SECTION
TRANSLATION
GUIDE

Section Translation Guide
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Foreward

The design and use of structural steel in construction is relatively low in Australia compared to the United States and Britain. Where structural steel is specified in Australian construction projects, it is largely dominated by traditional hot-rolled sections such as welded and universal beams and columns.

Whilst there is no doubt that traditional structural steel sections offer benefits over other structural construction products, such sections have some distinct limitations.

At Orrcon Steel, we believe that in many design situations there is an alternative to hot-rolled structural steel sections. The answer - structural steel hollow sections! Structural steel hollow sections can offer substantial advantages particularly in relation to aesthetics, design capacities in certain situations, weight and cost.

We understand that specifiers continually strive to improve designs and the design process. As such, Orrcon Steel has taken the initiative through the development of this Section Translation Guide to assist specifiers to quickly compare alternatives.

In essence, Orrcon Steel's Section Translation Guide has been developed to simplify the process for designers to specify structural steel hollow sections in lieu of hot-rolled structural sections. The guide incorporates several major elements to achieve this:

- Design capacity data for a range of commonly specified hot-rolled structural steel sections including universal beams (UB), universal columns (UC) and parallel flange channels (PFC)
- Translation Tables and Translation Charts which contain design capacity data for a range of structural steel hollow sections supplied by Orrcon Steel
- Sectional properties for structural steel hollow sections supplied by Orrcon Steel
- A range of suggested connections

Each Translation Table comprises design capacity data for various grades of rectangular, square and circular hollow sections. The guide is arranged such that data in each Translation Table can be easily compared with design capacity data for the selected hot-rolled structural steel section. Designers can therefore easily compare and identify which hollow sections possess capacities exceeding a particular UB, UC or PFC.

Each Translation Chart diagrammatically presents the data contained in a corresponding Translation Table so designers can graphically compare and identify the hollow section sizes and gauges which exceed the design capacities of the selected UB, UC or PFC.

Translation Tables and Charts can also be used by designers to minimise over-specification often occurring when a UB, UC or PFC is used due to their limited range of sizes.

The guide also includes tabulated sectional property data for structural steel hollow sections supplied by Orrcon Steel.

A series of connection illustrations which provides designers with suggested methods of connecting structural steel hollow sections with each other and with hot-rolled structural sections is also included in the guide.

This Section Translation Guide has been produced by Orrcon Steel to provide specification information in an improved, and uniquely comparative form using a familiar industry style and feel. We believe that as building and construction industry specifiers you will find it an 'easy to use' resource for the specification of cold-formed structural steel hollow sections as a replacement of traditional open hot-rolled structural steel sections.

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Acknowledgements

Orrcon Steel would like to thank the following organisations and people who have provided constructive assistance in the development of this publication:

- Carlosus, in particular Carl Spencer and Scott Barrenger for their creative skills in artwork, graphic design and printing
- Australian Steel Institute (ASI), for their support and exposure in delivery
- Auscad Drafting Pty. Ltd., in particular Mr. John Crossley for assistance with drafting and graphics representation of our connection examples
- Its employees, in particular Senior Project Engineer, Mr. Dario G. Beccia for calculating and generating all tables, charts, diagrams, data and information in this guide and drafting introductions to each section
- S.C.P. Consulting Pty. Ltd., and Mr. Tim Hogan for content review and checking of all tables and charts

Preface

The author hopes this Section Translation Guide will provide assistance to specifiers and designers, from architects to engineers, in understanding the possibilities and assisting in easy selection and comparison of traditional hot-rolled sections with cold-formed structural steel hollow sections through conceptual to final design stages of a project, providing the possibility of alternative solutions at a glance.

In line with modern design philosophy, I have tried to emphasise the importance of adequacy for strength in bending, compression and tension situations and serviceability (deflection) and combined actions for structural steel members. Today, a distinct importance is placed on serviceability, cost and aesthetics of structural members and buildings. Thus it was imperative in compiling this Section Translation Guide to provide comparable solutions in one location.

Most of the topics have been introduced in a very general form so they may be applied to any type of structural steel member in any particular design scenario. Examples have been provided to assist in understanding the common use of the associated tables and charts for each section.

As far as possible I have tried to maintain a similar format to the ASI Design Capacity Tables Volumes 1 and 2 for ease and familiarity for those using existing methods of finding relevant data using these design capacity tables.

In closing, I would like to express great appreciation for all assistance received. Especially the guidance and advice from Mr. Tim Hogan, and support from the Australian Steel Institute.

Dario G. Beccia
Author

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1.1 Overview of Orrcon Steel

1.1.1 An Australian Company

Orrcon Steel is an Australian company, wholly owned by Hills Industries which commenced operations in Adelaide in 1946 and began manufacturing steel hollow sections in the 1950s. Orrcon Steel commenced manufacturing structural steel hollow section products in Brisbane in 1989 as Welded Tube Mills of Australia. In August 2000, Hills Industries Tubing Division entered into a joint venture with Welded Tube Mills of Australia to form Orrcon Steel with 50 percent owned by each company. In February 2005, Hills Industries acquired the remaining 50 percent stake to become the sole owner of Orrcon Steel.

1.1.2 Leading Manufacturer and Supplier of Structural Steel Hollow Sections

Orrcon Steel is a leading manufacturer and supplier of electrical resistance welded (ERW) structural and precision steel hollow sections and linepipe, and a supplier of spiral welded steel pipe. These products are used in a myriad of industries including:

- Commercial construction
- Engineering and infrastructure construction
- Residential construction
- Manufacturing
- Fire pipe
- Water, slurry and sewage pipe lines
- Oil and gas pipe lines

1.1.3 Mills and Product Range

Orrcon Steel owns and operates three structural mills in Australia; two in Brisbane and one in Wollongong. The combined capacity of these structural mills results in Orrcon Steel being the second largest manufacturer of ERW pipe and tube in Australia.

The Brisbane mills are accredited to ISO:9001 and are capable of manufacturing painted steel hollow sections in the following size ranges:

- RHS from 38x25x1.6 to 150x100x6.0mm
- SHS from 20x20x1.6 to 125x125x6.0mm
- CHS from 26.9x2.0 to 168.3x6.4mm

These mills also manufacture structural RHS, SHS and CHS in ALLGAL, Orrcon Steel's proprietary internal and external zinc coated products (for hollow sections up to and including 5mm gauge).

The Brisbane mills also manufacture a range of other shaped steel hollow sections including design rail (flat-sided round), yard rail (flat-sided oval) and silo section.

Orrcon Steel's leading world class dual API Q1 and ISO 9001:2000 certified large linepipe and structural mill (API 5L licence number - 0464) located in Wollongong is capable of manufacturing structural steel hollow sections to a maximum unit length of 24 metres in the following size ranges:

- RHS from 200x100x4.0 to 250x150x12.0mm
- SHS from 150x150x4.0 to 250x250x12.0mm
- CHS from 168.3x3.2 to 457.0x12.7mm

Structural RHS, SHS and CHS manufactured at the Wollongong mill are tested to comply with AS1163 C350L0 and C450L0 with linepipe tested to ASTM A53B, API 5L B and API 5L X42 to X70.

Orrcon Steel has also developed supply agreements with quality assured mills overseas to import a range of competitively priced steel hollow sections to complement the products Orrcon Steel manufactures in its Australian mills.

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1.1.4 Distribution Network

Orrcon Steel has distribution centres located throughout Australia, including Brisbane, Toowoomba, Sydney, Melbourne, Adelaide, Perth, Bunbury, Maddington and Mandurah. Orrcon Steel also distributes its products through a range of national steel distributors and independent stockists located throughout metropolitan and regional centres in Australia.

1.2 Focus on Building and Construction

Hills Industries has a history as a manufacturer of products for the home. Orrcon Steel has traditionally been strong in making and supplying tubular steel products for the manufacturing sector. In recent years however, Orrcon Steel has also focused on supplying structural steel hollow sections for use in the building and construction sectors. As such many thousands of tonnes of Orrcon Steel products have been used in a vast array of high profile construction projects across Australia.

1.3 Advantages of Orrcon Steel's Structural Steel Hollow Sections

The specification and application of cold-formed structural steel hollow sections in certain situations can result in tangible cost savings compared to traditional hot-rolled structural steel sections. Such cost savings arise because cold-formed structural steel hollow sections:

- offer greater design capacities than similar sized hot-rolled structural steel sections in certain design situations resulting in reduction in weight. The Translation Tables contained in this guide highlight numerous such instances.
- are aesthetically superior which can result in eliminating or reducing the need for embellishment often required for visible structural steel sections in architectural situations.
- are more aerodynamic which may result in design capacity superiority to similar sized hot-rolled structural sections.
- can possess less surface area and weight compared to equivalent structural steel sections resulting in potential savings associated with the application of finish coatings.
- possess a superior surface finish as the application of paint coatings are standard in the manufacturing process. The painted finish provides short term corrosion protection during storage and transportation resulting in easier, cheaper and faster preparation for fabrication and any final surface coatings. Conversely, hot-rolled structural sections are typically unfinished comprising mill scale and thus subject to possible premature surface corrosion.
- are available in a very broad range of sizes and wall thicknesses compared to hot-rolled structural sections which means designers have greater potential to reduce costs as substantial over-specification can be minimised.
- contain liberal radius corners which can reduce the extent of potential injury in the case of body contact.
- are far superior in terms of accommodation of services as they can disguise or hide service wiring, cabling and pipework.

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1.4 Scope of the Section Translation Guide

The scope of Orrcon Steel's Section Translation Guide is limited to the provision of data and information pertaining to hot-rolled structural steel UB, UC and PFC (Grade 300) and cold-formed structural steel hollow sections including RHS and SHS (Grades C350L0 and C450L0) and CHS (Grades C250L0 and C350L0).

As its primary purpose relates to comparisons of hot-rolled sections and cold-formed structural steel hollow sections, the Comparison Tables and Charts contained in this guide include steel hollow sections possessing capacities which equal or exceed equivalent capacities of respective UB, UC or PFC sections. Therefore, the design capacities for a range of smaller sized steel hollow sections manufactured and or supplied by Orrcon Steel are not contained in the Comparison Tables and Charts although such sizes are listed in the section properties tables and capacity tables. Designers requiring design capacities of these sections can refer to the relevant manuals produced by the ASI (Australian Steel Institute) or contact Orrcon Steel.

1.5 Relevance of this Guide to Orrcon Steel's Structural Steel Hollow Sections

The tables, charts, diagrams, data and information contained in this guide related to cold-formed structural steel hollow sections manufactured and supplied by Orrcon Steel and should not be relied upon as applying to cold-formed structural steel hollow sections manufactured or supplied by other organisations. Such products can be inferior and may differ in critical product attributes such as gauge, size, grade, tolerance, feed, physical properties, chemical requirements and quality.

1.6 Abbreviations and Descriptions

A list of abbreviations either used in or relating to the tables, charts, diagrams, data and information in this design guide is found below.

Abbreviation	Description
A_e	Effective area of a cross-section
A_g	Gross area of a cross-section
A_n	Net area of a cross-section
AS/NZS 1163	Australian/New Zealand Standard – Structural steel hollow sections
AS 4100	Australian Standard – Steel structures
ASI	Australian Steel Institute
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	Compact (section)
C	Torsional Modulus Constant
C250 (C250L0)	Cold-formed section, nominal minimum yield strength of 250MPa, impact properties tested at 0°C
C350 (C350L0)	Cold-formed section, nominal minimum yield strength of 350MPa, impact properties tested at 0°C
C450 (C450L0)	Cold-formed section, nominal minimum yield strength of 450MPa, impact properties tested at 0°C
CHS	Circular Hollow Section(s)
c_m	Factor for unequal moments
d	Depth of section
d_o	Outside diameter of a circular hollow section (CHS)
d_1	Clear depth between flanges ignoring fillets or welds

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Abbreviation	Description
E	Young's modulus of elasticity, $200x10^3$ MPa
e	Eccentricity
ERW	Electric Resistance Welding
FLR	Full Lateral Restraint
FRL	Fire Resistance Level
f_u	Tensile strength used in design
f_y	Yield stress used in design
f^*_{va}	Average design shear stress in a web
f^*_{vm}	Maximum design shear stress in a web
G	Shear modulus of elasticity, $80x10^3$ MPa; or nominal dead load
h_s	Storey height
HB 48	Steel Structures Design Handbook published by Standards Australia
I	Second moment of area of a cross-section
I_w	Warping constant for a cross-section (approximately equal to 0 for hollow sections)
I_x	I about the cross-sectional major principal axis
I_y	I about the cross-sectional minor principal 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	Load height effective length factor
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 twist restraint effective length factor
kN	Kilo newton

Abbreviation	Description
kNm	Kilo newton metre
l	Span or member length; or segment or sub-segment length
l_e	Effective length of a compression member or laterally unrestrained member
M_b	Nominal member moment capacity
M_{bx}	M_b about the major principal x-axis
M_{cx}	Lesser of M_{ix} and M_{ox}
M_i	Nominal in-plane member moment capacity
M_{ix}	M_i about the major principal x-axis
M_{iy}	M_i about the minor principal y-axis
M_o	Reference elastic buckling moment for a member subject to bending; or nominal out-of-plane member moment capacity
M_{oa}	Amended elastic buckling moment for a member subject to bending
M_{ox}	M_o about the major principal x-axis
M_{rx}	M_s about the major principal x-axis reduced by axial force
M_{ry}	M_s about the minor principal y-axis reduced by axial force
M_s	Nominal section moment capacity
M_{sx}	M_s about the major principal x-axis
M_{sy}	M_s about the minor principal y-axis
M_{tx}	Lesser of M_{rx} and M_{ox}
M^*	Design bending moment
M^*_m	Maximum calculated design bending moment along the length of a member or in a segment
M^*_x	Design bending moment about the major principal x-axis
M^*_y	Design bending moment about the minor principal y-axis
MPa	Megapascal
N	Non-compact (section)

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Abbreviation	Description
N_c	Nominal member capacity in compression
N_{cx}	N_c for member buckling about the major principal x-axis
N_{cy}	N_c for member buckling about the minor principal y-axis
N_{om}	Elastic flexural buckling load of a member
N_{omb}	N_{om} for a braced member
N_s	Nominal section capacity of a concentrically loaded compression member
N_t	Nominal section capacity in tension
N^*	Design axial force, compressive or tensile
O.D.	Outside diameter (for CHS)
P^*	Design concentrated load
Q	Nominal live load
R_b	Nominal bearing capacity of a web
R_{bb}	Nominal bearing buckling capacity
R_{by}	Nominal bearing yield capacity
R_u	Nominal capacity
r	Radius of gyration; or radius
r_x	Radius of gyration about the major principal x-axis
r_y	Radius of gyration about the minor principal y-axis
R^*	Design bearing force
RHS	Rectangular Hollow Section(s)
S	Slender (section)
S	Plastic section modulus
S_n	S about the n-axis
S_x	S about the major principal x-axis
S_y	S about the minor principal y-axis

Abbreviation	Description
S^*	Design action effect
SHS	Square Hollow Section(s)
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	Uniformly Distributed Load (UDL)
W	Total uniformly distributed applied load
w^*	Design UDL
W^*	Design total UDL
W^*_L	Strength limit state maximum design load
W^*_{S1}	Serviceability limit state maximum design load
Z	Elastic section modulus
Z_e	Effective section modulus
Z_{ex}	Z_e for bending about the major principal x-axis
Z_{ey}	Z_e for bending about the minor principal y-axis
Z_n	Z about the n-axis
Z_x	Z for bending about the major principal x-axis
Z_y	Z for bending about the minor principal y-axis
α_a	Compression member factor
α_b	Compression member section constant

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Abbreviation	Description
α_c	Compression member slenderness reduction factor
α_m	Moment modification factor for bending
α_s	Slenderness reduction factor
α_T	Coefficient of thermal expansion for steel, 11.7 x 10^{-6} per degree Celsius
α_v	Shear buckling coefficient for a web
β_m	Ratio of smaller to larger bending moments at the ends of a member
Υ	Ratio for compression member stiffness to end restraint stiffness
Δ	Deflection
Δ_s	Translational displacement of the top relative to the bottom for a storey height
δ_b	Moment amplification factor for a braced member
δ_m	Moment amplification factor, taken as the greater of δ_b and δ_s
δ_s	Moment amplification factor for a sway member
ξ	Compression member factor
η	Compression member imperfection factor
π	Pi (approximately equal to 3.14159)
λ	Slenderness ratio
λ_c	Elastic buckling load factor
λ_e	Plate element slenderness
λ_{ep}	Plate element plasticity slenderness limit
λ_{ey}	Plate element yield slenderness limit
λ_n	Modified compression member slenderness
ν	Poisson's ratio for steel, 0.25
ρ	Density for steel, 7850 kg per cubic metre
ϕ	Capacity factor

1.7 Sales, Product, Design & Engineering Support

Orrcon Steel has experienced representatives who can assist builders, specifiers and fabricators in the design, fabrication, application and purchase of structural steel hollow sections.

Sales, Product and Supply Enquiries and Support:

Manager Vic / SA / Tas, Pipelines and Infrastructure
Telephone: 03 9238 2544
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1.8 Disclaimer

The information and data presented in whole or in part by Orrcon Steel in this publication has been prepared for general information only and does not in any way constitute recommendations or professional advice. While every effort has been made and all reasonable care taken to ensure the accuracy of the information and data contained in this publication, the information and data should not be used or relied upon for any specific application without investigation and verification as to its accuracy, suitability and applicability by a competent professional person in this regard. Orrcon Steel, its officers, employees, agencies and the author of this publication do not give any warranties or make any representations in relation to the information and data provided herein and to the extent permitted by law (a) will not be held liable or responsible in any way; and (b) expressly disclaim any liability or responsibility for any loss or damage costs or expenses incurred in connection with this publication by any person. Without limitation, this includes loss, damage, costs and expenses incurred as a result of the negligence of Orrcon Steel, its agencies, the author or publishers.

The information and data in this publication should not be relied upon as a substitute for independent due diligence, professional or legal advice and in this regards the services of a competent professional person or persons should be sought.

The information and data in this publication relating to cold-formed structural steel hollow sections are only applicable to products manufactured or supplied by Orrcon Steel and are not applicable for other manufacturers' and suppliers' products which may differ in grade, size, gauge, chemical composition, tolerances, conformance to relevant standards and mechanical properties.

The product range manufactured and supplied by Orrcon Steel may change without notice.

1.9 References

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