $\phi M_{ry}$  are calculated using the methods presented in Sections 8.4.1.1 and 8.4.2.1.

### 8.4.3.2 Member Capacity

$$\left( \frac{M_x^*}{\phi M_{tx}} \right)^{1.4} + \left( \frac{M_y^*}{\phi M_{ty}} \right)^{1.4} \leq 1.0 \quad (\text{Clause 8.4.5.2 of AS 4100})$$

where  $\phi M_{tx} = \text{lesser of } \phi M_{rx} \text{ and } \phi M_{ox}$  (see Sections 8.4.1.1 and 8.4.1.2) and  $\phi M_{ty}$  is calculated using the method presented in Section 8.4.2.1.

### 8.4.3.3 Tables

For CHS, Tables 8-1 and 8-2 list these parameters as  $\phi N_t$  and  $\phi M_s$ . For RHS and SHS, Tables 8-3 to 8-6 list  $\phi N_t$ ,  $\phi M_{sx}$  and  $\phi M_{sy}$ . As noted in Sections 8.4.1.3 and 8.4.2.2, the parameters  $\phi M_{rx}$ ,  $\phi M_{ry}$ , and  $\phi M_{ox}$  can also be calculated from these and other referenced tables.

### 8.5 Biaxial Bending in the absence of Axial Force

In this section:

$$\phi = 0.9 \quad (\text{Table 3.4 of AS 4100})$$

$M_x^*$  = design bending moment about the major principal x-axis

$\phi M_{sx}$  = design section moment capacity for bending about the major principal x-axis

$M_y^*$  = design bending moment about the minor principal y-axis

$\phi M_{sy}$  = design section moment capacity for bending about the minor principal y-axis

For a member subject to biaxial bending without any axial force, the following conditions defined in Sections 8.5.1 and 8.5.2 must be satisfied.

#### 8.5.1 Section Capacity

The following inequality must be satisfied at all points along the member:

$$\frac{M_x^*}{\phi M_{sx}} + \frac{M_y^*}{\phi M_{sy}} \leq 1.0 \quad (\text{Clause 8.3.4 of AS 4100})$$

Alternatively, for RHS and SHS to AS/NZS 1163, which are compact about both the x- and y-axes, sections of all points along the member shall satisfy:

$$\left( \frac{M_x^*}{\phi M_{sx}} \right)^{1.4} + \left( \frac{M_y^*}{\phi M_{sy}} \right)^{1.4} \leq 1.0 \quad (\text{Clause 8.3.4 of AS 4100})$$

# Part 8

## MEMBERS SUBJECT TO COMBINED ACTIONS

### 8.5.2 Member Capacity

$$\left(\frac{M_x^*}{\phi M_{bx}}\right)^{1.4} + \left(\frac{M_y^*}{\phi M_{sy}}\right)^{1.4} \leq 1.0 \quad (\text{Clause 8.4.5 of AS 4100})$$

where  $\phi M_{bx}$  = design member moment capacity for bending about the major principal x-axis.

### 8.5.3 Tables

Tables 8-1 to 8-2 list  $\phi M_s$  for CHS. For RHS, Table 8-3 and 8-4 lists  $\phi M_{sx}$  and  $\phi M_{sy}$ . For SHS, Tables 8-5 and 8-6 list these parameters as  $\phi M_{sx}$ . For specific hollow sections, the 8 Series Tables also provide references to other Tables – e.g.  $\phi M_b$  for RHS (whereas  $\phi M_b = \phi M_s$  generally for CHS/SHS) – to evaluate  $\phi M_{bx}$ .

### 8.6 Example

Considering further Example 1 of Section 4.3, the adequacy of the braced Beam-Column under the calculated design action effects from a first-order elastic analysis plus moment amplification in accordance with section 4 of AS 4100, is assessed.

#### Design Data:

Section:	250 x 150 x 12.5 RHS – Grade C450L0 (C450PLUS®) steel		
	Section is Compact about both axes.		
Effective lengths:	Flexural buckling (x-axis)	= 10.0 m	(for axial compression)
	Flexural buckling (y-axis)	= 5.0 m	(for axial compression)
	Lateral buckling	= 5.0 m	(for bending about x-axis)
Design action effects:	$N^*$	= 450 kN	
	$M_x^*$	= 135 kNm	
	$M_y^*$	= 24.6 kNm	

**Solution:** The example involves biaxial bending and axial compression as described in Section 8.3.3 of these Tables.

(i) Section Capacity Check (Section 8.3.3.1) – using the higher tier provision

From Table 8-4(1):

$$\begin{aligned} \phi N_s &= 3580 \text{ kN} > N^* \\ \phi M_{sx} &= 282 \text{ kNm} \\ \phi M_{sy} &= 198 \text{ kNm} \end{aligned}$$

$$\text{Now } n = \frac{N^*}{\phi N_s} = \frac{450}{3580} = 0.126$$

Using Table 8-4(1) again:

$$\begin{aligned} \phi M_{rx} (\text{comp}) &= 332 \times (1 - 0.126) = 290 \text{ kNm} > \phi M_{sx} \\ \therefore \phi M_{rx} &= \phi M_{sx} = 282 \text{ kNm} \\ \phi M_{ry} &= 233 \times (1 - 0.126) = 204 \text{ kNm} > \phi M_{sy} \\ \therefore \phi M_{ry} &= \phi M_{sy} = 198 \text{ kNm} \end{aligned}$$

$$\text{Now } \gamma = 1.4 + \left(\frac{N^*}{\phi N_s}\right) = 1.53 < 2.0$$

$$\text{Then } \left(\frac{M_x^*}{\phi M_{rx}}\right)^\gamma + \left(\frac{M_y^*}{\phi M_{ry}}\right)^\gamma = \left(\frac{135}{282}\right)^{1.53} + \left(\frac{24.6}{198}\right)^{1.53} = 0.365 (< 1.0 \therefore \text{O.K.})$$

The above interaction equation was used as the section is Compact about both x- and y-axes (see Table 3.1-4(1)).

(ii) Member Capacity Check (Section 8.3.3.2)

$$\left(\frac{M_x^*}{\phi M_{cx}}\right)^{1.4} + \left(\frac{M_y^*}{\phi M_{iy}}\right)^{1.4} \leq 1.0$$

From the Tables noted below:

$$\begin{aligned} \phi M_{bx} &= 282 \text{ kNm} \quad (\text{Table 5.3-2(1) for } L_e = 5.0 \text{ m}) \quad (\text{based on } \alpha_m = 1.0) \\ \phi N_{cx} &= 1100 \text{ kN} \quad (\text{Table 6-4(1)(A) for } L_{ex} = 10.0 \text{ m}) \\ \phi N_{cy} &= 1800 \text{ kN} \quad (\text{Table 6-4(1)(B) for } L_{ey} = 5.0 \text{ m}) \end{aligned}$$

For this example, the moment distribution for x-axis bending is not uniform though the above value of  $\phi M_{bx}$  is based on the uniform moment case. From Table 5.6.1 of AS 4100,  $\alpha_m = 1.75$

$$\begin{aligned} \therefore \phi M_{bx} &= \min. [\alpha_m (\phi M_{bx}); \phi M_{sx}] \\ &= \min. [1.75 \times 282; 282] \\ &= 282 \text{ kNm} \end{aligned}$$

## Part 8

### MEMBERS SUBJECT TO COMBINED ACTIONS

Calculate the in-plane and out-of-plane capacities

$$\begin{aligned} \text{(a) } \phi M_{ix} &= \phi M_{sx} \left( 1 - \frac{N^*}{\phi N_{cx}} \right) \\ &= 282 \times \left( 1 - \frac{450}{1100} \right) \\ &= 167 \text{ kNm} \end{aligned}$$

$$\begin{aligned} \text{(b) } \phi M_{ox} &= \phi M_{bx} \left( 1 - \frac{N^*}{\phi N_{cy}} \right) \\ &= 282 \times \left( 1 - \frac{450}{1800} \right) \\ &= 212 \text{ kNm} \\ \therefore \phi M_{ox} &= \min. [\phi M_{ix}; \phi M_{ox}] \\ &= 167 \text{ kNm} \end{aligned}$$

$$\begin{aligned} \text{and } \phi M_{iy} &= \phi M_{sy} \left( 1 - \frac{N^*}{\phi N_{cy}} \right) \\ &= 198 \times \left( 1 - \frac{450}{1800} \right) \\ &= 149 \text{ kNm} \end{aligned}$$

$$\begin{aligned} \text{Thus } \left( \frac{M_x^*}{\phi M_{cx}} \right)^{1.4} + \left( \frac{M_y^*}{\phi M_{iy}} \right)^{1.4} &= \left( \frac{135}{167} \right)^{1.4} + \left( \frac{24.6}{149} \right)^{1.4} \\ &= 0.823 (< 1.0 \therefore \text{O.K.}) \end{aligned}$$

Further consideration of the use of design capacity tables for members subject to combined actions can be found in Ref.[8.1].

### 8.7 References

- [8.1] Bradford, M.A., Bridge, R.Q. and Trahair, N.S., "Worked Examples for Steel Structures", third edition, Australian Institute of Steel Construction, 1997 (Note: AISC is now ASI – Australian Steel Institute).

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

TABLE 8-1

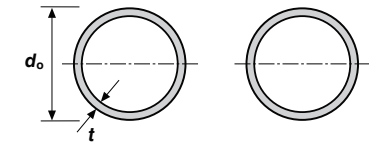
# Circular Hollow Sections AS/NZS 1163 Grade C250L0

## DESIGN SECTION CAPACITIES

about any axis

Designation	Mass per m	Design Section Axial Capacities		Design Section Moment Capacities	Design Shear Capacity	Torsion
		Comp $\phi N_s$	Tens $\phi N_t$			
$d_o$ x t	kg/m	kN	kN	$\phi M_s$	$\phi V_v$	$\phi M_z$
mm x mm						
165.1 x 5.4 CHS	21.3	610	610	31.0	219	28.3
165.1 x 5.0 CHS	19.7	566	566	28.8	204	26.4
139.7 x 5.4 CHS	17.9	513	513	21.9	185	19.9
139.7 x 5.0 CHS	16.6	476	476	20.4	171	18.6
114.3 x 5.4 CHS	14.5	416	416	14.4	150	13.0
114.3 x 4.5 CHS	12.2	349	349	12.2	126	11.1
101.6 x 5.0 CHS	11.9	341	341	10.5	123	9.43
101.6 x 4.0 CHS	9.63	276	276	8.58	99.3	7.77
88.9 x 5.9 CHS	12.1	346	346	9.16	125	8.09
88.9 x 5.0 CHS	10.3	297	297	7.93	107	7.07
88.9 x 4.0 CHS	8.38	240	240	6.49	86.4	5.85
76.1 x 5.9 CHS	10.2	293	293	6.56	105	5.73
76.1 x 4.5 CHS	7.95	228	228	5.20	82.0	4.62
76.1 x 3.6 CHS	6.44	184	184	4.26	66.4	3.83
60.3 x 5.4 CHS	7.31	210	210	3.67	75.4	3.17
60.3 x 4.5 CHS	6.19	177	177	3.16	63.9	2.77
60.3 x 3.6 CHS	5.03	144	144	2.61	51.9	2.32
48.3 x 4.0 CHS	4.37	125	125	1.77	45.1	1.54
48.3 x 3.2 CHS	3.56	102	102	1.47	36.7	1.30
42.4 x 4.0 CHS	3.79	109	109	1.33	39.1	1.15
42.4 x 3.2 CHS	3.09	88.7	88.7	1.11	31.9	0.970
33.7 x 4.0 CHS	2.93	84.0	84.0	0.799	30.2	0.671
33.7 x 3.2 CHS	2.41	69.0	69.0	0.672	24.8	0.578
26.9 x 4.0 CHS	2.26	64.7	64.7	0.477	23.3	0.390
26.9 x 3.2 CHS	1.87	53.6	53.6	0.407	19.3	0.342
26.9 x 2.6 CHS	1.56	44.7	44.7	0.347	16.1	0.297

- 1 CHS
- 2 C250L0
- 3 Finish



### Notes:

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- $\phi M_r$  = design section moment capacity reduced by compression or tension, and must be less than or equal to  $\phi M_s$ .
- For all CHS,  $\phi M_r = \phi M_s (1 - N^*/\phi N_s) \leq \phi M_s$ .
- For all CHS, the design member moment capacity ( $\phi M_o$ ) =  $\phi M_s$ .
- For the design member capacity in compression  $\phi N_c$ , see Table 6-1.
- This product is also compliant with AS 1074 – Steel tubes and tubulars for ordinary service. Refer to the ATM Product Manual for details on AS 1074 sections.

TABLE 8-2(1)

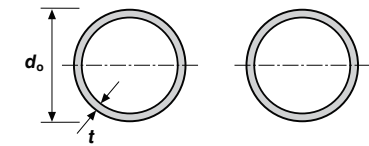
# Circular Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN SECTION CAPACITIES

about any axis

Designation	Mass per m	Design Section Axial Capacities		Design Section	Design Shear	Torsion		
		Comp	Tens	Moment Capacities	Capacity			
$d_o$	$t$	$\phi N_s$	$\phi N_t$	$\phi M_s$	$\phi V_v$	$\phi M_z$		
mm	mm	kN	kN	kNm	kN	kNm		
508.0 x	12.7	CHS	155	6220	6220	962	2240	902
	9.5	CHS	117	4690	4690	683	1690	688
	6.4	CHS	79.2	2720	3180	408	1140	472
457.0 x	12.7	CHS	139	5580	5580	789	2010	724
	9.5	CHS	105	4210	4210	565	1510	553
	6.4	CHS	71.1	2580	2850	343	1030	380
406.4 x	12.7	CHS	123	4950	4950	620	1780	567
	9.5	CHS	93.0	3730	3730	456	1340	434
	6.4	CHS	63.1	2430	2530	282	912	299
355.6 x	12.7	CHS	107	4310	4310	471	1550	428
	9.5	CHS	81.1	3250	3250	356	1170	329
	6.4	CHS	55.1	2210	2210	224	796	228
323.9 x	12.7	CHS	97.5	3910	3910	388	1410	351
	9.5	CHS	73.7	2960	2960	296	1060	271
	6.4	CHS	50.1	2010	2010	189	724	188
273.1 x	12.7	CHS	81.6	3270	3270	271	1180	244
	9.3	CHS	60.5	2430	2430	204	874	186
	6.4	CHS	42.1	1690	1690	139	608	132
	4.8	CHS	31.8	1270	1270	98.3	459	101
219.1 x	8.2	CHS	42.6	1710	1710	115	616	104
	6.4	CHS	33.6	1350	1350	91.2	485	83.5
	4.8	CHS	25.4	1020	1020	66.3	366	64.0
168.3 x	7.1	CHS	28.2	1130	1130	58.2	408	52.6
	6.4	CHS	25.6	1030	1030	52.9	369	48.0
	4.8	CHS	19.4	777	777	40.4	280	37.0

- 1 CHS
- 2 C350L0
- 3 Finish



### Notes:

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- $\phi M_r$  = design section moment capacity reduced by compression or tension, and must be less than or equal to  $\phi M_s$ .
- For all CHS,  $\phi M_r = \phi M_s (1 - N^*/\phi N_s) \leq \phi M_s$ .
- For all CHS, the design member moment capacity ( $\phi M_b$ ) =  $\phi M_s$ .
- For the design member capacity in compression  $\phi N_c$ , see Table 6-2(1).

TABLE 8-2(2)

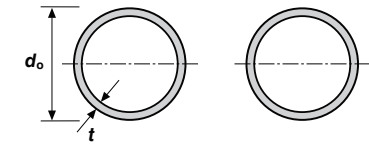
# Circular Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN SECTION CAPACITIES

about any axis

Designation	Mass per m	Design Section Axial Capacities		Design Section Moment Capacities	Design Shear Capacity	Torsion	
		Comp $\phi N_s$	Tens $\phi N_t$				
$d_o$ mm	t mm	kg/m	kN	kN	$\phi M_s$ kNm	$\phi V_v$ kN	$\phi M_z$ kNm
165.1 x	3.5 CHS	13.9	560	560	27.3	201	26.6
	3.0 CHS	12.0	481	481	22.6	173	23.0
139.7 x	3.5 CHS	11.8	472	472	20.1	170	18.8
	3.0 CHS	10.1	406	406	16.8	146	16.3
114.3 x	3.6 CHS	9.83	394	394	13.9	142	12.7
	3.2 CHS	8.77	352	352	12.4	127	11.4
101.6 x	3.2 CHS	7.77	312	312	9.76	112	8.92
	2.6 CHS	6.35	255	255	7.90	91.7	7.38
88.9 x	3.2 CHS	6.76	271	271	7.41	97.7	6.74
	2.6 CHS	5.53	222	222	6.10	79.9	5.59
76.1 x	3.2 CHS	5.75	231	231	5.36	83.1	4.85
	2.3 CHS	4.19	168	168	3.95	60.5	3.61
60.3 x	2.9 CHS	4.11	165	165	3.01	59.3	2.71
	2.3 CHS	3.29	132	132	2.44	47.5	2.21
48.3 x	2.9 CHS	3.25	130	130	1.89	46.9	1.67
	2.3 CHS	2.61	105	105	1.53	37.7	1.38
42.4 x	2.6 CHS	2.55	102	102	1.30	36.9	1.15
	2.0 CHS	1.99	80.0	80.0	1.03	28.8	0.926
33.7 x	2.6 CHS	1.99	80.0	80.0	0.794	28.8	0.694
	2.0 CHS	1.56	62.7	62.7	0.634	22.6	0.563
26.9 x	2.3 CHS	1.40	56.0	56.0	0.440	20.2	0.381
	2.0 CHS	1.23	49.3	49.3	0.391	17.7	0.343

- 1 CHS
- 2 C350L0
- 3 Finish



**Notes:**

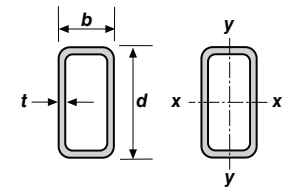
- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- $\phi M_r$  = design section moment capacity reduced by compression or tension, and must be less than or equal to  $\phi M_s$ .
- For all CHS,  $\phi M_r = \phi M_s (1 - N^*/\phi N_s) \leq \phi M_s$ .
- For all CHS, the design member moment capacity ( $\phi M_o$ ) =  $\phi M_s$ .
- For the design member capacity in compression  $\phi N_c$ , see Table 6-2(2).



TABLE 8-3

# Rectangular Hollow Sections AS/NZS 1163 Grade C350L0 DESIGN SECTION CAPACITIES

- 1 RHS
- 2 C350L0
- 3 Finish



Designation			Mass per m kg/m	Design Section Axial Capacities		Design Section Moment Capacities					Design Shear Capacities		Torsion kNm			
d	b	t		Comp $\phi N_s$	Tens $\phi N_t$	About x-axis			About y-axis		$\phi V_{vx}$	$\phi V_{vy}$				
						$\phi M_{sx}$	$\phi M_{rx}$ (comp)	$\phi M_{rx}$ (tens)	$\phi M_{sy}$	$\phi M_{ry}$						
mm	mm	mm	kN	kN	kNm	kNm	kNm	kNm	kNm	kN	kN	kNm				
75	x	25	x	2.5	RHS	3.60	145	145	3.17	3.74 (1-n)	3.74 (1-n)	1.36	1.36 (1-n)	61.5	18.9	1.35
				2.0	RHS	2.93	113	118	2.62	3.07 (1-n)	3.09 (1-n)	1.00	1.00 (1-n)	49.9	15.9	1.14
				1.6	RHS	2.38	77.6	95.5	2.15	2.41 (1-n)	2.53 (1-n)	0.699	0.699 (1-n)	40.4	13.2	0.954
65	x	35	x	4.0	RHS	5.35	215	215	4.18	4.94 (1-n)	4.94 (1-n)	2.70	3.19 (1-n)	82.4	40.8	2.37
				3.0	RHS	4.25	170	170	3.46	4.09 (1-n)	4.09 (1-n)	2.24	2.64 (1-n)	64.0	32.9	1.97
				2.5	RHS	3.60	145	145	2.98	3.51 (1-n)	3.51 (1-n)	1.93	2.28 (1-n)	54.2	28.4	1.72
				2.0	RHS	2.93	118	118	2.46	2.90 (1-n)	2.90 (1-n)	1.48	1.48 (1-n)	44.1	23.4	1.44
50	x	25	x	3.0	RHS	3.07	123	123	1.85	2.18 (1-n)	2.18 (1-n)	1.12	1.33 (1-n)	47.5	21.5	0.979
				2.5	RHS	2.62	105	105	1.61	1.90 (1-n)	1.90 (1-n)	0.982	1.16 (1-n)	40.5	18.9	0.869
				2.0	RHS	2.15	86.2	86.2	1.34	1.58 (1-n)	1.58 (1-n)	0.824	0.972 (1-n)	33.1	15.9	0.741
				1.6	RHS	1.75	70.3	70.3	1.11	1.31 (1-n)	1.31 (1-n)	0.644	0.644 (1-n)	27.0	13.2	0.623
50	x	20	x	3.0	RHS	2.83	114	114	1.62	1.92 (1-n)	1.92 (1-n)	0.827	0.976 (1-n)	46.9	15.9	0.733
				2.5	RHS	2.42	97.3	97.3	1.42	1.68 (1-n)	1.68 (1-n)	0.729	0.861 (1-n)	40.0	14.2	0.659
				2.0	RHS	1.99	79.9	79.9	1.19	1.41 (1-n)	1.41 (1-n)	0.616	0.727 (1-n)	32.7	12.1	0.568
				1.6	RHS	1.63	65.3	65.3	0.989	1.17 (1-n)	1.17 (1-n)	0.484	0.484 (1-n)	26.6	10.2	0.482

**Notes:**

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- $\phi M_{rx}$  (comp) refers to the design section moment capacity reduced by compression (where  $n = N^*/\phi N_s$ ) and must be less than or equal to  $\phi M_{sx}$ .
- $\phi M_{rx}$  (tens) refers to the design section moment capacity reduced by tension (where  $n = N^*/\phi N_t$ ) and must be less than or equal to  $\phi M_{sx}$ .
- $\phi M_{ry}$  refers to the design section moment capacity reduced by axial force (where  $n = N^*/\phi N_t$  or  $N^*/\phi N_s$ ) and must be less than or equal to  $\phi M_{sy}$ .
- For the design member moment capacity  $\phi M_b$ , see Table 5.3-1.
- For the design member capacity in compression (x-axis)  $\phi N_{cx}$ , see Table 6-3(A).
- For the design member capacity in compression (y-axis)  $\phi N_{cy}$ , see Table 6-3(B).

**ADDITIONAL NOTES:**

(A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.

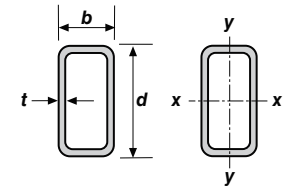
(B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.

TABLE 8-4(1)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION CAPACITIES

- 1 RHS
- 2 C450PLUS®
- 3 Finish



Designation			Mass per m kg/m	Design Section Axial Capacities		Design Section Moment Capacities					Design Shear Capacities		Torsion φM <sub>z</sub> kNm	
d	b	t		Comp φN <sub>s</sub> kN	Tens φN <sub>t</sub> kN	About x-axis			About y-axis		φV <sub>vx</sub> kN	φV <sub>vy</sub> kN		
						φM <sub>sx</sub> kNm	φM <sub>rx</sub> (comp) kNm	φM <sub>rx</sub> (tens) kNm	φM <sub>sy</sub> kNm	φM <sub>ry</sub> kNm				
400	x 300	16.0	RHS	161	8300	7840	1110	1320 (1-n)	1320 (1-n)	905	905 (1-n)	2790	2080	771
		12.5	RHS	128	6590	6250	901	1060 (1-n)	1060 (1-n)	641	641 (1-n)	2220	1670	628
		10.0	RHS	104	4710	5070	649	649 (1-n)	649 (1-n)	454	454 (1-n)	1800	1360	518
		8.0	RHS	84.2	3110	4100	463	463 (1-n)	463 (1-n)	324	324 (1-n)	1450	1100	425
400	x 200	16.0	RHS	136	7010	6620	866	1020 (1-n)	1020 (1-n)	527	527 (1-n)	2730	1310	485
		12.5	RHS	109	5580	5290	705	831 (1-n)	832 (1-n)	379	379 (1-n)	2170	1060	401
		10.0	RHS	88.4	3900	4310	581	658 (1-n)	685 (1-n)	266	266 (1-n)	1760	875	334
		8.0	RHS	71.6	2750	3490	467	467 (1-n)	467 (1-n)	188	188 (1-n)	1420	715	275
350	x 250	16.0	RHS	136	7010	6620	807	952 (1-n)	952 (1-n)	641	756 (1-n)	2400	1700	543
		12.5	RHS	109	5600	5290	657	775 (1-n)	775 (1-n)	487	487 (1-n)	1920	1370	446
		10.0	RHS	88.4	4300	4310	533	533 (1-n)	533 (1-n)	350	350 (1-n)	1560	1120	370
		8.0	RHS	71.6	3080	3490	376	376 (1-n)	376 (1-n)	249	249 (1-n)	1260	910	304
300	x 200	16.0	RHS	111	5710	5390	548	647 (1-n)	647 (1-n)	414	489 (1-n)	2020	1310	354
		12.5	RHS	89.0	4590	4340	450	531 (1-n)	531 (1-n)	341	402 (1-n)	1620	1060	294
		10.0	RHS	72.7	3750	3540	373	440 (1-n)	440 (1-n)	254	254 (1-n)	1320	875	246
		8.0	RHS	59.1	2750	2880	302	302 (1-n)	302 (1-n)	181	181 (1-n)	1070	715	204
250	x 150	16.0	RHS	85.5	4410	4170	338	398 (1-n)	398 (1-n)	236	279 (1-n)	1630	918	203
		12.5	RHS	69.4	3580	3380	282	332 (1-n)	332 (1-n)	198	233 (1-n)	1320	759	173
		10.0	RHS	57.0	2940	2780	236	278 (1-n)	278 (1-n)	164	164 (1-n)	1080	632	146
		9.0	RHS	51.8	2670	2520	216	255 (1-n)	255 (1-n)	143	143 (1-n)	976	577	135
250	x 150	8.0	RHS	46.5	2400	2270	195	230 (1-n)	230 (1-n)	121	121 (1-n)	875	521	122
		6.0	RHS	35.6	1550	1730	149	149 (1-n)	149 (1-n)	77.5	77.5 (1-n)	668	402	96.0
		5.0	RHS	29.9	1180	1460	111	111 (1-n)	111 (1-n)	58.5	58.5 (1-n)	561	340	81.8

**Notes:**

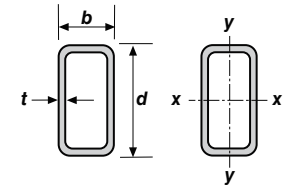
- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- $\phi M_{sx}$  (comp) refers to the design section moment capacity reduced by compression (where  $n = N^*/\phi N_s$ ) and must be less than or equal to  $\phi M_{sx}$ .
- $\phi M_{rx}$  (tens) refers to the design section moment capacity reduced by tension (where  $n = N^*/\phi N_t$ ) and must be less than or equal to  $\phi M_{sx}$ .
- $\phi M_{ry}$  refers to the design section moment capacity reduced by axial force (where  $n = N^*/\phi N_t$  or  $N^*/\phi N_s$ ) and must be less than or equal to  $\phi M_{sy}$ .
- For the design member moment capacity  $\phi M_b$ , see Table 5.3-2(1).
- For the design member capacity in compression (x-axis)  $\phi N_{sx}$ , see Table 6-4(1)(A).
- For the design member capacity in compression (y-axis)  $\phi N_{sy}$ , see Table 6-4(1)(B).

TABLE 8-4(2)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION CAPACITIES

- 1 RHS
- 2 C450PLUS®
- 3 Finish



Designation			Mass per m kg/m	Design Section Axial Capacities		Design Section Moment Capacities					Design Shear Capacities		Torsion φM <sub>z</sub> kNm	
d mm	b mm	t mm		Comp φN <sub>s</sub> kN	Tens φN <sub>t</sub> kN	About x-axis			About y-axis		φV <sub>vx</sub> kN	φV <sub>vy</sub> kN		
						φM <sub>sx</sub> kNm	φM <sub>rx</sub> (comp) kNm	φM <sub>rx</sub> (tens) kNm	φM <sub>sy</sub> kNm	φM <sub>ry</sub> kNm				
200	x 100	10.0	RHS	41.3	2130	2010	129	152 (1-n)	152 (1-n)	79.1	93.3 (1-n)	833	389	71.0
		9.0	RHS	37.7	1940	1840	119	140 (1-n)	140 (1-n)	73.1	86.2 (1-n)	758	359	66.0
		8.0	RHS	33.9	1750	1650	108	128 (1-n)	128 (1-n)	65.9	65.9 (1-n)	681	327	60.7
		6.0	RHS	26.2	1310	1270	85.1	99.7 (1-n)	100 (1-n)	44.4	44.4 (1-n)	522	257	48.5
		5.0	RHS	22.1	974	1080	72.6	82.2 (1-n)	85.6 (1-n)	33.3	33.3 (1-n)	440	219	41.7
		4.0	RHS	17.9	688	873	58.4	58.4 (1-n)	58.4 (1-n)	23.5	23.5 (1-n)	355	179	34.4
152	x 76	6.0	RHS	19.4	1000	944	47.0	55.5 (1-n)	55.5 (1-n)	28.4	28.4 (1-n)	389	187	26.4
		5.0	RHS	16.4	848	801	40.4	47.7 (1-n)	47.7 (1-n)	22.3	22.3 (1-n)	329	160	22.9
150	x 100	10.0	RHS	33.4	1720	1630	80.7	95.2 (1-n)	95.2 (1-n)	60.9	71.8 (1-n)	611	389	51.3
		9.0	RHS	30.6	1580	1490	74.8	88.3 (1-n)	88.3 (1-n)	56.5	66.7 (1-n)	559	359	47.9
		8.0	RHS	27.7	1430	1350	68.5	80.8 (1-n)	80.8 (1-n)	51.8	61.1 (1-n)	504	327	44.2
		6.0	RHS	21.4	1110	1050	54.4	64.2 (1-n)	64.2 (1-n)	40.7	40.7 (1-n)	389	257	35.6
		5.0	RHS	18.2	937	885	46.6	55.0 (1-n)	55.0 (1-n)	31.8	31.8 (1-n)	329	219	30.7
		4.0	RHS	14.8	688	720	37.8	37.8 (1-n)	37.8 (1-n)	22.6	22.6 (1-n)	267	179	25.5
150	x 50	6.0	RHS	16.7	864	816	36.9	43.6 (1-n)	43.6 (1-n)	16.4	16.4 (1-n)	374	111	15.6
		5.0	RHS	14.2	735	694	31.9	37.7 (1-n)	37.7 (1-n)	12.9	12.9 (1-n)	316	97.2	13.8
		4.0	RHS	11.6	526	567	26.5	30.4 (1-n)	31.3 (1-n)	9.19	9.19 (1-n)	257	81.6	11.7
		3.0	RHS	8.96	329	436	20.8	22.4 (1-n)	24.6 (1-n)	5.89	5.89 (1-n)	195	64.2	9.30
		2.5	RHS	7.53	246	367	17.6	17.9 (1-n)	20.8 (1-n)	4.40	4.40 (1-n)	164	54.7	7.97
		2.0	RHS	6.07	173	296	12.8	12.8 (1-n)	12.8 (1-n)	3.10	3.10 (1-n)	132	44.7	6.55
127	x 51	6.0	RHS	14.7	757	715	27.9	32.9 (1-n)	32.9 (1-n)	14.5	17.1 (1-n)	315	114	13.3
		5.0	RHS	12.5	646	610	24.3	28.6 (1-n)	28.6 (1-n)	12.4	12.4 (1-n)	267	99.6	11.8
		3.5	RHS	9.07	423	442	18.1	20.8 (1-n)	21.3 (1-n)	7.49	7.49 (1-n)	192	74.8	9.04
125	x 75	6.0	RHS	16.7	864	816	34.1	40.2 (1-n)	40.2 (1-n)	23.9	28.2 (1-n)	317	184	21.0
		5.0	RHS	14.2	735	694	29.5	34.8 (1-n)	34.8 (1-n)	20.5	20.5 (1-n)	269	158	18.3
		4.0	RHS	11.6	600	567	24.4	28.8 (1-n)	28.8 (1-n)	15.1	15.1 (1-n)	219	130	15.3
		3.0	RHS	8.96	390	436	18.8	18.8 (1-n)	18.8 (1-n)	9.80	9.80 (1-n)	167	101	12.0
		2.5	RHS	7.53	296	367	14.1	14.1 (1-n)	14.1 (1-n)	7.39	7.39 (1-n)	140	85.1	10.2
		2.0	RHS	6.07	196	296	10.0	10.0 (1-n)	10.0 (1-n)	5.27	5.27 (1-n)	113	69.0	8.36
102	x 76	6.0	RHS	14.7	757	715	25.1	29.6 (1-n)	29.6 (1-n)	20.5	24.1 (1-n)	255	187	17.0
		5.0	RHS	12.5	646	610	21.7	25.7 (1-n)	25.7 (1-n)	17.8	21.0 (1-n)	218	160	14.9
		3.5	RHS	9.07	468	442	16.1	19.1 (1-n)	19.1 (1-n)	12.1	12.1 (1-n)	157	117	11.2

**Notes:**

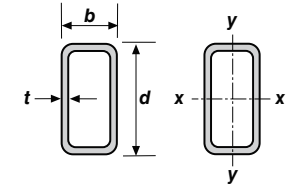
1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
2. Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
3.  $\phi M_{rx}$  (comp) refers to the design section moment capacity reduced by compression (where  $n = N^*/\phi N_s$ ) and must be less than or equal to  $\phi M_{sx}$ .
4.  $\phi M_{rx}$  (tens) refers to the design section moment capacity reduced by tension (where  $n = N^*/\phi N_t$ ) and must be less than or equal to  $\phi M_{sx}$ .
5.  $\phi M_{ry}$  refers to the design section moment capacity reduced by axial force (where  $n = N^*/\phi N_t$  or  $N^*/\phi N_s$ ) and must be less than or equal to  $\phi M_{sy}$ .
6. For the design member moment capacity  $\phi M_{\phi}$ , see Table 5.3-2(2).
7. For the design member capacity in compression (x-axis)  $\phi N_{sx}$ , see Table 6-4(2)(A).
8. For the design member capacity in compression (y-axis)  $\phi N_{sy}$ , see Table 6-4(2)(B).

TABLE 8-4(3)

# Rectangular Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION CAPACITIES

- 1 RHS
- 2 C450PLUS®
- 3 Finish



Designation			Mass per m kg/m	Design Section Axial Capacities		Design Section Moment Capacities					Design Shear Capacities		Torsion kNm	
d	b	t		Comp $\phi N_s$	Tens $\phi N_t$	About x-axis			About y-axis		$\phi V_{vx}$	$\phi V_{vy}$		
mm	mm	mm	kN	kN	$\phi M_{sx}$	$\phi M_{rx}$ (comp)	$\phi M_{rx}$ (tens)	$\phi M_{sy}$	$\phi M_{ry}$	kN	kN	kNm		
100	x 50	6.0	RHS	12.0	621	586	18.4	21.7 (1-n)	21.7 (1-n)	11.2	13.3 (1-n)	244	111	9.94
		5.0	RHS	10.3	532	503	16.1	19.0 (1-n)	19.0 (1-n)	9.88	11.7 (1-n)	208	97.2	8.87
		4.0	RHS	8.49	438	414	13.5	16.0 (1-n)	16.0 (1-n)	8.23	8.23 (1-n)	170	81.6	7.58
		3.5	RHS	7.53	388	367	12.1	14.3 (1-n)	14.3 (1-n)	6.92	6.92 (1-n)	151	73.1	6.85
		3.0	RHS	6.60	329	322	10.8	12.6 (1-n)	12.7 (1-n)	5.63	5.63 (1-n)	131	64.2	6.08
		2.5	RHS	5.56	246	271	9.18	10.4 (1-n)	10.8 (1-n)	4.22	4.22 (1-n)	110	54.7	5.22
		2.0	RHS	4.50	173	219	7.37	7.37 (1-n)	7.37 (1-n)	2.97	2.97 (1-n)	88.9	44.7	4.31
1.6	RHS	3.64	124	177	5.05	5.05 (1-n)	5.05 (1-n)	2.10	2.10 (1-n)	71.7	36.4	3.53		
76	x 38	4.0	RHS	6.23	321	303	7.34	8.66 (1-n)	8.66 (1-n)	4.50	5.31 (1-n)	126	58.3	4.03
		3.0	RHS	4.90	253	239	6.00	7.07 (1-n)	7.07 (1-n)	3.61	3.61 (1-n)	97.2	46.7	3.31
		2.5	RHS	4.15	214	202	5.14	6.06 (1-n)	6.06 (1-n)	2.83	2.83 (1-n)	82.2	40.1	2.87
75	x 50	6.0	RHS	9.67	499	471	11.4	13.4 (1-n)	13.4 (1-n)	8.56	10.1 (1-n)	178	111	7.11
		5.0	RHS	8.35	431	407	10.1	11.9 (1-n)	11.9 (1-n)	7.61	8.98 (1-n)	153	97.2	6.41
		4.0	RHS	6.92	357	337	8.56	10.1 (1-n)	10.1 (1-n)	6.47	7.64 (1-n)	126	81.6	5.52
		3.0	RHS	5.42	280	264	6.92	8.17 (1-n)	8.17 (1-n)	5.17	5.17 (1-n)	97.4	64.2	4.47
		2.5	RHS	4.58	236	223	5.91	6.97 (1-n)	6.97 (1-n)	4.03	4.03 (1-n)	82.3	54.7	3.85
		2.0	RHS	3.72	173	181	4.77	4.77 (1-n)	4.77 (1-n)	2.86	2.86 (1-n)	66.8	44.7	3.19
		1.6	RHS	3.01	124	147	3.34	3.34 (1-n)	3.34 (1-n)	2.03	2.03 (1-n)	54.0	36.4	2.62
75	x 25	2.5	RHS	3.60	186	176	4.07	4.81 (1-n)	4.81 (1-n)	1.64	1.64 (1-n)	79.1	24.3	1.73
		2.0	RHS	2.93	133	143	3.36	3.86 (1-n)	3.97 (1-n)	1.17	1.17 (1-n)	64.2	20.4	1.47
		1.6	RHS	2.38	91.6	116	2.76	3.02 (1-n)	3.26 (1-n)	0.816	0.816 (1-n)	51.9	17.0	1.23
65	x 35	4.0	RHS	5.35	276	261	5.38	6.35 (1-n)	6.35 (1-n)	3.48	4.10 (1-n)	106	52.5	3.05
		3.0	RHS	4.25	219	207	4.45	5.25 (1-n)	5.25 (1-n)	2.88	3.40 (1-n)	82.3	42.3	2.54
		2.5	RHS	3.60	186	176	3.83	4.52 (1-n)	4.52 (1-n)	2.41	2.41 (1-n)	69.7	36.5	2.21
		2.0	RHS	2.93	149	143	3.16	3.72 (1-n)	3.73 (1-n)	1.77	1.77 (1-n)	56.7	30.1	1.85
50	x 25	3.0	RHS	3.07	158	149	2.37	2.80 (1-n)	2.80 (1-n)	1.44	1.70 (1-n)	61.1	27.7	1.26
		2.5	RHS	2.62	135	128	2.07	2.44 (1-n)	2.44 (1-n)	1.26	1.49 (1-n)	52.1	24.3	1.12
		2.0	RHS	2.15	111	105	1.73	2.04 (1-n)	2.04 (1-n)	1.05	1.05 (1-n)	42.6	20.4	0.952
		1.6	RHS	1.75	90.4	85.4	1.43	1.68 (1-n)	1.68 (1-n)	0.777	0.777 (1-n)	34.7	17.0	0.800
50	x 20	3.0	RHS	2.83	146	138	2.09	2.46 (1-n)	2.46 (1-n)	1.06	1.25 (1-n)	60.3	20.4	0.942
		2.5	RHS	2.42	125	118	1.83	2.16 (1-n)	2.16 (1-n)	0.938	1.11 (1-n)	51.4	18.2	0.847
		2.0	RHS	1.99	103	97.0	1.53	1.81 (1-n)	1.81 (1-n)	0.783	0.783 (1-n)	42.0	15.6	0.730
		1.6	RHS	1.63	83.9	79.2	1.27	1.50 (1-n)	1.50 (1-n)	0.582	0.582 (1-n)	34.2	13.1	0.619

**Notes:**

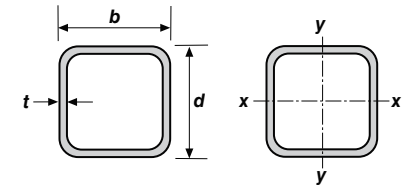
- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- $\phi M_{rx}$  (comp) refers to the design section moment capacity reduced by compression (where  $n = N^*/\phi N_s$ ) and must be less than or equal to  $\phi M_{sx}$ .
- $\phi M_{rx}$  (tens) refers to the design section moment capacity reduced by tension (where  $n = N^*/\phi N_t$ ) and must be less than or equal to  $\phi M_{sx}$ .
- $\phi M_{ry}$  refers to the design section moment capacity reduced by axial force (where  $n = N^*/\phi N_t$  or  $N^*/\phi N_s$ ) and must be less than or equal to  $\phi M_{sy}$ .
- For the design member moment capacity  $\phi M_b$ , see Table 5.3-2(3).
- For the design member capacity in compression (x-axis)  $\phi N_{sx}$ , see Table 6-4(3)(A).
- For the design member capacity in compression (y-axis)  $\phi N_{sy}$ , see Table 6-4(3)(B).
- NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**

TABLE 8-5

# Square Hollow Sections AS/NZS 1163 Grade C350L0

## DESIGN SECTION CAPACITIES

- 1 SHS
- 2 C350L0
- 3 Finish



Designation			Mass per m kg/m	Design Section Axial Capacities		Design Section Moment Capacities			Design Shear Capacities φV <sub>v</sub> kN	Torsion φM <sub>z</sub> kNm	
d	b	t		Comp φN <sub>s</sub>	Tens φN <sub>t</sub>	About x-axis					
mm	mm	mm		kN	kN	φM <sub>sx</sub> kNm	φM <sub>rx</sub> (comp) kNm	φM <sub>rx</sub> (tens) kNm			
50	x	50	x	6.0 SHS	294	294	4.58	5.40 (1-n)	5.40 (1-n)	85.1	3.34
				5.0 SHS	256	256	4.14	4.89 (1-n)	4.89 (1-n)	74.7	3.07
				4.0 SHS	215	215	3.59	4.23 (1-n)	4.23 (1-n)	62.7	2.70
				3.0 SHS	170	170	2.96	3.49 (1-n)	3.49 (1-n)	49.3	2.22
				2.5 SHS	145	145	2.54	3.00 (1-n)	3.00 (1-n)	42.0	1.93
				2.0 SHS	118	118	2.10	2.48 (1-n)	2.48 (1-n)	34.3	1.61
				1.6 SHS	95.5	95.5	1.61	1.61 (1-n)	1.61 (1-n)	28.0	1.33
40	x	40	x	4.0 SHS	164	164	2.12	2.50 (1-n)	2.50 (1-n)	47.8	1.57
				3.0 SHS	133	133	1.80	2.13 (1-n)	2.13 (1-n)	38.1	1.34
				2.5 SHS	113	113	1.56	1.85 (1-n)	1.85 (1-n)	32.7	1.17
				2.0 SHS	92.5	92.5	1.30	1.54 (1-n)	1.54 (1-n)	26.9	0.989
				1.6 SHS	75.3	75.3	1.07	1.27 (1-n)	1.27 (1-n)	22.0	0.824
35	x	35	x	3.0 SHS	114	114	1.33	1.57 (1-n)	1.57 (1-n)	32.5	0.978
				2.5 SHS	97.3	97.3	1.16	1.37 (1-n)	1.37 (1-n)	28.0	0.866
				2.0 SHS	79.9	79.9	0.975	1.15 (1-n)	1.15 (1-n)	23.1	0.735
				1.6 SHS	65.3	65.3	0.808	0.954 (1-n)	0.954 (1-n)	19.0	0.616
				30	x	30	x	3.0 SHS	94.8	94.8	0.932
2.5 SHS	81.6	81.6	0.822					0.970 (1-n)	0.970 (1-n)	23.3	0.605
2.0 SHS	67.3	67.3	0.695					0.820 (1-n)	0.820 (1-n)	19.4	0.519
1.6 SHS	55.2	55.2	0.580					0.684 (1-n)	0.684 (1-n)	16.0	0.439
25	x	25	x	3.0 SHS	75.9	75.9	0.603	0.712 (1-n)	0.712 (1-n)	21.3	0.430
				2.5 SHS	65.8	65.8	0.539	0.637 (1-n)	0.637 (1-n)	18.7	0.391
				2.0 SHS	54.7	54.7	0.462	0.545 (1-n)	0.545 (1-n)	15.7	0.341
				1.6 SHS	45.1	45.1	0.389	0.459 (1-n)	0.459 (1-n)	13.0	0.292
20	x	20	x	2.0 SHS	42.1	42.1	0.276	0.326 (1-n)	0.326 (1-n)	11.9	0.200
				1.6 SHS	35.0	35.0	0.236	0.279 (1-n)	0.279 (1-n)	10.0	0.175

**Notes:**

1. REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
2. φM<sub>r</sub> (comp) refers to the design section moment capacity reduced by compression (where n = N\*/φN<sub>s</sub>) and must be less than or equal to φM<sub>s</sub>.
3. φM<sub>r</sub> (tens) refers to the design section moment capacity reduced by tension (where n = N\*/φN<sub>t</sub>) and must be less than or equal to φM<sub>s</sub>.
4. For all SHS, the design member moment capacity (φM<sub>o</sub>) = φM<sub>s</sub>.
5. For the design member capacity in compression φN<sub>s</sub>, see Table 6-5.

**ADDITIONAL NOTES:**

(A) THE ABOVE IS THE STANDARD GRADE FOR THE LISTED PRODUCTS. SEE THE FOLLOWING TABLE FOR THESE SECTIONS LISTED IN NON-STANDARD C450PLUS.

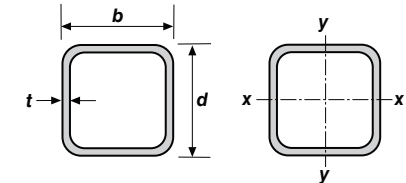
(B) SEE FOLLOWING TABLE FOR OTHER SIZES IN ATM'S LARGER RANGE OF C450PLUS PRODUCTS.

TABLE 8-6(1)

# Square Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION CAPACITIES

- 1 SHS
- 2 C450PLUS®
- 3 Finish



Designation			Mass per m kg/m	Design Section Axial Capacities		Design Section Moment Capacities			Design Shear Capacities kN	Torsion kNm	
d	b	t		Comp φN <sub>s</sub>	Tens φN <sub>t</sub>	About x-axis					
mm	mm	mm		kN	kN	φM <sub>xx</sub> kNm	φM <sub>rx</sub> (comp) kNm	φM <sub>rx</sub> (tens) kNm			
400	x 400	16.0	SHS	186	9600	9060	1350	1350 (1-n)	1350 (1-n)	2830	1060
		12.5	SHS	148	7580	7210	937	937 (1-n)	937 (1-n)	2250	856
		10.0	SHS	120	4850	5840	670	670 (1-n)	670 (1-n)	1820	703
350	x 350	16.0	SHS	161	8300	7840	1020	1210 (1-n)	1210 (1-n)	2440	790
		12.5	SHS	128	6620	6250	768	768 (1-n)	768 (1-n)	1950	644
		10.0	SHS	104	4850	5070	548	548 (1-n)	548 (1-n)	1580	530
		8.0	SHS	84.2	3110	4100	393	393 (1-n)	393 (1-n)	1280	434
300	x 300	16.0	SHS	136	7010	6620	732	864 (1-n)	864 (1-n)	2060	562
		12.5	SHS	109	5600	5290	596	703 (1-n)	703 (1-n)	1650	461
		10.0	SHS	88.4	4560	4310	436	436 (1-n)	436 (1-n)	1340	382
		8.0	SHS	71.6	3110	3490	311	311 (1-n)	311 (1-n)	1090	314
250	x 250	16.0	SHS	111	5710	5390	489	577 (1-n)	577 (1-n)	1670	373
		12.5	SHS	89.0	4590	4340	402	474 (1-n)	474 (1-n)	1350	309
		10.0	SHS	72.7	3750	3540	329	329 (1-n)	329 (1-n)	1100	258
		9.0	SHS	65.9	3400	3210	283	283 (1-n)	283 (1-n)	1000	236
		8.0	SHS	59.1	3050	2880	237	237 (1-n)	237 (1-n)	899	213
		6.0	SHS	45.0	1750	2190	154	154 (1-n)	154 (1-n)	685	165
200	x 200	16.0	SHS	85.5	4410	4170	295	348 (1-n)	348 (1-n)	1290	222
		12.5	SHS	69.4	3580	3380	246	290 (1-n)	290 (1-n)	1050	188
		10.0	SHS	57.0	2940	2780	206	243 (1-n)	243 (1-n)	864	158
		9.0	SHS	51.8	2670	2520	188	222 (1-n)	222 (1-n)	786	146
		8.0	SHS	46.5	2400	2270	168	168 (1-n)	168 (1-n)	707	132
		6.0	SHS	35.6	1750	1730	110	110 (1-n)	110 (1-n)	541	103
		5.0	SHS	29.9	1210	1460	83.8	83.8 (1-n)	83.8 (1-n)	456	87.9
150	x 150	10.0	SHS	41.3	2130	2010	109	129 (1-n)	129 (1-n)	624	82.9
		9.0	SHS	37.7	1940	1840	101	119 (1-n)	119 (1-n)	570	76.8
		8.0	SHS	33.9	1750	1650	91.5	108 (1-n)	108 (1-n)	515	70.2
		6.0	SHS	26.2	1350	1270	71.0	71.0 (1-n)	71.0 (1-n)	397	55.7
		5.0	SHS	22.1	1140	1080	54.6	54.6 (1-n)	54.6 (1-n)	336	47.8

**Notes:**

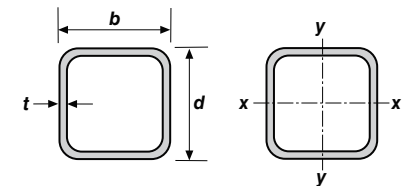
- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- $\phi M_x$  (comp) refers to the design section moment capacity reduced by compression (where  $n = N^*/\phi N_s$ ) and must be less than or equal to  $\phi M_{sx}$ .
- $\phi M_x$  (tens) refers to the design section moment capacity reduced by tension (where  $n = N^*/\phi M_t$ ) and must be less than or equal to  $\phi M_{tx}$ .
- For all SHS, the design member moment capacity ( $\phi M_{xx}$ ) =  $\phi M_{sx}$ .
- For the design member capacity in compression  $\phi N_s$ , see Table 6-6(1).

TABLE 8-6(2)

# Square Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION CAPACITIES

- 1 SHS
- 2 C450PLUS®
- 3 Finish



Designation			Mass per m kg/m	Design Section Axial Capacities		Design Section Moment Capacities			Design Shear Capacities φV <sub>v</sub> kN	Torsion φM <sub>t</sub> kNm	
d	b	t		Comp φN <sub>s</sub>	Tens φN <sub>t</sub>	About x-axis					
mm	mm	mm		kN	kN	φM <sub>sx</sub>	φM <sub>rx</sub> (comp)	φM <sub>rx</sub> (tens)			
125	x 125	10.0	SHS	33.4	1720	1630	72.0	85.0 (1-n)	85.0 (1-n)	504	54.2
		9.0	SHS	30.6	1580	1490	66.8	78.8 (1-n)	78.8 (1-n)	462	50.6
		8.0	SHS	27.7	1430	1350	61.2	72.2 (1-n)	72.2 (1-n)	419	46.6
		6.0	SHS	21.4	1110	1050	48.6	57.3 (1-n)	57.3 (1-n)	325	37.4
		5.0	SHS	18.2	937	885	41.1	41.1 (1-n)	41.1 (1-n)	276	32.3
100	x 100	10.0	SHS	25.6	1320	1250	42.6	50.3 (1-n)	50.3 (1-n)	384	31.6
		9.0	SHS	23.5	1210	1150	39.9	47.1 (1-n)	47.1 (1-n)	354	29.8
		8.0	SHS	21.4	1100	1040	36.9	43.5 (1-n)	43.5 (1-n)	323	27.8
		6.0	SHS	16.7	864	816	29.8	35.1 (1-n)	35.1 (1-n)	253	22.7
		5.0	SHS	14.2	735	694	25.7	30.4 (1-n)	30.4 (1-n)	216	19.8
90	x 90	2.5	SHS	6.74	305	329	9.03	9.03 (1-n)	9.03 (1-n)	102	8.80
		2.0	SHS	5.45	196	265	6.48	6.48 (1-n)	6.48 (1-n)	82.6	7.20
		6.0	SHS	14.7	757	715	23.0	27.1 (1-n)	27.1 (1-n)	222	17.4
		5.0	SHS	12.5	646	610	19.9	23.5 (1-n)	23.5 (1-n)	190	15.3
		3.5	SHS	9.07	468	442	14.5	14.5 (1-n)	14.5 (1-n)	138	11.5
75	x 75	2.0	SHS	5.38	196	262	6.37	6.37 (1-n)	6.37 (1-n)	81.6	7.04
		6.0	SHS	12.0	621	586	15.6	18.4 (1-n)	18.4 (1-n)	181	11.7
		5.0	SHS	10.3	532	503	13.6	16.1 (1-n)	16.1 (1-n)	156	10.4
		4.0	SHS	8.49	438	414	11.4	13.5 (1-n)	13.5 (1-n)	129	8.78
		3.5	SHS	7.53	388	367	10.2	12.1 (1-n)	12.1 (1-n)	114	7.90
65	x 65	3.0	SHS	6.60	341	322	8.99	8.99 (1-n)	8.99 (1-n)	99.4	6.98
		2.5	SHS	5.56	287	271	6.90	6.90 (1-n)	6.90 (1-n)	84.0	5.98
		2.0	SHS	4.50	196	219	4.91	4.91 (1-n)	4.91 (1-n)	68.2	4.91
		6.0	SHS	10.1	523	494	11.1	13.1 (1-n)	13.1 (1-n)	153	8.31
		5.0	SHS	8.75	451	426	9.85	11.6 (1-n)	11.6 (1-n)	132	7.43
65	x 65	4.0	SHS	7.23	373	352	8.34	9.84 (1-n)	9.84 (1-n)	109	6.36
		3.0	SHS	5.66	292	276	6.71	7.92 (1-n)	7.92 (1-n)	85.0	5.11
		2.5	SHS	4.78	247	233	5.54	5.54 (1-n)	5.54 (1-n)	72.0	4.40
		2.0	SHS	3.88	196	189	3.97	3.97 (1-n)	3.97 (1-n)	58.6	3.63
		1.6	SHS	3.13	125	153	2.84	2.84 (1-n)	2.84 (1-n)	47.5	2.98

**Notes:**

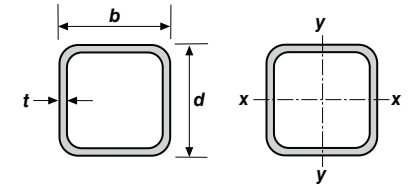
- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- $\phi M_r$  (comp) refers to the design section moment capacity reduced by compression (where  $n = N^*/\phi N_s$ ) and must be less than or equal to  $\phi M_s$ .
- $\phi M_r$  (tens) refers to the design section moment capacity reduced by tension (where  $n = N^*/\phi N_t$ ) and must be less than or equal to  $\phi M_s$ .
- For all SHS, the design member moment capacity ( $\phi M_b$ ) =  $\phi M_s$ .
- For the design member capacity in compression  $\phi N_c$ , see Table 6-6(2).

TABLE 8-6(3)

# Square Hollow Sections C450PLUS® – designed as AS/NZS 1163 Grade C450L0

## DESIGN SECTION CAPACITIES

- 1 SHS
- 2 C450PLUS®
- 3 Finish



Designation			Mass per m kg/m	Design Section Axial Capacities		Design Section Moment Capacities			Design Shear Capacities kN	Torsion kNm
d mm	b mm	t mm		Comp φN <sub>s</sub> kN	Tens φN <sub>t</sub> kN	About x-axis				
						φM <sub>xx</sub> kNm	φM <sub>rx</sub> (comp) kNm	φM <sub>rx</sub> (tens) kNm		
50	x	50 x 6.0 SHS	7.32	378	357	5.89	6.94 (1-n)	6.94 (1-n)	109	4.30
		5.0 SHS	6.39	330	311	5.33	6.29 (1-n)	6.29 (1-n)	96.0	3.95
		4.0 SHS	5.35	276	261	4.61	5.44 (1-n)	5.44 (1-n)	80.6	3.47
		3.0 SHS	4.25	219	207	3.80	4.49 (1-n)	4.49 (1-n)	63.4	2.86
		2.5 SHS	3.60	186	176	3.27	3.86 (1-n)	3.86 (1-n)	54.0	2.48
		2.0 SHS	2.93	151	143	2.66	2.66 (1-n)	2.66 (1-n)	44.2	2.07
40	x	40 x 4.0 SHS	4.09	211	199	2.73	3.22 (1-n)	3.22 (1-n)	61.4	2.02
		3.0 SHS	3.30	170	161	2.32	2.74 (1-n)	2.74 (1-n)	49.0	1.72
		2.5 SHS	2.82	145	137	2.01	2.37 (1-n)	2.37 (1-n)	42.0	1.51
		2.0 SHS	2.31	119	112	1.67	1.98 (1-n)	1.98 (1-n)	34.6	1.27
		1.6 SHS	1.88	96.9	91.5	1.36	1.36 (1-n)	1.36 (1-n)	28.3	1.06
		35	x	35 x 3.0 SHS	2.83	146	138	1.71	2.02 (1-n)	2.02 (1-n)
2.5 SHS	2.42			125	118	1.50	1.77 (1-n)	1.77 (1-n)	36.0	1.11
2.0 SHS	1.99			103	97.0	1.25	1.48 (1-n)	1.48 (1-n)	29.8	0.945
1.6 SHS	1.63			83.9	79.2	1.04	1.23 (1-n)	1.23 (1-n)	24.4	0.792
30	x	30 x 3.0 SHS	2.36	122	115	1.20	1.41 (1-n)	1.41 (1-n)	34.6	0.869
		2.5 SHS	2.03	105	99.0	1.06	1.25 (1-n)	1.25 (1-n)	30.0	0.778
		2.0 SHS	1.68	86.5	81.7	0.893	1.05 (1-n)	1.05 (1-n)	25.0	0.667
		1.6 SHS	1.38	70.9	67.0	0.746	0.880 (1-n)	0.880 (1-n)	20.6	0.564
25	x	25 x 3.0 SHS	1.89	97.5	92.1	0.776	0.915 (1-n)	0.915 (1-n)	27.4	0.553
		2.5 SHS	1.64	84.6	79.9	0.694	0.818 (1-n)	0.818 (1-n)	24.0	0.503
		2.0 SHS	1.36	70.3	66.4	0.594	0.701 (1-n)	0.701 (1-n)	20.2	0.438
		1.6 SHS	1.12	58.0	54.8	0.500	0.591 (1-n)	0.591 (1-n)	16.7	0.375
20	x	20 x 2.0 SHS	1.05	54.1	51.1	0.355	0.419 (1-n)	0.419 (1-n)	15.4	0.258
		1.6 SHS	0.873	45.0	42.5	0.304	0.359 (1-n)	0.359 (1-n)	12.9	0.224

**Notes:**

- REFER to the Australian Tube Mills **PRODUCT AVAILABILITY GUIDE (PAG)** for information on the **availability of listed sections and associated finishes**. The PAG can be found at [www.austubemills.com](http://www.austubemills.com).
- Australian Tube Mills C450PLUS products satisfy both the strength and elongation requirements of AS/NZS 1163 Grades C350L0 (with the higher elongation requirements) and C450L0 (with the higher strength requirements of  $f_y = 450$  MPa and  $f_u = 500$  MPa). See Section 2.4.2 for a detailed definition of C450PLUS.
- $\phi M_x$  (comp) refers to the design section moment capacity reduced by compression (where  $n = N^*/\phi N_s$ ) and must be less than or equal to  $\phi M_s$ .
- $\phi M_x$  (tens) refers to the design section moment capacity reduced by tension (where  $n = N^*/\phi N_t$ ) and must be less than or equal to  $\phi M_s$ .
- For all SHS, the design member moment capacity ( $\phi M_s$ ) =  $\phi M_s$ .
- For the design member capacity in compression  $\phi N_c$ , see Table 6-6(3).
- NOTE: Grey shaded listings are to C450L0 which is a non-standard grade - availability is subject to minimum order criteria. The standard grade for the shaded listings is AS/NZS 1163-C350L0. Please refer to earlier tables for design values associated with this as a standard grade. See the ATM PAG for further information on grades and availability.**



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# Part 9

## CONNECTIONS

Section	Page
9.1 Bolts	9-2
9.2 Welds	9-2
9.3 Connection Design	9-2
9.4 References	9-2

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

# Part 9

## CONNECTIONS

### 9.1 Bolts

See Ref. [9.1] for information on AS 4100 requirements, bolt types and bolting categories, design capacities of commonly used bolts, minimum edge distances and geometric/design details for bolts.

The ASI has published a suite of Guides which relate to bolts, bolt groups and bolted structural connections. These Guides are also considered in Ref. [9.1].

### 9.2 Welds

See Ref. [9.1] for information on AS 4100 requirements, weld quality, design of butt welds, design of fillet welds.

The ASI has published a suite of Guides which relate to welds, weld groups and welded structural connections. These guides are also considered in Ref. [9.1].

### 9.3 Connection Design

See Ref. [9.2] for information and connection design models for Australian Standards and practice. Ref. [9.2] also notes further quality publications for hollow section connection design.

Ref. [9.1] also provides information on general structural connections and should be consulted for such information. Additional Guides on (open section) structural steel connections are noted in Ref. [9.1].

### 9.4 References

- [9.1] ASI, "Design Capacity Tables for Structural Steel – Volume 1: Open Sections", fourth edition, Australian Steel Institute, 2009.
- [9.2] Syam, A.A. & Chapman, B.G., "Design of Structural Steel Hollow Section Connections – Volume 1: Design Models", Australian Institute of Steel Construction, 1996.

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

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