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DuraGal®
design capacity tables for steel hollow sections

MARCH 2002

The company that published this work is now in a joint venture company named **Australian Tube Mills**. For technical support or sale enquiries please contact **Australian Tube Mills**.

This publication, the DuraGal® design capacity tables for hollow sections, is also available on CD, as part of the OneSteel Structural Products catalogue, and on our web site at www.onesteel.com

Other OneSteel Pipe & Tube technical publications and design aids that are available are:

- DuraGal design capacity tables for structural steel angles, channels & flats
- Technical Information – DuraGal Profiles, angles, channels & flats, Technical Specification TS100 (There is no Australian Standard for these products, TS100 details technical requirements for manufacture & supply)
- Technical Information – Structural Cold Formed Hollow Sections and Profiles (Product information, specifications, dimensions and properties and product availability)
- CAD Files – DFX Format Files for OneSteel Market Mills Pipe & Tube structural steel sections, both hollows and profiles, available only from the web site (www.onesteel.com)
- DuraGal Easy Welding Guide
- DuraGal Easy Painting & Corrosion Protection Guide
- DuraGal & Galtube Plus Powder Coating Guide
- Product Guide (a list of all OneSteel Market Mills Pipe & Tube products)
- DuraGal Flooring System (A bearer, joist and height adjustable pier system using DuraGal RHS)
- DuraGal Mezzanine Flooring System for commercial storage and industrial applications.
- DuraGal Post – The low maintenance steel verandah post
- DuraGal Verandah beam spanning tables
- DuraGal Plus for Lintels

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Issue (6) March 2002. Printed March 13 2002

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FOREWORD

DuraGal C450L0 Rectangular Hollow Sections offer significant benefits in the design of tubular structures of all kinds.

The high strength characteristics of DuraGal make the product design efficient in terms of mass reduction and therefore improve the economy of tubular structures.

It is strongly recommended that DuraGal hollow sections manufactured by OneSteel be specified for use when any of the design information in these design capacity tables are used. The calculations including product tolerances, mechanical properties and chemical composition have been validated by testing using only OneSteel products.

To ensure that the designers intentions are met, it is recommended that a note to this effect is included on any design documentation.

ACKNOWLEDGMENTS

OneSteel Market Mills Pipe & Tube wish to acknowledge the cooperation of the Australian Institute of Steel Construction in allowing some data from their publication “Design Capacity Tables for Structural Steel Hollow Sections” to be included in this publication.

Recognition and thanks are also due to:

- AISC Technical Services staff

in the calculation and compilation of the technical text and design capacity tables. Acknowledgment is also made of Standards of Australia permission to reprint a table from AS 4100-1998.

PREVIOUS ISSUES

June 1994

June 1996

September 1999

September 2000

July 2001 (electronic format only)

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PREFACE

DuraGal RHS is manufactured to meet the requirements of AS 1163 Grade C450L0.

The companion is necessary as the DuraGal DCT's include some research that was not available to The AISC and some design aids that were not incorparated in the AISC DCT's. The Differences are :-

- Dramatically increased segment length for full lateral restraint (FLR)[6].
- Maximum design loads for continuous, fixed end and cantilever beams.
- Elastic buckling loads (N_{om}) for various effective lengths.

INTRODUCTION

DESIGN CAPACITY TABLES

The DuraGal Design Capacity Tables have been prepared in accordance with AS 4100-1998 - Steel Structures.

Research was undertaken at the Centre for Advanced Structural Engineering, The University of Sydney[1,2] to confirm the application of those member design rules in AS 4100 applicable to the design of cold-formed sections for the determination of DuraGal Design Capacities.

The tables in this publication use the method recommended in [6] for calculating the segment length for full lateral restraint (FLR) of Rectangular Hollow Sections (RHS). OneSteel Market Mills Pipe & Tube commissioned the Centre for Advanced Structural Engineering, Civil Engineering, The University of Sydney to undertake an analytical study of the lateral buckling of RHS. The study was conducted as RHS sections rarely buckle laterally, yet AS 4100-1990 Steel Structures required a reduction in the section capacity to account for lateral buckling in RHS members with comparatively closely spaced braces. The results of the study are contained in [6] and show that the rules in AS 4100 give conservative values of FLR for RHS. The results of the analytical investigation have been confirmed by a testing program. [8]

Design capacity tables have been included for the 2.3 and 2.8 mm thick C450L0 material produced by OneSteel and are headed Non-Standard thickness. These tables are provided to allow designers to select an equivalent capacity section when converting to a OneSteel standard DuraGal section. Design capacities for sizes in thicknesses 1.6 to 6 mm are contained in tables headed Standard Thickness.

CONNECTIONS

A research program[7] has been completed at the Centre for Advanced Structural Engineering, The University of Sydney, to develop rules for the design of connections in cold-formed steel hollow sections manufactured by OneSteel. The program included DuraGal and also covered sections less than 3.0 mm thick.

Standards Australia, Amendment No. 3 to AS 4100-1990 Steel Structures, incorporated this research work and allowed the use of hollow sections to AS 1163, thinner than 3mm thick.

PLASTIC DESIGN

Another research program[10] completed at the Centre for Advanced Structural Engineering, The University of Sydney, has shown that plastic design methods can be used in the design of portal frames using DuraGal hollow sections. Typically a 15% increase in strength design capacity can result. This increase can be of most benefit in rigid frames, ie low rise portal frames such as those used in commercial/ industrial sheds, garages, farm buildings, etc, where deflection due to design loads is not a critical limit state.

The research was partially funded by CIDECT, an international committee for the development and study of tubular structures, and will eventually be incorporated in their series of design aids.

OneSteel is developing a range of proprietary fittings suitable for use in the above types of buildings. For more information ring Freecall 1800 1 STEEL (1800 1 78335) or Freefax on 1800 101 141.

GRADE

DuraGal RHS is manufactured by a unique cold forming process which ensures that it complies with the requirements of AS 1163 to both Grade C350L0 and Grade C450L0.

Grade and Mechanical Properties			
Grade	Minimum Yield Stress f_y MPa	Minimum Tensile Strength f_u MPa	Minimum elongation as a proportion of gauge length of $5.65\sqrt{S_o}$ %
C350L0/C450L0	450	500	16

L0 indicates that DuraGal has Charpy V-notch impact properties as specified in AS 1163-1991. AS4100 - 1998 Steel Structures, in section 10, permits L0 grades to have the following minimum service temperature:

Thickness - mm	Lowest One Day Mean Ambient Temperature - ^{o}C
$t \leq 6$	-30

SURFACE FINISH

External

In-line Hot dip galvanizes over a prepared metal surface to produce a fully bonded coating with a minimum average coating mass of 100 g/m^2 or approximately 14.3 microns thick, in accordance with AS/NZS 4792:1999, Hot-dip galvanized (zinc) coatings on ferrous hollow sections, applied by a continuous or a specialized process. A surface conversion coating is applied to protect the galvanizing prior to fabrication.

Internal

Black steel surface.

SIZE RANGE

Square	Rectangle
20 x 20 to 100 x 100	50 x 20 to 150 x 50

LENGTH RANGE

DuraGal is stocked by distributors in the following lengths.

Size	Standard Length - m	Non-Standard Lengths* - m
20 x 20 to 30 x 30	6.5	4.5 to 8.0
35 x 35 to 100 x 100 50 x 20 to 150 x 50	8.0	4.5 to 13.0

* Non-standard Lengths - Minimum order quantities and/or price extras may apply.

CHEMISTRY

Chemical Composition (Cast or Product), % max.						
C	Si	Mn	P	S	Al	CE
0.20	0.05	1.60	0.040	0.030	0.10	0.39

The carbon equivalent (CE) in the above is calculated for an actual composition using the following equation:

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

This value is used in AS/NZS 1554.1:2000 Structural steel welding - Welding of steel structures, to determine the welding preheat required. Steels with CE of less than 0.39 in general, do not require preheat.

TOLERANCES

Cross Section

Outside Dimension *d* or *b* mm	Maximum permissible Variation from specified outside dimension (mm)	Maximum permissible out-of-square at corners (degree)
$\leq$ 50 > 50	± 0.5 ± 0.01*d* or ± 0.01*b*	1

d = outside depth of section
b = outside breadth of section

Thickness ±10% of nominal

Mass Not less than 0.96 times nominal

Straightness $\frac{\text{Specified length}}{500}$

Twist 2 mm plus 0.5 mm per metre of length

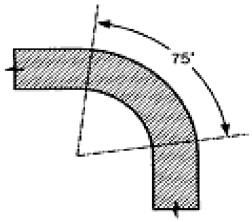
Length

Size	Mill Cut Length Tolerance*
20 x 20 to 30 x 30	- 0 + 25mm
35 x 35 to 100 x 100 50 x 20 to 150 x 50	- 0 + 50mm

* Exact lengths, subject to enquiry.

Corner Radii

Size	Typical external corner radii	Typical angle of arc
$t \leq 3$mm	2.0t	75^o
$t > 3$mm	2.5t	75^o



t = section thickness

WELDING

DuraGal is readily welded. Its thin, evenly applied galvanized coating ensures minimal welding fumes. However, the ventilation recommendations given in WTIA (Welding Technology Institute of Australia) Technical Note 7, July 1989 Table 17.2 should be observed. Mechanical dilution ventilation is advised for open work space and mechanical ventilation by local exhaust system for limited work space and confined space.

DuraGal's carbon equivalent of less than 0.39 allows it to be welded without preheat, in accordance with AS/NZS 1554.1:2000 Structural steel welding - Welding of steel structures. The following are recommended consumables.

Process	Recommended Consumables
Manual Metal-Arc (AS/NZS 1553.1)	E48XX (Grade 2)
Gas-Metal-Arc (AS/NZS 2717.1)	W502
Submerged Arc (AS 1858.1)	W502Y
Flux-Cored Arc (AS 2203.1)	W502X.X

For more advice reference should be made to the DuraGal Easy Welding Guide available from OneSteel.

Further research [5], [7] has shown that the mechanical properties of cold-formed hollow sections are not reduced by a wide range of welding operations. The grade designations of cold-formed hollow sections based on yield strength are also not affected by hot dip galvanising.

PAINTING

DuraGal's unique surface preparation and protective coating means painting and powder coating are easy and economical, and the result is a smooth attractive surface. Refer to the DuraGal Painting and Corrosion Protection Guide for more detailed information.

POWDER COATING

A degrease and zinc phosphate pretreatment prior to applying the powder coating is recommended. Refer to the OneSteel Powder Coating Guide for more detailed recommendations.

WHITE RUST

If white rust is present, this should be removed before painting. Refer to the DuraGal Easy Painting Guide for information on the removal of white rust.

PROTECTION OF WELD AFFECTED AREAS

See the DuraGal Easy Painting & Corrosion Protection Guide for information.

Copies of the painting guide can be obtained by contacting OneSteel Direct

Freecall	1800 1 STEEL (1800 1 78335)
Freefax	1800 101 141
E-mail	onesteeldirect@onesteel.com

REFERENCES

[1] Centre for Advanced Structural Engineering, The University of Sydney, “Tests to Determine the Reliability of Stub Columns of DuraGal RHS”, Investigation Report S916, August 1992.

[2] Centre for Advanced Structural Engineering, The University of Sydney, “Tests to Determine the Reliability of Beams of DuraGal RHS”, Investigation Report S917, August 1992.

[3] Hasan, S.W., Hancock, G.J., “Plastic Bending Tests of Cold-Formed Rectangular Hollow Sections”, Steel Construction, AISC, Vol.23, No.4 1989.

[4] Key, P.W., Hasan, S.W., Hancock, G.J., “Column Behaviour of Cold-Formed Hollow Sections”, Journal of Structural Engineering, ASCE, Vol. 114, No. 2, 1988.

[5] HERA, “Investigation of the Brittle Fracture Resistance of Cold-Formed Rectangular Hollow section. (Part 2)”, HERA Report R4-39, Auckland Industrial Development Division Department of Scientific and Industrial Research, 1987.

[6] Centre For Advanced Structural Engineering, Civil Engineering, The University of Sydney, “Inelastic Buckling Strength of RHS’s”, Investigation Report S941, May 1993.

[7] Centre For Advanced Structural Engineering, School of Civil and Mining Engineering, The University of Sydney, “Tests and Design of Butt Welds and Fillet Welds in DuraGal RHS Members”, Research Report No. R702, November 1994.

[8] Zhao, X-L, Hancock, G.J., and Trahair, N.S., “Lateral-Buckling Tests of Cold-Formed RHS Beams”, Journal of Structural Engineering, ASCE, Vol. 121, No. 11, 1995.

[9] Centre for Advanced Structural Engineering, School of Civil and Mining Engineering, The University of Sydney, “Behaviour of Cold-Formed Slender SHS Beam Columns”, Research Report No. R707, September 1995.

[10] Centre for Advanced Structural Engineering, School of Civil and Mining Engineering, The University of Sydney, “Plastic Design of Cold-Formed RHS”, CIDECT Project 2S-5-98, Final Report.

LIMIT STATES DESIGN USING THESE TABLES

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 for structural steel are considered in these tables - strength limit state, and where applicable, serviceability limit state.

Australian Standard AS 4100-1998 Steel Structures introduced a limit states approach to structural steel design within Australia. The code follows a semi-probabilistic limit states basis presented in a deterministic format.

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

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

Design action or design load (W^*) is the combination of the nominal actions or loads (e.g. transverse loads on a beam) imposed upon the structure, multiplied by the appropriate load factors as specified in AS 1170. These design actions/loads are identified by a superscript (*) after the appropriate action/load (e.g. W^*_L describes the design transverse load on a beam).

Design action effects (S^*) are the actions (e.g. design bending moments, shear forces, axial loads) computed from the design actions or design loads using an acceptable method of analysis. These effects are identified by a superscript (*) after the appropriate action effect (e.g. M^* describes the design bending moment).

Design capacity (ϕR_u) is the product of the nominal capacity (R_u) and the appropriate capacity factor (ϕ) found in Table 3.4 of AS 4100. R_u is determined from Sections 5 to 8 as appropriate, in AS 4100.

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

The corresponding design action effect (S^*) is the design bending moment (M^*) which is determined by:

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

where L = span of the beam

In this case the design capacity (ϕR_u) is equal to the design section moment capacity (ϕM_s), which is given by:

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

where ϕ = the capacity factor
f_y = yield stress used in design
Z_e = effective section modulus

To satisfy the requirement for strength limit state design the following relationship must be satisfied:

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

The maximum design bending moment is therefore equal to the design section moment capacity ($M^* \leq \phi M_s$), and the **maximum design load** is that design load (W^*_L) which corresponds to the maximum design bending moment. It should be noted that in this instance the bending capacity of the beam may not be the only criteria in the strength limit state which needs to be considered. (eg. shear capacity, bearing capacity).

The DCTDHS gives values of **design capacity** (ϕR_u) and **maximum design load** (W^*), where applicable, determined in accordance with AS 4100. When using these tables, the designer must determine the relevant *strength limit state* **design action** (W^*) and/or the corresponding **design action effects** (S^*) to ensure the *strength limit state* requirements of AS 4100 are satisfied. Other limit states (e.g. serviceability, fatigue) must also be considered by the designer. Section 8 of the tables contains design aids for checking the serviceability limit state for some specific beam load and support configurations.

GENERAL NOTES ON THE TABLES

CONTENTS AND USAGE

For the commonly available Australian structural steel hollow sections, tables are provided for:

(i) **section dimensions** and **section properties,** i.e:

- Dimensions and Properties (PART 1)
- Surface Areas (PART 1)
- Properties for Assessing Section Capacity to AS 4100 (PART 1)
- Properties for Fire Design (PART 1)
- Telescoping Sections (PART 1)

(ii) **design capacity** (ϕR_u) for:

- Section Capacities (PART 3)
- Members Subject to Bending (PART 4)
- Members Subject to Axial Compression (PART 5)
- Members Subject to Axial Tension (PART 6)

(iii) **elastic buckling load** (N_{om}) (PART 7)

(iv) **maximum design load** (W^*) for:

- Strength Limit State (W^*_L) *for* Beams (PART 8)
- Serviceability Limit State (W^*_S) for Beams (PART 8)
  (simply supported, continuous, fixed end and cantilever beams)

Acceptable methods of analysis for determining the **design action effects** are described in Section 4 of AS 4100 and PART 2 of this publication. Information relevant to such methods of analysis is presented briefly in PART 7 of this publication.

The above recommendations apply to predominantly statically loaded structures but also in broad principle to dynamically loaded structures subject to moderate cyclic loads, as specified in AS 4100 Section 1, Fatigue.

PROPERTIES OF STEEL

The properties of steel adopted in these tables are listed below:

Property	Symbol	Value
Elastic Modulus	E	200 x 10^3 MPa
Shear Modulus	G	80 x 10^3 MPa
Density	ρ	7850 kg/m^3
Poisson's Ratio	ν	0.25
Coefficient of Thermal Expansion	α_T	11.7 x 10^{-6} per ^{o}C

VALUES PUBLISHED IN TABLES

The design capacities given in these tables are limit states design capacities calculated in accordance with AS 4100, and must be equal to or greater than the design action effect (eg. bending moment, shear force, axial force) resulting from the design loads. These ***design loads are not working loads***, but are obtained by factoring the nominal (working) loads applied to the structure in accordance with the loading code AS 1170.

LIST OF PRINCIPAL SYMBOLS USED IN THE TABLES

A_e	effective area of a cross-section
A_g	gross area of a cross-section
A_n	net area of a cross-section
b	width of a section
b_e	effective width of a plate element
b_b, b_{bf}, b_{bw}, b_s	bearing widths defined in Section D4.3.2
C	torsional section modulus
C_m	factor for unequal moments
d	depth of a section
d_e	effective outside diameter of a circular hollow section
d_o	outside diameter of a circular hollow section
d_w	depth of web
d_1	clear depth between flanges
E	Young's modulus of elasticity
f_u	tensile strength used in design
f_y	yield stress used in design
f^*_{va}	average design shear stress in the web
f^*_{vm}	maximum design shear stress in the web
G	shear modulus of elasticity; or nominal dead load
I	second moment of area of a cross-section
I_w	warping section constant
I_x	I about the cross-sectional major principal x-axis
I_y	I about the cross-sectional minor principal y-axis
J	torsional section constant
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
L	span or member length; or segment or sub-segment length
L_e	effective length of a compression member; or effective length of a laterally unsupported flexural member
M_b	nominal member moment capacity
M_{bx}	M_b about major principal x-axis
M_{ix}	nominal in-plane member moment capacity about major principal x-axis
M_{iy}	nominal in-plane member moment capacity about minor principal y-axis
M_o	reference elastic buckling moment for a member subject to bending
M_{oa}	amended elastic buckling moment for a member subject to bending
M_{ox}	nominal out-of-plane member moment capacity about major principal x-axis
M_{rx}	M_s about major principal x-axis reduced by axial force

M_{ry} — M_s about minor principal y-axis reduced by axial force
M_s — nominal section moment capacity
M_{sx} — M_s about major principal x-axis
M_{sy} — M_s about minor principal y-axis
M_z — nominal torsional moment section capacity
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 major principal x-axis
M^*_y — design bending moment about minor principal y-axis
M^*_z — design torsional moment
N_c — nominal member capacity in compression
N_{cx} — N_c for member buckling about major principal x-axis
N_{cy} — N_c for member buckling about minor principal y-axis
N_{om} — elastic flexural buckling load of a member
N_{omb} — N_{om} for a braced member

N_{omx} — $\dfrac{\pi^2 EI_x}{(k_e L)^2}$ — N_{om} about major principal x-axis

N_{omy} — $\dfrac{\pi^2 EI_x}{(k_e L)^2}$ — N_{om} about minor principal y-axis

N_s — nominal section capacity of a concentrically loaded compression member
N_t — nominal section capacity in tension
N^* — design axial force, tensile or compressive
P — applied 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
r_{ext} — external corner radius
r_x — radius of gyration about major principal x-axis
r_y — radius of gyration about minor principal y-axis
R^* — design bearing force
S — plastic section modulus
S_x — S about major principal x-axis
S_y — S about minor principal y-axis
S^* — design action effect
t — thickness of a section
t_f — thickness of a flange
t_w — thickness of a web

V_u	nominal shear capacity of a web with a uniform shear stress distribution
V_v	nominal shear capacity of a web
V_{vx}	V_v of a member in the major principal x-axis direction
V_{vy}	V_v of a member in the minor principal y-axis direction
V^*	design shear force
W	applied load
W^*	design action
W^*_L	strength limit state maximum design load
W^*_S	serviceability limit state maximum design load
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 for bending about n-axis
Z_x	Z for bending about major principal x-axis
Z_y	Z for bending about minor principal y-axis
α_a	compression member factor (as defined in Clause 6.3.3 of AS 4100)
α_b	compression member section constant (as defined in Clause 6.3.3 of AS 4100)
α_c	compression member slenderness reduction factor
α_m	moment modification factor for bending
α_{sh}	modified slenderness reduction factor
α_T	coefficient of thermal expansion for steel
β_m	ratio of smaller to larger bending moments at the ends of a member
Δ	deflection of a member
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
η	compression member imperfection factor (as defined in Clause 6.3.3 of AS 4100)
θ	angle of twist per unit length slenderness ratio
λ_c	elastic buckling load factor
λ_e	plate element slenderness
λ_{ed}	plate element deformation slenderness limit
λ_{ep}	plate element plasticity slenderness limit
λ_{ey}	plate element yield slenderness limit
λ_n	modified compression member slenderness
ν	Poisson's ratio
ξ	compression member factor (as defined in Clause 6.3.3 of AS 4100)
π	pi ($\approx$ 3.14159)
ρ	density of a material
ϕ	capacity factor

PART 1 SECTION PROPERTIES

TABLES

NOTE: SEE PAGE vii FOR THE SPECIFIC MATERIAL STANDARD REFERRED TO BY THE SECTION TYPE AND STEEL GRADE IN THESE TABLES.

PART 1 SECTION PROPERTIES

*D*1.1 INTRODUCTION

The section property tables include all relevant section dimensions and properties necessary for assessing 'DuraGal' tubular steel structures in accordance with AS 4100 - 1998.

*D*1.2 SECTION PROPERTY TABLES

For each group of structural hollow section the tables include:

- Dimensions and Properties
- Properties for Assessing Section Capacity to AS 4100.

*D*1.2.1 Dimensions and Properties

The tables give standard dimensions and properties for DuraGal structural steel hollow sections. The second moments of area are required for serviceability calculations and the radii of gyration are required for assessing member stability. The elastic and plastic section moduli for bending about the various axes are also tabulated. These are utilised in an intermediate step to determine the effective section modulus for flexural design to AS 4100. The elastic section moduli are also used in the determination of elastic stresses where design for fatigue must be considered, or where the stress state at serviceability loads may need to be checked. The torsion constants are used in determining the torsional moment and angle of twist per unit length.

D1.2.1.1 Torsion Constants

The torsional inertia 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 $R_c = \dfrac{R_o + R_i}{2}$

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

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

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

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

as shown in Figure D1.2.1.1

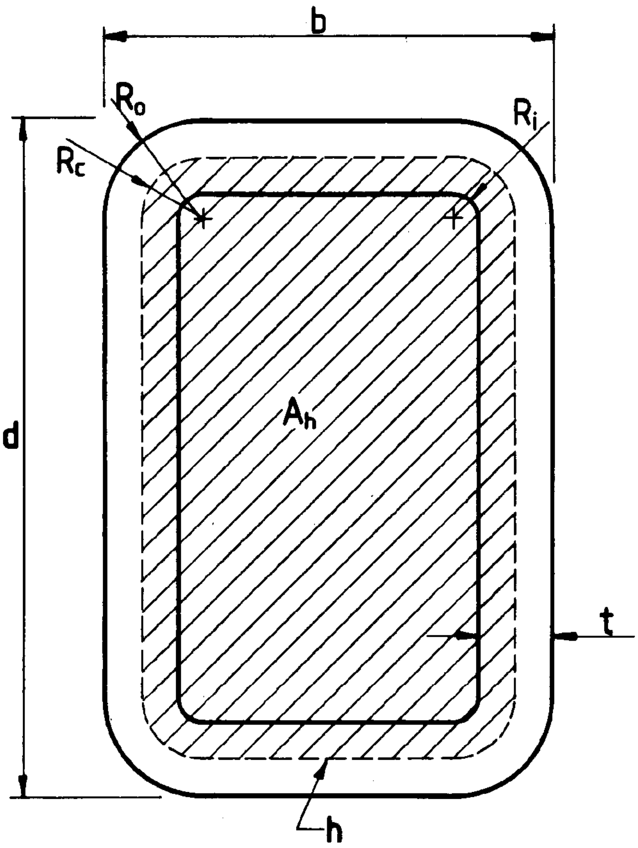


Figure D1.2.1.1: Parameters for Calculation of Torsion Constants

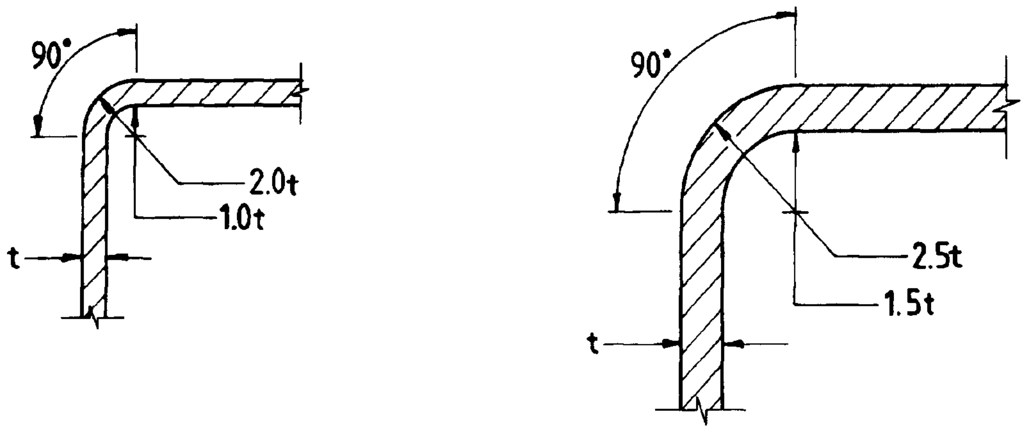
The information contained in Section D1.2.1.1 was extracted from:

- International Standard ISO 657/XIV, “Hot-rolled steel sections - Part XIV : Hot-finished structural hollow sections - Dimensions and sectional properties”, 1977.

*D*1.2.1.2 Corner Radii

The section properties presented in this publication are calculated in accordance with AS 1163.

Figure *D*1.2.1.2 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.



a) thickness 3.0 mm and less

b) thickness greater than 3.0 mm

Figure *D*1.2.1.2: Corner Geometry for Determining Section Properties

*D*1.2.2 Surface Areas

Surface area data may be used in estimating quantities of protective coatings. Tables *D*1.2-1 to *D*1.2-6 include values of external surface area per metre and external surface area per tonne.

*D*1.2.3 Properties for Assessing Section Capacities

These properties are necessary for calculating the section capacities of the structural hollow sections in accordance with AS 4100. The effective section moduli, "compactness" of section, and the form factor are tabulated according to steel grade.

*D*1.2.3.1 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.** This type of categorisation provides a measure of the relative importance of yielding and local buckling on the effective section modulus.

The tables include a column headed “compactness” where the compactness or otherwise of the sections is indicated for a given axis of bending as follows:

C compact
N non-compact
S slender

These terms are important with respect to selecting the methods of analysis that may be used to determine the design action effects (see Clause 4.5 of AS 4100) or in using the 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 structural hollow sections.

Research has shown that most DuraGal hollow sections are suitable for design by plastic analysis and AS 4100 will be revised as soon as possible. In the interim, for details of the research in a case study phone OneSteel Direct on Freecall 1800 1 STEEL (1800 1 78335) or Freefax 1800 101 141.

*D*1.2.3.2 Effective Section Modulus

Subsequent to the evaluation of “compactness” the effective section modulus (Z_e) is also tabulated. Z_e is determined by the requirements of Clauses 5.2.2 to 5.2.5 inclusive, of AS 4100 and is used in the calculation of the nominal section moment capacity (M_s) as defined in Clause 5.2.1 of AS 4100.

Table *D*1.2.3.2 gives values of plate element slenderness limits for structural hollow sections used in the determination of Z_e in Tables *D*1.2-1 to *D*1.2-4. It should be noted that the deformation limit (λ_{ed}) is only exceeded for one of the hollow sections manufactured in accordance with AS 1163 and listed in this manual. Therefore noticeable deformations (local buckling) will not occur under service loadings except for 150x50x2.0 product bent about the weak y-axis (λ_{ey} = 97.9).

Section	Element	Residual Stresses	Plasticity Limit λ_{ep}	Yield Limit λ_{ey}	Deformation Limit λ_{ed}
RHS,SHS	Compression	CF	30	40	90
	Web	CF	82	115	-

Table *D*1.2.3.2: Plate Element Slenderness Limits for Members Subject to Bending

The CF residual stress classification is used as DuraGal is manufactured in Australia by the cold forming process.

D1.2.3.3 Form Factor

The form factor (k_f) determined in accordance with Clause 6.2.2 of AS 4100 is given by:

$$k_f = \frac{A_e}{A_g}$$

where A_g = gross cross-sectional area

A_e = effective area

A_e was calculated by summing the effective areas of the individual elements whose effective widths are specified:

for RHS and SHS by

$$b_e = (b - 2t)\left(\frac{\lambda_{ey}}{\lambda_e}\right) \leq (b - 2t)$$

where b_e = effective width of section (Clause 6.2.4 of AS 4100)

b = full width of section

t = thickness of section

λ_{ey} = yield slenderness limit (see Table *D*1.2.3.3)

λ_e = plate element slenderness (see Table *D*1.2.3.3)

Table *D*1.2.3.3: Plate Element Slenderness Limits for Members Subject to Axial Compression

Section	Residual Stresses	Yield Slenderness Limit λ_{ey}	Plate Element Slenderness λ_e
RHS, SHS	CF	40	$\frac{(b-2t)}{t}\sqrt{\left(\frac{f_y}{250}\right)}$

k_f must be known in order to determine the nominal section capacity of a concentrically loaded compression member (N_s) as defined in Clause 6.2.1 of AS 4100. The calculation of k_f indicates the degree to which the column section will buckle locally before squashing (i.e. k_f = 1.0 signifies a column section which will yield rather than buckle locally in a short or stub column test). A knowledge of k_f is also important when using the provisions of Section 8 of AS 4100 for designing members subject to combined actions.

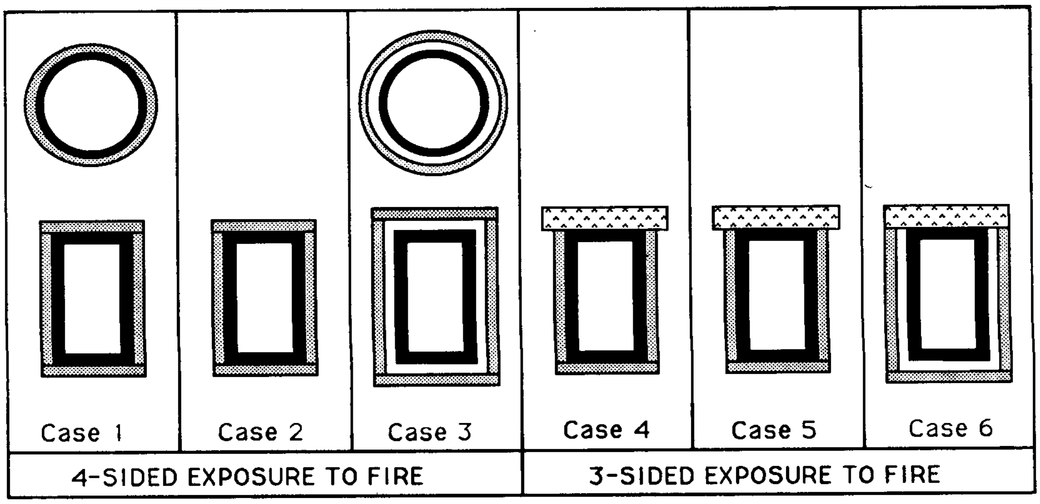
*D*1.3 PROPERTIES FOR FIRE DESIGN

To assist in the design of 'DuraGal' sections for fire resistance in accordance with Section 12 of AS 4100, values of the exposed surface area to mass ratio (k_{sm}) are tabulated for the various cases shown in Figure *D*1.3.

For **unprotected structural 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 these instances fire protection is necessary where a fire rating is required.

For members requiring the addition of fire protection materials, the "Handbook of Fire Protection Materials for Structural Steel" published by AISC [1] may be consulted to determine the thickness of proprietary materials required for a given value of k_{sm} and Fire-Resistance Level (FRL). In the AISC Handbook, the exposed surface area to mass ratio (E) may be taken as equivalent to $k_{sm.}$ (See also references[3][4])

Figure *D*1.3: Cases for Calculation of Exposed Surface Area to Mass Ratio



Cases of fire exposure considered:

1 = 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

Suggested references for Fire Design**:**

[1] Proe, D.J., Bennetts, I.D., Thomas, I.R., Szeto, W.T., "Handbook of Fire Protection Materials for Structural Steel", *Australian Institute of Steel Construction,* 1990.

[2] Bennetts, I.D., Proe, D.J., Thomas, I.R., "Guidelines for Assessment of Fire Resistance of Structural Steel Members", *Australian Institute of Steel Construction,* 1987.

[3] Thomas, I.R Bennetts, I.D and Proe, D.J., "Design of Steel Structures for Fire Resistance in Accordance with AS 4100", Steel Construction, Australian Institute of Steel Construction, Vol 26, No 3, 1992.

[4] 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, Australian Institute of Steel Construction, Vol 26, No2, 1992.

*D*1.4 TELESCOPING SECTIONS

*D*1.4.1 Scope

The tables of telescoping sections provided can be used to determine hollow sections which are suitable for telescoping.

*D*1.4.2 Method

Total available clearance is tabulated to allow designers to select sections with suitable clearance for the type of fit required. Sections with clearances less than 2.0 mm are shown **bold** in the tables. Figure *D*1.4.2 shows typical telescoping data required to select appropriate sections.

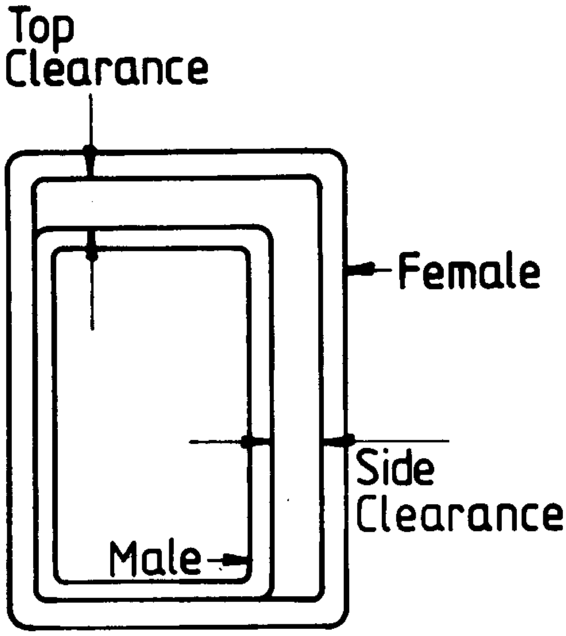
All calculations used in preparation of the tables are based on the nominal dimensions of hollow sections and manufacturing tolerances specified in AS 1163. Owing to dimensional tolerances permitted within that standard actual clearances of sections manufactured to this specification will vary marginally 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 clearances due to the larger corner radii of the thicker section.

Typical corner geometry may differ from that used for calculation of section properties and reference should be made to individual manufacturers.

a) **RHS**



b) **SHS**

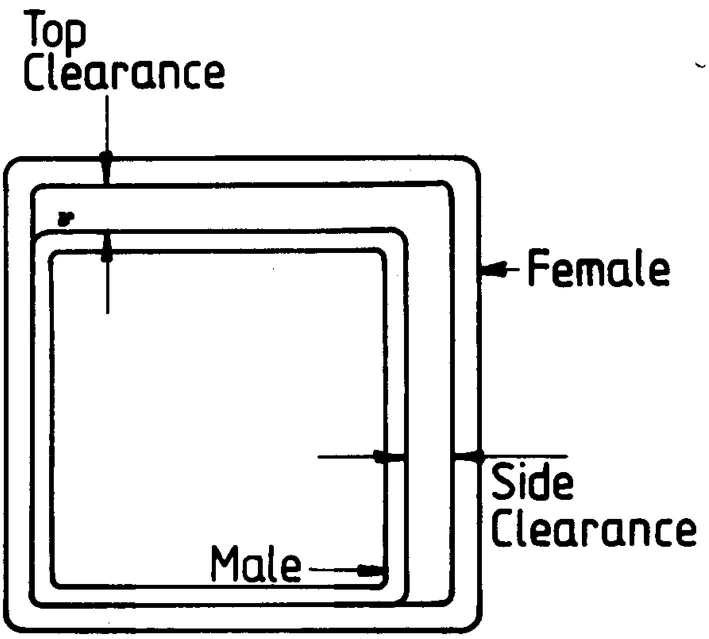


Figure *D*1.4.2: Telescoping Data

[BLANK]

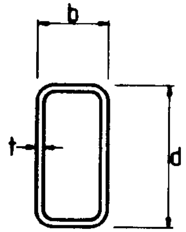
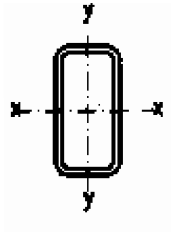


TABLE *D*1.2-1(1)

DIMENSIONS AND PROPERTIES

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Standard Thickness



DIMENSIONS AND RATIOS						PROPERTIES												PROPERTIES FOR DESIGN TO AS 4100						
Designation	Mass per m	External Surface Area		*b-2t* / *t*	*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 t		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	λ_{ex}	Compact-ness	Z_{ex}	λ_{ey}	Compact-ness	Z_{ey}
mm mm mm	kg/m	m^2/m	m^2/t			mm^2	$10^6 mm^4$	$10^3 mm^3$	$10^3 mm^3$	mm	$10^6 mm^4$	$10^3 mm^3$	$10^3 mm^3$	mm	$10^6 mm^4$	$10^3 mm^3$			(C,N,S)	$10^3 mm^3$		(C,N,S)	$10^3 mm^3$
150 x 50 x 6.0 RHS	16.7	0.374	22.4	6.33	23.0	2130	5.06	67.5	91.2	48.7	0.860	34.4	40.9	20.1	2.63	64.3	1.00	8.50	C	91.2	30.9	N	40.4
5.0 RHS	14.2	0.379	26.6	8.00	28.0	1810	4.44	59.2	78.9	49.5	0.765	30.6	35.7	20.5	2.30	56.8	1.00	10.7	C	78.9	37.6	N	31.8
4.0 RHS	11.6	0.383	32.9	10.5	35.5	1480	3.74	49.8	65.4	50.2	0.653	26.1	29.8	21.0	1.93	48.2	0.887	14.1	C	65.4	47.6	S	22.7
3.0 RHS	8.96	0.390	43.5	14.7	48.0	1140	2.99	39.8	51.4	51.2	0.526	21.1	23.5	21.5	1.50	38.3	0.713	19.7	C	51.4	64.4	S	14.5
2.5 RHS	7.53	0.391	52.0	18.0	58.0	959	2.54	33.9	43.5	51.5	0.452	18.1	19.9	21.7	1.28	32.8	0.633	24.1	C	43.5	77.8	S	10.9
2.0 RHS	6.07	0.393	64.7	23.0	73.0	774	2.08	27.7	35.3	51.8	0.372	14.9	16.3	21.9	1.04	26.9	0.553	30.9	N	31.6	97.9	S	7.64
125 x 75 x 6.0 RHS	16.7	0.374	22.4	10.5	18.8	2130	4.16	66.6	84.2	44.2	1.87	50.0	59.1	29.6	4.44	86.2	1.00	14.1	C	84.2	25.3	C	59.1
5.0 RHS	14.2	0.379	26.6	13.0	23.0	1810	3.64	58.3	72.7	44.8	1.65	43.9	51.1	30.1	3.83	75.3	1.00	17.4	C	72.7	30.9	N	50.5
4.0 RHS	11.6	0.383	32.9	16.8	29.3	1480	3.05	48.9	60.3	45.4	1.39	37.0	42.4	30.6	3.16	63.0	1.00	22.5	C	60.3	39.2	N	37.4
3.0 RHS	8.96	0.390	43.5	23.0	39.7	1140	2.43	38.9	47.3	46.1	1.11	29.5	33.3	31.1	2.43	49.5	0.845	30.9	N	46.5	53.2	S	24.2
2.5 RHS	7.53	0.391	52.0	28.0	48.0	959	2.07	33.0	40.0	46.4	0.942	25.1	28.2	31.4	2.05	42.1	0.763	37.6	N	34.7	64.4	S	18.2
2.0 RHS	6.07	0.393	64.7	35.5	60.5	774	1.69	27.0	32.5	46.7	0.771	20.6	22.9	31.6	1.67	34.4	0.624	47.6	S	24.8	81.2	S	13.0
100 x 50 x 6.0 RHS	12.0	0.274	22.8	6.33	14.7	1530	1.71	34.2	45.3	33.4	0.567	22.7	27.7	19.2	1.53	40.9	1.00	8.50	C	45.3	19.7	C	27.7
5.0 RHS	10.3	0.279	27.0	8.00	18.0	1310	1.53	30.6	39.8	34.1	0.511	20.4	24.4	19.7	1.35	36.5	1.00	10.7	C	39.8	24.1	C	24.4
4.0 RHS	8.49	0.283	33.3	10.5	23.0	1080	1.31	26.1	33.4	34.8	0.441	17.6	20.6	20.2	1.13	31.2	1.00	14.1	C	33.4	30.9	N	20.3
3.5 RHS	7.53	0.285	37.9	12.3	26.6	959	1.18	23.6	29.9	35.1	0.400	16.0	18.5	20.4	1.01	28.2	1.00	16.5	C	29.9	35.6	N	17.1
3.0 RHS	6.60	0.290	43.9	14.7	31.3	841	1.06	21.3	26.7	35.6	0.361	14.4	16.4	20.7	0.886	25.0	0.967	19.7	C	26.7	42.0	S	13.9
2.5 RHS	5.56	0.291	52.4	18.0	38.0	709	0.912	18.2	22.7	35.9	0.311	12.4	14.0	20.9	0.754	21.5	0.856	24.1	C	22.7	51.0	S	10.4
2.0 RHS	4.50	0.293	65.1	23.0	48.0	574	0.750	15.0	18.5	36.2	0.257	10.3	11.5	21.2	0.616	17.7	0.746	30.9	N	18.2	64.4	S	7.33
1.6 RHS	3.64	0.295	81.0	29.3	60.5	463	0.613	12.3	15.0	36.4	0.211	8.43	9.33	21.3	0.501	14.5	0.661	39.2	N	12.5	81.2	S	5.19

Notes:
1. For Grade C450L0 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.
2. Grade C450L0 to AS 1163 is cold-formed and therefore is allocated the CF residual stresses classification in AS 4100.
3. C =Compact Section; N = Non-compact Section; S =Slender Section; as defined in AS 4100.

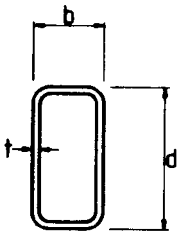
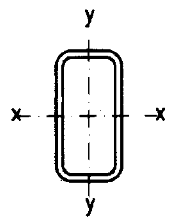


TABLE *D*1.2-1(2)

DIMENSIONS AND PROPERTIES

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0
Standard Thickness



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	t		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	λ_{ex}	Compact-ness	Z_{ex}	λ_{ey}	Compact-ness	Z_{ey}
mm	mm	mm	kg/m	m²/m	m²/t			mm²	10⁶mm⁴	10³mm³	10³mm³	mm	10⁶mm⁴	10³mm³	10³mm³	mm	10⁶mm⁴	10³mm³			(C,N,S)	10³mm³		(C,N,S)	10³mm³
75	x 50	x 6.0 RHS	9.67	0.224	23.2	6.33	10.5	1230	0.800	21.3	28.1	25.5	0.421	16.9	21.1	18.5	1.01	29.3	1.00	8.50	C	28.1	14.1	C	21.1
		5.0 RHS	8.35	0.229	27.4	8.00	13.0	1060	0.726	19.4	24.9	26.1	0.384	15.4	18.8	19.0	0.891	26.4	1.00	10.7	C	24.9	17.4	C	18.8
		4.0 RHS	6.92	0.233	33.7	10.5	16.8	881	0.630	16.8	21.1	26.7	0.335	13.4	16.0	19.5	0.754	22.7	1.00	14.1	C	21.1	22.5	C	16.0
		3.0 RHS	5.42	0.240	44.2	14.7	23.0	691	0.522	13.9	17.1	27.5	0.278	11.1	12.9	20.0	0.593	18.4	1.00	19.7	C	17.1	30.9	N	12.8
		2.5 RHS	4.58	0.241	52.7	18.0	28.0	584	0.450	12.0	14.6	27.7	0.240	9.60	11.0	20.3	0.505	15.9	1.00	24.1	C	14.6	37.6	N	9.95
		2.0 RHS	3.72	0.243	65.4	23.0	35.5	474	0.372	9.91	12.0	28.0	0.199	7.96	9.06	20.5	0.414	13.1	0.904	30.9	N	11.8	47.6	S	7.07
		1.6 RHS	3.01	0.245	81.3	29.3	44.9	383	0.305	8.14	9.75	28.2	0.164	6.56	7.40	20.7	0.337	10.8	0.799	39.2	N	8.26	60.2	S	5.01
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	10.7	C	10.1	37.6	N	4.05
		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	0.878	14.1	C	8.31	47.6	S	2.88
		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	0.746	18.3	C	6.81	60.2	S	2.02
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	9.06	C	13.3	19.1	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	13.0	C	11.0	26.4	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	16.1	C	9.45	32.2	N	5.95
		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	0.985	20.8	C	7.80	40.9	S	4.37
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	8.50	C	5.86	19.7	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	10.7	C	5.11	24.1	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	14.1	C	4.26	30.9	N	2.58
		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	18.3	C	3.53	39.2	N	1.92
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	6.26	C	5.16	19.7	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	8.05	C	4.51	24.1	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	10.7	C	3.78	30.9	N	1.93
		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	14.1	C	3.14	39.2	N	1.44

Notes:
1. For Grade C450L0 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.
2. Grade C450L0 to AS 1163 is cold-formed and therefore is allocated the CF residual stresses classification in AS 4100.
3. C =Compact Section; N = Non-compact Section; S =Slender Section; as defined in AS 4100.

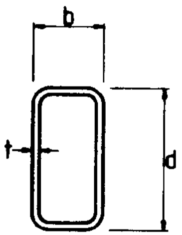
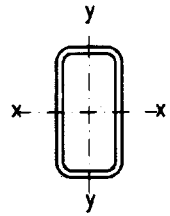


TABLE *D*1.2-2

DIMENSIONS AND PROPERTIES

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0
Non-Standard Thickness



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 t		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	λ_{ex}	Compact-ness	Z_{ex}	λ_{ey}	Compact-ness	Z_{ey}
mm mm mm	kg/m	m²/m	m²/t		mm²	10^6mm^4	10^3mm^3	10^3mm^3	mm	10^6mm^4	10^3mm^3	10^3mm^3	mm	10^6mm^4	10^3mm^3		(C,N,S)		10^3mm^3		(C,N,S)		10^3mm^3
125 x 75 x 2.8 RHS	8.39	0.390	46.5	24.8	42.6	1070	2.29	36.6	44.4	46.2	1.04	27.8	31.3	31.2	2.28	46.6	0.812	33.3	N	41.8	57.2	S	21.7
2.3 RHS	6.95	0.392	56.4	30.6	52.3	885	1.92	30.6	37.0	46.5	0.875	23.3	26.1	31.4	1.90	39.1	0.721	41.1	S	30.2	70.2	S	16.1
100 x 50 x 2.8 RHS	6.19	0.290	46.9	15.9	33.7	788	1.00	20.1	25.1	35.7	0.341	13.6	15.5	20.8	0.834	23.6	0.922	21.3	C	25.1	45.2	S	12.5
2.3 RHS	5.14	0.292	56.8	19.7	41.5	655	0.848	17.0	21.0	36.0	0.290	11.6	13.0	21.0	0.699	20.0	0.812	26.5	C	21.0	55.6	S	9.12
75 x 50 x 2.8 RHS	5.09	0.240	47.2	15.9	24.8	648	0.493	13.2	16.1	27.6	0.263	10.5	12.2	20.1	0.558	17.4	1.00	21.3	C	16.1	33.3	N	11.6
2.3 RHS	4.24	0.242	57.1	19.7	30.6	540	0.419	11.2	13.6	27.9	0.224	8.96	10.3	20.4	0.469	14.8	0.984	26.5	C	13.6	41.1	S	8.80
65 x 35 x 2.8 RHS	3.99	0.190	47.7	10.5	21.2	508	0.267	8.21	10.4	22.9	0.101	5.75	6.73	14.1	0.245	9.92	1.00	14.1	C	10.4	28.5	C	6.73
2.3 RHS	3.34	0.192	57.6	13.2	26.3	425	0.229	7.04	8.81	23.2	0.0869	4.96	5.72	14.3	0.208	8.53	1.00	17.7	C	8.81	35.2	N	5.32
50 x 25 x 2.8 RHS	2.89	0.140	48.5	6.93	15.9	368	0.107	4.27	5.57	17.0	0.0352	2.82	3.39	9.78	0.0917	4.96	1.00	9.30	C	5.57	21.3	C	3.39
2.3 RHS	2.44	0.142	58.4	8.87	19.7	310	0.0931	3.72	4.78	17.3	0.0310	2.48	2.92	10.0	0.0790	4.34	1.00	11.9	C	4.78	26.5	C	2.92
50 x 20 x 2.8 RHS	2.67	0.130	48.8	5.14	15.9	340	0.0912	3.65	4.91	16.4	0.0205	2.05	2.51	7,76	0.0594	3.73	1.00	6.90	C	4.91	21.3	C	2.51
2.3 RHS	2.25	0.132	58.6	6.70	19.7	287	0.0800	3.20	4.23	16.7	0.0183	1.83	2.18	7.98	0.0518	3.31	1 .00	8.98	C	4.23	26.5	C	2.18

Notes:
1. For Grade C450L0 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.
2. Grade C450L0 to AS 1163 is cold-formed and therefore is allocated the CF residual stresses classification in AS 4100.
3. C =Compact Section; N = Non-compact Section; S =Slender Section; as defined in AS 4100.

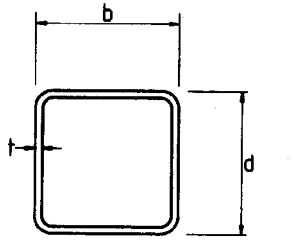
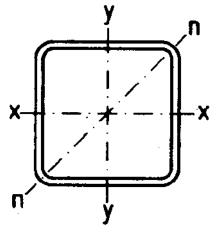


TABLE *D*1.2-3(1)

DIMENSIONS AND PROPERTIES

DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0
Standard Thickness



DIMENSIONS AND RATIOS					PROPERTIES								PROPERTIES FOR DESIGN TO AS 4100			
Designation	Mass per m	External Surface Area		$\frac{b-2t}{t}$	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_g	I_x	Z_x	Z_n	S_x	r_x	J	C	k_f	λ_e	Compactness	Z_e
mm mm mm	kg/m	m^2/m	m^2/t		mm^2	$10^6 mm^4$	$10^3 mm^3$	$10^3 mm^3$	$10^3 mm^3$	mm	$10^6 mm^4$	$10^3 mm^3$			(C,N,S)	$10^3 mm^3$
100 x100 x 6.0 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
5.0 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
4.0 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
3.0 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
2.5 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	26.2
2.0 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	19.0
90 x 90 x 3.0 SHS	8.01	0.350	43.6	28.0	1020	1.27	28.3	20.8	33.0	35.3	2.01	42.5	1.00	37.6	N	29.4
2.5 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
2.0 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	16.1
1.6 SHS	4.39	0.355	80.8	54.3	559	0.724	16.1	11.6	18.5	36.0	1.12	24.1	0.553	72.8	S	11.6
89 x 89 x 6.0 SHS	14.6	0.330	22.5	12.8	1870	2.06	46.2	36.3	56.6	33.2	3.54	71.6	1.00	17.2	C	56.6
5.0 SHS	12.5	0.334	26.7	15.8	1590	1.81	40.7	31.4	49.1	33.7	3.05	62.7	1.00	21.2	C	49.1
3.5 SHS	9.06	0.341	37.6	23.4	1150	1.37	30.9	23.2	36.5	34.5	2.24	47.1	1.00	31.4	N	35.7
75 x 75 x 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
5.0 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
4.0 SHS	8.49	0.283	33.3	16.8	1080	0.882	23.5	18.0	28.2	28.6	1.48	36.1	1.00	22.5	C	28.2
3.5 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
3.0 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
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
2.0 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	12.2
65 x 65 x 6.0 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
5.0 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
4.0 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
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
2.5 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
2.0 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
1.6 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	7.03

Notes:
1. For Grade C450L0 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.
2. Grade C450L0 to AS 1163 is cold-formed and therefore is allocated the CF residual stresses classification in AS 4100.
3. C =Compact Section; N = Non-compact Section; S =Slender Section; as defined in AS 4100.

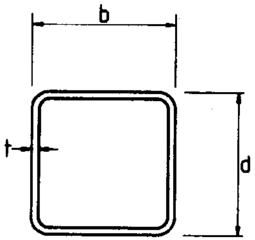
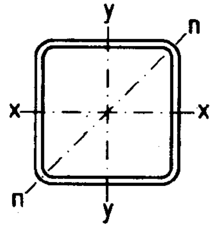


TABLE *D*1.2-3(2)

DIMENSIONS AND PROPERTIES

DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0
Standard Thickness



DIMENSIONS AND RATIOS					PROPERTIES								PROPERTIES FOR DESIGN TO AS 4100			
Designation	Mass per m	External Surface Area		$\frac{b-2t}{t}$	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_g	I_x	Z_x	Z_n	S_x	r_x	J	C	k_f	λ_e	Compactness	Z_e
mm mm mm	kg/m	m^2/m	m^2/t		mm^2	10^6mm^4	10^3mm^3	10^3mm^3	10^3mm^3	mm	10^6mm^4	10^3mm^3			(C,N,S)	10^3mm^3
50 x 50 x 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 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 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 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:
1. For Grade C450L0 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.
2. Grade C450L0 to AS 1163 is cold-formed and therefore is allocated the CF residual stresses classification in AS 4100.
3. C =Compact Section; N = Non-compact Section; S =Slender Section; as defined in AS 4100.

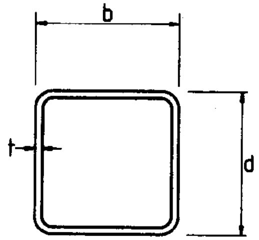
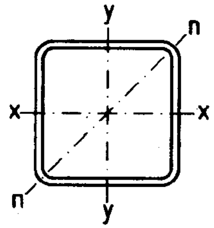


TABLE *D*1.2-4

DIMENSIONS AND PROPERTIES

DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0
Non-Standard Thickness



DIMENSIONS AND RATIOS					PROPERTIES								PROPERTIES FOR DESIGN TO AS 4100			
Designation	Mass per m	External Surface Area		$\frac{b-2t}{t}$	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_g	I_x	Z_x	Z_n	S_x	r_x	J	C	k_f	λ_e	Compactness	Z_e
mm mm mm	kg/m	m^2/m	m^2/t		mm^2	$10^6 mm^4$	$10^3 mm^3$	$10^3 mm^3$	$10^3 mm^3$	mm	$10^6 mm^4$	$10^3 mm^3$			(C,N,S)	$10^3 mm^3$
100 x 100 x 2.8 SHS	8.39	0.390	46.5	33.7	1070	1.67	33.3	24.4	38.7	39.5	2.61	50.0	0.886	45.2	S	31.0
2.3 SHS	6.95	0.392	56.4	41.5	885	1.40	27.9	20.3	32.3	39.7	2.17	41.9	0.721	55.6	S	23.1
75 x 75 x 2.8 SHS	6.19	0.290	46.9	24.8	788	0.676	18.0	13.3	21.2	29.3	1.08	27.1	1.00	33.3	N	20.1
2.3 SHS	5.14	0.292	56.8	30.6	655	0.571	15.2	11.2	17.7	29.5	0.900	22.9	0.974	41.1	S	15.0
65 x 65 x 2.3 SHS	4.42	0.252	57.0	26.3	563	0.364	11.2	8.27	13.1	25.4	0.579	16.9	1.00	35.2	N	12.1
50 x 50 x 2.8 SHS	3.99	0.190	47.7	15.9	508	0.185	7.40	5.60	8.87	19.1	0.303	11.2	1.00	21.3	C	8.87
2.3 SHS	3.34	0.192	57.6	19.7	425	0.159	6.34	4.74	7.52	19.3	0.256	9.55	1.00	26.5	C	7.52
40 x 40 x 2.8 SHS	3.11	0.150	48.3	12.3	396	0.0890	4.45	3.43	5.43	15.0	0.149	6.74	1.00	16.5	C	5.43
2.3 SHS	2.62	0.152	58.1	15.4	333	0.0773	3.86	2.93	4.64	15.2	0.127	5.83	1.00	20.6	C	4.64
35 x 35 x 2.8 SHS	2.67	0.130	48.8	10.5	340	0.0570	3.26	2.54	4.02	12.9	0.0970	4.95	1.00	14.1	C	4.02
2.3 SHS	2.25	0.132	58.6	13.2	287	0.0499	2.85	2.19	3.46	13.2	0.0831	4.32	1.00	17.7	C	3.46

Notes:
1. For Grade C450L0 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.
2. Grade C450L0 to AS 1163 is cold-formed and therefore is allocated the CF residual stresses classification in AS 4100.
3. C =Compact Section; N = Non-compact Section; S =Slender Section; as defined in AS 4100.

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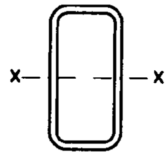
TABLE *D*1.3-1(A)

FIRE ENGINEERING DESIGN
EXPOSED SURFACE AREA TO MASS RATIO (m^2/t)

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0
Standard Thickness
about x-axis



1 = TOTAL PERIMETER, PROFILE-PROTECTED
2 = TOTAL PERIMETER, BOX-PROTECTED, NO GAP
3 = TOTAL PERIMETER, BOX-PROTECTED, 25mm GAP
4 = TOP FLANGE EXCLUDED, PROFILE-PROTECTED
5 = TOP FLANGE EXCLUDED, BOX-PROTECTED, NO GAP
6 = TOP FLANGE EXCLUDED, BOX PROTECTED, 25mm GAP

Designation d b t	Mass per m	1	2	3	4	5	6
mm mm mm	kg/m						
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
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
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
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
50 x 20 x 3.0 RHS	2.83	45.8	49.4	120	43.0	42.4	77.7
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

See page *D*1-7 for details of the cases of fire exposure considered.

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TABLE *D*1.3-1(B)

FIRE ENGINEERING DESIGN
EXPOSED SURFACE AREA TO MASS RATIO (m^2/t)

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0
Standard Thickness
about y-axis

1 = TOTAL PERIMETER, PROFILE-PROTECTED
2 = TOTAL PERIMETER, BOX-PROTECTED, NO GAP
3 = TOTAL PERIMETER, BOX-PROTECTED, 25mm GAP
4 = TOP FLANGE EXCLUDED, PROFILE-PROTECTED
5 = TOP FLANGE EXCLUDED, BOX-PROTECTED, NO GAP
6 = TOP FLANGE EXCLUDED, BOX PROTECTED, 25mm GAP

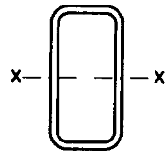
Designation d b t	Mass per m	1	2	3	4	5	6
mm mm mm	kg/m						
150 x 50 x 6.0 RHS	16.7	22.4	23.9	35.8	15.2	14.9	20.9
5.0 RHS	14.2	26.6	28.1	42.1	17.8	17.6	24.6
4.0 RHS	11.6	32.9	34.4	51.6	21.7	21.5	30.1
3.0 RHS	8.96	43.5	44.7	67.0	28.1	27.9	39.1
2.5 RHS	7.53	52.0	53.1	79.7	33.4	33.2	46.5
2.0 RHS	6.07	64.7	65.9	98.8	41.3	41.2	57.6
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
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
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
50 x 20 x 3.0 RHS	2.83	45.8	49.4	120	32.4	31.8	67.1
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

See page *D*1-7 for details of the cases of fire exposure considered.

TABLE *D*1.3-2(A)

FIRE ENGINEERING DESIGN
EXPOSED SURFACE AREA TO MASS RATIO (m^2/t)

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0
Non-Standard Thickness
about x-axis



1 = TOTAL PERIMETER, PROFILE-PROTECTED
2 = TOTAL PERIMETER, BOX-PROTECTED, NO GAP
3 = TOTAL PERIMETER, BOX-PROTECTED, 25mm GAP
4 = TOP FLANGE EXCLUDED, PROFILE-PROTECTED
5 = TOP FLANGE EXCLUDED, BOX-PROTECTED, NO GAP
6 = TOP FLANGE EXCLUDED, BOX PROTECTED, 25mm GAP

Designation d b t	Mass per m	1	2	3	4	5	6
mm mm mm	kg/m						
125 x 75 x 2.8 RHS	8.39	46.5	47.7	71.5	38.9	38.7	50.7
2.3 RHS	6.95	56.4	57.6	86.3	47.0	46.8	61.2
100 x 50 x 2.8 RHS	6.19	46.9	48.5	80.8	40.6	40.4	56.5
2.3 RHS	5.14	56.8	58.3	97.2	48.9	48.6	68.0
75 x 50 x 2.8 RHS	5.09	47.2	49.1	88.4	39.6	39.3	58.9
2.3 RHS	4.24	57.1	59.0	106	47.5	47.2	70.7
65 x 35 x 2.8 RHS	3.99	47.7	50.1	100	41.7	41.3	66.4
2.3 RHS	3.34	57.6	59.9	120	49.8	49.4	79.4
50 x 25 x 2.8 RHS	2.89	48.5	51.9	121	43.8	43.2	77.8
2.3 RHS	2.44	58.4	61.6	144	51.9	51.3	92.4
50 x 20 x 2.8 RHS	2.67	48.8	52.4	127	45.5	44.9	82.3
2.3 RHS	2.25	58.6	62.1	151	53.8	53.2	97.6

See page *D*1-7 for details of the cases of fire exposure considered.

TABLE *D*1.3-2(B)

FIRE ENGINEERING DESIGN
EXPOSED SURFACE AREA TO MASS RATIO (m^2/t)

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0
Non-Standard Thickness
about y-axis

1 = TOTAL PERIMETER, PROFILE-PROTECTED
2 = TOTAL PERIMETER, BOX-PROTECTED, NO GAP
3 = TOTAL PERIMETER, BOX-PROTECTED, 25mm GAP
4 = TOP FLANGE EXCLUDED, PROFILE-PROTECTED
5 = TOP FLANGE EXCLUDED, BOX-PROTECTED, NO GAP
6 = TOP FLANGE EXCLUDED, BOX PROTECTED, 25mm GAP

Designation d b t	Mass per m	1	2	3	4	5	6
mm mm mm	kg/m						
125 x 75 x 2.8 RHS	8.39	46.5	47.7	71.5	33.0	32.8	44.7
2.3 RHS	6.95	56.4	57.6	86.3	39.8	39.6	54.0
100 x 50 x 2.8 RHS	6.19	46.9	48.5	80.8	32.6	32.3	48.5
2.3 RHS	5.14	56.8	58.3	97.2	39.1	38.9	58.3
75 x 50 x 2.8 RHS	5.09	47.2	49.1	88.4	34.7	34.4	54.0
2.3 RHS	4.24	57.1	59.0	106	41.6	41.3	64.8
65 x 35 x 2.8 RHS	3.99	47.7	50.1	100	34.2	33.8	58.9
2.3 RHS	3.34	57.6	59.9	120	40.8	40.4	70.4
50 x 25 x 2.8 RHS	2.89	48.5	51.9	121	35.1	34.6	69.1
2.3 RHS	2.44	58.4	61.6	144	41.6	41.1	82.1
50 x 20 x 2.8 RHS	2.67	48.8	52.4	127	34.3	33.7	71.1
2.3 RHS	2.25	58.6	62.1	151	40.5	39.9	84.3

See page *D*1-7 for details of the cases of fire exposure considered.

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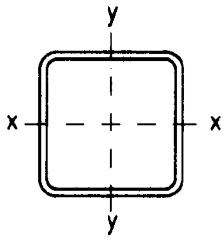
TABLE *D*1.3-3

FIRE ENGINEERING DESIGN
EXPOSED SURFACE AREA TO MASS RATIO (m^2/t)

DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0
Standard Thickness
about x- and y-axis



1 = TOTAL PERIMETER, PROFILE-PROTECTED
2 = TOTAL PERIMETER, BOX-PROTECTED, NO GAP
3 = TOTAL PERIMETER, BOX-PROTECTED, 25mm GAP
4 = TOP FLANGE EXCLUDED, PROFILE-PROTECTED
5 = TOP FLANGE EXCLUDED, BOX-PROTECTED, NO GAP
6 = TOP FLANGE EXCLUDED, BOX PROTECTED, 25mm GAP

Designation d b t	Mass per m	1	2	3	4	5	6
mm mm mm	kg/m						
100 x 100 x 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 3.0 SHS	8.01	43.6	44.9	69.9	33.9	33.7	46.2
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
1.6 SHS	4.39	80.8	82.0	128	61.7	61.5	84.3
89 x 89 x 6.0 SHS	14.6	22.5	24.3	37.9	18.5	18.2	25.0
5.0 SHS	12.5	26.7	28.5	44.5	21.6	21.3	29.3
3.5 SHS	9.06	37.6	39.3	61.4	29.7	29.5	40.5
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
50 x 50 x 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
1.6 SHS	2.38	81.7	84.0	168	63.4	63.0	105
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	120	37.7	37.1	72.4
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 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 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 1.6 SHS	0.873	85.4	91.7	321	69.8	68.8	183

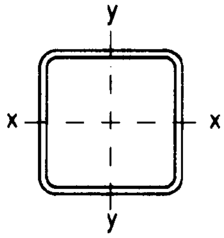
See page *D*1-7 for details of the cases of fire exposure considered.

TABLE *D*1.3-4

FIRE ENGINEERING DESIGN
EXPOSED SURFACE AREA TO MASS RATIO (m^2/t)

DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0
Non-Standard Thickness
about x- and y-axis

1 = TOTAL PERIMETER, PROFILE-PROTECTED
2 = TOTAL PERIMETER, BOX-PROTECTED, NO GAP
3 = TOTAL PERIMETER, BOX-PROTECTED, 25mm GAP
4 = TOP FLANGE EXCLUDED, PROFILE-PROTECTED
5 = TOP FLANGE EXCLUDED, BOX-PROTECTED, NO GAP
6 = TOP FLANGE EXCLUDED, BOX PROTECTED, 25mm GAP



Designation d b t	Mass per m	1	2	3	4	5	6
mm mm mm	kg/m						
100 x 100 x 2.8 SHS	8.39	46.5	47.7	71.5	36.0	35.8	47.7
2.3 SHS	6.95	56.4	57.6	86.3	43.4	43.2	57.6
75 x 75 x 2.8 SHS	6.19	46.9	48.5	80.8	36.6	36.4	52.5
2.3 SHS	5.14	56.8	58.3	97.2	44.0	43.7	63.2
65 x 65 x 2.3 SHS	4.42	57.0	58.8	104	44.4	44.1	66.7
50 x 50 x 2.8 SHS	3.99	47.7	50.1	100	38.0	37.6	62.6
2.3 SHS	3.34	57.6	59.9	120	45.3	44.9	74.9
40 x 40 x 2.8 SHS	3.11	48.3	51.4	116	39.1	38.6	70.7
2.3 SHS	2.62	58.1	61.2	138	46.4	45.9	84.1
35 x 35 x 2.8 SHS	2.67	48.8	52.4	127	39.9	39.3	76.7
2.3 SHS	2.25	58.6	62.1	151	47.1	46.6	90.9

See page *D*1-7 for details of the cases of fire exposure considered.

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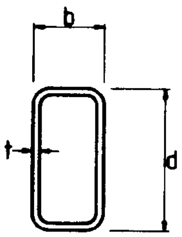
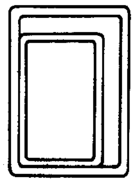
TABLE *D*1.4-1

DuraGal TELESCOPING INFORMATION

RECTANGULAR HOLLOW SECTIONS





Female (outer)			Nominal Clearance		Male (inner)	
d mm	b mm	t mm	Top mm	Side mm	d mm	b mm
125	75	6.0	13.0	13.0	100	50
125	75	5.0	15.0	15.0	100	50
125	75	4.0	17.0	17.0	100	50
125	75	3.0	19.0	19.0	100	50
125	75	2.8*	19.4	19.4	100	50
125	75	2.5	20.0	20.0	100	50
125	75	2.3*	20.4	20.4	100	50
125	75	2.0	21.0	21.0	100	50
100	50	6.0	23.0	3.0	65	35
100	50	5.0	25.0	5.0	65	35
100	50	4.0	27.0	7.0	65	35
100	50	3.5	28.0	8.0	65	35
100	50	3.0	29.0	9.0	65	35
100	50	2.8*	29.4	9.4	65	35
100	50	2.5	30.0	10.0	65	35
100	50	2.3*	30.4	10.4	65	35
100	50	2.0	31.0	11.0	65	35
100	50	1.6	31.8	11.8	65	35
100	50	6.0	13.0	13.0	75	25
100	50	5.0	15.0	15.0	75	25
100	50	4.0	17.0	17.0	75	25
100	50	3.5	18.0	18.0	75	25
100	50	3.0	19.0	19.0	75	25
100	50	2.8*	19.4	19.4	75	25
100	50	2.5	20.0	20.0	75	25
100	50	2.3*	20.4	20.4	75	25
100	50	2.0	21.0	21.0	75	25
100	50	1.6	21.8	21.8	75	25
75	50	6.0	13.0	13.0	50	25
75	50	5.0	**0.0**	5.0	65	35
75	50	4.0	2.0	7.0	65	35
75	50	3.0	4.0	9.0	65	35
75	50	2.8*	4.4	9.4	65	35
75	50	2.5	5.0	10.0	65	35
75	50	2.3*	5.4	10.4	65	35
75	50	2.0	6.0	11.0	65	35
75	50	1.6	6.8	11.8	65	35

Female (outer)			Nominal Clearance		Male (inner)	
d mm	b mm	t mm	Top mm	Side mm	d mm	b mm
75	25	2.5	20.0	**0.0**	50	20
75	25	2.0	21.0	**1.0**	50	20
75	25	1.6	21.8	**1.8**	50	20
65	35	4.0	7.0	2.0	50	25
65	35	3.0	9.0	4.0	50	25
65	35	2.8*	9.4	4.4	50	25
65	35	2.5	10.0	5.0	50	25
65	35	2.3*	10.4	5.4	50	25
65	35	2.0	11.0	6.0	50	25
50	25	3.0	NO SECTION AVAILABLE			
50	25	2.8*				
50	25	2.5				
50	25	2.3*				
50	25	2.0				
50	25	1.6				
50	20	3.0	NO SECTION AVAILABLE			
50	20	2.8*				
50	20	2.5				
50	20	2.3*				
50	20	2.0				

* Non-Standard thickness

Note:
RHS is not a precision tube and all dimensions 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. SIZES WITH A CLEARANCE LESS THAN 2.0 mm ARE SHOWN BOLDER IN THE CHARTS. For tight fits it is recommended that some form of testing is carried out prior to committing material. Where telescoping over some length is required, additional allowance may be needed for straightness.

HOW TO USE THIS CHART

1. Select the size of Female (or outer) member closest to your requirements from the left hand column.
2. Depending on the application select the clearance required between the two members. 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.
3. Having selected the most suitable clearance for your application, take the appropriate size of the Male (inner) section from the right hand column, eg.

Female Section (outer)	Clearance mm	Male Section (inner)
75 x 50 x 3.0	4.0 x 9.0	65 x 35

Note that the clearance is total available difference between member dimensions, not the gap on both sides.

4. 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.
5. RHS has the obvious advantage that its shape prevents rotation of the section.
6. Press Fit: for short pieces with no need for separation or sliding an interference fit can be achieved using the ductility of the steel. Sizes where clearance is shown as 0.0 may occasionally require press fit.

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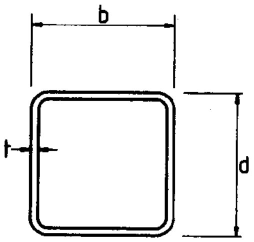
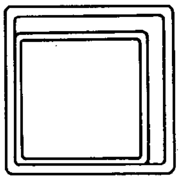


TABLE D1.4-2

DuraGal TELESCOPING INFORMATION

SQUARE HOLLOW SECTIONS



Female (outer)			Nominal Clearance		Male (inner)	
d mm	b mm	t mm	Top mm	Side mm	d mm	b mm
100	100	6.0	13.0	13.0	75	75
100	100	5.0	15.0	15.0	75	75
100	100	4.0	17.0	17.0	75	75
100	100	3.0	19.0	19.0	75	75
100	100	2.8*	19.4	19.4	75	75
100	100	2.5	20.0	20.0	75	75
100	100	2.3*	20.4	20.4	75	75
100	100	2.0	21.0	21.0	75	75
100	100	6.0	13.0	13.0	75	75
100	100	5.0	**0.0**	**0.0**	90	90
100	100	4.0	2.0	2.0	90	90
100	100	3.0	3.0	3.0	90	90
100	100	2.8*	4.4	4.4	90	90
100	100	2.5	5.0	5.0	90	90
100	100	2.3*	5.4	5.4	90	90
100	100	2.0	6.0	6.0	90	90
90	90	3.0	9.0	9.0	75	75
90	90	2.5	10.0	10.0	75	75
90	90	2.0	11.0	11.0	75	75
90	90	1.6	11.8	11.8	75	75
89	89	6.0	**1.9**	**1.9**	75	75
89	89	5.0	3.9	3.9	75	75
89	89	3.5	6.9	6.9	75	75
75	75	6.0	13.0	13.0	50	50
75	75	5.0	**0.0**	**0.0**	65	65
75	75	4.0	2.0	2.0	65	65
75	75	3.5	3.0	3.0	65	65
75	75	3.0	4.0	4.0	65	65
75	75	2.8*	4.4	4.4	65	65
75	75	2.5	5.0	5.0	65	65
75	75	2.3*	5.4	5.4	65	65
75	75	2.0	6.0	6.0	65	65
65	65	6.0	3.0	3.0	50	50
65	65	5.0	5.0	5.0	50	50
65	65	4.0	7.0	7.0	50	50
65	65	3.0	9.0	9.0	50	50
65	65	2.5	10.0	10.0	50	50
65	65	2.3*	10.4	10.4	50	50
65	65	2.0	11.0	11.0	50	50
65	65	1.6	11.8	11.8	50	50

Female (outer)			Nominal Clearance		Male (inner)	
d mm	b mm	t mm	Top mm	Side mm	d mm	b mm
50	50	5.0	**0.0**	**0.0**	40	40
50	50	4.0	2.0	2.0	40	40
50	50	3.0	4.0	4.0	40	40
50	50	2.8*	4.4	4.4	40	40
50	50	2.5	5.0	5.0	40	40
50	50	2.3*	5.4	5.4	40	40
50	50	2.0	6.0	6.0	40	40
50	50	1.6	6.8	6.8	40	40
40	40	4.0	2.0	2.0	30	30
40	40	3.0	4.0	4.0	30	30
40	40	2.8*	4.4	4.4	30	30
40	40	2.5	**0.0**	**0.0**	35	35
40	40	2.3*	**0.4**	**0.4**	35	35
40	40	2.0	**1.0**	**1.0**	35	35
40	40	1.6	**1.8**	**1.8**	35	35
35	35	3.0	4.0	4.0	25	25
35	35	2.8*	4.4	4.4	25	25
35	35	2.5	**0.0**	**0.0**	30	30
35	35	2.3*	**0.4**	**0.4**	30	30
35	35	2.0	**1.0**	**1.0**	30	30
35	35	1.6	**1.8**	**1.8**	30	30
30	30	2.0	**1.0**	**1.0**	25	25
30	30	1.6	**1.8**	**1.8**	25	25
25	25	2.5	**0.0**	**0.0**	20	20
25	25	2.0	**1.0**	**1.0**	20	20
25	25	1.6	**1.8**	**1.8**	20	20
20	20	1.6	**1.8**	**1.8**	15	15

* Non-Standard thickness

Note:
RHS is not a precision tube and all dimensions 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. SIZES WITH A CLEARANCE LESS THAN 2.0 mm ARE SHOWN BOLDER IN THE CHARTS. For tight fits it is recommended that some form of testing is carried out prior to committing material. Where telescoping over some length is required, additional allowance may be needed for straightness.

HOW TO USE THIS CHART

1. Select the size of Female (or outer) member closest to your requirements from the left hand column.
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3. Having selected the most suitable clearance for your application, take the appropriate size of the Male (inner) section from the right hand column, eg.

Female Section (outer)	Clearance mm	Male Section (inner)
75 x 75 x 3.0	4.0 x 4.0	65 x 65

Note that the clearance is total available difference between member dimensions, not the gap on both sides.

4. 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.
5. RHS has the obvious advantage that its shape prevents rotation of the section.
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PART 2 DETERMINATION OF DESIGN ACTION EFFECTS

2

PAGE

PART 2 DETERMINATION OF DESIGN ACTION EFFECTS

*D*2.1 METHODS OF ANALYSIS

The methods of structural analysis that are recognised in AS 4100 and most likely to be used for structural hollow sections are:

a) First-order elastic analysis

b) First-order elastic analysis with moment amplification (Clause 4.4.2 of AS 4100)

c) Second-order elastic analysis in accordance with Appendix E of AS 4100

Plastic analysis is currently not permitted by AS 4100 for structural steel hollow sections, although research [1] has already been performed to establish the suitability of square and rectangular hollow sections.

*D*2.2 SECOND-ORDER EFFECTS

When combined bending and axial compression forces are present in members, SECOND-ORDER EFFECTS must be considered. Second-order bending moments are often classified as PΔ which arise from the relative end displacements (Δ), or as Pδ which arise from the member deflecting (δ) from a straight line joining the member's ends (Figure *D*2.2). In **braced frames** the relative member end displacements (δ) are small, and consideration is only given to the Pδ effects. In **sway frames** the PΔ effects are often more significant than the Pδ effects.

*D*2.3 USE OF TABLES

The tabulated values in PARTS 4, 5 and 6 may be used for design in those cases where second-order effects:

- can be neglected
- are accounted for using moment amplification factors in conjunction with a first-order elastic analysis
- are accounted for in a second-order elastic analysis

[1] Centre for Advanced Structural Engineering, School of Civil and Mining Engineering, The University of Sydney, "Plastic Design of Cold-Formed RHS", CIDECT Project 2S-5-98, Final Report.

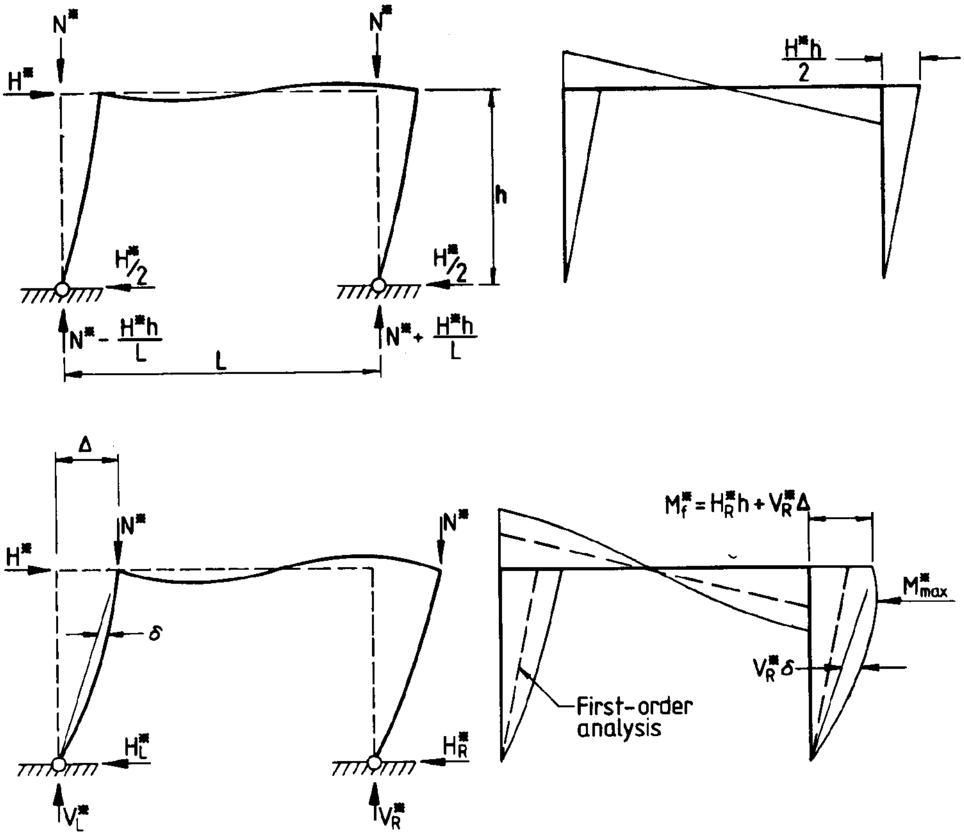

Figure *D*2.2: First-order Analysis and Second-order Behaviour

*D*2.4 USE OF ANALYSIS METHODS

*D*2.4.1 First-order Elastic Analysis

This method can be used to analyse members which do not have second-order effects. They are members with:

- bending moments only
- axial tension force only
- combined bending moments and tension force

*D*2.4.2 First-order Elastic Analysis with Moment Amplification

This method can be used to analyse members with combined bending and axial compression and when the moment amplification factors δ_b or δ_s (see Clauses 4.4.2.2 and 4.4.2.3 of AS 4100) are less than 1.4 (i.e. when second-order effects are less than 40%). The maximum moment in the member M^*_m as determined by the first-order elastic analysis, is multiplied by the moment amplification factor δ_b or δ_s. See PART 7, Figures *D*7.3(1) and *D*7.3(2) for the determination of δ_b and δ_s respectively.

*D*2.4.3 Second-order Elastic Analysis in Accordance with Appendix E of AS 4100

This method can be used to analyse members with combined bending and axial compression and must be used when the moment amplification factors δ_b or δ_s are greater than 1.4 (i.e. when second-order effects are greater than 40%).

A suitable computer analysis program is normally used due to the iterative nature of this analysis.

PART 3 SECTION CAPACITIES

3

PAGE

TABLES

TABLES _D_3.1-1 to _D_3.1-4

NOTE: SEE PAGE vii FOR THE SPECIFIC MATERIAL STANDARD REFERRED TO BY THE SECTION TYPE AND STEEL GRADE IN THESE TABLES.

PART 3 SECTION CAPACITIES

*D*3.1 SCOPE

The following tables give values of design section capacities for axial tension (ϕN_t), axial compression (ϕN_s), moment (ϕM_s), shear (ϕV_v) and torsional moment (ϕM_z).

*D*3.2 METHOD

The determination of each of the design section capacities (Tables *D*3.1-1 to *D*3.1-4) is detailed in Sections *D*3.2.1 to *D*3.2.5. PART 3 of the Tables contains design **section** capacities whilst PART 4 to PART 6 contain design **member** capacities. Section capacities give the maximum capacity of a section subjected to design action effects. Member capacities are determined by reducing the section capacities by factors accounting for restraints and loading conditions.

*D*3.2.1 Design Section Capacity for Axial Tension

The design section capacity for axial tension (ϕN_t) is determined from Clauses 7.1 and 7.2 of AS 4100 as the *lesser* of:

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

and $$\phi N_t = \phi\, 0.85\, K_t\, A_n\, f_u$$

where ϕ = 0.9 (Table 3.4 of AS 4100)
A_g = gross cross-sectional area
f_y = yield stress used in design
K_t = 1.0
A_n = net section area
= A_g
= gross cross-sectional area (assuming full perimeter welded connections with no penetrations or holes)
f_u = tensile strength used in design

*D*3.2.2 Design Section Capacity for Axial Compression

The design section capacity for axial compression (ϕN_s) *is* determined from Clauses 6.1 and 6.2 of AS 4100 as:

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

where ϕ = 0.9 (Table 3.4 of AS 4100)
k_f = A_e / A_g (see section *D*1.2.3.3 and Tables *D*1.2-1 to *D*1.2-4)
A_n = net section area
= A_g
= gross cross-sectional area (assuming no penetrations or holes)
f_y = yield stress used in design

*D*3.2.3 Design Moment Section Capacity

The design moment section capacity (ϕM_s) is determined from Clauses 5.1 and 5.2.1 of AS 4100 as:

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

where ϕ = 0.9 (Table 3.4 of AS 4100)
f_y = yield stress used in design
Z_e = effective section modulus (see Section *D*1.2.3.2 and Tables *D*1.2-1 to *D*1.2-4).

Values of the design section moment capacity (ϕM_s) can be found in the tables for members bent about either principal x- or y-axis. It should be noted that the design member capacity in the minor principal y-axis is the design section capacity (ϕM_s). For members which are fully restrained against flexural buckling the design member moment capacity equals the full section moment capacity (ϕM_s).

*D*3.2.4 Design Shear Capacity of a Web

The design shear capacity of a web (ϕV_v) is determined from Clauses 5.11.3 and 5.11.4 of AS 4100, for RHS and SHS and as the ***lesser*** of:-

$$\phi V_v = 0.6\,\phi\, f_y\,(d - 2t)\,2t \qquad \text{(Clause 5.11.4 of AS 4100)}$$

and

$$\phi V_v = \frac{2\phi V_u}{0.9 + \left(\dfrac{f^*_{vm}}{f^*_{va}}\right)} \qquad \text{(Clause 5.11.3 of AS 4100)}$$

where ϕ = 0.9 (Table 3.4 of AS 4100)
f_y = yield stress used in design
d = full depth
t = thickness of section
V_u = $0.6 f_y (d-2t) 2t$
f^*_{va} = average design shear stress in the web
f^*_{vm} = maximum design shear stress in the web

The ratio of maximum to average design shear stress in the web (f^*_{vm}/f^*_{va}) for bending about the x-axis is calculated [1] 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 the clear depth between flanges (d_1) for RHS and SHS.

[1] Bridge, R.Q., Trahair, N.S., "Thin Walls Beams", *Steel Construction*, AISC, Vol. 15, No.1, 1981.

*D*3.2.5 Design Torsional Moment Section Capacity

The design torsional moment section capacity (ϕM_z) *is* determined in accordance with Sections *D*3.2.5.1 and *D*3.2.5.2.

*D*3.2.5.1 Introduction

Although AS 4100 makes no provision for the design of members subject to torsion it is nevertheless considered appropriate to supply torsional capabilities 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 the references listed in Section *D*3.2.5.2.

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 torsion.

When the torsional moment that is applied is non-uniform, such as when the torsional load is applied midspan between rigid supports or when the free warping of the sections 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.

*D*3.2.5.2 Method

For hollow sections, torsional actions can be considered using the following formulae:

$$M^*_z \leq \phi M_z$$

$$\phi M^*_z = \phi\ 0.6\ f_y\ C$$

where M^*_z = design torsional moment
ϕ = 0.9 (Table 3.4 of AS 4100)
ϕM_z = design torsional moment section capacity
f_y = yield stress used in design
C = torsional section modulus

Note: The angle of twist per unit length θ (radians) can be determined using the following formula:

$$\phi = \frac{M^*_z}{GJ}$$

where M^*_z = design torsional moment for serviceability limit state
G = 80 x 10^3 MPa
J = torsional section constant

The method for determining the torsion sections constants *C* and *J* is detailed in Section *D*1.2.1.1.

Suggested references for design for torsion:

[1] "AS 4100 Supplement 1-1990: Steel Structures Commentary (Supplementary to AS 4100-1990)", Standards Australia, Section C8.5.

[2] Trahair, N.S.,Bradford, M.A., "The Behaviour and Design of Steel Structures", 2nd ed., Chapman and Hall, London, 1998.

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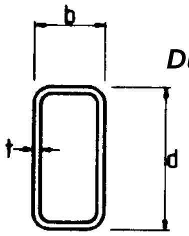
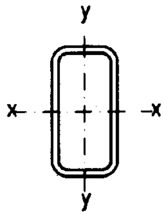
TABLE *D*3.1-1

DESIGN SECTION CAPACITIES

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Standard Thickness
about x- and y-axis





Designation d b t	Mass per m	Axial Tension ϕN_t		Axial Compression ϕN_s	Bending x-axis ϕM_{sx}	Bending y-axis ϕM_{sy}	Shear x-axis ϕV_{vx}		Shear y-axis ϕV_{vy}		Torsion ϕM_z
mm mm mm	kg/m	kN		kN	kNm	kNm	kN		kN		kNm
150 x 50 x 6.0 RHS	16.7	816	F	864	36.9	16.4	374	N	111	U	15.6
5.0 RHS	14.2	694	F	735	31.9	12.9	316	N	97.2	U	13.8
4.0 RHS	11.6	567	F	526	26.5	9.19	257	N	81.6	U	11.7
3.0 RHS	8.96	436	F	329	20.8	5.89	195	N	64.2	U	9.30
2.5 RHS	7.53	367	F	246	17.6	4.40	164	N	54.7	U	7.97
2.0 RHS	6.07	296	F	173	12.8	3.10	92.5	B	44.7	U	6.55
125 x 75 x 6.0 RHS	16.7	816	F	864	34.1	23.9	317	N	184	U	21.0
5.0 RHS	14.2	694	F	735	29.5	20.5	269	N	158	U	18.3
4.0 RHS	11.6	567	F	600	24.4	15.1	219	N	130	U	15.3
3.0 RHS	8.96	436	F	390	18.8	9.80	167	N	101	U	12.0
2.5 RHS	7.53	367	F	296	14.1	7.39	140	N	85.1	U	10.2
2.0 RHS	6.07	296	F	196	10.0	5.27	113	N	69.0	U	8.36
100 x 50 x 6.0 RHS	12.0	586	F	621	18.4	11.2	244	N	111	U	9.94
5.0 RHS	10.3	503	F	532	16.1	9.88	208	N	97.2	U	8.87
4.0 RHS	8.49	414	F	438	13.5	8.23	170	N	81.6	U	7.58
3.5 RHS	7.53	367	F	388	12.1	6.92	151	N	73.1	U	6.85
3.0 RHS	6.60	322	F	329	10.8	5.63	131	N	64.2	U	6.08
2.5 RHS	5.56	271	F	246	9.18	4.22	110	N	54.7	U	5.22
2.0 RHS	4.50	219	F	173	7.37	2.97	88.9	N	44.7	U	4.31
1.6 RHS	3.64	177	F	124	5.05	2.10	71.7	N	36.4	U	3.53
75 x 50 x 6.0 RHS	9.67	471	F	499	11.4	8.56	178	N	111	U	7.11
5.0 RHS	8.35	407	F	431	10.1	7.61	153	N	97.2	U	6.41
4.0 RHS	6.92	337	F	357	8.56	6.47	126	N	81.6	U	5.52
3.0 RHS	5.42	264	F	280	6.92	5.17	97.4	N	64.2	U	4.47
2.5 RHS	4.58	223	F	236	5.91	4.03	82.3	N	54.7	U	3.85
2.0 RHS	3.72	181	F	173	4.77	2.86	66.8	N	44.7	U	3.19
1.6 RHS	3.01	147	F	124	3.34	2.03	54.0	N	36.4	U	2.62
75 x 25 x 2.5 RHS	3.60	176	F	186	4.07	1.64	79.1	N	24.3	U	1.73
2.0 RHS	2.93	143	F	133	3.36	1.17	64.2	N	20.4	U	1.47
1.6 RHS	2.38	116	F	91.6	2.76	0.816	51.9	N	17.0	U	1.23
65 x 35 x 4.0 RHS	5.35	261	F	276	5.38	3.48	106	N	52.5	U	3.05
3.0 RHS	4.25	207	F	219	4.45	2.88	82.3	N	42.3	U	2.54
2.5 RHS	3.60	176	F	186	3.83	2.41	69.7	N	36.5	U	2.21
2.0 RHS	2.93	143	F	149	3.16	1.77	56.7	N	30.1	U	1.85
50 x 25 x 3.0 RHS	3.07	149	F	158	2.37	1.44	61.1	N	27.7	U	1.26
2.5 RHS	2.62	128	F	135	2.07	1.26	52.1	N	24.3	U	1.12
2.0 RHS	2.15	105	F	111	1.73	1.05	42.6	N	20.4	U	0.952
1.6 RHS	1.75	85.4	F	90.4	1.43	0.777	34.7	N	17.0	U	0.800
50 x 20 x 3.0 RHS	2.83	138	F	146	2.09	1.06	60.3	N	20.4	U	0.942
2.5 RHS	2.42	118	F	125	1.83	0.938	51.4	N	18.2	U	0.847
2.0 RHS	1.99	97.0	F	103	1.53	0.783	42.0	N	15.6	U	0.730
1.6 RHS	1.63	79.2	F	83.9	1.27	0.582	34.2	N	13.1	U	0.619

Notes :
1. ϕ = 0.9
2. N_t = $A_g f_y$ indicated by suffix Y (Clause 7.2 of AS 4100)
   N_t = $0.85 A_g f_u$ indicated by suffix F (Clause 7.2 of AS 4100)
3. N_s = $k_f A_g f_y$ (Clause 6.2.1 of AS 4100)
4. M_s = $f_y Z_e$ (Clause 5.2.1 of AS 4100)
5. M_z = $0.6 f_y C$ (See Section *D*3.2.5)
6. U = approximately uniform shear stress distribution. Design shear capacity calculated in accordance with clause 5.11.4 of AS 4100.
   $V_v = V_u = V_w = 0.6 f_y A_w$
   N = non-uniform shear stress distribution. Design shear capacity calculated in accordance with clause 5.11.3 of AS 4100.
   $V_v = 2V_u / (0.9 + (f^*_{vm} / f^*_{va})) \le V_u$
   B = shear bulckling failure mode. Design shear capacity calculated in accordance with clause 5.11.5 of AS 4100.
   $V_v = V_b = \alpha_v V_w \le V_w$

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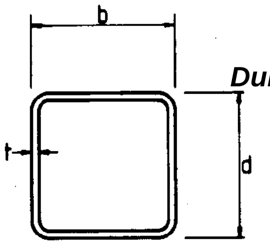
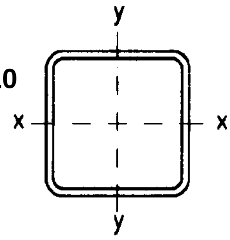
TABLE *D*3.1-2

DESIGN SECTION CAPACITIES

DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0
Standard Thickness





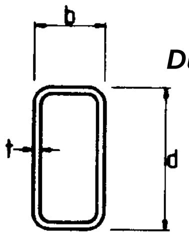
Designation d b t	Mass per m	Axial Tension ϕN_t		Axial Compression ϕN_s	Bending ϕM_s	Shear ϕV_v		Torsion ϕM_z
mm mm mm	kg/m	kN		kN	kNm	kN		kNm
100 x 100 x 6.0 SHS	16.7	816	F	864	29.8	253	N	22.7
5.0 SHS	14.2	694	F	735	25.7	216	N	19.8
4.0 SHS	11.6	567	F	600	21.0	177	N	16.5
3.0 SHS	8.96	436	F	440	13.9	135	N	12.9
2.5 SHS	7.53	367	F	305	10.6	114	N	11.0
2.0 SHS	6.07	296	F	196	7.63	92.2	N	8.97
90 x 90 x 3.0 SHS	8.01	390	F	413	11.9	121	N	10.3
2.5 SHS	6.74	329	F	305	9.03	102	N	8.80
2.0 SHS	5.45	265	F	196	6.48	82.6	N	7.20
1.6 SHS	4.39	214	F	125	4.70	66.7	N	5.87
89 x 89 x 6.0 SHS	14.6	714	F	756	22.9	221	N	17.4
5.0 SHS	12.5	609	F	645	19.9	189	N	15.2
3.5 SHS	9.06	441	F	467	14.5	138	N	11.4
75 x 75 x 6.0 SHS	12.0	586	F	621	15.6	181	N	11.7
5.0 SHS	10.3	503	F	532	13.6	156	N	10.4
4.0 SHS	8.49	414	F	438	11.4	129	N	8.78
3.5 SHS	7.53	367	F	388	10.2	114	N	7.90
3.0 SHS	6.60	322	F	341	8.99	99.4	N	6.98
2.5 SHS	5.56	271	F	287	6.90	84.0	N	5.98
2.0 SHS	4.50	219	F	196	4.91	68.2	N	4.91
65 x 65 x 6.0 SHS	10.1	494	F	523	11.1	153	N	8.31
5.0 SHS	8.75	426	F	451	9.85	132	N	7.43
4.0 SHS	7.23	352	F	373	8.34	109	N	6.36
3.0 SHS	5.66	276	F	292	6.71	85.0	N	5.11
2.5 SHS	4.78	233	F	247	5.54	72.0	N	4.40
2.0 SHS	3.88	189	F	196	3.97	58.6	N	3.63
1.6 SHS	3.13	153	F	125	2.84	47.5	N	2.98
50 x 50 x 5.0 SHS	6.39	311	F	330	5.33	96.0	N	3.95
4.0 SHS	5.35	261	F	276	4.61	80.6	N	3.47
3.0 SHS	4.25	207	F	219	3.80	63.4	N	2.86
2.5 SHS	3.60	176	F	186	3.27	54.0	N	2.48
2.0 SHS	2.93	143	F	151	2.66	44.2	N	2.07
1.6 SHS	2.38	116	F	123	1.92	35.9	N	1.71
40 x 40 x 4.0 SHS	4.09	199	F	211	2.73	61.4	N	2.02
3.0 SHS	3.30	161	F	170	2.32	49.0	N	1.72
2.5 SHS	2.82	137	F	145	2.01	42.0	N	1.51
2.0 SHS	2.31	112	F	119	1.67	34.6	N	1.27
1.6 SHS	1.88	91.5	F	96.9	1.36	28.3	N	1.06
35 x 35 x 3.0 SHS	2.83	138	F	146	1.71	41.8	N	1.26
2.5 SHS	2.42	118	F	125	1.50	36.0	N	1.11
2.0 SHS	1.99	97.0	F	103	1.25	29.8	N	0.945
1.6 SHS	1.63	79.2	F	83.9	1.04	24.4	N	0.792
30 x 30 x 2.0 SHS	1.68	81.7	F	86.5	0.893	25.0	N	0.667
1.6 SHS	1.38	67.0	F	70.9	0.746	20.6	N	0.564
25 x 25 x 2.5 SHS	1.64	79.9	F	84.6	0.694	24.0	N	0.503
2.0 SHS	1.36	66.4	F	70.3	0.594	20.2	N	0.438
1.6 SHS	1.12	54.8	F	58.0	0.500	16.7	N	0.375
20 x 20 x 1.6 SHS	0.873	42.5	F	45.0	0.304	12.9	N	0.224

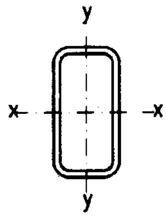
Notes :
1. ϕ = 0.9
2. N_t = $A_g f_y$ indicated by suffix Y (Clause 7.2 of AS 4100)
   N_t = $0.85 A_g f_u$ indicated by suffix F (Clause 7.2 of AS 4100)
3. N_s = $k_f A_g f_y$ (Clause 6.2.1 of AS 4100)
4. M_s = $f_y Z_e$ (Clause 5.2.1 of AS 4100)
5. M_z = $0.6 f_y C$ (See Section *D*3.2.5)
6. U = approximately uniform shear stress distribution. Design shear capacity calculated in accordance with clause 5.11.4 of AS 4100.
   $V_v = V_u = V_w = 0.6 f_y A_w$
   N = non-uniform shear stress distribution. Design shear capacity calculated in accordance with clause 5.11.3 of AS 4100.
   $V_v = 2V_u / (0.9 + (f^*_{vm} / f^*_{va})) \leq V_u$

TABLE *D*3.1-3

DESIGN SECTION CAPACITIES

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0
Non-Standard Thickness
about x- and y-axis





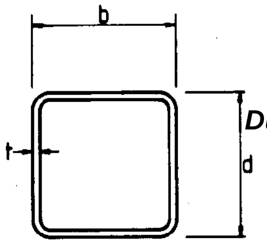
Designation d b t (mm mm mm)	Mass per m (kg/m)	Axial Tension ϕN_t (kN)		Axial Compression ϕN_s (kN)	Bending x-axis ϕM_{sx} (kNm)	Bending y-axis ϕM_{sy} (kNm)	Shear x-axis ϕV_{vx} (kN)		Shear y-axis ϕV_{vy} (kN)		Torsion ϕM_z (kNm)
125 x 75 x 2.8 RHS	8.39	409	F	351	16.9	8.80	156	N	94.4	U	11.3
2.3 RHS	6.95	339	F	259	12.3	6.50	129	N	78.7	U	9.50
100 x 50 x 2.8 RHS	6.19	302	F	295	10.2	5.05	122	N	60.4	U	5.74
2.3 RHS	5.14	251	F	215	8.52	3.70	102	N	50.7	U	4.86
75 x 50 x 2.8 RHS	5.09	248	F	263	6.52	4.71	91.4	N	60.4	U	4.23
2.3 RHS	4.24	207	F	215	5.49	3.56	76.2	N	50.7	U	3.59
65 x 35 x 2.8 RHS	3.99	194	F	206	4.21	2.72	77.3	N	40.0	U	2.41
2.3 RHS	3.34	163	F	172	3.57	2.16	64.6	N	34.0	U	2.07
50 x 25 x 2.8 RHS	2.89	141	F	149	2.26	1.37	57.5	N	26.4	U	1.21
2.3 RHS	2.44	119	F	126	1.94	1.18	48.3	N	22.8	U	1.05
50 x 20 x 2.8 RHS	2.67	130	F	138	1.99	1.02	56.8	N	19.6	U	0.907
2.3 RHS	2.25	110	F	116	1.71	0.882	47.7	N	17.2	U	0.803

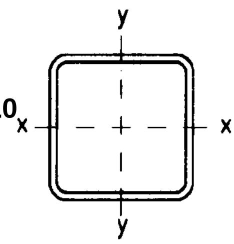
Notes :
1. ϕ = 0.9
2. N_t = $A_g f_y$ indicated by suffix Y (Clause 7.2 of AS 4100)
   N_t = $0.85 A_g f_u$ indicated by suffix F (Clause 7.2 of AS 4100)
3. N_s = $k_f A_g f_y$ (Clause 6.2.1 of AS 4100)
4. M_s = $f_y Z_e$ (Clause 5.2.1 of AS 4100)
5. M_z = $0.6 f_y C$ (See Section *D*3.2.5)
6. U = approximately uniform shear stress distribution. Design shear capacity calculated in accordance with clause 5.11.4 of AS 4100.
   $V_v = V_u = V_w = 0.6 f_y A_w$
   N = non-uniform shear stress distribution. Design shear capacity calculated in accordance with clause 5.11.3 of AS 4100.
   $V_v = 2V_u / (0.9 + (f^*_{vm} / f^*_{va})) \leq V_u$

TABLE *D*3.1-2

DESIGN SECTION CAPACITIES

DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0
Standard Thickness





Designation d b t (mm mm mm)	Mass per m (kg/m)	Axial Tension ϕN_t (kN)		Axial Compression ϕN_s (kN)	Bending ϕM_s (kNm)	Shear ϕV_v (kN)		Torsion ϕM_z (kNm)
100 x 100 x 2.8 SHS	8.39	409	F	383	12.5	127	N	12.2
2.3 SHS	6.95	339	F	259	9.35	105	N	10.2
75 x 75 x 2.8 SHS	6.19	302	F	319	8.16	93.3	N	6.59
2.3 SHS	5.14	251	F	259	6.07	77.7	N	5.56
65 x 65 x 2.3 SHS	4.42	215	F	228	4.91	66.7	N	4.10
50 x 50 x 2.8 SHS	3.99	194	F	206	3.59	59.7	N	2.71
2.3 SHS	3.34	163	F	172	3.05	50.1	N	2.32
40 x 40 x 2.8 SHS	3.11	152	F	161	2.20	46.2	N	1.64
2.3 SHS	2.62	127	F	135	1.88	39.1	N	1.42
35 x 35 x 2.8 SHS	2.67	130	F	138	1.63	39.5	N	1.20
2.3 SHS	2.25	110	F	116	1.40	33.6	N	1.05

Notes : Refer to TABLE *D*3.1-3

PART 4 MEMBERS SUBECT TO BENDING

4

PAGE

TABLES

NOTE: SEE PAGE vii FOR THE SPECIFIC MATERIAL STANDARD REFERRED TO BY THE SECTION TYPE AND STEEL GRADE IN THESE TABLES.

*D*4.1 DESIGN MOMENT CAPACITY FOR MEMBERS WITHOUT FULL LATERAL RESTRAINT

*D*4.1.1 Scope

These tables for RHS *bending about the x-axis*, without full lateral restraint, have been prepared in accordance with Section 5 of AS 4100 and [1]. Values of design moment capacity (ϕM_b) are given for various values of effective length (L_e).

SHS are not included in these tables as they are not susceptible to lateral buckling. The design member moment capacity (ϕM_b) always equals the design section moment capacity (ϕM_s), as given in Tables *D*3.1-2 to *D*3.1-4 for SHS, except for the extreme case when the load acts far above the shear centre (Clause C5.6.1.4 of the Commentary to AS 4100).

*D*4.1.2 Method

The values of design moment capacity (ϕM_b) are determined in accordance with AS 4100 and [1] as:

$$\phi M_b = \phi \, \alpha_m \, \alpha_{sh} \, M_s$$

where ϕ = 0.9 (Table 3.4 of AS 4100)

α_m = 1.0 (Table 5.6.1 of AS 4100 corresponding to the case of uniform moment over the effective length (L_e))

for $L_e \leq$ FLR (FLR = maximum segment length for full lateral restraint as determined in Section *D*4.1.3)

α_{sh} = 1.0

for $L_e >$ FLR

$$\alpha_{sh} = 0.7\left\{\left[\sqrt{\left(M_{px}/M_{yz}\right)^2 + 2.7}\right] - M_{px}/M_{yz}\right\}$$ from [1]

$M_{px} = M_{sx}$

$M_{yz} = M_{oa}$ - amended elastic buckling moment for a member subject to bending

$= M_o$ - reference buckling moment (Clause 5.6.1.1(a)(iv) of AS 4100)

$$= \sqrt{\left(\frac{\pi^2 E I_y}{L_e^{\,2}}\right) GJ}$$ (Equation 5.6.1.1(3) of AS 4100)

E = 200 x 10^3 MPa

I_y = second moment of area about the minor principal y-axis (Tables *D*1.2-1 to *D*1.2-4)

G = 80 X 10^3 MPa

J = torsional section constant (see Section *D*1.2.1.1 and Tables *D*1.2-1 to *D*1.2-4)

L_e = effective length (see Section *D*4.1.3)

M_s = $f_y Z_e$ (see Section *D*3.2.3 and Tables *D*3.1-1 to *D*3.1-4

f_y = yield stress used in design

Z_e = effective section modulus (see Section *D*1.2.3.2 and Tables *D*1.2-1 to *D*1.2-4)

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[1] Centre For Advanced Structural Engineering, Civil Engineering, The University of Sydney, "Inelastic Buckling Strength of RHS's", Investigation Report S941, May 1993.

*D*4.1.3 Segment Length for Full Lateral Restraint

FLR is the length of a member between braces for which:

$$M_{bx} = M_{sx}$$

OneSteel Pipe & Tube commissioned the Centre for Advanced Structural Engineering, Civil Engineering, The University of Sydney, to undertake an analytical study of the lateral buckling of Rectangular Hollow Sections (RHS). The study was conducted although RHS sections rarely buckle laterally, yet AS 4100-1990 Steel Structures, incorporating Amendment 2, in clauses 5.3.2.4 and 5.6.1.4 required reductions to be made below the section capacity to account for lateral buckling in RHS members with comparatively closely spaced braces. The results of the study are contained in [1] which recommends the following method for calculating the FLR values for RHS members loaded through their shear centre.

$$\text{FLR} = \left(\frac{M_{sx}}{M_{yz}}\right)_{\text{FLR}} \sqrt{\frac{\pi^2 E I_y G J}{M_{sx}^2}}$$

where	M_{sx}	=	nominal section moment capacity about major principal x-axis
	$(M_{sx}/M_{yz})_{FLR}$	=	see Table *D*4.1.5(1)
	E	=	Young's modulus of elasticity, 200 x 10^3 MPa
	I_y	=	second moment of area about the cross-section minor principal y-axis
	G	=	shear modulus of elasticity, 80 x 10^3 MPa

The FLR values listed in Tables *D*4.1-1(1) to *D*4.1-1(2) and Tables *D*8.1-1(1)(A) to *D*8.4-4(A) have been calculated using the above approach.

*D*4.1.4 Effective Length

Before using these tables it is necessary to determine the effective length *(L_e)*, which depends on the restraint against twisting and lateral rotation, and the load height. L_e is determined in accordance with Clause 5.6.3 of AS 4100 and given by:

$$L_e = k_t \, k_l \, k_r \, L$$

where	k_t	=	twist restraint factor	(Table *D*4.1.4(1))
	k_l	=	load height factor	(Table *D*4.1.4(2))
	k_r	=	lateral rotation restraint factor	(Table *D*4.1.4(3))
	L	=	length of segment	

Table D4.1.4(1): Twist Restraint Factors (k_t)

Restraint Arrangement	Factor, (k_t)
FF,FL,LL,FU	1.0
FP,PL,PU	$1+\frac{\left[\left(\frac{d_1}{L}\right)\left(\frac{t_f}{2t_w}\right)^3\right]}{n_w}$
PP	$1+\frac{\left[2\left(\frac{d_1}{L}\right)\left(\frac{t_f}{2t_w}\right)^3\right]}{n_w}$

Table D4.1.4(2): Load Height Factors (k_l) for Gravity Loads

Longitudinal load position	Restraint arrangement	Load height position	
		Shear	Top Flange
Within segment	FF, FP, FL, PP, PL, LL	1.0	1.4
	FU, PU	1.0	2.0
At segment end	FF, FP, FL, PP, PL, LL	1.0	1.0
	FU, PU	1.0	2.0

Table D4.1.4(3): Lateral Rotation Restraint Factors(k_r)

Restraint arrangement	Ends with lateral rotation restraints	Factor (k_r)
FU, PU	Any	1.0
FF, FP, FL, PP, PL, LL	None	1.0
FF, FP, PP	One	0.85
FF, FP, PP	Both	0.70

where

d_1 = clear depth between flanges ignoring fillets or welds

n_w = number of webs

t_f =thickness of critical flange

t_w =thickness of web

F ≡fully restrained

L ≡laterally restrained

P ≡partially restrained

U ≡unrestrained

and two of the symbols F, L, P, U are used to indicate the conditions at the ends of the segment. Restraint requirements are detailed in Clause 5.4.3 of AS 4100.

D4.1.5 Other Loading and Restraint Conditions

The design moment capacities presented in these tables can be used for other restraints and loading conditions. For these situations the effective length (L_e) corresponding to the relevant conditions must be assessed and the relevant value of α_m determined in accordance with Clause 5.6.1.1(a) of AS 4100 and [1]. The design moment capacity (ϕM_b) can then be determined as the ***lesser*** of:

$$\phi M_{sx} = \phi Z_e f_y$$

and

$$\phi M_{bx} = \phi \alpha_m \alpha_{sh} Z_e f_y$$

where ϕ = 0.9 (Table 3.4 of AS 4100)

ϕM_{sx} = the design section moment capacity (Tables D3.1-1 to D3.1-4)

ϕM_{bx} = α_m times the value of ($\phi M_b = \phi \alpha_s Z_e f_y$) given in Tables D4.1-1 to D4.1-2

α_m = moment modification factor

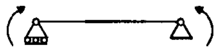
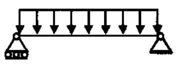
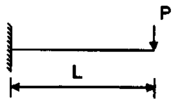
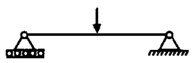
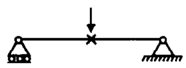
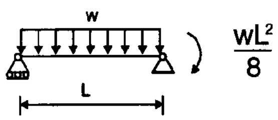
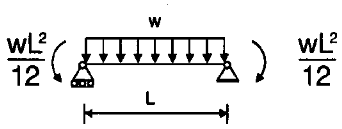
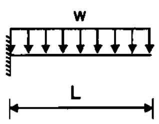
$$\le \frac{1}{\alpha_{sh}}$$

α_{sh} = slenderness reduction factor (see Section D4.1.2)

It should be noted that:

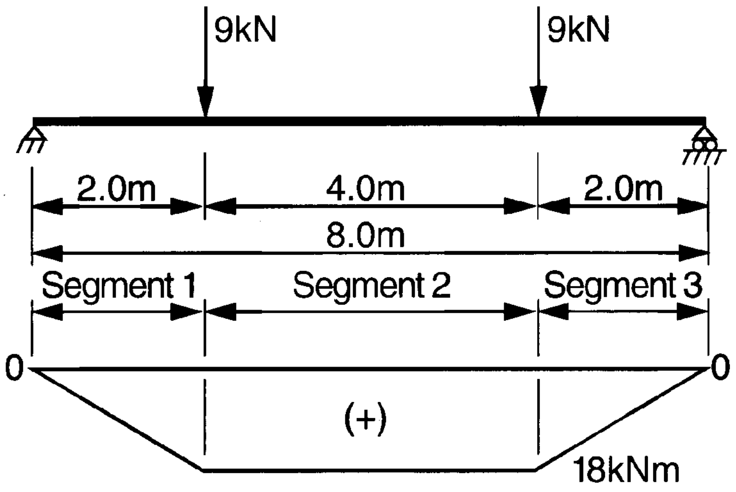
- *$\alpha_m \le 1.0$ for SHS as they are not susceptible to lateral buckling and $\alpha_{sh} = 1.0$*
- *generally $\alpha_m \le 1.0$ for RHS, as these sections (with the exception of 150 x 50 and 75 x 25) are only susceptible to lateral buckling at larger spans (ie. $\alpha_{sh} < 1.0$).*

Table D4.1.5(1) Values of $(M_{sx}/M_{yz})_{FLR}$

Load Type	α_m	$(M_{sx}/M_{yz})_{FLR}$
Simply Supported Beam Uniform Moment  $\alpha_m = 1.00$	1.0	0.231
Simply Supported Beam Uniformly Distributed Load  $\alpha_m = 1.13$	1.13	0.436
Fixed Cantilever Point Load at Free End  $\alpha_m = 1.25$	1.25	0.610
Point Load at centre of simply supported beam  $\alpha_m = 1.35$	1.35	0.747
Point Load at point of full or partial restraint  $\alpha_m = 1.75$ $\alpha_m = 1.75$ (c) Braced Central Load	1.75	1.246
2 Span Continuous Beam with UDL  $\alpha_m = 2.25$	2.25	1.809
Fixed End Beam with UDL  $\alpha_m = 2.42$	2.42	1.970
Fixed Cantilever with Uniformly Distributed Load  $\alpha_m = 2.25$	2.25	1.809

D4.1.6 Examples

1. A simply supported beam shown below has two concentrated loads applied in such a way that full restraint is provided at the location of the loads. The calculated design load at each point is 9 kN. What size beam is required to support these loads?



Bending Moment Diagram

<u>Design Data</u>**:**

Design bending moment $M^* = 18$ kNm

<u>Solution</u>**:**

For beam segment 2**:**

End restraint condition = FF (fully restrained at both ends of the segment)

Twist restraint factor $k_t = 1.0$ (Table *D*4.1.4(1))

Load Height Factor $k_l = 1.0$ (Table *D*4.1.4(2))

(For loading at segment end and top flange loading)

Lateral rotation restraint factor $k_r = 0.7$ (Table *D*4.1.4(3))

∴ Effective length

$$L_e = k_t\, k_l\, k_r\, L$$
$$= 1.0 \times 1.0 \times 0.7 \times 4.0$$
$$= 2.8 \text{ m}$$

A rectangular hollow section is the most efficient and most practical hollow section for this application. As a uniform bending moment is applied to segment 2, α_m = 1.0 (Table 5.6.1 of AS 4100). Thus alternatives can be read directly from Table *D*4.1-1(1) for a uniform bending moment of 18 kNm on segment 2 with an effective length (L_e = 2.8 m). They are:

150 x 50 x 3.0 DuraGal RHS Grade C450L0 (8.96 kg/m) ϕM_b = 20.8 kNm > M * (Table *D*4.1-1)(1)
125 x 75 x 3.0 DuraGal RHS Grade C450L0 (8.96 kg/m) ϕM_b = 18.8 kNm > M * (Table *D*4.1-1)(1)

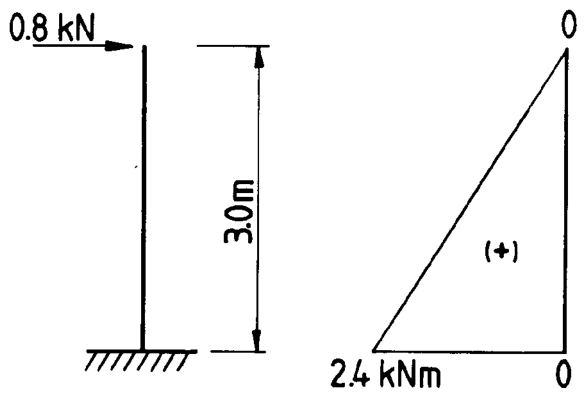
As both sections have the same mass select the stronger 150 x 50 x 3.0 DuraGal RHS Grade C450L0 (8.96 kg/m). The extra depth will provide increased stiffness which may be important.

Additional design checks which should be performed are:

- Additional design bending moment due to self-weight
- Shear (Section *D*4.2)
- Interaction of Shear and Bending (Section *D*4.2.3)
- Bearing (Section *D*4.3)
- Bearing and Bending Interaction (Section *D*4.4)
- Deflection (Section *D*4.5)

Beam segments 1 and 3 do not have to be checked because they have the same design bending moment and end restraints with a shorter effective length.

2. A free standing sign post which is securely concreted into the ground is required to resist a calculated horizontal design force of 0.8 kN at a height of 3 m. What size SHS is required?



Bending Moment Diagram

<u>Design Data</u>**:**

Design bending moment M * = 2.4 kNm

<u>Solution</u>**:**

The appropriate size of SHS may be selected from the **section** capacity tables in PART 3. The alternatives are:

40 x 40 x 4.0 DuraGal SHS Grade C450L0 (4.09 kg/m) ϕM_s = 2.73 kNm > M * (Table *D*3.1-2)
50 x 50 x 2.0 DuraGal SHS Grade C450L0 (2.93 kg/m) ϕM_s = 2.66 kNm > M * (Table *D*3.1-2)

Based on mass select 50 x 50 x 2.0 DuraGal SHS Grade C450L0 (2.93 kg/m).

Additional design checks which should be performed are:

- Shear (Section *D*4.2)
- Interaction of Shear and Bending (Section *D*4.2.3)
- Deflection (Section *D*4.5) if it is critical for this type of application

D4.2 DESIGN SHEAR CAPACITY

D4.2.1 Scope

The section capacity tables (Tables *D*3.1-1 to *D*3.1-4) include values of design web shear capacity for bending about the x- and y-axis.

D4.2.2 Method

The design shear capacity of a web (ϕV_v) is determined from the *lesser* of Clauses 5.11.3 and 5.11.4 of AS 4100 for RHS and SHS as described in Section *D*3.2.4.

D4.2.3 Interaction of Shear and Bending

The design web shear capacity determined in Section *D*4.2.2 of the Tables may be significantly reduced when the section is subject to a large bending moment at the same location. The reduced shear capacity (ϕV_{vm}) is determined in accordance with Clause 5.12.3 of AS 4100 as follows:

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

or

$$= \phi V_v \left[2.2 - \left(\frac{16 M^*}{\phi M_s} \right) \right] \quad \text{for} \quad 0.75\,\phi M_s \leq M^* \leq \phi M_s$$

where ϕV_v = design web shear capacity (Section *D*4.2.2)

M^* = design moment capacity

ϕM_s = design section moment capacity (Section *D*3.2.3)

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

D4.2.4 Examples

1. Check the shear capacity of the 150 x 50 x 3.0 DuraGal RHS Grade C450L0 beam in Example 1 from Section *D*4.1.6.

<u>Design Data</u>**:**

Design shear force $V^* = 9$ kN

<u>Solution</u>**:**

Design shear capacity of the section

$$\phi V_{vx} = 195 \text{ kN (Table } D3.1\text{-}1)$$
$$> V^*$$

Therefore the 150 x 50 x 3.0 DuraGal RHS Grade C450L0 is satisfactory.

2. Check the shear capacity of the 50 x 50 x 2.0 DuraGal SHS Grade C450L0 beam in Example 2 from Section *D*4.1.6.

Design Data**:**

Design shear force

$$V^* = 0.8 \text{ kN}$$

Solution**:**

Design shear capacity of the section

$$\phi V_v = 44.2 \text{ kN} \quad \text{(Table } D3.1\text{-2)}$$
$$> V^*$$

Therefore the 50 x 50 x 2.0 DuraGal SHS Grade C450L0 is satisfactory.

3. Check the 150 x 50 x 3.0 DuraGal RHS Grade C450L0 beam in Example 1 from Section *D*4.1.6 for the interaction of shear and bending.

Design Data**:**

Design shear force	V^*	=	9 kN	
Design shear capacity	ϕV_{vx}	=	195 kN	(Table *D*3.1-1)
Design bending moment	M^*	=	18 kNm	
Design member moment capacity	ϕM_{sx}	=	20.8 kNm	(Table *D*3.1-1)

Solution**:**

$$0.75\, \phi M_{sx} = 0.75 \times 20.8 = 15.6 \text{ kNm}$$

$$\text{then } M^* > 0.75\, \phi M_{sx}$$

$$\text{therefore } \phi V_{vm} = \phi V_v \left[2.2 - \left(\frac{16 M^*}{\phi M_{sx}} \right) \right]$$

$$= 195 \left[2.2 - \left(\frac{16 x 18}{20.8} \right) \right]$$

$$= 159 \text{ kN}$$

$$\text{therefore } V^* = 9 \text{ kN} < \phi V_{vm} = 159 \text{ kN}$$

Therefore the 150 x 50 x 3.0 DuraGal RHS Grade C450L0 is satisfactory.

D4.3 DESIGN WEB BEARING CAPACITY

D4.3.1 Scope

The tables give values of design web bearing capacity per unit length ($\phi R_{by}/b_b$) and the design web bearing buckling per unit length ($\phi R_{bb}/b_b$) for SHS and RHS for

- interior bearing, and
- end bearing.

D4.3.2 Method

The design web bearing capacity (ϕR_b) has been determined from 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
ϕ = 0.9 (Table 3.4 of AS 4100)
ϕR_{bb} = design web bearing buckling capacity (Clause 5.13.4 of AS 4100)
ϕR_{by} = design web bearing yield capacity (Clause 5.13.3 of AS 4100)
t = thickness of section
f_y = yield stress used in design

Interior bearing for $b_d \geq 1.5d_5$

b_b = $b_s + 5r_{ext} + d_5$
b_s = actual length of bearing (see Figure *D*4.3.2(b))
d_5 = flat width of web (see Figure *D*4.3.2(a))
r_{ext} = outside corner radius

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

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

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

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

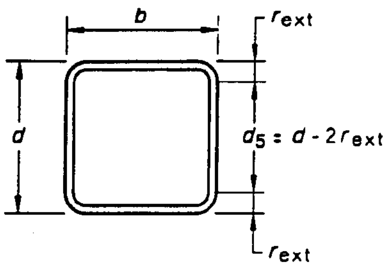
α_c = member slenderness reduction factor determined in accordance with Section *D*5.3 of these Tables using $k_f = 1.0$ and $\alpha_b = 0.5$, and modified slenderness ratio ($L_e/r = 3.5\ d_5/t$)

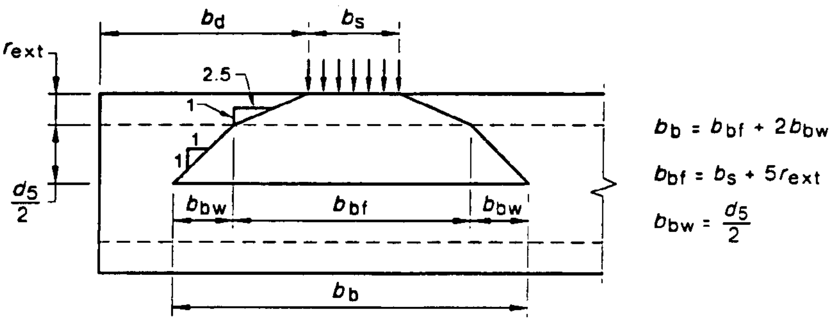
End bearing for $b_d < 1.5d_5$

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

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

α_c = member slenderness reduction factor determined in accordance with Section *D*5.3 of these Tables using $k_f = 1.0$ and $\alpha_b = 0.5$, and modified slenderness ratio $(L_e/r = 3.8\, d_5/t)$





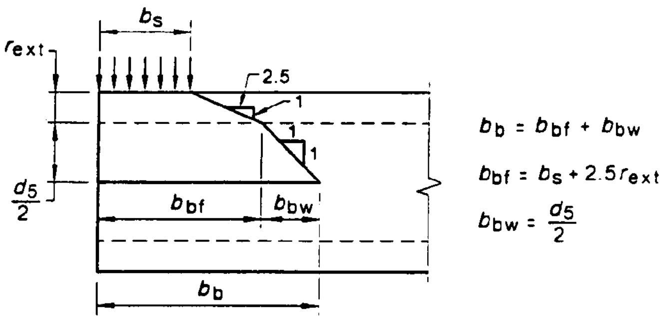
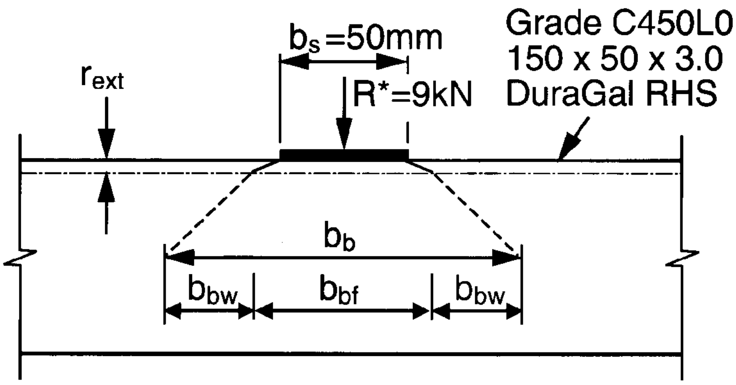


Figure *D*4.3.2: Dispersions of Force Through Flange, Radius and Web

D4.3.3 Example

1. The design concentrated force of 9 kN on the 150 x 50 x 3.0 DuraGal RHS Grade C450L0 beam in Example 1 of Section *D*4.1.6 is applied over the full width of the RHS and for a length of 50 mm along the RHS. Check the bearing capacity of the beam.



Design Data:

Design bearing force	R^*	=	9 kN	
Stiff bearing length	b_s	=	50 mm	
	$5r_{ext}$	=	30.0 mm	(Table *D*4.3-1(A))
	b_{bw}	=	69.0 mm	(Table *D*4.3-1(A))

Solution:

Bearing length at the edge of the corner radius $b_{bf} = b_s + 5r_{ext}$

$= 50 + 30.0$

$= 80$ mm

Bearing length at the centre of the web $b_b = b_{bf} + 2b_{bw}$

$= 80 + (2 \times 69.0)$

$= 218$ mm

The web bearing capacity (ϕR_b) is the lesser of ϕR_{by} and ϕR_{bb}.

From Table *D*4.3-1(A):

Design web yield capacity $\frac{\phi R_{by}}{b_b} = 0.785$ kN/mm

Design web buckling capacity $\frac{\phi R_{bb}}{b_b} = 0.357$ kN/mm

$$\frac{\phi R_{by}}{b_b} > \frac{\phi R_{bb}}{b_b}$$

Therefore web buckling will govern.

Design web bearing capacity $\phi R_b = \phi R_{bb}$

$= 0.357 \times 218$

$= 77.8$ kN ($> R^*$)

Therefore the 150 x 50 x 3.0 DuraGal RHS Grade C450L0 is satisfactory.

*D*4.4 BENDING AND BEARING INTERACTION

*D*4.4.1 Method

The design web bearing capacity determined in Section *D*4.3 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 hollow sections is not addressed by AS 4100, but suitable interaction equations have been developed from research. [1],[2]

The bending and bearing interaction is dependent on the ratio of bearing length to the width of bearing $\mathbf{b_s/b}$ and the web slenderness (d_1/t). The interaction equation for $\mathbf{b_s/b \geq 1.0}$ and $(d_1/t) \leq \mathbf{30}$ is:

$$12\left(\frac{R^*}{\phi R_b}\right)+\left(\frac{M^*}{\phi M_s}\right)\leq 15$$

or

$$0.8\left(\frac{R^*}{\phi R_b}\right)+\left(\frac{M^*}{\phi M_s}\right)\leq 10 \qquad \text{Otherwise}$$

where b_s = stiff bearing length (see Figure *D*4.3.2)

b = width of section

(d_1/t) = web slenderness

d_1 = clear depth between flanges

t = thickness of section

R^* = maximum design bearing force

ϕ = 0.9 (Table 3.4 of AS 4100)

ϕR_b = design web bearing capacity

M^* = maximum design bending moment

ϕM_s = design section moment capacity

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

Design aids have not been produced for this interaction because of the numerous bearing lengths which may occur for each section size.

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[1] Zhao, X.L., Hancock, G.J., "Square and Rectangular Hollow Sections Subject to Combined Actions", Journal of Structural Engineering, ASCE, Vol 118, No. 3, pp 648-668, 1992.

[2] Zhao, X.L., Hancock, G.J., "Design Formulae for Web Crippling of Rectangular Hollow Sections", Proceedings, Third Pacific Structural Steel Conference, Tokyo, Japan, 1992.

D4.4.2 Example

1. Considering further Example 1 of Section D4.1.6 and Example 1 of Section D4.3.3 the interaction of bending and bearing is checked for the 150 x 50 x 3.0 DuraGal RHS Grade C450L0 beam.

Design Data:

Design bearing force	R^*	=	9 kN	(Section D4.1.6)
Design web bearing capacity	ϕR_b	=	77.8 kN	(Section D4.3.3)
Design bending moment	M^*	=	18 kNm	(Section D4.1.6)
Design section moment capacity	ϕM_s	=	20.8 kNm	(Table D3.1-1)
Stiff bearing length	b_s	=	50 mm	(Section D4.3.3)
Web slenderness	d_1/t	=	48	(Table D1.2-1 (1))

Solution:

$$\frac{b_s}{b} = \frac{50}{50}$$

$$= 1.0$$

$$\geq 1.0$$

$$d_1/t = 48$$

$$\geq 30$$

$\therefore$ the interaction equation is

$$0.8\left[\frac{R^*}{\phi R_b}\right] + \left[\frac{M^*}{\phi M_s}\right] \leq 1.0$$

$$0.8\left[\frac{9}{77.8}\right] + \left[\frac{1.8}{20.8}\right] = 0.958$$

$$\leq 1.0$$

Therefore the 150 x 50 x 3.0 DuraGal RHS Grade C450L0 is satisfactory

D4.5 CALCULATION OF BEAM DEFLECTIONS

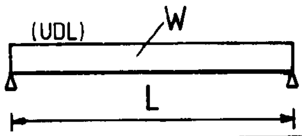
Common methods for calculating the elastic deflection of a beam include:

(i) integration of *M/EI* diagram
(ii) moment area
(iii) slope deflection
(iv) published solutions for particular cases
(v) approximate or numerical methods (eg. finite elements)

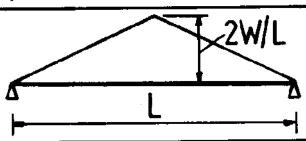
Table *D*4.5 gives the more commonly used beam deflection formulae. Due to the large range of loading configurations and support conditions considered for beams in design, a more comprehensive set of beam deflection formulae are published in the AISC technical journal “Steel Construction”, Volume 26 No. 1 (February 1992).

Table *D*4.5: Beam Deflection Formulae

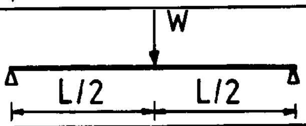
SIMPLY SUPPORTED BEAMS



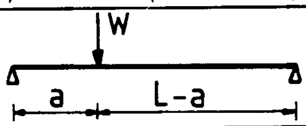
$$\Delta = \frac{5}{384}\frac{WL^3}{EI}$$



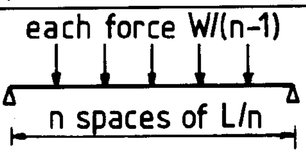
$$\Delta = \frac{1}{60}\frac{WL^3}{EI}$$



$$\Delta = \frac{1}{48}\frac{WL^3}{EI}$$



$$\Delta = \frac{WL^3}{48EI}\left[\frac{3a}{L} - 4\left(\frac{a}{L}\right)^3\right]$$

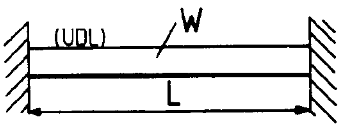


$$\Delta = \frac{k}{192\,(n-1)}\frac{WL^3}{EI}$$

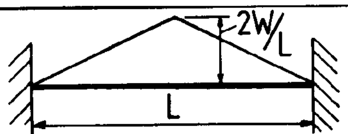
n odd, $k = [n - \frac{1}{n}]\,[3 - \frac{1}{2}(1 - \frac{1}{n^2})]$

n even, $k = n[3 - \frac{1}{2}(1 + \frac{4}{n^2})]$

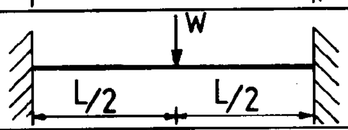
BUILT-IN BEAMS



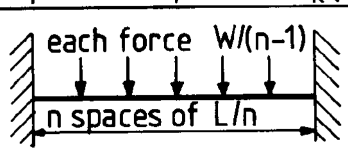
$$\Delta = \frac{1}{384}\frac{WL^3}{EI}$$



$$\Delta = \frac{1.4}{384}\frac{WL^3}{EI}$$



$$\Delta = \frac{1}{192}\frac{WL^3}{EI}$$

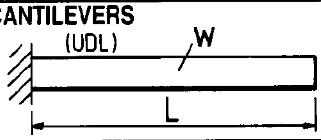


$$\Delta = \frac{k}{192\,(n-1)}\frac{WL^3}{EI}$$

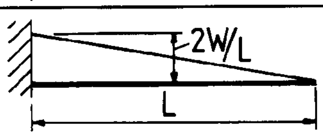
n odd, $k = [n - \frac{1}{n}]\,[1 - \frac{1}{2}(1 - \frac{1}{n^2})]$

n even, $k = [3 - \frac{1}{2}(1 + \frac{4}{n^2})] \times n - [2(n - \frac{1}{n})]$

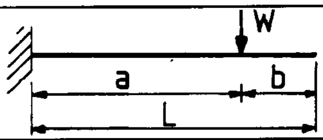
CANTILEVERS



$$\Delta = \frac{1}{8}\frac{WL^3}{EI}$$



$$\Delta = \frac{1}{15}\frac{WL^3}{EI}$$



$$\Delta = \frac{Wa^3}{EI}\,\frac{1}{3}\left[1 + \frac{3b}{2a}\right]$$

Where:

Δ = 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

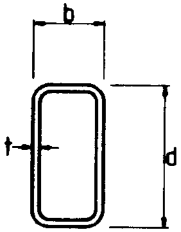


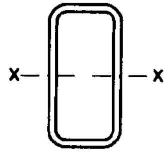
TABLE *D*4.1-1(1)

DESIGN MOMENT CAPACITIES FOR MEMBERS WITHOUT FULL LATERAL RESTRAINT

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

bending about x-axis



Designation d b t	Mass per m	Design Moment Capacities ϕM_b (kNm) Effective Length (L_e) in metres														FLR
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	m
150 x 50 x 6.0 RHS	16.7	36.9	36.9	36.9	36.0	34.5	33.1	31.8	30.6	29.4	28.3	27.2	26.2	25.3	24.4	3.37
5.0 RHS	14.2	31.9	31.9	31.9	31.2	30.0	28.8	27.7	26.6	25.6	24.7	23.7	22.9	22.1	21.3	3.43
4.0 RHS	11.6	26.5	26.5	26.5	26.0	25.0	24.0	23.1	22.2	21.4	20.6	19.8	19.1	18.5	17.8	3.50
3.0 RHS	8.96	20.8	20.8	20.8	20.4	19.7	18.9	18.2	17.5	16.9	16.2	15.7	15.1	14.6	14.1	3.53
2.5 RHS	7.53	17.6	17.6	17.6	17.3	16.7	16.0	15.4	14.9	14.3	13.8	13.3	12.8	12.4	12.0	3.56
2.0 RHS	6.07	12.8	12.8	12.8	12.8	12.4	12.0	11.6	11.2	10.8	10.5	10.1	9.79	9.48	9.19	4.01
125 x 75 x 6.0 RHS	16.7	34.1	34.1	34.1	34.1	34.1	34.1	34.1	33.4	32.8	32.1	31.5	30.9	30.3	29.7	6.99
5.0 RHS	14.2	29.5	29.5	29.5	29.5	29.5	29.5	29.5	28.9	28.3	27.8	27.3	26.7	26.2	25.7	7.04
4.0 RHS	11.6	24.4	24.4	24.4	24.4	24.4	24.4	24.4	24.0	23.5	23.1	22.6	22.2	21.8	21.3	7.08
3.0 RHS	8.96	18.8	18.8	18.8	18.8	18.8	18.8	18.8	18.5	18.2	17.8	17.5	17.2	16.9	16.5	7.18
2.5 RHS	7.53	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1	13.9	13.6	13.4	13.2	13.0	12.7	8.17
2.0 RHS	6.07	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	9.95	9.80	9.65	9.51	9.37	9.32
100 x 50 x6.0 RHS	12.0	18.4	18.4	18.4	18.4	17.9	17.3	16.7	16.2	15.7	15.2	14.7	14.3	13.8	13.4	4.19
5.0 RHS	10.3	16.1	16.1	16.1	16.1	15.7	15.2	14.7	14.3	13.8	13.4	13.0	12.6	12.2	11.8	4.26
4.0 RHS	8.49	13.5	13.5	13.5	13.5	13.2	12.8	12.4	12.0	11.7	11.3	11.0	10.6	10.3	10.0	4.31
3.5 RHS	7.53	12.1	12.1	12.1	12.1	11.9	11.5	11.1	10.8	10.5	10.1	9.84	9.54	9.26	8.99	4.34
3.0 RHS	6.60	10.8	10.8	10.8	10.8	10.6	10.2	9.91	9.60	9.31	9.02	8.75	8.49	8.23	7.99	4.32
2.5 RHS	5.56	9.18	9.18	9.18	9.18	8.99	8.71	8.44	8.18	7.93	7.69	7.46	7.23	7.02	6.82	4.35
2.0 RHS	4.50	7.37	7.37	7.37	7.37	7.25	7.03	6.81	6.61	6.41	6.22	6.03	5.86	5.69	5.52	4.46
1.6 RHS	3.64	5.05	5.05	5.05	5.05	5.05	4.96	4.83	4.71	4.59	4.47	4.36	4.25	4.15	4.04	5.32

Notes:
1. ϕ = 0.9
2. FLR - segment length for Full Lateral Restraint ($\phi M_{bx} = \phi M_{sx}$) for simply supported beams with uniform moment.
   FLR = 0.231 $(\pi^2 E\,Iy\,G\,J / M_{sx}^2)^{0.5}$ (See Section *D*4.1.3 of these tables for explanation)
3. Values to the left of the solid line are segment lengths with full lateral restraint.
4. α_{sh} = $0.7(((M_{sx} / M_{oa})^2 + 2.7))^{0.5} - M_s/M_{oa})$ (See Section *D*4.1.2 of these tables for explanation)
5. α_m = 1.0

DuraGal DESIGN CAPACITY TABLES for STRUCTURAL STEEL HOLLOW SECTIONS

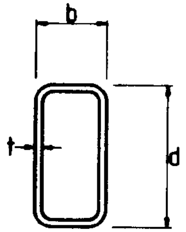


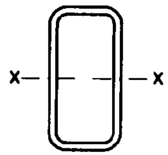
TABLE *D*4.1-1(2)

DESIGN MOMENT CAPACITIES FOR MEMBERS WITHOUT FULL LATERAL RESTRAINT

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

bending about x-axis



Designation d b t	Mass per m	Design Moment Capacities ϕM_b (kNm) Effective Length (L_e) in metres														FLR
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	m
100 x 50 x 6.0 RHS	12.0	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.2	17.9	17.3	4.19
5.0 RHS	10.3	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.0	15.7	15.2	4.26
4.0 RHS	8.49	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.4	13.2	12.8	4.31
3.5 RHS	7.53	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	11.9	11.5	4.34
3.0 RHS	6.60	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.7	10.6	10.2	4.32
2.5 RHS	5.56	9.18	9.18	9.18	9.18	9.18	9.18	9.18	9.18	9.18	9.18	9.18	9.14	8.99	8.71	4.35
2.0 RHS	4.50	7.37	7.37	7.37	7.37	7.37	7.37	7.37	7.37	7.37	7.37	7.37	7.36	7.25	7.03	4.46
1.6 RHS	3.64	5.05	5.05	5.05	5.05	5.05	5.05	5.05	5.05	5.05	5.05	5.05	5.05	5.05	4.96	5.32
75 x 50 x 6.0 RHS	9.67	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.3	10.9	4.73
5.0 RHS	8.35	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.0	9.73	4.79
4.0 RHS	6.92	8.56	8.56	8.56	8.56	8.56	8.56	8.56	8.56	8.56	8.56	8.56	8.56	8.52	8.28	4.85
3.0 RHS	5.42	6.92	6.92	6.92	6.92	6.92	6.92	6.92	6.92	6.92	6.92	6.92	6.92	6.89	6.69	4.84
2.5 RHS	4.58	5.91	5.91	5.91	5.91	5.91	5.91	5.91	5.91	5.91	5.91	5.91	5.91	5.89	5.72	4.87
2.0 RHS	3.72	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.64	4.97
1.6 RHS	3.01	3.34	3.34	3.34	3.34	3.34	3.34	3.34	3.34	3.34	3.34	3.34	3.34	3.34	3.33	5.80
75 x 25 x 2.5 RHS	3.60	4.07	4.07	4.07	4.07	4.07	4.06	3.97	3.81	3.66	3.52	3.38	3.25	3.13	2.90	1.70
2.0 RHS	2.93	3.36	3.36	3.36	3.36	3.36	3.36	3.29	3.16	3.04	2.92	2.81	2.71	2.61	2.42	1.73
1.6 RHS	2.38	2.76	2.76	2.76	2.76	2.76	2.76	2.71	2.60	2.50	2.41	2.32	2.23	2.15	2.00	1.76
65 x 35 x 4.0 RHS	5.35	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.27	5.15	5.03	4.92	4.71	3.05
3.0 RHS	4.25	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.37	4.27	4.17	4.08	3.90	3.07
2.5 RHS	3.60	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.76	3.68	3.60	3.52	3.37	3.10
2.0 RHS	2.93	3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.16	3.11	3.04	2.97	2.91	2.78	3.13
50 x 25 x 3.0 RHS	3.07	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.31	2.23	2.16	2.09	2.02	1.96	1.84	2.07
2.5 RHS	2.62	2.07	2.07	2.07	2.07	2.07	2.07	2.07	2.01	1.95	1.89	1.83	1.77	1.71	1.61	2.10
2.0 RHS	2.15	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.69	1.63	1.58	1.53	1.48	1.44	1.35	2.13
1.6 RHS	1.75	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.40	1.35	1.31	1.27	1.23	1.19	1.12	2.16
50 x 20 x 3.0 RHS	2.83	2.09	2.09	2.09	2.09	2.08	2.03	1.98	1.89	1.80	1.72	1.64	1.57	1.50	1.37	1.44
2.5 RHS	2.42	1.83	1.83	1.83	1.83	1.82	1.78	1.74	1.66	1.58	1.51	1.45	1.38	1.32	1.22	1.47
2.0 RHS	1.99	1.53	1.53	1.53	1.53	1.53	1.50	1.46	1.40	1.34	1.28	1.22	1.17	1.12	1.03	1.50
1.6 RHS	1.63	1.27	1.27	1.27	1.27	1.27	1.25	1.22	1.16	1.11	1.07	1.02	0.977	0.937	0.863	1.53

Notes:
1. ϕ = 0.9
2. FLR - segment length for Full Lateral Restraint ($\phi M_{bx} = \phi M_{sx}$) for simply supported beams with uniform moment.
   FLR = $0.231 (\pi^2 E I_y G J / M_{sx}^2)^{0.5}$ (See Section *D*4.1.3 of these tables for explanation)
3. Values to the left of the solid line are segment lengths with full lateral restraint.
4. $\alpha_{sh} = 0.7(((M_{sx} / M_{oa})^2 + 2.7))^{0.5} - M_s/M_{oa})$ (See Section *D*4.1.2 of these tables for explanation)
5. α_m = 1.0

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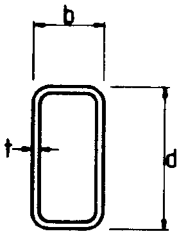
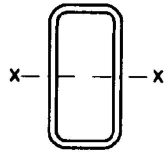


TABLE *D*4.1-2

DESIGN MOMENT CAPACITIES FOR MEMBERS WITHOUT FULL LATERAL RESTRAINT

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0
Non-Standard Thickness
bending about x-axis



Designation d b t		Mass per m	Design Moment Capacities ϕM_b (kNm) — Effective Length (L_e) in metres														FLR
mm mm mm		kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	m
125 x 75 x	2.8 RHS	8.39	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	7.51
	2.3 RHS	6.95	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	8.69
100 x 50 x	2.8 RHS	6.19	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.1	9.94	9.63	4.34
	2.3 RHS	5.14	8.52	8.52	8.52	8.52	8.52	8.52	8.52	8.52	8.52	8.52	8.52	8.48	8.34	8.08	4.37
75 x 50 x	2.8 RHS	5.09	6.52	6.52	6.52	6.52	6.52	6.52	6.52	6.52	6.52	6.52	6.52	6.52	6.49	6.31	4.85
	2.3 RHS	4.24	5.49	5.49	5.49	5.49	5.49	5.49	5.49	5.49	5.49	5.49	5.49	5.49	5.47	5.32	4.88
65 x 35 x	2.8 RHS	3.99	4.21	4.21	4.21	4.21	4.21	4.21	4.21	4.21	4.21	4.13	4.04	3.95	3.86	3.69	3.08
	2.3 RHS	3.34	3.57	3.57	3.57	3.57	3.57	3.57	3.57	3.57	3.57	3.50	3.43	3.35	3.28	3.14	3.11
50 x 25 x	2.8 RHS	2.89	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.19	2.12	2.05	1.99	1.92	1.86	1.75	2.08
	2.3 RHS	2.44	1.94	1.94	1.94	1.94	1.94	1.94	1.94	1.89	1.83	1.77	1.71	1.66	1.61	1.51	2.11
50 x 20 x	2.8 RHS	2.67	1.99	1.99	1.99	1.99	1.98	1.93	1.89	1.80	1.72	1.64	1.57	1.50	1.43	1.31	1.45
	2.3 RHS	2.25	1.71	1.71	1.71	1.71	1.71	1.67	1.63	1.56	1.49	1.42	1.36	1.30	1.25	1.15	1.48

Notes:
1. ϕ = 0.9
2. FLR - segment length for Full Lateral Restraint ($\phi M_{bx} = \phi M_{sx}$) for simply supported beams with uniform moment.
   FLR = $0.231 (\pi^2 E I_y G J / M_{sx}^2)^{0.5}$ (See Section *D*4.1.3 of these tables for explanation)
3. Values to the left of the solid line are segment lengths with full lateral restraint.
4. α_{sh} = $0.7(((M_{sx} / M_{oa})^2 + 2.7))^{0.5} - M_s/M_{oa})$ (See Section *D*4.1.2 of these tables for explanation)
5. α_m = 1.0

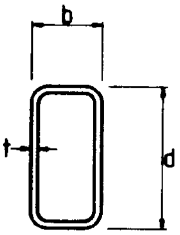


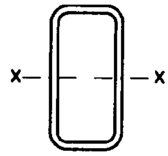
TABLE $D4.3$-1(A)

DESIGN WEB CAPACITIES OF BEAMS

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

about x-axis



Designation d b t	Mass per m	ϕV_v		Interior Bearing $\phi R_{by}/b_b$	Interior Bearing $\phi R_{bb}/b_b$	Interior Useful Parameters $5r_{ext}$	Interior Useful Parameters b_{bw}	Interior Useful Parameters L_e/r	End Bearing $\phi R_{by}/b_b$	End Bearing $\phi R_{bb}/b_b$	End Useful Parameters $2.5r_{ext}$	End Useful Parameters b_{bw}	End Useful Parameters L_e/r
mm mm mm	kg/m	kN		kN/mm	kN/mm	mm	mm	mm	kN/mm	kN/mm	mm	mm	mm
150 x 50 x 6.0 RHS	16.7	374	N	**1.28**	2.54	75.0	60.0	70.0	**1.18**	2.30	37.5	60.0	76.0
5.0 RHS	14.2	316	N	**1.05**	1.60	62.5	62.5	87.5	**0.983**	1.42	31.3	62.5	95.0
4.0 RHS	11.6	257	N	**0.828**	0.860	50.0	65.0	114	0.786	**0.752**	25.0	65.0	124
3.0 RHS	8.96	195	N	0.785	**0.357**	30.0	69.0	161	0.769	**0.308**	15.0	69.0	175
2.5 RHS	7.53	164	N	0.651	**0.208**	25.0	70.0	196	0.641	**0.179**	12.5	70.0	213
2.0 RHS	6.07	92.5	B	0.519	**0.107**	20.0	71.0	249	0.513	**0.0918**	10.0	71.0	270
125 x 75 x 6.0 RHS	16.7	317	N	**1.31**	3.16	75.0	47.5	55.4	**1.18**	2.95	37.5	47.5	60.2
5.0 RHS	14.2	269	N	**1.07**	2.11	62.5	50.0	70.0	**0.983**	1.92	31.3	50.0	76.0
4.0 RHS	11.6	219	N	**0.838**	1.19	50.0	52.5	91.9	**0.786**	1.06	25.0	52.5	99.8
3.0 RHS	8.96	167	N	0.790	**0.506**	30.0	56.5	132	0.769	**0.439**	15.0	56.5	143
2.5 RHS	7.53	140	N	0.654	**0.298**	25.0	57.5	161	0.641	**0.257**	12.5	57.5	175
2.0 RHS	6.07	113	N	0.521	**0.154**	20.0	58.5	205	0.513	**0.132**	10.0	58.5	222
100 x 50 x 6.0 RHS	12.0	244	N	**1.35**	3.79	75.0	35.0	40.8	**1.18**	3.64	37.5	35.0	44.3
5.0 RHS	10.3	208	N	**1.10**	2.74	62.5	37.5	52.5	**0.983**	2.58	31.3	37.5	57.0
4.0 RHS	8.49	170	N	**0.854**	1.69	50.0	40.0	70.0	**0.786**	1.54	25.0	40.0	76.0
3.5 RHS	7.53	151	N	**0.738**	1.21	43.8	41.3	82.5	**0.688**	1.08	21.9	41.3	89.6
3.0 RHS	6.60	131	N	0.797	**0.758**	30.0	44.0	103	0.769	**0.667**	15.0	44.0	111
2.5 RHS	5.56	110	N	0.659	**0.455**	25.0	45.0	126	0.641	**0.396**	12.5	45.0	137
2.0 RHS	4.50	88.9	N	0.524	**0.238**	20.0	46.0	161	0.513	**0.205**	10.0	46.0	175
1.6 RHS	3.64	71.7	N	0.417	**0.123**	16.0	46.8	205	0.410	**0.106**	8.00	46.8	222
75 x 50 x 6.0 RHS	9.67	178	N	**1.44**	4.33	75.0	22.5	26.3	**1.18**	4.25	37.5	22.5	28.5
5.0 RHS	8.35	153	N	**1.15**	3.34	62.5	25.0	35.0	**0.983**	3.25	31.3	25.0	38.0
4.0 RHS	6.92	126	N	**0.884**	2.32	50.0	27.5	48.1	**0.786**	2.20	25.0	27.5	52.3
3.0 RHS	5.42	97.4	N	**0.809**	1.20	30.0	31.5	73.5	**0.769**	1.08	15.0	31.5	79.8
2.5 RHS	4.58	82.3	N	**0.667**	0.756	25.0	32.5	91.0	**0.641**	0.670	12.5	32.5	98.8
2.0 RHS	3.72	66.8	N	0.528	**0.410**	20.0	33.5	117	0.513	**0.358**	10.0	33.5	127
1.6 RHS	3.01	54.0	N	0.420	**0.216**	16.0	34.3	150	0.410	**0.186**	8.00	34.3	163
75 x 25 x 2.5 RHS	3.60	79.1	N	**0.667**	0.756	25.0	32.5	91.0	**0.641**	0.670	12.5	32.5	98.8
2.0 RHS	2.93	64.2	N	0.528	**0.410**	20.0	33.5	117	0.513	**0.358**	10.0	33.5	127
1.6 RHS	2.38	51.9	N	0.420	**0.216**	16.0	34.3	150	0.410	**0.186**	8.00	34.3	163
65 x 35 x 4.0 RHS	5.35	106	N	**0.906**	2.56	50.0	22.5	39.4	**0.786**	2.47	25.0	22.5	42.8
3.0 RHS	4.25	82.3	N	**0.817**	1.44	30.0	26.5	61.8	**0.769**	1.33	15.0	26.5	67.1
2.5 RHS	3.60	69.7	N	**0.672**	0.945	25.0	27.5	77.0	**0.641**	0.850	12.5	27.5	83.6
2.0 RHS	2.93	56.7	N	0.532	**0.528**	20.0	28.5	99.8	0.513	**0.465**	10.0	28.5	108
50 x 25 x 3.0 RHS	3.07	61.1	N	**0.836**	1.82	30.0	19.0	44.3	**0.769**	1.74	15.0	19.0	48.1
2.5 RHS	2.62	52.1	N	**0.685**	1.31	25.0	20.0	56.0	**0.641**	1.22	12.5	20.0	60.8
2.0 RHS	2.15	42.6	N	**0.539**	0.800	20.0	21.0	73.5	**0.513**	0.723	10.0	21.0	79.8
1.6 RHS	1.75	34.7	N	**0.426**	0.452	16.0	21.8	95.4	0.410	**0.399**	8.00	21.8	104
50 x 20 x 3.0 RHS	2.83	60.3	N	**0.836**	1.82	30.0	19.0	44.3	**0.769**	1.74	15.0	19.0	48.1
2.5 RHS	2.42	51.4	N	**0.685**	1.31	25.0	20.0	56.0	**0.641**	1.22	12.5	20.0	60.8
2.0 RHS	1.99	42.0	N	**0.539**	0.800	20.0	21.0	73.5	**0.513**	0.723	10.0	21.0	79.8
1.6 RHS	1.63	34.2	N	**0.426**	0.452	16.0	21.8	95.4	0.410	**0.399**	8.00	21.8	104

Notes :
1. ϕ = 0.9
2. L_e/r = 3.5 d_5/t for interior bearing or L_e/r = 3.8 d_5/t for end bearing
3. ϕR_{by} = $2\phi\, \alpha_p\, b_b\, t\, f_y$
4. ϕR_{bb} = $2\phi\, \alpha_c\, b_b\, t\, f_y$
5. αb = 0.5
6. k_f = 1.0
7. U = approximately uniform shear stress distribution. Design shear capacity calculated in accordance with clause 5.11.4 of AS 4100.
   $V_v = V_u = V_w = 0.6\, f_y\, A_w$
   N = non-uniform shear stress distribution. Design shear capacity calculated in accordance with clause 5.11.3 of AS 4100.
   $V_v = 2V_u \,/\, (0.9 + (f^*_{vm}/f^*_{va})) \le V_u$
   B = shear buckling failure mode. Design shear capacity calculated in accordance with clause 5.11.5 of AS 4100.
   $V_v = V_b = \alpha_v V_w \le V_w$

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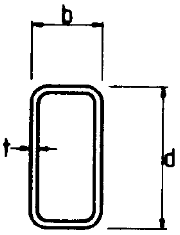


TABLE *D*4.3-1(B)

DESIGN WEB CAPACITIES OF BEAMS

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

about y-axis

Designation (d x b x t)	Mass per m	ϕV_v		Interior Bearing $\phi R_{by}/b_b$	Interior Bearing $\phi R_{bb}/b_b$	Interior Useful Parameters $5r_{ext}$	Interior Useful Parameters b_{bw}	Interior Useful Parameters L_e/r	End Bearing $\phi R_{by}/b_b$	End Bearing $\phi R_{bb}/b_b$	End Useful Parameters $2.5r_{ext}$	End Useful Parameters b_{bw}	End Useful Parameters L_e/r
mm mm mm	kg/m	kN		kN/mm	kN/mm	mm	mm	mm	kN/mm	kN/mm	mm	mm	mm
150 x 50 x 6.0 RHS	16.7	111	U	**1.72**	4.81	75.0	10.0	11.7	**1.18**	4.77	37.5	10.0	12.7
5.0 RHS	14.2	97.2	U	**1.30**	3.85	62.5	12.5	17.5	**0.983**	3.81	31.3	12.5	19.0
4.0 RHS	11.6	81.6	U	**0.962**	2.88	50.0	15.0	26.3	**0.786**	2.83	25.0	15.0	28.5
3.0 RHS	8.96	64.2	U	**0.836**	1.82	30.0	19.0	43.9	**0.769**	1.74	15.0	19.0	48.1
2.5 RHS	7.53	54.7	U	**0.685**	1.31	25.0	20.0	56.0	**0.641**	1.22	12.5	20.0	60.8
2.0 RHS	6.07	44.7	U	**0.539**	0.800	20.0	21.0	73.5	**0.513**	0.723	10.0	21.0	79.8
125 x 75 x 6.0 RHS	16.7	184	U	**1.44**	4.33	75.0	22.5	26.3	**1.18**	4.25	37.5	22.5	28.5
5.0 RHS	14.2	158	U	**1.15**	3.34	62.5	25.0	35.0	**0.983**	3.25	31.3	25.0	38.0
4.0 RHS	11.6	130	U	**0.884**	2.32	50.0	27.5	48.1	**0.786**	2.20	25.0	27.5	52.3
3.0 RHS	8.96	101	U	**0.809**	1.20	30.0	31.5	73.5	**0.769**	1.08	15.0	31.5	79.8
2.5 RHS	7.53	85.1	U	**0.667**	0.756	25.0	32.5	91.0	**0.641**	0.670	12.5	32.5	98.8
2.0 RHS	6.07	69.0	U	0.528	**0.410**	20.0	33.5	117	0.513	**0.358**	10.0	33.5	127
100 x 50 x 6.0 RHS	12.0	111	U	**1.72**	4.81	75.0	10.0	11.7	**1.18**	4.77	37.5	10.0	12.7
5.0 RHS	10.3	97.2	U	**1.30**	3.85	62.5	12.5	17.5	**0.983**	3.81	31.3	12.5	19.0
4.0 RHS	8.49	81.6	U	**0.962**	2.88	50.0	15.0	26.3	**0.786**	2.83	25.0	15.0	28.5
3.5 RHS	7.53	73.1	U	**0.814**	2.39	43.8	16.3	32.5	**0.688**	2.33	21.9	16.3	35.3
3.0 RHS	6.60	64.2	U	**0.836**	1.82	30.0	19.0	44.3	**0.769**	1.74	15.0	19.0	48.1
2.5 RHS	5.56	54.7	U	**0.685**	1.31	25.0	20.0	56.0	**0.641**	1.22	12.5	20.0	60.8
2.0 RHS	4.50	44.7	U	**0.539**	0.800	20.0	21.0	73.5	**0.513**	0.723	10.0	21.0	79.8
1.6 RHS	3.64	36.4	U	**0.426**	0.452	16.0	21.8	95.4	0.410	**0.399**	8.00	21.8	104
75 x 50 x 6.0 RHS	9.67	111	U	**1.72**	4.81	75.0	10.0	11.7	**1.18**	4.77	37.5	10.0	12.7
5.0 RHS	8.35	97.2	U	**1.30**	3.85	62.5	12.5	17.5	**0.983**	3.81	31.3	12.5	19.0
4.0 RHS	6.92	81.6	U	**0.962**	2.88	50.0	15.0	26.3	**0.786**	2.83	25.0	15.0	28.5
3.0 RHS	5.42	64.2	U	**0.836**	1.82	30.0	19.0	44.3	**0.769**	1.74	15.0	19.0	48.1
2.5 RHS	4.58	54.7	U	**0.685**	1.31	25.0	20.0	56.0	**0.641**	1.22	12.5	20.0	60.8
2.0 RHS	3.72	44.7	U	**0.539**	0.800	20.0	21.0	73.5	**0.513**	0.723	10.0	21.0	79.8
1.6 RHS	3.01	36.4	U	**0.426**	0.452	16.0	21.8	95.4	0.410	**0.399**	8.00	21.8	104
75 x 25 x 2.5 RHS	3.60	24.3	U	**0.754**	1.88	25.0	7.50	21.0	**0.641**	1.85	12.5	7.50	22.8
2.0 RHS	2.93	20.4	U	**0.578**	1.40	20.0	8.50	29.8	**0.513**	1.37	10.0	8.50	32.3
1.6 RHS	2.38	17.0	U	**0.449**	1.01	16.0	9.30	40.7	**0.410**	0.973	8.00	9.30	44.2
65 x 35 x 4.0 RHS	5.35	52.5	U	**1.11**	3.17	50.0	7.50	13.1	**0.786**	3.15	25.0	7.50	14.3
3.0 RHS	4.25	42.3	U	**0.878**	2.15	30.0	11.5	26.8	**0.769**	2.11	15.0	11.5	29.1
2.5 RHS	3.60	36.5	U	**0.711**	1.67	25.0	12.5	35.0	**0.641**	1.62	12.5	12.5	38.0
2.0 RHS	2.93	30.1	U	**0.554**	1.17	20.0	13.5	47.3	**0.513**	1.11	10.0	13.5	51.3
50 x 25 x 3.0 RHS	3.07	27.7	U	**0.949**	2.35	30.0	6.50	15.2	**0.769**	2.33	15.0	6.50	16.5
2.5 RHS	2.62	24.3	U	**0.754**	1.88	25.0	7.50	21.0	**0.641**	1.85	12.5	7.50	22.8
2.0 RHS	2.15	20.4	U	**0.578**	1.40	20.0	8.50	29.8	**0.513**	1.37	10.0	8.50	32.3
1.6 RHS	1.75	17.0	U	**0.449**	1.01	16.0	9.30	40.7	**0.410**	0.973	8.00	9.30	44.2
50 x 20 x 3.0 RHS	2.83	20.4	U	**1.02**	2.43	30.0	4.00	9.33	**0.769**	2.43	15.0	4.00	10.1
2.5 RHS	2.42	18.2	U	**0.801**	1.97	25.0	5.00	14.0	**0.641**	1.95	12.5	5.00	15.2
2.0 RHS	1.99	15.6	U	**0.603**	1.50	20.0	6.00	21.0	**0.513**	1.48	10.0	6.00	22.8
1.6 RHS	1.63	13.1	U	**0.463**	1.12	16.0	6.80	29.8	**0.410**	1.10	8.00	6.80	32.3

Notes :
1. ϕ = 0.9
2. L_e/r = 3.5 d_5/t for interior bearing or L_e/r = 3.8 d_5/t for end bearing
3. ϕR_{by} = $2\phi\, \alpha_p\, b_b\, t\, f_y$
4. ϕR_{bb} = $2\phi\, \alpha_c\, b_b\, t\, f_y$
5. αb = 0.5
6. k_f = 1.0
7. U = approximately uniform shear stress distribution. Design shear capacity calculated in accordance with clause 5.11.4 of AS 4100. $V_v = V_u = V_w = 0.6\, f_y\, A_w$

   N = non-uniform shear stress distribution. Design shear capacity calculated in accordance with clause 5.11.3 of AS 4100. $V_v = 2V_u / (0.9 + (f^*_{vm}/f^*_{va})) \leq V_u$

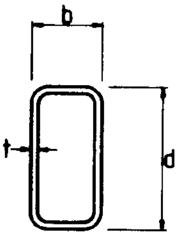
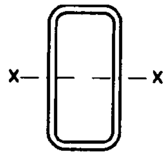


TABLE *D*4.3-2(A)

DESIGN WEB CAPACITIES OF BEAMS

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0
Non-Standard Thickness
about x-axis



Designation d b t	Mass per m	ϕV_v		Interior Bearing ϕR_{by} / b_b	Interior Bearing ϕR_{bb} / b_b	Useful Parameters $5r_{ext}$	Useful Parameters b_{bw}	Useful Parameters L_e/r	End Bearing ϕR_{by} / b_b	End Bearing ϕR_{bb} / b_b	Useful Parameters $2.5r_{ext}$	Useful Parameters b_{bw}	Useful Parameters L_e/r
mm mm mm	kg/m	kN		kN/mm	kN/mm	mm	mm	mm	kN/mm	kN/mm	mm	mm	mm
125 x 75 x 2.8 RHS	8.39	156	N	0.735	**0.414**	28.0	56.9	142	0.718	**0.359**	14.0	56.9	154
2.3 RHS	6.95	129	N	0.601	**0.233**	23.0	57.9	176	0.590	**0.200**	11.5	57.9	191
100 x 50 x 2.8 RHS	6.19	122	N	0.741	**0.626**	28.0	44.4	111	0.718	**0.548**	14.0	44.4	121
2.3 RHS	5.14	102	N	0.605	**0.358**	23.0	45.4	138	0.590	**0.310**	11.5	45.4	150
75 x 50 x 2.8 RHS	5.09	91.4	N	**0.752**	1.01	28.0	31.9	79.8	**0.718**	0.908	14.0	31.9	86.6
2.3 RHS	4.24	76.2	N	**0.611**	0.604	23.0	32.9	100	0.590	**0.532**	11.5	32.9	109
65 x 35 x 2.8 RHS	3.99	77.3	N	**0.758**	1.24	28.0	26.9	67.3	**0.718**	1.13	14.0	26.9	73.0
2.3 RHS	3.34	64.6	N	**0.616**	0.766	23.0	27.9	84.9	**0.590**	0.683	11.5	27.9	92.2
50 x 25 x 2.8 RHS	2.89	57.5	N	**0.775**	1.62	28.0	19.4	48.5	**0.718**	1.53	14.0	19.4	52.7
2.3 RHS	2.44	48.3	N	**0.626**	1.10	23.0	20.4	62.1	**0.590**	1.01	11.5	20.4	67.4
50 x 20 x 2.8 RHS	2.67	56.8	N	**0.775**	1.62	28.0	19.4	48.5	**0.718**	1.53	14.0	19.4	52.7
2.3 RHS	2.25	47.7	N	**0.626**	1.10	23.0	20.4	62.1	**0.590**	1.01	11.5	20.4	67.4

Notes : 1. ϕ = 0.9
2. L_e/r = 3.5 d_5/t for interior bearing or L_e/r = 3.8 d_5/t for end bearing
3. ϕR_{by} = $2\phi\, \alpha_p\, b_b\, t\, f_y$
4. ϕR_{bb} = $2\phi\, \alpha_c\, b_b\, t\, f_y$
5. αb = 0.5
6. k_f = 1.0
7. U = approximately uniform shear stress distribution. Design shear capacity calculated in accordance with clause 5.11.4 of AS 4100. $V_v = V_u = V_w = 0.6\, f_y\, A_w$
N = non-uniform shear stress distribution. Design shear capacity calculated in accordance with clause 5.11.3 of AS 4100. $V_v = 2V_u / (0.9 + (f^*_{vm}/f^*_{va})) \leq V_u$

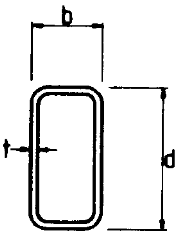
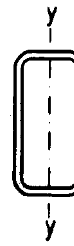


TABLE *D*4.3-2(B)

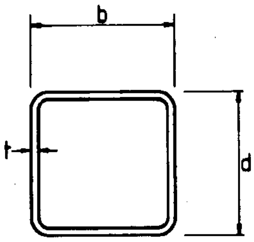
DESIGN WEB CAPACITIES OF BEAMS

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0
Non-Standard Thickness
about y-axis



Designation d b t	Mass per m	ϕV_v		Interior Bearing ϕR_{by} / b_b	Interior Bearing ϕR_{bb} / b_b	Useful Parameters $5r_{ext}$	Useful Parameters b_{bw}	Useful Parameters L_e/r	End Bearing ϕR_{by} / b_b	End Bearing ϕR_{bb} / b_b	Useful Parameters $2.5r_{ext}$	Useful Parameters b_{bw}	Useful Parameters L_e/r
mm mm mm	kg/m	kN		kN/mm	kN/mm	mm	mm	mm	kN/mm	kN/mm	mm	mm	mm
125 x 75 x 2.8 RHS	8.39	94.4	U	**0.752**	1.01	28.0	31.9	79.8	**0.718**	0.908	14.0	31.9	86.6
2.3 RHS	6.95	78.7	U	0.611	**0.609**	23.0	32.9	100	0.590	**0.532**	11.5	32.9	109
100 x 50 x 2.8 RHS	6.19	60.4	U	**0.775**	1.62	28.0	19.4	48.5	**0.718**	1.53	14.0	19.4	52.7
2.3 RHS	5.14	50.7	U	**0.626**	1.10	23.0	20.4	62.1	**0.590**	1.01	11.5	20.4	67.4
75 x 50 x 2.8 RHS	5.09	60.4	U	**0.775**	1.62	28.0	19.4	48.5	**0.718**	1.53	14.0	19.4	52.7
2.3 RHS	4.24	50.7	U	**0.626**	1.10	23.0	20.4	62.1	**0.590**	1.01	11.5	20.4	67.4
65 x 35 x 2.8 RHS	3.99	40.0	U	**0.810**	1.96	28.0	11.9	29.8	**0.718**	1.92	14.0	11.9	32.3
2.3 RHS	3.34	34.0	U	**0.647**	1.48	23.0	12.9	39.3	**0.590**	1.42	11.5	12.9	42.6
50 x 25 x 2.8 RHS	2.89	26.4	U	**0.869**	2.16	28.0	6.90	17.3	**0.718**	2.14	14.0	6.90	18.7
2.3 RHS	2.44	22.8	U	**0.682**	1.69	23.0	7.90	24.0	**0.590**	1.66	11.5	7.90	26.1
50 x 20 x 2.8 RHS	2.67	19.6	U	**0.932**	2.25	28.0	4.40	11.0	**0.718**	2.24	14.0	4.40	11.9
2.3 RHS	2.25	17.2	U	**0.719**	1.78	23.0	5.40	16.4	**0.590**	1.77	11.5	5.40	17.8

Notes : 1. ϕ = 0.9
2. L_e/r = 3.5 d_5/t for interior bearing or L_e/r = 3.8 d_5/t for end bearing
3. ϕR_{by} = $2\phi\, \alpha_p\, b_b\, t\, f_y$
4. ϕR_{bb} = $2\phi\, \alpha_c\, b_b\, t\, f_y$
5. αb = 0.5
6. k_f = 1.0
7. U = approximately uniform shear stress distribution. Design shear capacity calculated in accordance with clause 5.11.4 of AS 4100. $V_v = V_u = V_w = 0.6\, f_y\, A_w$
N = non-uniform shear stress distribution. Design shear capacity calculated in accordance with clause 5.11.3 of AS 4100. $V_v = 2V_u / (0.9 + (f^*_{vm}/f^*_{va})) \leq V_u$



onesteel
market mills

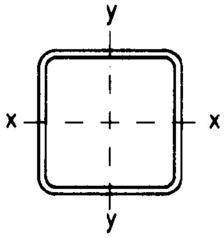
TABLE *D*4.3-3

DESIGN WEB CAPACITIES OF BEAMS

DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

about x- and y-axis



Designation d b t	Mass per m	ϕV_v		Interior Bearing ϕR_{by} / b_b	ϕR_{bb} / b_b	Useful Parameters $5r_{ext}$	b_{bw}	L_e/r	End Bearing ϕR_{by} / b_b	ϕR_{bb} / b_b	Useful Parameters $2.5r_{ext}$	b_{bw}	L_e/r
mm mm mm	kg/m	kN		kN/mm	kN/mm	mm	mm	mm	kN/mm	kN/mm	mm	mm	mm
100 x 100 x 6.0 SHS	16.7	253	N	**1.35**	3.79	75.0	35.0	40.8	**1.18**	3.64	37.5	35.0	44.3
5.0 SHS	14.2	216	N	**1.10**	2.74	62.5	37.5	52.5	**0.983**	2.58	31.3	37.5	57.0
4.0 SHS	11.6	177	N	**0.854**	1.69	50.0	40.0	70.0	**0.786**	1.54	25.0	40.0	76.0
3.0 SHS	8.96	135	N	0.797	**0.758**	30.0	44.0	103	0.769	**0.667**	15.0	44.0	111
2.5 SHS	7.53	114	N	0.659	**0.455**	25.0	45.0	126	0.641	**0.396**	12.5	45.0	137
2.0 SHS	6.07	92.2	N	0.524	**0.238**	20.0	46.0	161	0.513	**0.205**	10.0	46.0	175
90 x 90 x 3.0 SHS	8.01	121	N	**0.800**	0.907	30.0	39.0	91.0	**0.769**	0.804	15.0	39.0	98.8
2.5 SHS	6.74	102	N	0.662	**0.551**	25.0	40.0	112	0.641	**0.482**	12.5	40.0	122
2.0 SHS	5.45	82.6	N	0.525	**0.291**	20.0	41.0	144	0.513	**0.252**	10.0	41.0	156
1.6 SHS	4.39	66.7	N	0.418	**0.151**	16.0	41.8	183	0.410	**0.130**	8.00	41.8	199
89 x 89 x 6.0 SHS	14.6	221	N	**1.38**	4.04	75.0	29.5	34.4	**1.18**	3.93	37.5	29.5	37.3
5.0 SHS	12.5	189	N	**1.11**	3.02	62.5	32.0	44.7	**0.983**	2.89	31.3	32.0	48.6
3.5 SHS	9.06	138	N	**0.746**	1.45	43.8	35.7	71.4	**0.688**	1.31	21.9	35.7	77.5
75 x 75 x 6.0 SHS	12.0	181	N	**1.44**	4.33	75.0	22.5	26.3	**1.18**	4.25	37.5	22.5	28.5
5.0 SHS	10.3	156	N	**1.15**	3.34	62.5	25.0	35.0	**0.983**	3.25	31.3	25.0	38.0
4.0 SHS	8.49	129	N	**0.884**	2.32	50.0	27.5	48.1	**0.786**	2.20	25.0	27.5	52.3
3.5 SHS	7.53	114	N	**0.760**	1.79	43.8	28.8	57.5	**0.688**	1.66	21.9	28.8	62.4
3.0 SHS	6.60	99.4	N	**0.809**	1.20	30.0	31.5	73.5	**0.769**	1.08	15.0	31.5	79.8
2.5 SHS	5.56	84.0	N	**0.667**	0.756	25.0	32.5	91.0	**0.641**	0.670	12.5	32.5	98.8
2.0 SHS	4.50	68.2	N	0.528	**0.410**	20.0	33.5	117	0.513	**0.358**	10.0	33.5	127
65 x 65 x 6.0 SHS	10.1	153	N	**1.51**	4.52	75.0	17.5	20.4	**1.18**	4.46	37.5	17.5	22.2
5.0 SHS	8.75	132	N	**1.19**	3.55	62.5	20.0	28.0	**0.983**	3.48	31.3	20.0	30.4
4.0 SHS	7.23	109	N	**0.906**	2.56	50.0	22.5	39.4	**0.786**	2.47	25.0	22.5	42.8
3.0 SHS	5.66	85.0	N	**0.817**	1.44	30.0	26.5	61.8	**0.769**	1.33	15.0	26.5	67.1
2.5 SHS	4.78	72.0	N	**0.672**	0.945	25.0	27.5	77.0	**0.641**	0.850	12.5	27.5	83.6
2.0 SHS	3.88	58.6	N	0.532	**0.528**	20.0	28.5	99.8	0.513	**0.465**	10.0	28.5	108
1.6 SHS	3.13	47.5	N	0.422	**0.283**	16.0	29.3	128	0.410	**0.246**	8.00	29.3	139
50 x 50 x 5.0 SHS	6.39	96.0	N	**1.30**	3.85	62.5	12.5	17.5	**0.983**	3.81	31.3	12.5	19.0
4.0 SHS	5.35	80.6	N	**0.962**	2.88	50.0	15.0	26.3	**0.786**	2.83	25.0	15.0	28.5
3.0 SHS	4.25	63.4	N	**0.836**	1.82	30.0	19.0	44.3	**0.769**	1.74	15.0	19.0	48.1
2.5 SHS	3.60	54.0	N	**0.685**	1.31	25.0	20.0	56.0	**0.641**	1.22	12.5	20.0	60.8
2.0 SHS	2.93	44.2	N	**0.539**	0.800	20.0	21.0	73.5	**0.513**	0.723	10.0	21.0	79.8
1.6 SHS	2.38	35.9	N	**0.426**	0.452	16.0	21.8	95.4	0.410	**0.399**	8.00	21.8	104
40 x 40 x 4.0 SHS	4.09	61.4	N	**1.04**	3.08	50.0	10.0	17.5	**0.786**	3.05	25.0	10.0	19.0
3.0 SHS	3.30	49.0	N	**0.859**	2.05	30.0	14.0	32.7	**0.769**	2.00	15.0	14.0	35.5
2.5 SHS	2.82	42.0	N	**0.700**	1.56	25.0	15.0	42.0	**0.641**	1.50	12.5	15.0	45.6
2.0 SHS	2.31	34.6	N	**0.548**	1.05	20.0	16.0	56.0	**0.513**	0.975	10.0	16.0	60.8
1.6 SHS	1.88	28.3	N	**0.431**	0.640	16.0	16.8	73.5	**0.410**	0.578	8.00	16.8	79.8
35 x 35 x 3.0 SHS	2.83	41.8	N	**0.878**	2.15	30.0	11.5	26.8	**0.769**	2.11	15.0	11.5	29.1
2.5 SHS	2.42	36.0	N	**0.711**	1.67	25.0	12.5	35.0	**0.641**	1.62	12.5	12.5	38.0
2.0 SHS	1.99	29.8	N	**0.554**	1.17	20.0	13.5	47.3	**0.513**	1.11	10.0	13.5	51.3
1.6 SHS	1.63	24.4	N	**0.435**	0.760	16.0	14.3	62.6	**0.410**	0.699	8.00	14.3	67.9
30 x 30 x 2.0 SHS	1.68	25.0	N	**0.564**	1.29	20.0	11.0	38.5	**0.513**	1.25	10.0	11.0	41.8
1.6 SHS	1.38	20.6	N	**0.441**	0.888	16.0	11.8	51.6	**0.410**	0.836	8.00	11.8	56.1
25 x 25 x 2.5 SHS	1.64	24.0	N	**0.754**	1.88	25.0	7.50	21.0	**0.641**	1.85	12.5	7.50	22.8
2.0 SHS	1.36	20.2	N	**0.578**	1.40	20.0	8.50	29.8	**0.513**	1.37	10.0	8.50	32.3
1.6 SHS	1.12	16.7	N	**0.449**	1.01	16.0	9.30	40.7	**0.410**	0.973	8.00	9.30	44.2
20 x 20 x 1.6 SHS	0.873	12.9	N	**0.463**	1.12	16.0	6.80	29.8	**0.410**	1.10	8.00	6.80	32.3

Notes :
1. ϕ = 0.9
2. L_e/r = 3.5 d_5/t for interior bearing or L_e/r = 3.8 d_5/t for end bearing
3. ϕR_{by} = $2\phi\ \alpha_p\ b_b\ t\ f_y$
4. ϕR_{bb} = $2\phi\ \alpha_c\ b_b\ t\ f_y$
5. αb = 0.5
6. k_f = 1.0
7. U = approximately uniform shear stress distribution. Design shear capacity calculated in accordance with clause 5.11.4 of AS 4100. $V_v = V_u = V_w = 0.6\ f_y\ A_w$

   N = non-uniform shear stress distribution. Design shear capacity calculated in accordance with clause 5.11.3 of AS 4100. $V_v = 2V_u / (0.9 + (f^*_{vm}/f^*_{va})) \le V_u$

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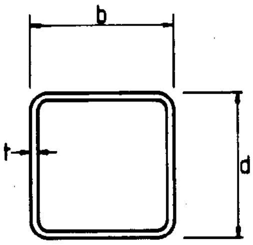
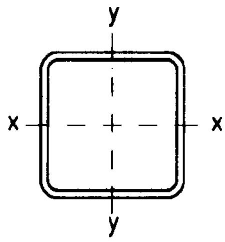


TABLE *D*4.3-4

DESIGN WEB CAPACITIES OF BEAMS

DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0
Non-Standard Thickness
about x- and y-axis



Designation d b t	Mass per m	ϕV_v		Interior Bearing $\phi R_{by}/b_b$	$\phi R_{bb}/b_b$	Useful Parameters $5r_{ext}$	b_{bw}	L_e/r	End Bearing $\phi R_{by}/b_b$	$\phi R_{bb}/b_b$	Useful Parameters $2.5r_{ext}$	b_{bw}	L_e/r
mm mm mm	kg/m	kN		kN/mm	kN/mm	mm	mm	mm	kN/mm	kN/mm	mm	mm	mm
100 x 100 x 2.8 SHS	8.39	127	N	0.741	**0.626**	28.0	44.4	111	0.718	**0.548**	14.0	44.4	121
2.3 SHS	6.95	105	N	0.605	**0.358**	23.0	45.4	138	0.590	**0.310**	11.5	45.4	150
75 x 75 x 2.8 SHS	6.19	93.3	N	**0.752**	1.01	28.0	31.9	79.8	**0.718**	0.908	14.0	31.9	86.6
2.3 SHS	5.14	77.7	N	0.611	**0.604**	23.0	32.9	100	0.590	**0.532**	11.5	32.9	109
65 x 65 x 2.3 SHS	4.42	66.7	N	**0.616**	0.766	23.0	27.9	84.9	**0.590**	0.683	11.5	27.9	92.2
50 x 50 x 2.8 SHS	3.99	59.7	N	**0.775**	1.62	28.0	19.4	48.5	**0.718**	1.53	14.0	19.4	52.7
2.3 SHS	3.34	50.1	N	**0.626**	1.10	23.0	20.4	62.1	**0.590**	1.01	11.5	20.4	67.4
40 x 40 x 2.8 SHS	3.11	46.2	N	**0.794**	1.86	28.0	14.4	36.0	**0.718**	1.80	14.0	14.4	39.1
2.3 SHS	2.62	39.1	N	**0.638**	1.36	23.0	15.4	46.9	**0.590**	1.29	11.5	15.4	50.9
35 x 35 x 2.8 SHS	2.67	39.5	N	**0.810**	1.96	28.0	11.9	29.8	**0.718**	1.92	14.0	11.9	32.3
2.3 SHS	2.25	33.6	N	**0.647**	1.48	23.0	12.9	39.3	**0.590**	1.42	11.5	12.9	42.6

Notes :
1. ϕ = 0.9
2. L_e/r = 3.5 d_5/t for interior bearing or L_e/r = 3.8 d_5/t for end bearing
3. ϕR_{by} = $2\phi\, \alpha_p\, b_b\, t\, f_y$
4. ϕR_{bb} = $2\phi\, \alpha_c\, b_b\, t\, f_y$
5. αb = 0.5
6. k_f = 1.0
7. U = approximately uniform shear stress distribution. Design shear capacity calculated in accordance with clause 5.11.4 of AS 4100. $V_v = V_u = V_w = 0.6\, f_y\, A_w$

   N = non-uniform shear stress distribution. Design shear capacity calculated in accordance with clause 5.11.3 of AS 4100. $V_v = 2V_u\, /\, (0.9 + (f^*_{vm}/f^*_{va})) \le V_u$

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PART 5 MEMBERS SUBECT TO AXIAL COMPRESSION

5

TABLES

NOTE: SEE PAGE vii FOR THE SPECIFIC MATERIAL STANDARD REFERRED TO BY THE SECTION TYPE AND STEEL GRADE IN THESE TABLES.

PART 5 MEMBERS SUBECT TO AXIAL COMPRESSION

*D*5.1 SCOPE

The following tables give values of design axial compression capacity for various effective lengths and have been determined using Section 6 of AS 4100.

All loads are assumed to be applied through the centroid of the section and the column capacity is assumed to be associated with flexural buckling about either the x- or y-axis.

*D*5.2 DESIGN CAPACITY FOR MEMBERS SUBJECT TO AXIAL COMPRESSION

Values of the design capacity for axial compression (ϕN_c) for buckling about both principal axes, based on the appropriate effective length (L_e), are given in Tables *D*5.2-1 to *D*5.2-4.

The tables in this section have been grouped into two series for rectangular hollow sections:

- the (A) series (e.g. Table *D*5.2-1(1)(A)) for the member buckling about the x-axis, and
- the (B) series (e.g. Table *D*5.2-1(1)(B)) for the member buckling about the y-axis.

The (A) series tables are immediately followed by the (B) series tables.

*D*5.3 METHOD

The design axial compression member capacity is obtained from Clauses 6.3 *of* AS 4100 and is given by:

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

where

ϕ	=	0.9	(Table 3.4 of AS 4100)
ϕN_s	=	$\phi\, k_f\, A_n\, f_y$	(see Section *D*3.2.2 and Tables *D*3.1-1 to *D*3.1-4)
k_f	=	A_e / A_g	(see Section *D*1.2.3.3 and Clause 6.2.2 of AS 4100)
A_n	=	net section area	
	=	A_g	
	=	gross cross-sectional area	(assumed no penetrations or holes)
f_y	=	yield stress used in design	
α_c	=	member slenderness reduction factor	

According to Clause 6.3.3 of AS 4100, α_c depends on the modified slenderness reduction factor (λ_n) and the member section constant (α_b). The member slenderness reduction factor (α_c) is determined from Clause 6.3.3 of AS 4100 and taken as:

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

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

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

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

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

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

α_a = -0.5 (Table *D*5.3)

$\left(\dfrac{L_e}{r}\right)$ = geometrical slenderness ratio

L_e = effective length of a compression member (see Section *D*5.4)

r = radius of gyration (see Tables *D*1.2-1 to *D*1.2-4)

k_f = form factor (see Section *D*1.2.3.3 and Tables *D*1.2-1 to *D*1.2-4)

f_y = yield stress used in design

Note that the member capacity equals the section capacity ($\phi N_c = \phi N_s$) when the effective length $L_e = 0$. The residual stress classification used in determining k_f is shown in Table *D*5.3 and is described in Section *D*1.2.3.3 of the Tables.

Table *D*5.3

Section	Residual Stresses	Yield Slenderness Limit λ_{ey}	α_b	
			k_f = 1.0	k_f < 1.0
RHS, SHS	CF	40	- 0.5	- 0.5

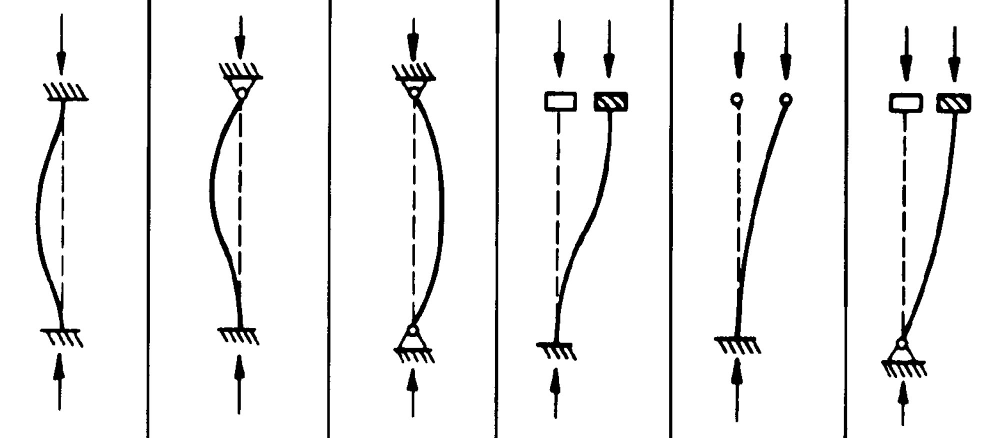
*D*5.4 EFFECTIVE LENGTH

Before using these tables and graphs it is necessary to determine the effective length, which depends on the rotational and translational restraints at the ends of the member and is determined using the following formula:

$$L_e = k_e L$$

The member effective length factor (k_e) (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 as described in Clause 4.7 of AS 4100. Information relevant to assessing k_e, for members in frames using Clause 4.6 of AS 4100, is reproduced in Part 7 of this publication. For members with idealised end restraints k_e is given in Table *D*5.4.

Table *D*5.4: Effective Length Factors for Members for Idealised Conditions of End Restraint

	Braced Member			Sway Member		
Buckled Shape						
Effective length factor (k_e)	0.7	0.85	1.0	1.2	2.2	2.2
Symbols for end restraint conditions	= Rotation fixed, translation fixed = Rotation free, translation fixed			= Rotation fixed, translation free = Rotation free, translation free		

Note: This table reproduced from AS 4100 -1998 by kind permission of Standards Australia.

Advice on the determination of effective lengths of members in trusses and girders is not covered in AS 4100, but suitable equations have been developed in [1]. The following equations are applicable for:

- welded joints with gap or partial overlap
- bracing members welded along the full perimeter
- no cropping or flattening of the ends of the bracings

In all cases $L_e / L \geq 0.5$

(i) Chord: square
Bracing: circular

$$\frac{L_e}{L} = 2.35\left(\frac{d_1^{\,2}}{Lb_o}\right)^{0.25} \leq 0.75$$

(ii) Chord: square
Bracing: square

$$\frac{L_e}{L} = 2.30\left(\frac{b_1^{\,2}}{Lb_o}\right)^{0.25} \leq 0.75$$

where L_e = effective length of a compression member
L = distance between intersection points of chord and web centre lines (see Figure *D*5.4)
d_1 = outside diameter of a circular bracing member
b_o = external width of a square chord member
b_1 = external width of a square bracing member

The effective length of members in a pitched roof can be determined from the reference[2] below.

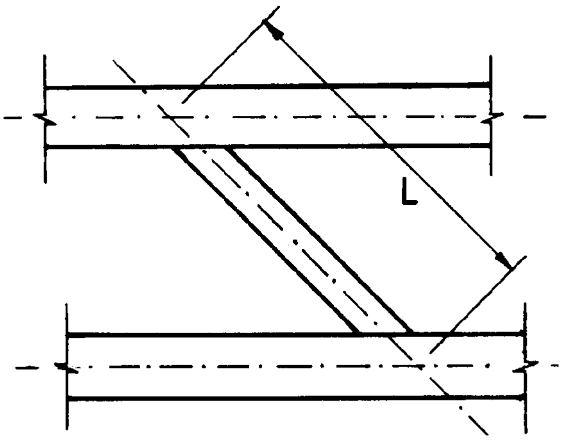


Figure *D*5.4

[1] Rondal, J., "Effective Lengths of Tubular Lattice Girder Members Statistical Tests", *CIDECT Report 3 K - 90/3 Final Report,* University of Liege, 1990.

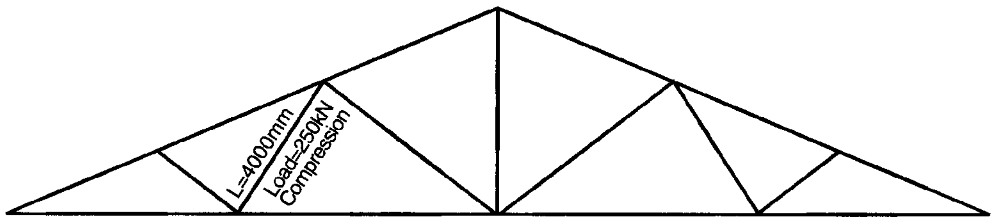
[2] Fraser, D.J., "Stability of Pitched Roof Frames", *Transaction of The Institution of Engineers Australia, Civil Engineering,* Vol. CE28, No. 1, 1986.

D5.5 MODES OF BUCKLING

Although it is also possible for some doubly symmetric sections to buckle in a torsional mode, this is not the governing buckling mode for hollow sections.

D5.6 EXAMPLE

1. A compression member in a truss, shown below, is to resist a concentrically applied axial compression force of 250 kN. End connections are full perimeter welded gap joints, with chord and web members being the same size *DuraGal* SHS.



Design Data:

N^* = 250 kN

Solution: From Section 5.4

$$\frac{L_e}{L} = 2.30\left(\frac{b_1^2}{Lb_0}\right)^{0.25} \leq 0.75$$ For SHS chord and bracing

$b_i = b_o$ For same size chord and bracing

$$\frac{L_e}{L} = 2.30\left(\frac{b_o}{L}\right)^{0.25} \leq 0.75$$

Trial L_e = 0.75 x 4.0 m (Section *D*5.4)
= 3.0 m

For $\frac{L_e}{L}$ = 0.75

b_o = 0.113 *L* = 0.113 x 4
= 45 mm

- Selecting the DuraGal section with the least mass from Table *D*5.2-3(1):

100 x 100 x 3.0 SHS Grade C450L0 (8.96 kg/m) $\phi N_c = 265 > N^*$ (Table *D*5.2-3(1))

As b_o = 100 mm > 45 mm ∴ section is satisfactory

$$\frac{L_e}{L} = 2.30\left(\frac{100}{4000}\right)^{0.25} = 0.914 > 0.75$$

∴ The assumption that $L_e = 0.75L$ was correct

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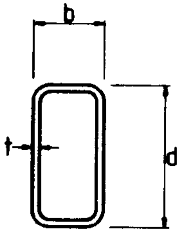
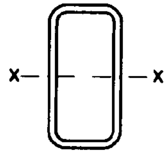


TABLE *D*5.2-1(1)(A)

DESIGN CAPACITIES FOR MEMBERS SUBJECT TO AXIAL COMPRESSION

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0
Standard Thickness
buckling about x-axis



Designation d b t		Mass per m	Design Capacities for Axial Compression ϕN_c (kN) — Effective Length (L_e) in metres													
mm mm mm		kg/m	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
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
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
	2.0 RHS	6.07	196	192	187	180	171	160	147	131	98.7	73.3	55.6	43.3	28.3	19.9
100 x 50 x	6.0 RHS	12.0	621	583	534	462	371	286	220	173	114	80.0	59.3	45.7	29.6	20.7
	5.0 RHS	10.3	532	502	461	402	326	253	196	154	101	71.4	53.0	40.8	26.4	18.5
	4.0 RHS	8.49	438	414	382	335	274	214	167	131	86.5	61.0	45.3	34.9	22.6	15.8
	3.5 RHS	7.53	388	367	340	299	246	193	150	119	78.1	55.1	40.9	31.5	20.4	14.3
	3.0 RHS	6.60	329	313	291	258	216	171	134	106	70.2	49.5	36.8	28.4	18.4	12.8
	2.5 RHS	5.56	246	235	221	200	172	141	112	89.6	59.7	42.2	31.4	24.2	15.7	11.0
	2.0 RHS	4.50	173	167	158	146	129	109	89.0	72.1	48.5	34.5	25.7	19.8	12.8	8.99
	1.6 RHS	3.64	124	120	115	107	96.6	83.7	69.9	57.5	39.2	28.0	20.9	16.1	10.5	7.33

Notes :
1. ϕ = 0.9
2. ϕN_c = $\phi \alpha_c N_s$ (Clause 6.3.3 of AS 4100)
3. α_b = - 0.5 (Table 6.3.3 of AS 4100)

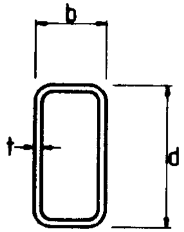


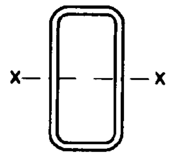
TABLE *D*5.2-1(2)(A)

DESIGN CAPACITIES FOR MEMBERS SUBJECT TO AXIAL COMPRESSION

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

Buckling about x-axis



Designation d b t	Mass per m	Design Capacities for Axial Compression ϕN_c (kN) — Effective Length (L_e) in metres													
mm mm mm	kg/m	0.0	0.25	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	5.0
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
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	42.3	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	275	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	90.5	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 :
1. ϕ = 0.9
2. ϕN_c = $\phi \alpha_c N_s$ (Clause 6.3.3 of AS 4100)
3. α_b = - 0.5 (Table 6.3.3 of AS 4100)

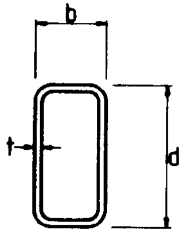


TABLE *D*5.2-1(1)(B)

DESIGN CAPACITIES FOR MEMBERS SUBJECT TO AXIAL COMPRESSION

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

buckling about y-axis

Designation d b t (mm mm mm)	Mass per m (kg/m)	Design Capacities for Axial Compression ϕN_c (kN) — Effective Length (L_e) in metres: 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
150 x 50 x 6.0 RHS	16.7	864	714	517	335	224	159	118	91.1	59.0	41.3	30.5	23.5	15.1	10.6
5.0 RHS	14.2	735	614	452	296	199	141	105	81.0	52.5	36.7	27.2	20.9	13.5	9.40
4.0 RHS	11.6	526	454	356	245	167	119	88.9	68.7	44.6	31.2	23.1	17.8	11.5	8.00
3.0 RHS	8.96	329	295	248	185	131	94.5	70.8	54.9	35.7	25.0	18.5	14.3	9.20	6.43
2.5 RHS	7.53	246	223	193	151	110	80.0	60.3	46.8	30.5	21.4	15.8	12.2	7.88	5.50
2.0 RHS	6.07	173	160	142	116	87.2	64.8	49.1	38.3	25.0	17.5	13.0	10.0	6.47	4.52
125 x 75 x 6.0 RHS	16.7	864	797	709	579	438	326	247	193	126	88.3	65.4	50.4	32.6	22.8
5.0 RHS	14.2	735	680	608	501	382	285	217	169	110	77.5	57.5	44.3	28.6	20.0
4.0 RHS	11.6	600	556	500	415	319	239	182	142	92.8	65.3	48.4	37.3	24.1	16.8
3.0 RHS	8.96	390	367	337	293	237	184	142	112	73.4	51.7	38.3	29.6	19.1	13.4
2.5 RHS	7.53	296	281	261	231	192	152	119	94.2	62.2	43.9	32.6	25.1	16.3	11.4
2.0 RHS	6.07	196	187	177	161	141	116	93.7	75.2	50.3	35.6	26.5	20.4	13.2	9.27
100 x 50 x 6.0 RHS	12.0	621	503	352	223	149	105	78.1	60.3	39.0	27.3	20.2	15.5	10.0	6.98
5.0 RHS	10.3	532	437	311	200	133	94.5	70.2	54.2	35.1	24.6	18.2	14.0	9.01	6.29
4.0 RHS	8.49	438	363	264	171	115	81.3	60.5	46.7	30.2	21.2	15.7	12.0	7.76	5.42
3.5 RHS	7.53	388	324	237	155	104	73.8	54.9	42.4	27.4	19.2	14.2	10.9	7.05	4.92
3.0 RHS	6.60	329	278	209	138	93.3	66.3	49.3	38.1	24.7	17.3	12.3	9.84	6.34	4.43
2.5 RHS	5.56	246	213	168	116	79.3	56.6	42.2	32.7	21.2	14.8	11.0	8.45	5.45	3.81
2.0 RHS	4.50	173	154	127	92.1	64.4	46.3	34.7	26.9	17.4	12.2	9.05	6.97	4.49	3.14
1.6 RHS	3.64	124	112	95.2	72.4	51.8	37.6	28.3	21.9	14.3	10.0	7.41	5.70	3.68	2.57

Notes :
1. ϕ = 0.9
2. ϕN_c = $\phi \alpha_c N_s$ (Clause 6.3.3 of AS 4100)
3. α_b = - 0.5 (Table 6.3.3 of AS 4100)

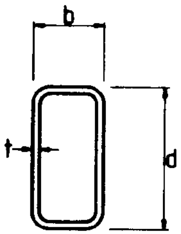


TABLE *D*5.2-1(2)(B)

DESIGN CAPACITIES FOR MEMBERS SUBJECT TO AXIAL COMPRESSION

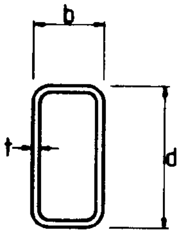
DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

buckling about y-axis

Designation d b t	Mass per m	Design Capacities for Axial Compression ϕN_c (kN) — Effective Length (L_e) in metres													
mm mm mm	kg/m	0.0	0.25	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	5.0
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
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	72.1	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

Notes :
1. ϕ = 0.9
2. ϕN_c = $\phi \alpha_c N_s$ (Clause 6.3.3 of AS 4100)
3. α_b = - 0.5 (Table 6.3.3 of AS 4100)



DESIGN CAPACITIES FOR MEMBERS SUBJECT TO AXIAL COMPRESSION

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Non-Standard Thickness

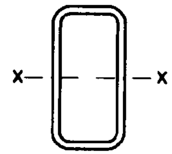


TABLE *D*5.2-2(A)

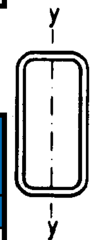
buckling about x-axis

Designation d b t	Mass per m	Design Capacities for Axial Compression ϕN_c (kN) — Effective Length (L_e) in metres													
mm mm mm	kg/m	0.0	0.25	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	5.0
125 x 75 x 2.8 RHS	8.39	351	351	351	348	343	338	331	324	315	293	266	233	199	141
2.3 RHS	6.95	259	259	259	256	253	250	246	241	235	221	204	183	159	116
100 x 50 x 2.8 RHS	6.19	295	295	292	287	280	272	262	249	235	198	159	126	99.7	66.1
2.3 RHS	5.14	215	215	214	211	206	201	195	187	178	155	128	103	82.7	55.3
75 x 50 x 2.8 RHS	5.09	263	263	258	250	239	225	208	187	163	119	87.2	65.8	51.1	33.3
2.3 RHS	4.24	215	215	211	205	197	186	172	155	136	100	73.8	55.7	43.3	28.2
65 x 35 x 2.8 RHS	3.99	206	206	200	191	179	163	142	120	99.1	68.0	48.6	36.3	28.0	18.2
2.3 RHS	3.34	172	172	167	160	150	137	120	102	84.5	58.1	41.6	31.1	24.0	15.6
50 x 25 x 2.8 RHS	2.89	149	148	141	129	113	91.3	70.8	54.8	43.1	28.4	20.0	14.8	11.4	7.39
2.3 RHS	2.44	126	124	119	109	95.9	78.4	61.2	47.5	37.5	24.7	17.4	12.9	9.95	6.43
50 x 20 x 2.8 RHS	2.67	138	136	129	118	101	80.3	61.4	47.2	37.0	24.3	17.1	12.7	9.77	6.32
2.3 RHS	2.25	116	115	109	100	86.5	69.4	53.5	41.2	32.4	21.3	15.0	11.1	8.57	5.54

Notes : 1. $\phi = 0.9$ 2. $\phi N_c = \phi \alpha_c N_s$ (Clause 6.3.3 of AS 4100) 3. $\alpha_b = -0.5$ (Table 6.3.3 of AS 4100)

TABLE *D*5.2-2(B)

buckling about y-axis



Designation d b t	Mass per m	Design Capacities for Axial Compression ϕN_c (kN) — Effective Length (L_e) in metres													
mm mm mm	kg/m	0.0	0.25	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	5.0
125 x 75 x 2.8 RHS	8.39	351	348	348	341	332	320	306	289	268	219	171	133	105	69.0
2.3 RHS	6.95	259	259	257	252	246	239	229	219	205	173	139	109	86.9	57.6
100 x 50 x 2.8 RHS	6.19	295	294	284	271	251	225	192	159	130	87.8	62.5	46.6	36.0	23.3
2.3 RHS	5.14	215	215	209	200	188	172	151	128	107	73.5	52.6	39.3	30.4	19.7
75 x 50 x 2.8 RHS	5.09	263	261	252	238	217	190	158	127	102	68.5	48.5	36.1	27.9	18.0
2.3 RHS	4.24	215	214	207	196	180	158	132	107	86.7	58.2	41.3	30.7	23.7	15.4
65 x 35 x 2.8 RHS	3.99	206	202	188	165	131	96.4	70.9	53.5	41.6	27.1	19.0	14.1	10.9	7.01
2.3 RHS	3.34	172	169	158	139	111	82.6	60.9	46.1	35.9	23.4	16.4	12.2	9.37	6.05
50 x 25 x 2.8 RHS	2.89	149	143	122	86.4	55.2	36.8	26.1	19.4	14.9	9.68	6.78	5.01	3.85	2.48
2.3 RHS	2.44	126	120	104	74.8	48.4	32.3	22.9	17.0	13.1	8.51	5.96	4.41	3.39	2.19
50 x 20 x 2.8 RHS	2.67	138	128	96.6	56.2	33.5	21.9	15.4	11.4	8.80	5.69	3.98	2.94	2.26	1.45
2.3 RHS	2.25	116	109	83.5	49.7	29.8	19.5	13.7	10.2	7.84	5.07	3.54	2.62	2.01	1.30

Notes : 1. $\phi = 0.9$ 2. $\phi N_c = \phi \alpha_c N_s$ (Clause 6.3.3 of AS 4100) 3. $\alpha_b = -0.5$ (Table 6.3.3 of AS 4100)

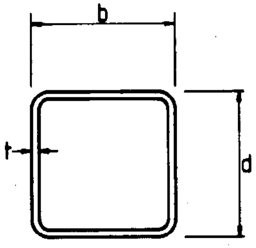
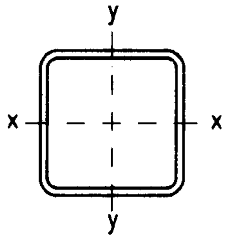


TABLE *D*5.2-3(1)

DESIGN CAPACITIES FOR MEMBERS SUBJECT TO AXIAL COMPRESSION

DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0
Standard Thickness
buckling about x- and y-axis



Designation d b t	Mass per m	Design Capacities for Axial Compression ϕN_c (kN) — Effective Length (L_e) in metres													
mm mm mm	kg/m	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
100 x 100 x 6.0 SHS	16.7	864	823	770	693	590	477	377	300	199	141	105	80.7	52.3	36.6
5.0 SHS	14.2	735	701	658	594	508	413	328	262	174	123	91.5	70.6	45.7	32.0
4.0 SHS	11.6	600	573	539	488	420	344	274	219	146	103	76.7	59.2	38.3	26.8
3.0 SHS	8.96	440	422	399	365	319	265	214	172	115	81.7	60.7	46.9	30.4	21.3
2.5 SHS	7.53	305	296	282	263	238	206	172	141	96.4	68.8	51.3	39.6	25.7	18.0
2.0 SHS	6.07	196	191	184	175	162	146	128	108	76.5	55.2	41.4	32.1	20.9	14.6
90 x 90 x 3.0 SHS	8.01	413	391	362	319	264	207	162	128	84.1	59.3	44.0	34.0	22.0	15.4
2.5 SHS	6.74	305	291	273	246	210	170	135	107	71.2	50.3	37.4	28.9	18.7	13.1
2.0 SHS	5.45	196	189	179	166	148	126	104	84.7	57.3	40.7	30.3	23.4	15.2	10.6
1.6 SHS	4.39	125	122	117	110	102	90.6	77.9	65.4	45.5	32.7	24.5	18.9	12.3	8.62
89 x 89 x 6.0 SHS	14.6	756	710	649	559	448	344	265	208	137	96.2	71.4	55.0	35.6	24.9
5.0 SHS	12.5	645	607	557	483	390	301	233	183	120	84.7	62.8	48.4	31.3	21.9
3.5 SHS	9.06	467	441	406	356	290	226	176	138	91.1	64.2	47.6	36.7	23.7	16.6
75 x 75 x 6.0 SHS	12.0	621	565	490	384	280	205	154	120	78.1	54.8	40.6	31.3	20.2	14.1
5.0 SHS	10.3	532	486	425	337	248	182	137	107	69.6	48.8	36.2	27.9	18.0	12.6
4.0 SHS	8.49	438	401	353	283	210	155	117	91.0	59.4	41.7	30.9	23.8	15.4	10.7
3.5 SHS	7.53	388	357	315	253	189	140	106	82.2	53.6	37.6	27.9	21.5	13.9	9.70
3.0 SHS	6.60	341	313	278	225	169	125	94.7	73.7	48.1	33.8	25.0	19.3	12.5	8.71
2.5 SHS	5.56	287	265	235	191	144	107	81.0	63.1	41.2	29.0	21.4	16.5	10.7	7.46
2.0 SHS	4.50	196	183	166	142	112	85.4	65.5	51.3	33.6	23.7	17.6	13.5	8.75	6.12

Notes :
1. ϕ = 0.9
2. ϕN_c = $\phi \alpha_c N_s$ (Clause 6.3.3 of AS 4100)
3. α_b = - 0.5 (Table 6.3.3 of AS 4100)

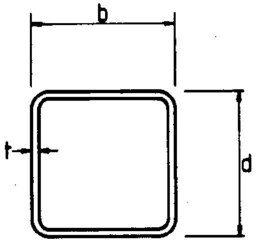


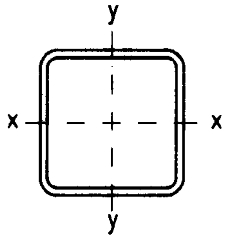
TABLE *D*5.2-3(2)

DESIGN CAPACITIES FOR MEMBERS SUBJECT TO AXIAL COMPRESSION

DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

buckling about x- and y-axis



Designation d b t	Mass per m	Design Capacities for Axial Compression ϕN_c (kN) Effective Length (L_e) in metres													
mm mm mm	kg/m	0.0	0.25	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	5.0
75 x 75 x 6.0 SHS	12.0	621	621	608	590	565	532	490	440	384	280	205	154	120	78.1
5.0 SHS	10.3	532	532	522	507	486	459	425	383	337	248	182	137	107	69.6
4.0 SHS	8.49	438	438	430	418	401	380	353	320	283	210	155	117	91.0	59.4
3.5 SHS	7.53	388	388	382	371	357	338	315	286	253	189	140	106	82.2	53.6
3.0 SHS	6.60	341	341	335	326	313	298	278	253	225	169	125	94.7	73.7	48.1
2.5 SHS	5.56	287	287	282	275	265	252	235	215	191	144	107	81.0	63.1	41.2
2.0 SHS	4.50	196	196	193	189	183	176	166	155	142	112	85.4	65.5	51.3	33.6
65 x 65 x 6.0 SHS	10.1	523	523	508	487	458	418	368	313	260	179	128	95.8	74.1	48.1
5.0 SHS	8.75	451	451	439	421	397	365	324	277	232	161	116	86.4	66.9	43.4
4.0 SHS	7.23	373	373	363	349	330	305	273	235	198	138	99.6	74.5	57.7	37.5
3.0 SHS	5.66	292	292	285	274	260	241	217	189	161	113	81.7	61.2	47.4	30.8
2.5 SHS	4.78	247	247	241	232	220	205	185	162	137	97.2	70.2	52.6	40.8	26.5
2.0 SHS	3.88	196	196	191	184	176	164	149	131	112	79.8	57.8	43.4	33.6	21.9
1.6 SHS	3.13	125	125	123	120	115	109	102	93.2	83.0	62.3	46.2	35.0	27.3	17.8
50 x 50 x 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
1.6 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
40 x 40 x 4.0 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
3.0 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
2.5 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
2.0 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
1.6 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
35 x 35 x 3.0 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
2.5 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
2.0 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
1.6 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
30 x 30 x 2.0 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
1.6 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
25 x 25 x 2.5 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
2.0 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
1.6 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
20 x 20 x 1.6 SHS	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

Notes : 1. $\phi = 0.9$ 2. $\phi N_c = \phi \alpha_c N_s$ (Clause 6.3.3 of AS 4100) 3. $\alpha_b = -0.5$ (Table 6.3.3 of AS 4100)

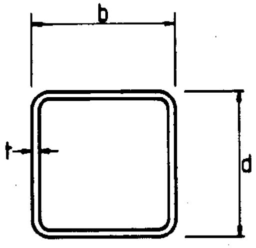
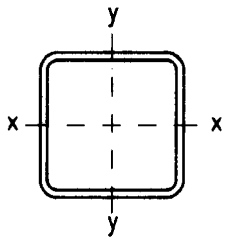


TABLE *D*5.2-4

DESIGN CAPACITIES FOR MEMBERS SUBJECT TO AXIAL COMPRESSION

DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0
Non-Standard Thickness
buckling about x- and y-axis



Designation d b t	Mass per m	Design Capacities for Axial Compression ϕN_c (kN) — Effective Length (L_e) in metres													
mm mm mm	kg/m	0.0	0.25	0.50	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	5.0
100 x 100 x 2.8 SHS	8.39	383	383	382	376	369	360	350	337	323	286	242	198	160	108
2.3 RHS	6.95	259	259	258	255	251	246	241	234	226	207	182	155	128	88.6
75 x 75 x 2.8 SHS	6.19	319	319	314	305	294	279	261	238	212	159	118	89.3	69.6	45.4
2.3 SHS	5.14	259	259	255	248	239	228	213	195	175	133	99.0	75.2	58.6	38.3
65 x 65 x 2.3 SHS	4.42	228	228	223	215	204	190	172	150	128	90.5	65.4	49.0	38.0	24.7
50 x 50 x 2.8 SHS	3.99	206	205	197	184	166	142	115	91.5	73.0	48.5	34.3	25.5	19.7	12.7
2.3 SHS	3.34	172	171	165	154	140	120	98.1	78.1	62.4	41.5	29.4	21.8	16.8	10.9
40 x 40 x 2.8 SHS	3.11	161	158	148	133	109	82.7	61.7	46.9	36.5	23.9	16.8	12.4	9.58	6.19
2.3 SHS	2.62	135	133	125	112	92.9	71.2	53.3	40.6	31.7	20.7	14.5	10.8	8.31	5.37
35 x 35 x 2.8 SHS	2.67	138	135	124	105	79.0	56.3	40.8	30.6	23.7	15.4	10.8	8.01	6.17	3.98
2.3 SHS	2.25	116	114	105	89.6	68.3	49.0	35.6	26.8	20.8	13.5	9.47	7.01	5.40	3.49

Notes :
1. ϕ = 0.9
2. ϕN_c = $\phi \alpha_c N_s$ (Clause 6.3.3 of AS 4100)
3. α_b = - 0.5 (Table 6.3.3 of AS 4100)

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PART 6 MEMBERS SUBJECT TO AXIAL TENSION

6

TABLES

NOTE: SEE PAGE vii FOR THE SPECIFIC MATERIAL STANDARD REFERRED TO BY THE SECTION TYPE AND STEEL GRADE IN THESE TABLES.

PART 6 MEMBERS SUBJECT TO AXIAL TENSION

*D*6.1 SCOPE

Tables *D*6.1-1 to *D*6.1-4 give values of design section capacity for axial tension determined in accordance with Section 7 of AS 4100.

The tables give values of design capacity for *DuraGal* structural steel hollow sections with full perimeter welded connections.

*D*6.2 METHOD

The design section capacity for axial tension (ϕN_t) has been determined from Clause 7.2 of AS 4100 and taken as the *lesser* o :

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

and

$$\phi N_t = \phi\, (0.85)\, k_t\, A_n\, f_u$$

where ϕ = 0.9 (Table 3.4 of AS 4100)

f_y = yield stress used in design

A_n = net section area

= A_g

= gross cross-sectional area (for full perimeter welded connections)

f_u = ultimate strength used in design

k_t = tension correction factor

= 1.0 (Clause 7.3.1 of AS 4100)

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

Note: for Grade C450L0 $\phi N_t = \phi\, (0.85)\, A_g\, f_u$ is the lesser value of ϕN_t.

For sections reduced by penetrations or holes, the value of ϕN_t can be determined from the tables as the lesser value of:

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

and

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

where A_n = net section area

Values of A_g are tabulated in Tables *D*6.1-1 to *D*6.1-4.

Note that all the values in Tables D6.1-1 to D6.1-4 assume $k_t = 1.0$.

*D*6.3 EXAMPLE

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

Design Data:

N^* = 150 kN

k_t = 1.0 (for a full perimeter welded connection)

Solution:

Select a suitable DuraGal member from Tables *D*6.1-1 and *D*6.1-3. The alternatives are:

65 x 35 x 2.5 DuraGal RHS Grade C450L0 (3.60 kg/m) $\phi N_t = 176 > N^*$
65 x 65 x 1.6 DuraGal SHS Grade C450L0 (3.13 kg/m) $\phi N_t = 153 > N^*$

Choose 65 x 65 x 1.6 RHS Grade C450L0 (3.13 kg/m) because it is more economical based on mass.

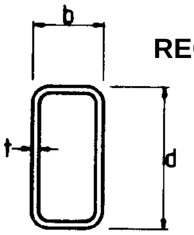
TABLE *D*6.1-1

DESIGN CAPACITIES FOR MEMBERS SUBJECT TO AXIAL TENSION

DuraGal

RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Standard Thickness



Designation d b t	Mass per m	Axial Tension ϕN_t ϕN_t (1)	ϕN_t (2)	Gross Section Area A_g
mm mm mm	kg/m	kN	kN	mm^2
150 x 50 x 6 0 RHS	16.7	864	**816**	2130
5 0 RHS	14.2	735	**694**	1810
4.0 RHS	11.6	600	**567**	1480
3.0 RHS	8.96	462	**436**	1140
2.5 RHS	7.53	388	**367**	959
2.0 RHS	6.07	313	**296**	774
125 x 75 x 6.0 RHS	16.7	864	**816**	2130
5.0 RHS	14.2	735	**694**	1810
4.0 RHS	11.6	600	**567**	1480
3.0 RHS	8.96	462	**436**	1140
2.5 RHS	7.53	388	**367**	959
2.0 RHS	6.07	313	**296**	774
100 x 50 x 6.0 RHS	12.0	621	**586**	1530
5.0 RHS	10.3	532	**503**	1310
4.0 RHS	8.49	438	**414**	1080
3.5 RHS	7.53	388	**367**	959
3.0 RHS	6.60	341	**322**	841
2.5 RHS	5.56	287	**271**	709
2.0 RHS	4.50	232	**219**	574
1.6 RHS	3.64	188	**177**	463
75 x 50 x 6.0 RHS	9.67	499	**471**	1230
5.0 RHS	8.35	431	**407**	1060
4.0 RHS	6.92	357	**337**	881
3.0 RHS	5.42	280	**264**	691
2.5 RHS	4.58	236	**223**	584
2.0 RHS	3.72	192	**181**	474
1.6 RHS	3.01	155	**147**	383
75 x 25 x 2.5 RHS	3.60	186	**176**	459
2.0 RHS	2.93	151	**143**	374
1.6 RHS	2.38	123	**116**	303
65 x 35 x 4.0 RHS	5.35	276	**261**	681
3.0 RHS	4.25	219	**207**	541
2.5 RHS	3.60	186	**176**	459
2.0 RHS	2.93	151	**143**	374
50 x 25 x 3.0 RHS	3.07	158	**149**	391
2.5 RHS	2.62	135	**128**	334
2.0 RHS	2.15	111	**105**	274
1.6 RHS	1.75	90.4	**85.4**	223
50 x 20 x 3.0 RHS	2.83	146	**138**	361
2.5 RHS	2.42	125	**118**	309
2.0 RHS	1.99	103	**97.0**	254
1.6 RHS	1.63	83.9	**79.2**	207

Notes: 1. ϕ = 0.9
2. $\phi N_t(1)$ = $\phi A_g f_y$ (Clause 7.2 of AS 4100)
3. ϕNt (2) = $\phi\, 0.85\, A_g f_u$ (Clause 7.2 of AS 4100)

TABLE *D*6.1-2

DESIGN CAPACITIES FOR MEMBERS SUBJECT TO AXIAL TENSION

DuraGal

RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Non-Standard Thickness

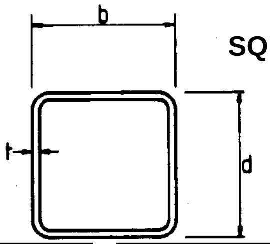
Designation d b t	Mass per m	Axial Tension ϕN_t ϕN_t (1)	ϕN_t (2)	Gross Section Area A_g
mm mm mm	kg/m	kN	kN	mm^2
125 x 75 x 2.8 RHS	8.39	433	**409**	1070
2.3 RHS	6.95	359	**339**	885
100 x 50 x 2.8 RHS	6.19	319	**302**	788
2.3 RHS	5.14	265	**251**	655
75 x 50 x 2.8 RHS	5.09	263	**248**	648
2.3 RHS	4.24	219	**207**	540
65 x 35 x 2.8 RHS	3.99	206	**194**	508
2.3 RHS	3.34	172	**163**	425
50 x 25 x 2.8 RHS	2.89	149	**141**	368
2.3 RHS	2.44	126	**119**	310
50 x 20 x 2.8 RHS	2.67	138	**130**	340
2.3 RHS	2.25	116	**110**	287

Notes: 1. ϕ = 0.9
2. $\phi N_t(1)$ = $\phi A_g f_y$ (Clause 7.2 of AS 4100)
3. ϕNt (2) = $\phi\, 0.85\, A_g f_u$ (Clause 7.2 of AS 4100)

TABLE *D*6.1-3

DESIGN CAPACITIES FOR MEMBERS SUBJECT TO AXIAL TENSION

DuraGal
SQUARE HOLLOW SECTIONS: GRADE C450L0
Standard Thickness



Designation d b t	Mass per m	Axial Tension ϕN_t ϕN_t (1)	ϕN_t (2)	Gross Section Area A_g
mm mm mm	kg/m	kN	kN	mm^2
100 x 100 x 6.0 SHS	16.7	864	**816**	2130
5.0 SHS	14.2	735	**694**	1810
4.0 SHS	11.6	600	**567**	1480
3.0 SHS	8.96	462	**436**	1140
2.5 SHS	7.53	388	**367**	959
2.0 SHS	6.07	313	**296**	774
90 x 90 x 3.0 SHS	8.01	413	**390**	1020
2.5 SHS	6.74	348	**329**	859
2.0 SHS	5.45	281	**265**	694
1.6 SHS	4.39	226	**214**	559
89 x 89 x 6.0 SHS	14.6	756	**714**	1870
5.0 SHS	12.5	645	**609**	1590
3.5 SHS	9.06	467	**441**	1150
75 x 75 x 6.0 SHS	12.0	621	**586**	1530
5.0 SHS	10.3	532	**503**	1310
4.0 SHS	8.49	438	**414**	1080
3.5 SHS	7.53	388	**367**	959
3.0 SHS	6.60	341	**322**	841
2.5 SHS	5.56	287	**271**	709
2.0 SHS	4.50	232	**219**	574
65 x 65 x 6.0 SHS	10.1	523	**494**	1290
5.0 SHS	8.75	451	**426**	1110
4.0 SHS	7.23	373	**352**	921
3.0 SHS	5.66	292	**276**	721
2.5 SHS	4.78	247	**233**	609
2.0 SHS	3.88	200	**189**	494
1.6 SHS	3.13	162	**153**	399
50 x 50 x 5.0 SHS	6.39	330	**311**	814
4.0 SHS	5.35	276	**261**	681
3.0 SHS	4.25	219	**207**	541
2.5 SHS	3.60	186	**176**	459
2.0 SHS	2.93	151	**143**	374
1.6 SHS	2.38	123	**116**	303
40 x 40 x 4.0 SHS	4.09	211	**199**	521
3.0 SHS	3.30	170	**161**	421
2.5 SHS	2.82	145	**137**	359
2.0 SHS	2.31	119	**112**	294
1.6 SHS	1.88	96.9	**91.5**	239
35 x 35 x 3.0 SHS	2.83	146	**138**	361
2.5 SHS	2.42	125	**118**	309
2.0 SHS	1.99	103	**97.0**	254
1.6 SHS	1.63	83.9	**79.2**	207
30 x 30 x 2.0 SHS	1.68	86.5	**81.7**	214
1.6 SHS	1.38	70.9	**67.0**	175
25 x 25 x 2.5 SHS	1.64	84.6	**79.9**	209
2.0 SHS	1.36	70.3	**66.4**	174
1.6 SHS	1.12	58.0	**54.8**	143
20 x 20 x 1.6 SHS	0.873	45.0	**42.5**	111

Notes: 1. ϕ = 0.9

2. $\phi N_t(1)$ = $\phi A_g f_y$ (Clause 7.2 of AS 4100)

3. $\phi Nt(2)$ = $\phi\, 0.85 A_g f_u$ (Clause 7.2 of AS 4100)

TABLE *D*6.1-4

DESIGN CAPACITIES FOR MEMBERS SUBJECT TO AXIAL TENSION

DuraGal
SQUARE HOLLOW SECTIONS: GRADE C450L0
Non-Standard Thickness

Designation d b t	Mass per m	Axial Tension ϕN_t ϕN_t (1)	ϕN_t (2)	Gross Section Area A_g
mm mm mm	kg/m	kN	kN	mm^2
100 x l00 x 2.8 SHS	8.39	433	**409**	1070
2.3 RHS	6.95	359	**339**	885
75 x 75 x 2.8 SHS	6.19	319	**302**	788
2.3 SHS	5.14	265	**251**	655
65 x 65 x 2.3 SHS	4.42	228	**215**	563
50 x 50 x 2.8 SHS	3.99	206	**194**	508
2.3 SHS	3.34	172	**163**	425
40 x 40 x 2.8 SHS	3.11	161	**152**	396
2.3 SHS	2.62	135	**127**	333
35 x 35 x 2.8 SHS	2.67	138	**130**	340
2.3 SHS	2.25	116	**110**	287

Notes: 1. ϕ = 0.9

2. $\phi N_t(1)$ = $\phi A_g f_y$ (Clause 7.2 of AS 4100)

3. $\phi Nt(2)$ = $\phi\, 0.85 A_g f_u$ (Clause 7.2 of AS 4100)

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PART 7 MEMBERS SUBJECT TO COMBINED ACTIONS

PAGE

TABLES

NOTE: SEE PAGE vii FOR THE SPECIFIC MATERIAL STANDARD REFERRED TO BY THE SECTION TYPE AND STEEL GRADE IN THESE TABLES.

PART 7 MEMBERS SUBJECT TO COMBINED ACTIONS

*D*7.1 SCOPE

This part of the Tables contains the interaction formulae which must be used to design members subject to combined actions in accordance with Section 8 of AS 4100.The table below provides the location of design capacities and reference points within this publication for checking interaction effects on member capacities.

Design Capacity	Description	Reference
N_{omx}	Elastic flexural buckling load of a member, about the principal x- axis	Tables 7.3.2-1 to D7.3.2-4
N_{omy}	Elastic flexural buckling load of a member, about the principal y- axis	Tables 7.3.2-1 to D7.3.2-4
ϕN_c	Nominal member capacity in compression	Tables D5.2-1(A) to D5.2-4
ϕN_s	Design section capacity in axial compression	Tables D3.1-1 to D3.1-4
ϕN_t	Design section capacity in axial tension	Tables D3.1-1 to D3.1-4
ϕM_s	Design section moment capacity (SHS)	Tables D3.1-1 to D3.1-4
ϕM_{sx}, ϕM_{sy}	ϕM_s about x- and y- axes (RHS)	Tables D3.1-1 & D3.1-3
ϕM_{rx} (comp)	ϕM_{sx} reduced by axial compression force (RHS)	Section D7.4.1.1
ϕM_{rx} (tens)	ϕM_{sx} reduced by axial tension force (RHS)	Section D7.5.1.1
ϕM_{ry}	ϕM_{sy} reduced by axial force (RHS)	Section D7.4.2.1 & D7.5.2.1
ϕM_r (comp)	ϕM_s about a principal axis reduced by axial compression force	Section D7.4.1.1
ϕM_r (tens)	ϕM_s about a principal axis reduced by axial tension force	Section D7.5.1.1
ϕM_b	Design moment capacity (RHS)	Tables D4.1-1 to D4.1-2
ϕV_v	Design shear capacity of a web (SHS)	Table D3.1-2 & D3.1-4
ϕV_{vx}	ϕV_v for bending about x- axis (RHS)	Table D3.1-1 & D3.1-3
ϕV_{vy}	ϕV_v for bending about y- axis (RHS)	Table D3.1-1 & D3.1-3
ϕM_z	Design torsional section moment capacity	Tables D3.1-1 to D3.1-4

*D*7.2 METHOD

Section *D*7.3 describes the use and determination of moment amplification factors and the determination of the elastic buckling load for braced or sway members. The elastic buckling load required for combined bending and axial compression when the moment is amplified by the moment amplification factors δ_b and δ_s.

Sections *D*7.4 and *D*7.5 give the interaction formulae for combined bending and axial compression and combined bending and axial tension respectively. Each section describes the method for uniaxial bending about the major principal x-axis, for uniaxial bending about the minor principal y-axis, and for biaxial bending. Section *D*7.6 gives the interaction formulae for biaxial bending without axial forces. In every case both the section capacity and the member capacity must be checked.

*D*7.3 MOMENT AMPLIFICATION

For a member subjected to combined bending and axial compression force, irrespective of whether that member is an isolated statically determinate member or part of a statically indeterminate frame the bending moments will be amplified by the presence of axial compression force. Such amplification can be accounted for by a variety of means and these are now considered in relation to braced and sway members.

Braced Member - the member is braced such that its ends cannot move relative to one another.

If a first order elastic analysis is conducted then δ_b (Clause 4.4.2.2 of AS 4100) must be used to amplify the design action effects between the ends of the member. However, when the moment amplification factor is greater than 1.4, a second order elastic analysis must be carried out (see Appendix E of AS 4100).

If an appropriate second order elastic analysis is carried out, such that the design action effects at sufficient number of locations between the ends of the member are determined, then there is no need to modify the design action effects in the member using δ_b.

The moment amplification factor (δ_b) must be calculated using the procedure shown in Figure *D*7.3(1).

Sway Member - the ends of the member are permitted to move relative to one another.

If a first order elastic analysis is carried out then the design action effects must be modified using the moment amplification factor (δ_m), which is the greater of δ_b and δ_s (see Clause 4.4.2.3 of AS 4100). However, when the moment amplification factor is greater than 1.4, a second order elastic analysis must be carried out (see Appendix E of AS 4100).

If an appropriate second order elastic analysis is carried out, such that the design action effects at a sufficient number of locations along the length of the member are determined, then there is no need to modify the design action effects using δ_m. If this is not the situation, then the design action effects obtained from the second order elastic analysis may need to be modified using δ_b, as described in Appendix E of AS 4100.

The moment amplification factors (δ_b and δ_s) must be calculated using the procedure shown in Figures *D*7.3(1) and *D*7.3(2).

*D*7.3.1 Values of c_m

The value of c_m is specified in Clause 4.4.2.2 of AS 4100 as:

$$c_m = 0.6 - 0.4\,\beta_m \leq 1.0$$

where β_m is the ratio of the smaller to the larger bending moments at the ends of the member, taken as positive when the member is bent in reverse curvature. Where the member is subjected to transverse loading, β_m may be taken as described in Clauses 4.4.2.2(a), (b) and (c) of AS 4100. Table *D*7.3.1 gives values of c_m for a range of β_m values for single and reverse curvature bending.

*D*7.3.2 Elastic Buckling Load

Values of elastic buckling load (N_{om}) for various effective lengths (L_e) are given in Tables *D*7.3.2-1 to *D*7.3.2-4. N_{om} values are determined in accordance with Clause 4.6.2 of AS 4100 as:

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

where E = 200 x 10^3 MPa

I = second moment of area

$k_e L$ = effective length (Section 5.4 of these tables)

"N_{om} x-axis" indicates N_{om} for the member buckling about the x-axis. "N_{om} y-axis" indicates N_{om} for the member buckling about the y-axis.

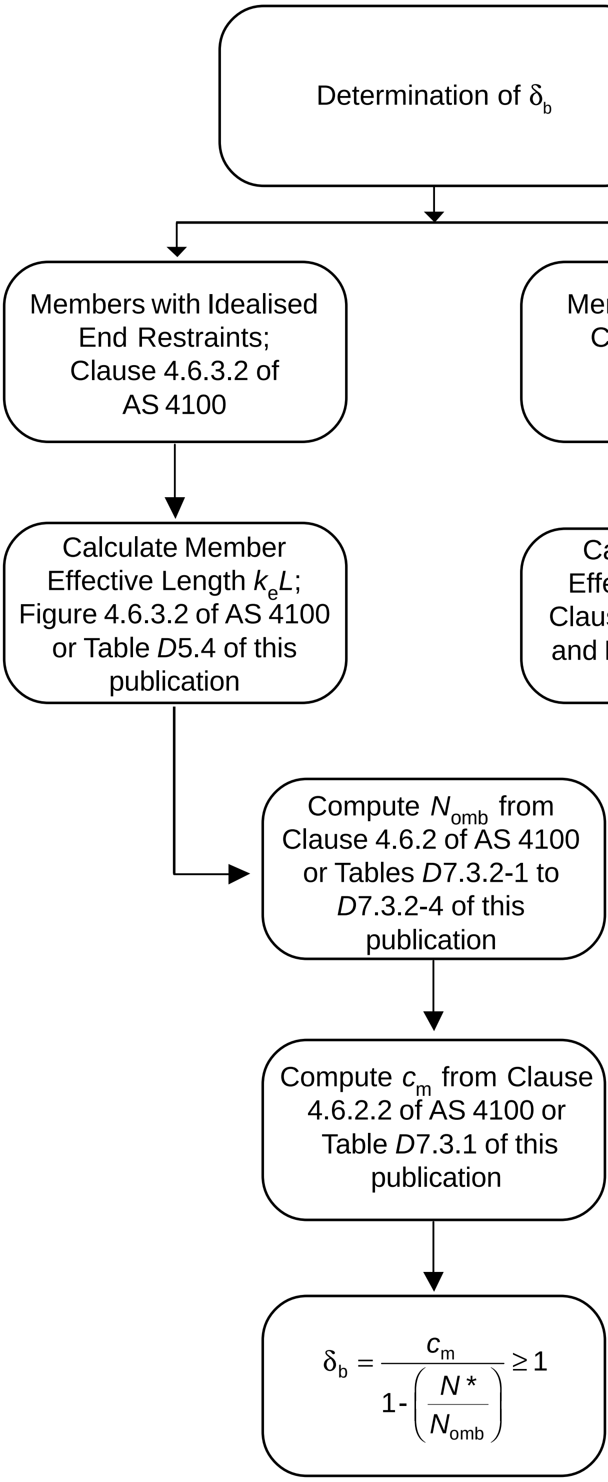


Figure D7.3(1): Flow Chart for Determination of δ_b

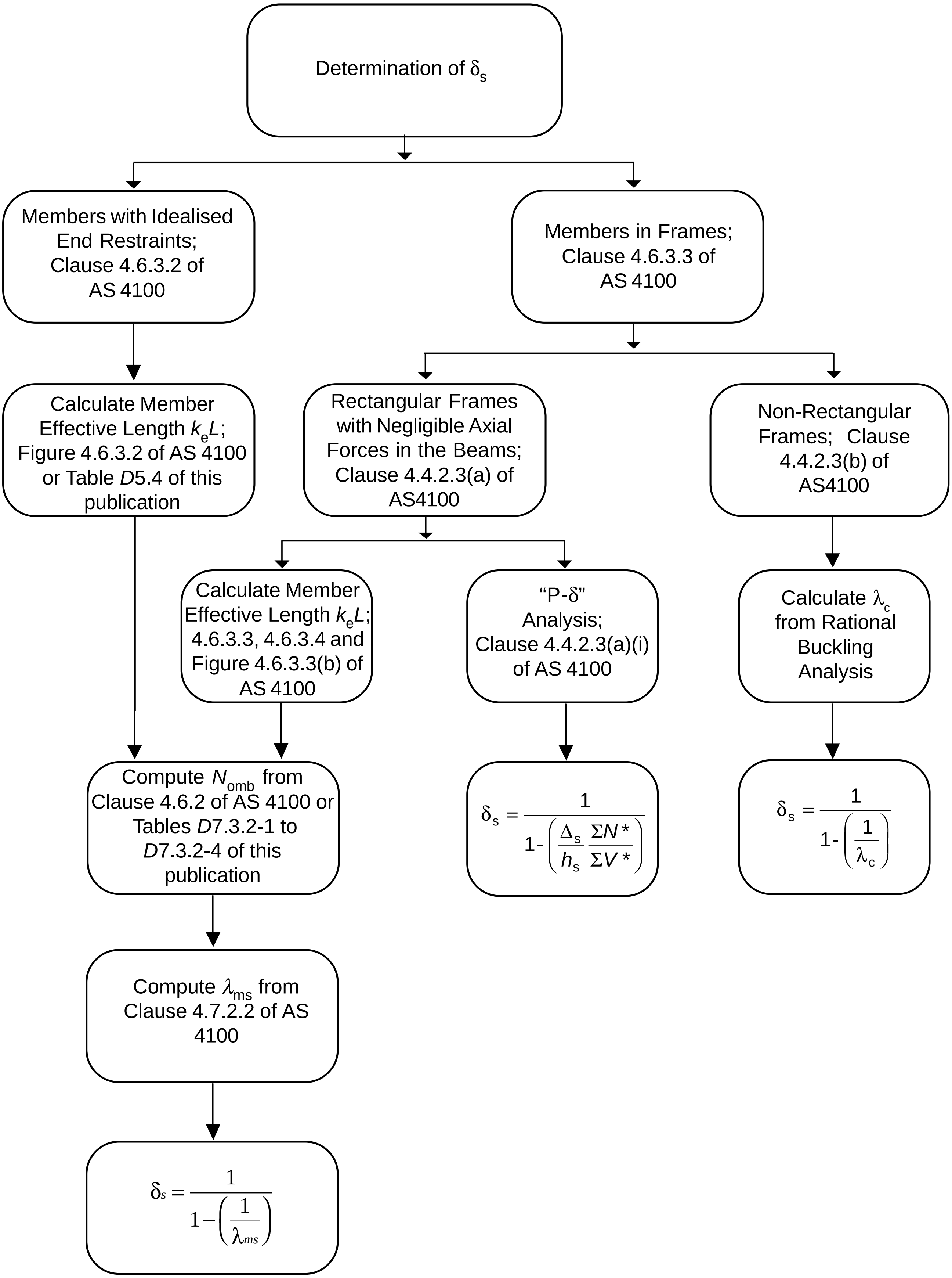


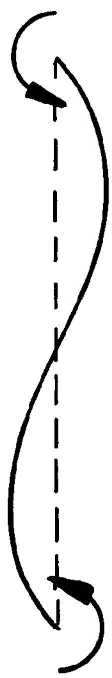
Figure *D*7.3(2): Flow Chart for Determination of δ_s

Table *D*7.3.1: Values of c_m for Braced Members

β_m	c_m	β_m	c_m	β_m	c_m	β_m	c_m
-1.00	1.00	-0.50	0.80	+0.05	0.58	+0.55	0.38
-0.95	0.98	-0.45	0.78	+0.10	0.56	+0.60	0.36
-0.90	0.96	-0.40	0.76	+0.15	0.54	+0.65	0.34
-0.85	0.94	-0.35	0.74	+0.20	0.52	+0.70	0.32
-0.80	0.92	-0.30	0.72	+0.25	0.50	+0.75	0.30
-0.75	0.90	-0.25	0.70	+0.30	0.48	+0.80	0.28
-0.70	0.88	-0.20	0.68	+0.35	0.46	+0.85	0.26
-0.65	0.86	-0.15	0.66	+0.40	0.44	+0.90	0.24
-0.60	0.84	-0.10	0.64	+0.45	0.42	+0.95	0.22
-0.55	0.82	-0.05	0.62	+0.50	0.40	+1.00	0.20
		0.00	0.60				

β_m is negative for single curvature bending:

β_m is positive for reverse curvature bending:



D7.4 COMBINED BENDING AND AXIAL COMPRESSION

In this section:

ϕ = 0.9 (Table 3.4 of AS 4100)

ϕM_{sx} = design section moment capacity for bending about the major principal x-axis (see Section *D*3.2.3 and Tables *D*3.1-1 to *D*3.1-4)

ϕM_{sy} = design section moment capacity for bending about the minor principal y-axis (see Section *D*3.2.3 and Tables *D*3.1-1 to *D*3.1-4)

N^* = design axial compressive force

ϕN_s = design section capacity of a compression member (see Section *D*3.2.2 and Tables *D*3.1-1 to *D*3.1-4)

ϕN_{cx} = design member capacity in compression, buckling about the x-axis (see Section *D*5.3 and Tables *D*5.2-1 to *D*5.2-4)

ϕN_{cy} = design member capacity in compression, buckling about the y-axis (see Section *D*5.3 and Tables *D*5.2-1 to *D*5.2-4)

Note: In the determination of ϕN_{cx} and ϕN_y the effective length factor (k_e) should equal 1.0 for both braced and sway members unless a lower value is calculated for braced members.

D7.4.1 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 ϕ = 0.90 (Table 3.4 of AS 4100)

M^*_x = design bending moment about the major principal x-axis

ϕM_{rx} = design section moment capacity (ϕM_s) for bending about the major principal x-axis reduced by axial force (see Section *D*7.4.1.1)

ϕM_{ix} = design in-plane member moment capacity (ϕM_i) for bending about the major principal x-axis (see Section *D*7.4.1.2(a))

ϕM_{ox} = design out-of-plane member moment capacity (ϕM_o) for bending about the major principal x-axis (see Section *D*7.4.1.2(b))

D7.4.1.1 Section Capacity

The value of ϕM_{rx} must be determined at all points along the member and the minimum value used to satisfy Section *D*7.4.1.

$$\phi M_{rx} = \phi M_{sx}\left(1 - \frac{N^*}{\phi N_s}\right) \qquad \text{(Clause 8.3.2 of AS 4100)}$$

Note: $N^* \leq \phi N_s$

Alternatively, For RHS & SHS to AS 1163, which are compact about the x- axis, ϕM_{rx} may be calculated by one of the following:

(a) For compression members where k_f = 1.0, subject to bending

$$\phi M_{rx} = 1.18\,\phi M_{sx}\left(1-\frac{N^*}{\phi N_s}\right) \leq M_{sx}$$ (Clause 8.3.2 of AS 4100)

(b) For compression members where k_f is < 1.0, subject to bending

$$\phi M_{rx} = \phi M_{sx}\left(1-\frac{N^*}{\phi N_s}\right)\left[1+0.18\left(\frac{82-\lambda_w}{82-\lambda_{wy}}\right)\right] \leq \phi M_{sx}$$ (Clause 8.3.2 of AS 4100)

where $\lambda_w = \lambda_e$ for the element slenderness of the web (Clause 6.2.3 of AS 4100)

$$= \frac{d-2t}{t}\sqrt{\frac{f_y}{250}}$$

λ_{wy} = 40 for DuraGal RHS and SHS (Table 6.2.4 of AS 4100)

D7.4.1.2 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 Sections D7.4.1.1 and D7.4.1.2 need to be satisfied. If there is insufficient restraint to prevent lateral buckling, then both the in-plane and out-of-plane requirements of Sections D7.4.1.1 and D7.4.1.2 need to be satisfied.

(a) **In-plane capacity**

$$\phi M_{ix} = \phi M_{sx}\left(1-\frac{N^*}{\phi N_{cx}}\right)$$ (Clause 8.4.2.2 of AS 4100)

Note: $N^* \leq \phi N_{cx}$

where ϕN_{cx} is determined in accordance with Clause 6.3 for buckling about the same principal axis, with an effective length factor *(k_{ex})* taken as 1.0 for braced and sway members, unless a lower value of *(k_{ex})* is calculated for braced members (Clause 4.6.3 of AS 4100)

Alternatively, For RHS & SHS to AS 1163, which are compact as defined in Clause 5.2.3 of AS 4100, and where the form factor (k_f) determined in accordance with Clause 6.2.2 is unity, ϕM_{ix} may be calculated as per Clause 8.4.2.2 of AS 4100.

$$\phi M_{ix} = \phi M_{sx}\left\{\left[1-\left(\frac{1+\beta_m}{2}\right)^3\right]\left(1-\frac{N^*}{\phi N_{cx}}\right)+1.18\left(\frac{1+\beta_m}{2}\right)^3\sqrt{1-\left(\frac{N^*}{\phi N_{cx}}\right)}\right\} \leq \phi M_{rx}$$

Where

β_m = the ratio of the smaller to the larger end bearing moment, taken as positive when the member is bent in reverse curvature for members without transverse load, or

= the value determined in accordance with Clause 4.4.2.2 of AS 4100 for members with transverse load.

M_{rx} = the nominal section moment capacity about the appropriate principal axis determined in accordance with Clause 8.3 of AS 4100.

(b) **Out-of-plane capacity**

$$\phi M_{ox} = \phi M_{bx}\left(1 - \frac{N^*}{\phi N_{cy}}\right) \qquad \text{(Clause 8.4.4.1 of AS 4100)}$$

where ϕM_{bx} = design member moment capacity for bending about the major principal x-axis (see Section *D*4.1.2 and Tables *D*4.1-1 to *D*4.1-2)

Note: $N^* \le \phi N_{cy}$

*D*7.4.2 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:

$$M^*_y \le \min.[\phi M_{ry} ; \phi M_{iy}]$$

where M^*_y = design bending moment about the minor principal y-axis

ϕ = 0.9 (Table 3.4 of AS 4100)

ϕM_{ry} = design section moment capacity (ϕM_s) about the minor principal y-axis reduced by axial force (see Section *D*7.4.2.1)

ϕM_{iy} = nominal in-plane member moment capacity (ϕM_i) about the minor principal y-axis (see Section *D*7.4.2.2)

*D*7.4.2.1 Section Capacity

The value of ϕM_{ry} must be determined at all points along the member and the minimum value is used to satisfy Section *D*7.4.2.

$$\phi M_{ry} = \phi M_{sy}\left(1 - \frac{N^*}{\phi N_s}\right) \qquad \text{(Clause 8.3.3 of AS 4100)}$$

Note: $N^* \le \phi N_s$

Alternatively, for RHS and SHS to AS 1163, which are compact about the y-axis subject to bending and compression:

$$\phi M_{ry} = 1.18\phi M_{sy}\left(1 - \frac{N^*}{\phi N_s}\right) \le \phi M_{sy} \qquad \text{(Clause 8.3.3 of AS 4100)}$$

D7.4.2.2 Member Capacity

This section applies only 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.

In-plane capacity

$$\phi M_{iy} = \phi M_{sy}\left(1-\frac{N^*}{\phi N_{cy}}\right) \qquad \text{(Clause 8.4.2.2 of AS 4100)}$$

Note: $N^* \leq \phi N_{cy}$

where ϕN_{cy} is determined in accordance with Clause 6.3 for buckling about the same principal axis, with an effective length factor (k_{ey}) taken as 1.0 for braced and sway members, unless a lower value of (k_{ey}) is calculated for braced members (refer 4.6.3 of AS 4100)

Alternatively, For RHS & SHS to AS 1163, which are compact as defined in Clause 5.2.3 of AS 4100, and where the form factor (k_f) determined in accordance with Clause 6.2.2 is unity, ϕM_{iy} may be calculated as per Clause 8.4.2.2 of AS 4100.

$$\phi M_{iy} = \phi M_{sy}\left\{\left[1-\left(\frac{1+\beta_{my}}{2}\right)^3\right]\left(1-\frac{N^*}{\phi N_{cy}}\right)+1.18\left(\frac{1+\beta_{my}}{2}\right)^3\sqrt{\left(1-\frac{N^*}{\phi N_{cy}}\right)}\right\} \leq \phi M_{ry}$$

Where

β_m = the ratio of the smaller to the larger end bearing moment, taken as positive when the member is bent in reverse curvature for members without transverse load, or

= the value determined in accordance with Clause 4.4.2.2 of AS 4100 for members with transverse load.

M_{ry} = the nominal section moment capacity about the appropriate principal axis determined in accordance with Clause 8.3 of AS 4100.

D7.4.3 Biaxial Bending and Axial Compression

For a member subject to biaxial bending and axial compression, both the conditions defined in Sections *D*7.4.3.1 and *D*7.4.3.2 must be satisfied.

D7.4.3.1 Section Capacity

$$\frac{N^*}{\phi N_s} + \frac{M^*_x}{\phi M_{sx}} + \frac{M^*_y}{\phi M_{sy}} \leq 1 \qquad \text{(Clause 8.3.4 of AS 4100)}$$

Alternatively, for RHS and SHS to AS 1163, which are compact about both the x- and y- axes:

$$\left(\frac{M_x^*}{\phi M_{rx}}\right)^\gamma + \left(\frac{M_y^*}{\phi M_{ry}}\right)^\gamma \leq 1 \qquad \text{(Clause 8.3.4 of AS 4100)}$$

where

$$\gamma = 1.4 + \left(\frac{N^*}{\phi N_s}\right) \leq 2.0$$

where

ϕM_{rx} and ϕM_{ry} are calculated in accordance with Clauses 8.3.2 and 8.3.3 of AS 4100

D7.4.3.2 Member Capacity

$$\left(\frac{M_x^*}{\phi M_{cx}}\right)^{1.4} + \left(\frac{M_y^*}{\phi M_{iy}}\right)^{1.4} \leq 1 \qquad \text{(Clause 8.4.5.1 of AS 4100)}$$

where

M^*_x = design bending moment about the major principal x-axis

ϕM_{cx} = lesser of the design in-plane member moment capacity (ϕM_{ix}) and the design out-of-plane member moment capacity (ϕM_{ox}) for bending about the major principal x-axis, determined in accordance with Sections *D*7.4.1.2(a) and (b) respectively

M^*_y = design bending moment about the minor principal y-axis

ϕM_{iy} = design in-plane member moment capacity determined in accordance with Section *D*7.4.2.2

Note: $M^*_x \leq \phi M_{cx}$
$M^*_y \leq \phi M_{iy}$

D7.5 COMBINED BENDING AND AXIAL TENSION

In this section:

ϕ = 0.9 (Table *D*3.4 of AS 4100)

ϕM_{sx} = design section moment capacity for bending about the major principal x-axis (see Section 3.2.3 and Tables *D*3.1-1 to *D*3.1-4)

ϕM_{sy} = design section moment capacity for bending about the minor principal y-axis(see Section 3.2.3 and Tables *D*3.1-1 to *D*3.1-4)

N^* = design axial compressive force

ϕN_t = design member capacity in tension (see Section *D*6.2 and Tables *D*6.1-1 to *D*6.1-4)

D7.5.1 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 condition must be satisfied:

$$M^*_x \leq \text{min.}[\phi M_{rx} ; \phi M_{ox}]$$

where ϕ = 0.9 (Table 3.4 of AS 4100)

M^*_x = design bending moment about the major principal x-axis

ϕM_{rx} = design section moment capacity (ϕM_s) for bending about the major principal x-axis reduced by axial force (see section *D*7.5.1.1)

ϕM_{ox} = design out-of-plane member moment capacity (ϕM_o) for bending about the major principal x-axis(see section *D*7.5.1.2)

*D*7.5.1.1 Section Capacity

The value of ϕM_{rx} must be determined at all points along the member and the minimum value is used to satisfy Section *D*7.5.1.

$$\phi M_{rx} = \phi M_{sx}\left(1-\frac{N^*}{\phi N_t}\right) \qquad \text{(Clause 8.3.2 of AS 4100)}$$

where ϕN_t = design section capacity in tension (see Section *D*3.2.1 and Tables *D*3.1-1 to *D*3.1-4)

Note: $N^* \le \phi N_t$

Alternatively, for RHS and SHS to AS 1163, which are compact about the x-axis subject to bending and tension:

$$\phi M_{rx} = 1.18\phi M_{sx}\left(1-\frac{N^*}{\phi N_t}\right) \le \phi M_{sx} \qquad \text{(Clause 8.3.2 of AS 4100)}$$

*D*7.5.1.2 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.

Out-of-plane capacity

$$\phi M_{ox} = \phi M_{bx}\left(1+\frac{N^*}{\phi N_t}\right) \le \phi M_{rx} \qquad \text{(Clause 8.4.4.2 of AS 4100)}$$

where ϕM_{bx} = design member moment capacity for bending about the major principal x-axis (see Section *D*4.1.2 and Tables *D*4.1-1 to *D*4.1-2)

ϕN_t = design member capacity in tension (see Section *D*6.2 and Tables *D*6.1-1 to *D*6.1-4)

Note: $N^* \le \phi N_t$

*D*7.5.2 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:

$$M^*_y \le \phi M_{ry}$$

where ϕ = 0.9 (Table 3.4 of AS 4100)

M^*_y = design bending moment about the minor principal y-axis

ϕM_{ry} = design section moment capacity (ϕM_s) for bending about the minor principal y-axis reduced by axial force

D7.5.2.1 Section Capacity

For The value of ϕM_{ry} must be determined at all points along the member and the following condition must be satisfied:

$$\phi M_{ry} = \phi M_{sy} \left(1 - \frac{N^*}{\phi N_t}\right) \qquad \text{(Clause 8.3.3 of AS 4100)}$$

ϕN_t = design section capacity in tension (see Section *D*3.2.1 and Tables *D*3.1-1 to *D*3.1-4)

Note: $N^* \leq \phi N_t$

Alternatively, for RHS and SHS to AS 1163, which are compact about the y-axis subject to bending and tension:

$$\phi M_{ry} = 1.18 \phi M_{sy} \left(1 - \frac{N^*}{\phi N_t}\right) \leq \phi M_{sy} \qquad \text{(Clause 8.3.3 of AS 4100)}$$

D7.5.3 Biaxial Bending and Axial Tension

For a member subject to biaxial bending and axial tension both the conditions defined in Sections *D*7.5.3.1 and *D*7.5.3.2 must be satisfied.

D7.5.3.1 Section Capacity

$$\frac{N^*}{\phi N_t} + \frac{M^*_x}{\phi M_{sx}} + \frac{M^*_y}{\phi M_{sy}} \leq 1 \qquad \text{(Clause 8.3.4 of AS 4100)}$$

where ϕN_t = design section capacity in tension (see Section *D*3.2.1 and Tables *D*3.1-1 to *D*3.1-4)

M^*_x = design bending moment about the major principal x-axis

M^*_y = design bending moment about the minor principal y-axis

Note: $N^* \leq \phi N_t$
$M^*_x \leq \phi M_{sx}$
$M^*_y \leq \phi M_{sy}$

Alternatively, for RHS and SHS to AS 1163, which are compact about both the x- and y- axes:

$$\left(\frac{M^*_x}{\phi M_{rx}}\right)^\gamma + \left(\frac{M^*_y}{\phi M_{ry}}\right)^\gamma \leq 1$$

where

$$\gamma = 1.4 + \left(\frac{N^*}{\phi N_t}\right) \leq 2.0$$

where

ϕM_{rx} and ϕM_{ry} are calculated using the alternatives presented in Section 8.4.1.1 and 8.4.2.1 of AS 4100.

D7.5.3.2 Member Capacity

$$\left(\frac{M_x^*}{\phi M_{tx}}\right)^{1.4} + \left(\frac{M_y^*}{\phi M_{ry}}\right)^{1.4} \leq 1$$ (Clause 8.4.5.2 of AS 4100)

where M^*_x = design bending moment about the major principal x-axis

ϕM_{tx} = *lesser* of the design section moment capacity (ϕM_{rx}) reduced by axial tension and the design out-of-plane member moment capacity (ϕM_{ox}) for bending about the major principal x-axis, determined in accordance with Sections *D*7.5.1.1 and *D*7.5.1.2 respectively

M^*_y = design bending moment about the minor principal y-axis

ϕM_{ry} = design section moment capacity reduced by axial tension, determined in accordance with Section *D*7.5.2

Note: $M^*_x \leq \phi M_{tx}$

$M^*_y \leq \phi M_{ry}$

D7.6 BIAXIAL BENDING

For a member subject to biaxial bending without any axial force both the conditions defined in Sections D7.6.1 and D7.6.2 must be satisfied.

D7.6.1 Section Capacity

$$\frac{M_x^*}{\phi M_{sx}} + \frac{M_y^*}{\phi M_{sy}} \leq 1.0$$ (Clause 8.3.4 of AS 4100)

where M^*_x = design bending moment about the major principal x-axis

ϕ = 0.9 (Table 3.4 of AS 4100)

ϕM_{sx} = design section moment capacity for bending about the major principal x-axis (see Section D3.2.3 and Tables D3.1-1 to D3.1-4)

M^*_y = design bending moment about the minor principal y-axis

ϕM_{sy} = design section moment capacity for bending about the minor principal y-axis (see Section D3.2.3 and Tables D3.1-1 to D3.1-4)

Note: $M^*_x \leq \phi M_{sx}$
$M^*_y \leq \phi M_{sy}$

Alternatively, for RHS and SHS to AS 1163, which are compact about both the x- and y- axes:

$$\left(\frac{M_x^*}{\phi M_{sx}}\right)^{1.4} + \left(\frac{M_y^*}{\phi M_{sy}}\right)^{1.4} \leq 1$$ (Clause 8.3.4 of AS 4100)

D7.6.2 Member Capacity

$$\left(\frac{M^*_x}{\phi M_{bx}}\right)^{1.4} + \left(\frac{M^*_y}{\phi M_{sy}}\right)^{1.4} \leq 1$$ (Clause 8.4.5 of AS 4100)

where M^*_x = design bending moment about the major principal x-axis

ϕ = 0.9 (Table 3.4 of AS 4100)

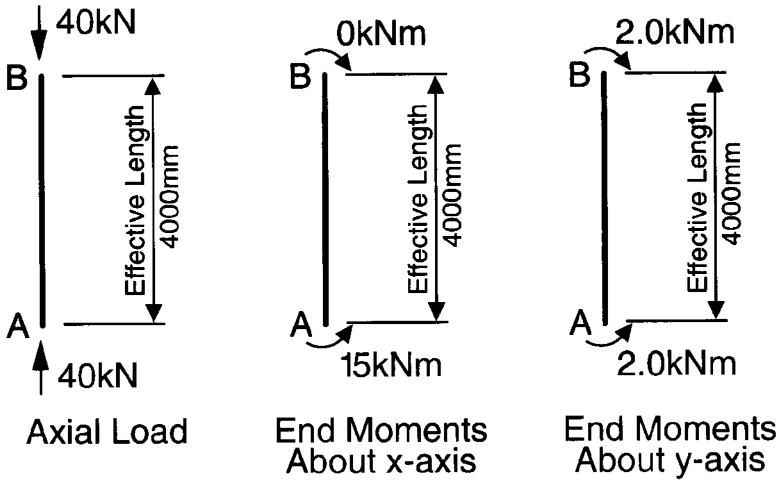
ϕM_{bx} = design section moment capacity for bending about the major principal x-axis (see Section D4.1.2 and Tables D4.1-1 to D4.1-2)

M^*_y = design bending moment about the minor principal y-axis

ϕM_{sy} = design section moment capacity for bending about the minor principal y-axis (see Section D3.2.3 and Tables D3.1-1 to D3.1-4)

Note: $M^*_x \leq \phi M_{bx}$
$M^*_y \leq \phi M_{sy}$

D7.7 EXAMPLES



Exampe A. Braced Beam Column

Design Data:

Section: 125 x 75 x 4.0 DuraGal RHS Grade C450L0 steel

Effective lengths: Flexural buckling (x-axis) = 4.0 m
Flexural buckling (y-axis) = 4.0 m

1. The purpose of this example is to illustrate the calculation of design moments using the amplification factor (δ_b). This factor is relevant for calculating the design moments as the member is braced against sway.

Solution:

N^* = 40 kN

N_{ombx} = 377 kN from Table *D*7.3.2-1(1)(A) for L_{ex} = 4.0 m

N_{omby} = 171 kN from Table *D*7.3.2-1(1)(B) for L_{ey} = 4.0 m

M^*_x = 15 kNm maximum at End A

M^*_y = 2.0 kNm maximum at Ends A and B

β_{mx} = 0

β_{my} = -1

c_{mx} = 0.60 from Table *D*7.3.1 for β_{mx} = 0

c_{my} = 1.00 from Table *D*7.3.1 for β_{my} = -1.0

From Figure *D*7.3(1) the moment amplification factor (δ_b) is given by:

$$\delta_b = \frac{C_m}{1-\left(\dfrac{N^*}{N_{omb}}\right)} \geq 1.0$$

	Considering flexural buckling about x-axis:	δ_{bx}	=	0.671	(< 1)
∴	Maximum moment occurs at the ends, ie. at End A	M^*_x	=	15 kNm	
	Considering flexural buckling about y-axis:	δ_{by}	=	1.31	(> 1 and < 1.4)
∴	Maximum moment occurs between the ends, ie. in the span	M^*_y	=	1.31 x 2.0	
			=	2.62 kNm	

2. Considering further Example 1 (Section *D*7.7), the adequacy of the member under the calculated design action effects is now checked as required by Clauses 8.3 and 8.4 of AS 4100.

Design Data:

Section: 125 x 75 x 4.0 DuraGal RHS Grade C450L0

Effective lengths:

Flexural buckling (x-axis) = 4.0 m
Flexural buckling (y-axis) = 4.0 m
Lateral buckling = 6.0 m

Design action effects:

N^* = 40 kN
M^*_x = 15 kNm
M^*_y = 2.62 kNm

Solution: The example involves biaxial bending and axial compression as defined in Section *D*7.4.3 of these Tables.

(i) Section Capacity Check (Section *D*7.4.3.1)

From Table *D*3.1-1 we obtain:

ϕN_s = 600 kN
ϕM_{sx} = 24.4 kNm
ϕM_{sy} = 15.1 kNm

Thus,

$$\frac{N^*}{\phi N_s} + \frac{M^*_x}{\phi M_{sx}} + \frac{M^*_y}{\phi M_{sy}} = \frac{40}{600} + \frac{15}{24.4} + \frac{2.62}{15.1}$$

$$= 0.855 \ (< 1.0 \therefore \text{O.K.})$$

Note: This interaction formula was used as the section in this example is non-compact about the principal y- axis.

For RHS and SHS to AS 1163, which are **compact** about both the x- and y- axes**,** as defined by Clause 5.2.2 of AS 4100, the interaction equation given in section D7.4.3.1 should be used .

(ii) Member Capacity Check (Section *D*7.4.3.2)

$$\left(\frac{M^*_x}{\phi M_{cx}}\right)^{1.4} + \left(\frac{M^*_y}{\phi M_{iy}}\right)^{1.4} \le 1 \qquad \text{(Clause 8.4.5 of AS 4100)}$$

From the Tables we obtain:

ϕN_{cx} = 285 kN (Table *D*5.2-1(1)(A))

ϕN_{cy} = 142 kN (Table *D*5.2-1(1)(B))

ϕM_{bx} = 24.4 kNm (Table *D*4.1-1(1))

ϕM_{sy} = 15.1 kNm (Table *D*3.1-1)

Calculate, ϕM_{cx} = lesser of $(\phi M_{ix},\ \phi M_{ox})$

(a) $$\phi M_{ix} = \phi M_{sx}\left(1-\frac{N^*}{\phi N_{cx}}\right) \qquad \text{(Clause 8.4.2.2 of AS 4100)}$$

$$= 24.4\left(1-\frac{40}{285}\right)$$

$$= 21.0 \text{ kNm}$$

(b) $$\phi M_{ox} = \phi M_{bx}\left(1-\frac{N^*}{\phi N_{cy}}\right) \qquad \text{(Clause 8.4.4.1 of AS 4100)}$$

Although α_m is given as 1.75 in Table 5.6.1 of AS 4100, $\phi\ \alpha_m\ \alpha_s\ M_{sx}$ must be less than or equal to ϕM_{sx},

therefore: $\phi M_{bx} = \phi\ \alpha_m\ \alpha_s\ M_{sx} \le \phi M_{sx}$

α_s = 1.0 (L_e (lateral buckling) < FLR ie, 6 < 7.08 - Table *D*4.1-1(1))

α_m = 1.0 ($\phi M_{sx} = M_{bx}$)

$$\phi M_{ox} = 1.0 \times 24.4\left(1-\frac{40}{142}\right)$$

$$= 17.5 \text{ kNm}$$

therefore: ϕM_{cx} = lesser of (21.0 kNm, 17.5 kNm)
= 17.5 kNm

$$\phi M_{iy} = \phi M_{sy}\left(1-\frac{N^*}{\phi N_{cy}}\right)$$

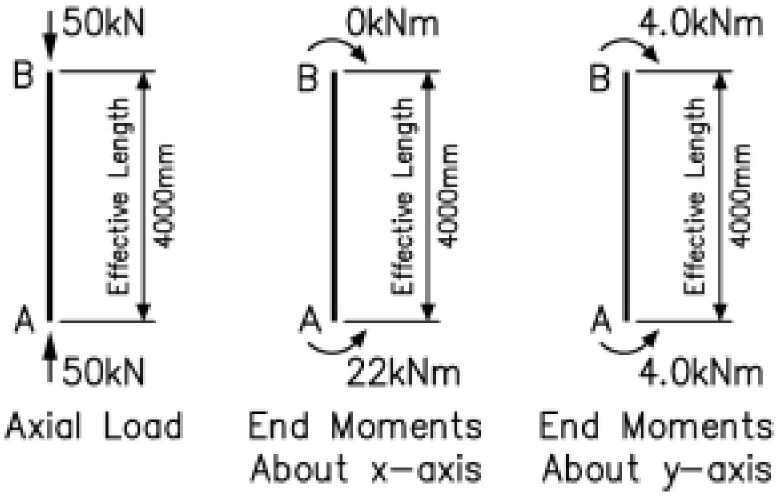
$$= 15.1\left(1-\frac{40}{142}\right)$$

$$= 10.8 \text{ kNm}$$

Thus: $$\left(\frac{M^*_x}{\phi M_{cx}}\right)^{1.4} + \left(\frac{M^*_y}{\phi M_{iy}}\right)^{1.4} = \left(\frac{15}{17.5}\right)^{1.4} + \left(\frac{2.62}{10.8}\right)^{1.4}$$

= 0.944 (<1.0 ∴ O.K.)

*D*7.7 EXAMPLES



Example 2.0 Braced Beam Column

Design Data:

Section: 125 x 75 x 6.0 DuraGal RHS Grade C450L0

Effective lengths:
Flexural buckling (x-axis) = 4.0 m
Flexural buckling (y-axis) = 4.0 m
Lateral buckling = 6.0 m

(1). The purpose of this second example is to illustrate the calculation of design moments using the amplification factor (δ_b), and the alternative methods for calculating Member and Section capacities for *Compact Sections* as described in Sections D7.4.3.1 and D7.4.3.2. This factor is relevant for calculating the design moments as the member is braced against sway.

Solution:

N^* = 50 kN

N_{ombx} = 513 kN from Table *D*7.3.2-1(1)(A) for L_{ex} = 4.0 m

N_{omby} = 231 kN from Table *D*7.3.2-1(1)(B) for L_{ey} = 4.0 m

M^*_x = 22 kNm maximum at End A

M^*_y = 4.0 kNm maximum at Ends A and B

β_{mx} = 0

β_{my} = -1

c_{mx} = 0.60 from Table *D*7.3.1 for $\beta_{mx} = 0$

c_{my} = 1.00 from Table *D*7.3.1 for $\beta_{my} = -1.0$

From Figure *D*7.3(1) the moment amplification factor (δ_b) is given by:

$$\delta_b = \frac{C_m}{1 - \left(\frac{N^*}{N_{omb}}\right)} \geq 1.0$$

	Considering flexural buckling about x-axis:	δ_{bx}	=	0.665	(< 1)
∴	Maximum moment occurs at the ends, ie. at End A	M^*_x	=	22 kNm	
	Considering flexural buckling about y-axis:	δ_{by}	=	1.28	(> 1 and < 1.4)
∴	Maximum moment occurs between the ends, ie. in the span	M^*_y	=	1.28 x 4.0	
			=	5.12 kNm	

(2). Considering further Example 1 (Section *D*7.7), the adequacy of the member under the calculated design action effects is now checked as required by Clauses 8.3 and 8.4 of AS 4100.

Design Data:

Section: 125 x 75 x 6.0 DuraGal RHS Grade C450L0 steel

Effective lengths:

- Flexural buckling (x-axis) = 4.0 m
- Flexural buckling (y-axis) = 4.0 m
- Lateral buckling = 6.0 m

Design action effects:

- N^* = 50 kN
- M^*_x = 22 kNm
- M^*_y = 5.12 kNm

Solution: The example involves biaxial bending and axial compression as defined in Section *D*7.4.3 of these Tables.

(i) Section Capacity Check (Section *D*7.4.3.1)

From Table *D*3.1-1 we obtain:

ϕN_s = 864 kN

ϕM_{sx} = 34.1 kNm

ϕM_{sy} = 23.9 kNm

As 127 x 75 x 6.0 DuraGal RHS is compact about the x- and y- axis, and k_f = 1.0

Then

$$\left(\frac{M_x^*}{\phi M_{rx}}\right)^{\gamma} + \left(\frac{M_y^*}{\phi M_{ry}}\right)^{\gamma} \leq 1$$ (Clause 8.3.4 of AS AS 4100)

where

$$\gamma = 1.4 + \left(\frac{N^*}{\phi N_t}\right) \leq 2.0$$

Then

$$\phi M_{rx} = 1.18\phi M_{sx}\left(1 - \frac{N^*}{\phi N_s}\right) \le \phi M_{sx}$$ (Clause 8.3.2 of AS 4100)

$$\phi M_{rx} = 1.18 \times 34.1\left(1 - \frac{50}{864}\right) \le 34.1$$

= 34.1 kNm

and

$$\phi M_{ry} = 1.18\phi M_{sy}\left(1 - \frac{N^*}{\phi N_s}\right) \le \phi M_{sy}$$ (Clause 8.3.3 of AS 4100)

$$\phi M_{ry} = 1.18 \times 23.9\left(1 - \frac{50}{864}\right) \le 23.9$$

= 23.9 kNm

Then

$$\gamma = 1.4 + \left(\frac{50}{864}\right) \le 2.0 \qquad \gamma = 1.46$$

$$\left(\frac{22}{34.1}\right)^{1.46} + \left(\frac{5.10}{23.9}\right)^{1.46} \le 1$$

= 0.633 < 1.0

Member Capacity Check (Section *D*7.4.3.2)

From the Tables we obtain:	ϕN_{cx}	=	392 kN	(Table *D*5.2-1(1)(A))
	ϕN_{cy}	=	193 kN	(Table *D*5.2-1(1)(B))
	ϕM_{bx}	=	34.1 kNm	(Table *D*4.1-1(1))
Calculate,	ϕM_{cx}	=	lesser of	(ϕM_{ix}, ϕM_{ox})

(a) (Clause 8.4.2.2 of AS 4100)

$$\phi M_{ix} = \phi M_{sx}\left\{\left[1 - \left(\frac{1+\beta_m}{2}\right)^3\right]\left(1 - \frac{N^*}{\phi N_{cx}}\right) + 1.18\left(\frac{1+\beta_m}{2}\right)^3\sqrt{1 - \left(\frac{N^*}{\phi N_{cx}}\right)}\right\} \le \phi M_{rx}$$

$$\phi M_{ix} = 34.1\left\{\left[1 - \left(\frac{1+0}{2}\right)^3\right]\left(1 - \frac{50}{392}\right) + 1.18\left(\frac{1+0}{2}\right)^3\sqrt{\left(1 - \frac{50}{392}\right)}\right\} \le 34.1 kNm$$

$\therefore$ ϕM_{ix} = 30.7 kNm $\le$ ϕM_{rx} = 34.1kNm

(b) $$\phi M_{ox} = \phi M_{bx}\left(1 - \frac{N^*}{\phi N_{cy}}\right)$$ (Clause 8.4.4.1 of AS 4100)

$$\phi M_{ox} = 34.1\left(1 - \frac{50}{193}\right)$$

= 25.3 kNm

therefore: ϕM_{cx} = lesser of (ϕM_{ix}, ϕM_{ox})

= 25.3 kNm

(Clause 8.4.2.2 of AS 4100)

$$\phi M_{iy} = \phi M_{sy}\left\{\left[1 - \left(\frac{1+\beta_{my}}{2}\right)^3\right]\left(1 - \frac{N^*}{\phi N_{cy}}\right) + 1.18\left(\frac{1+\beta_{my}}{2}\right)^3\sqrt{\left(1 - \frac{N^*}{\phi N_{cy}}\right)}\right\} \le \phi M_{ry}$$

$$\phi M_{iy} = 23.9\left\{\left[1 - \left(\frac{1+(-1)}{2}\right)^3\right]\left(1 - \frac{50}{193}\right) + 1.18\left(\frac{1+(-1)}{2}\right)^3\sqrt{\left(1 - \frac{50}{193}\right)}\right\} \le 17.7 kNm$$

∴ ϕM_{iy} = 17.7 kNm ≤ ϕM_{ry} = 23.9 kNm

Then

$$\left(\frac{M_x^*}{\phi M_{cx}}\right)^{1.4} + \left(\frac{M_y^*}{M_{iy}}\right)^{1.4} \le 1$$

(Clause 8.4.5.1 of AS 4100)

$$\left(\frac{22}{25.3}\right)^{1.4} + \left(\frac{5.12}{17.7}\right)^{1.4} \le 1$$

= 0.998 < 1 Therefore OK

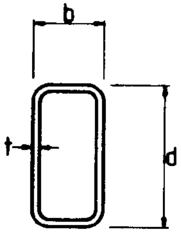


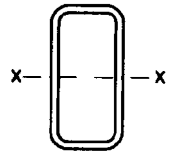
TABLE *D*7.3.2-1(1)(A)

ELASTIC BUCKLING LOADS

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

buckling about x-axis



Designation d b t	Mass per m	Elastic Buckling Loads N_{om} (MN) Effective Length (L_e) in metres													
mm mm mm	kg/m	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
150 x 50 x 6.0 RHS	16.7	∞	9.99	4.44	2.50	1.60	1.11	0.815	0.624	0.399	0.277	0.204	0.156	0.0999	0.0694
5.0 RHS	14.2	∞	8.77	3.90	2.19	1.40	0.974	0.716	0.548	0.351	0.244	0.179	0.137	0.0877	0.0609
4.0 RHS	11.6	∞	7.37	3.28	1.84	1.18	0.819	0.602	0.461	0.295	0.205	0.151	0.115	0.0737	0.0512
3.0 RHS	8.96	∞	5.89	2.62	1.47	0.943	0.655	0.481	0.368	0.236	0.164	0.120	0.0921	0.0589	0.0409
2.5 RHS	7.53	∞	5.02	2.23	1.25	0.802	0.557	0.409	0.313	0.201	0.139	0.102	0.0784	0.0502	0.0348
2.0 RHS	6.07	∞	4.10	1.82	1.02	0.655	0.455	0.334	0.256	0.164	0.114	0.0836	0.0640	0.0410	0.0284
125 x 75 x 6.0 RHS	16.7	∞	8.21	3.65	2.05	1.31	0.913	0.671	0.513	0.329	0.228	0.168	0.128	0.0821	0.0570
5.0 RHS	14.2	∞	7.19	3.19	1.80	1.15	0.798	0.587	0.449	0.287	0.200	0.147	0.112	0.0719	0.0499
4.0 RHS	11.6	∞	6.03	2.68	1.51	0.964	0.670	0.492	0.377	0.241	0.167	0.123	0.0942	0.0603	0.0419
3.0 RHS	8.96	∞	4.79	2.13	1.20	0.767	0.533	0.391	0.300	0.192	0.133	0.0978	0.0749	0.0479	0.0333
2.5 RHS	7.53	∞	4.08	1.81	1.02	0.652	0.453	0.333	0.255	0.163	0.113	0.0832	0.0637	0.0408	0.0283
2.0 RHS	6.07	∞	3.33	1.48	0.832	0.532	0.370	0.272	0.208	0.133	0.0924	0.0679	0.0520	0.0333	0.0231
100 x 50 x 6.0 RHS	12.0	∞	3.37	1.50	0.844	0.540	0.375	0.275	0.211	0.135	0.0937	0.0689	0.0527	0.0337	0.0234
5.0 RHS	10.3	∞	3.02	1.34	0.754	0.483	0.335	0.246	0.188	0.121	0.0838	0.0615	0.0471	0.0302	0.0209
4.0 RHS	8.49	∞	2.58	1.15	0.645	0.413	0.287	0.211	0.161	0.103	0.0717	0.0526	0.0403	0.0258	0.0179
3.5 RHS	7.53	∞	2.33	1.04	0.583	0.373	0.259	0.190	0.146	0.0933	0.0648	0.0476	0.0364	0.0233	0.0162
3.0 RHS	6.60	∞	2.10	0.934	0.525	0.336	0.233	0.172	0.131	0.0841	0.0584	0.0429	0.0328	0.0210	0.0146
2.5 RHS	5.56	∞	1.80	0.800	0.450	0.288	0.200	0.147	0.113	0.0720	0.0500	0.0367	0.0281	0.0180	0.0125
2.0 RHS	4.50	∞	1.48	0.658	0.370	0.237	0.164	0.121	0.0925	0.0592	0.0411	0.0302	0.0231	0.0148	0.0103
1.6 RHS	3.64	∞	1.21	0.538	0.302	0.194	0.134	0.0988	0.0756	0.0484	0.0336	0.0247	0.0189	0.0121	0.00840

Note: 1. $N_{om} = \pi^2 EI / L_e^2$ (Clause 4.6.2 of AS 4100)

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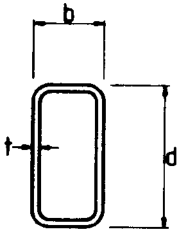


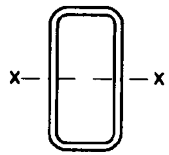
TABLE *D*7.3.2-1(2)(A)

ELASTIC BUCKLING LOADS

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

buckling about x-axis



Designation d b t	Mass per m	Elastic Buckling Loads N_{om} (kN) Effective Length (L_e) in metres													
mm mm mm	kg/m	0.0	0.25	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	5.0
100 x 50 x 6.0 RHS	12.0	∞	54000	13500	6000	3370	2160	1500	1100	844	540	375	275	211	135
5.0 RHS	10.3	∞	48300	12100	5360	3020	1930	1340	985	754	483	335	246	188	121
4.0 RHS	8.49	∞	41300	10300	4590	2580	1650	1150	842	645	413	287	211	161	103
3.5 RHS	7.53	∞	37300	9330	4140	2330	1490	1040	761	583	373	259	190	146	93.3
3.0 RHS	6.60	∞	33600	8410	3740	2100	1340	934	686	525	336	233	172	131	84.1
2.5 RHS	5.56	∞	28800	7200	3200	1800	1150	800	588	450	288	200	147	113	72.0
2.0 RHS	4.50	∞	23700	5920	2630	1480	947	658	483	370	237	164	121	92.5	59.2
1.6 RHS	3.64	∞	19400	4840	2150	1210	774	538	395	302	194	134	98.9	75.6	48.4
75 x 50 x 6.0 RHS	9.67	∞	25300	6320	2810	1580	1010	702	516	395	253	175	129	98.7	63.2
5.0 RHS	8.35	∞	22900	5730	2550	1430	917	637	468	358	229	159	117	89.6	57.3
4.0 RHS	6.92	∞	19900	4970	2210	1240	796	553	406	311	199	138	102	77.7	49.7
3.0 RHS	5.42	∞	16500	4120	1830	1030	659	458	336	257	165	114	84.1	64.4	41.2
2.5 RHS	4.58	∞	14200	3550	1580	887	568	394	290	222	142	98.6	72.4	55.5	35.5
2.0 RHS	3.72	∞	11700	2930	1300	734	469	326	240	183	117	81.5	59.9	45.8	29.3
1.6 RHS	3.01	∞	9640	2410	1070	602	385	268	197	151	96.4	66.9	49.2	37.6	24.1
75 x 25 x 2.5 RHS	3.60	∞	9010	2250	1000	563	360	250	184	141	90.1	62.5	46.0	35.2	22.5
2.0 RHS	2.93	∞	7530	1880	836	471	301	209	154	118	75.3	52.3	38.4	29.4	18.8
1.6 RHS	2.38	∞	6230	1560	693	390	249	173	127	97.4	62.3	43.3	31.8	24.3	15.6
65 x 35 x 4.0 RHS	5.35	∞	10400	2590	1150	648	415	288	212	162	104	72.0	52.9	40.5	25.9
3.0 RHS	4.25	∞	8880	2220	986	555	355	247	181	139	88.8	61.6	45.3	34.7	22.2
2.5 RHS	3.60	∞	7720	1930	858	483	309	214	158	121	77.2	53.6	39.4	30.2	19.3
2.0 RHS	2.93	∞	6440	1610	716	403	258	179	131	101	64.4	44.7	32.9	25.2	16.1
50 x 25 x 3.0 RHS	3.07	∞	3530	882	392	221	141	98.0	72.0	55.1	35.3	24.5	18.0	13.8	8.82
2.5 RHS	2.62	∞	3120	781	347	195	125	86.7	63.7	48.8	31.2	21.7	15.9	12.2	7.81
2.0 RHS	2.15	∞	2650	662	294	165	106	73.5	54.0	41.4	26.5	18.4	13.5	10.3	6.62
1.6 RHS	1.75	∞	2220	554	246	139	88.7	61.6	45.2	34.6	22.2	15.4	11.3	8.66	5.54
50 x 20 x 3.0 RHS	2.83	∞	3000	751	334	188	120	83.5	61.3	46.9	30.0	20.9	15.3	11.7	7.51
2.5 RHS	2.42	∞	2680	669	297	167	107	74.4	54.6	41.8	26.8	18.6	13.7	10.5	6.69
2.0 RHS	1.99	∞	2280	571	254	143	91.3	63.4	46.6	35.7	22.8	15.9	11.7	8.92	5.71
1.6 RHS	1.63	∞	1920	480	213	120	76.8	53.3	39.2	30.0	19.2	13.3	9.80	7.50	4.80

Note: 1. $N_{om} = \pi^2 EI / L_e^2$ (Clause 4.6.2 of AS 4100)

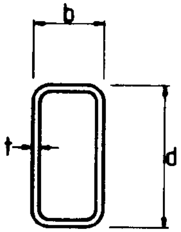


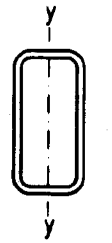
TABLE *D*7.3.2-1(1)(B)

ELASTIC BUCKLING LOADS

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

buckling about y-axis



Designation d b t	Mass per m	Elastic Buckling Loads N_{om} (MN) Effective Length (L_e) in metres													
mm mm mm	kg/m	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
150 x 50 x 6.0 RHS	16.7	∞	6.79	1.70	0.754	0.424	0.272	0.189	0.139	0.106	0.0679	0.0471	0.0346	0.0265	0.0170
5.0 RHS	14.2	∞	6.04	1.51	0.671	0.378	0.242	0.168	0.123	0.0944	0.0604	0.0420	0.0308	0.0236	0.0151
4.0 RHS	11.6	∞	5.16	1.29	0.573	0.322	0.206	0.143	0.105	0.0806	0.0516	0.0358	0.0263	0.0201	0.0129
3.0 RHS	8.96	∞	4.16	1.04	0.462	0.260	0.166	0.115	0.0848	0.0650	0.0416	0.0289	0.0212	0.0162	0.0104
2.5 RHS	7.53	∞	3.57	0.892	0.396	0.223	0.143	0.0991	0.0728	0.0557	0.0357	0.0248	0.0182	0.0139	0.00892
2.0 RHS	6.07	∞	2.94	0.734	0.326	0.184	0.117	0.0816	0.0559	0.0459	0.0294	0.0204	0.0150	0.0115	0.00734
125 x 75 x 6.0 RHS	16.7	∞	14.8	3.70	1.64	0.925	0.592	0.411	0.302	0.231	0.148	0.103	0.0755	0.0578	0.0370
5.0 RHS	14.2	∞	13.0	3.25	1.44	0.812	0.520	0.361	0.265	0.203	0.130	0.0903	0.0663	0.0508	0.0325
4.0 RHS	11.6	∞	11.0	2.74	1.22	0.684	0.438	0.304	0.224	0.171	0.110	0.0761	0.0559	0.0428	0.0274
3.0 RHS	8.96	∞	8.73	2.18	0.970	0.545	0.349	0.242	0.178	0.136	0.0873	0.0606	0.0445	0.0341	0.0218
2 5 RHS	7.53	∞	7.44	1.86	0.827	0.465	0.298	0.207	0.152	0.116	0.0744	0.0517	0.0380	0.0291	0.0186
2.0 RHS	6.07	∞	6.09	1.52	0.677	0.381	0.244	0.169	0.124	0.0952	0.0609	0.0423	0.0311	0.0238	0.0152
100 x 50 x 6.0 RHS	12.0	∞	4.48	1.12	0.498	0.280	0.179	0.124	0.0914	0.0700	0.0448	0.0311	0.0229	0.0175	0.0112
5.0 RHS	10.3	∞	4.04	1.01	0.448	0.252	0.161	0.112	0.0824	0.0631	0.0404	0.0280	0.0206	0.0158	0.0101
4.0 RHS	8.49	∞	3.48	0.870	0.387	0.218	0.139	0.0967	0.0710	0.0544	0.0348	0.0242	0.0178	0.0136	0.00870
3.5 RHS	7.53	∞	3.16	0.790	0.351	0.197	0.126	0.0878	0.0645	0.0494	0.0316	0.0219	0.0161	0.0123	0.00790
3.0 RHS	6.60	∞	2.85	0.712	0.316	0.178	0.114	0.0791	0.0581	0.0445	0.0285	0.0198	0.0145	0.0111	0.00712
2.5 RHS	5.56	∞	2.45	0.613	0.272	0.153	0.0981	0.0681	0.0500	0.0383	0.0245	0.0170	0.0125	0.00958	0.00613
2.0 RHS	4.50	∞	2.03	0.507	0.225	0.127	0.0811	0.0563	0.0414	0.0317	0.0203	0.0141	0.0103	0.00792	0.00507
1.6 RHS	3.64	∞	1.66	0.416	0.185	0.104	0.0666	0.0462	0.0340	0.0260	0.0166	0.0116	0.00849	0.00650	0.00416

Note: 1. $N_{om} = \pi^2 EI / L_e^2$ (Clause 4.6.2 of AS 4100)

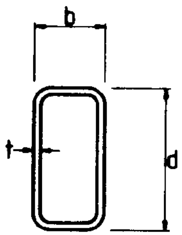
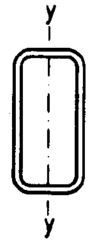


TABLE *D*7.3.1(2)(B)

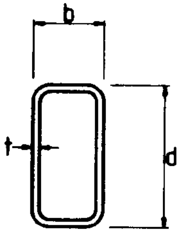
ELASTIC BUCKLING LOADS

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0
Standard Thickness
buckling about y-axis



Designation d b t	Mass per m	Elastic Buckling Loads N_{om} (kN) Effective Length (L_e) in metres													
mm mm mm	kg/m	0.0	0.25	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	5.0
100 x 50 x 6.0 RHS	12.0	∞	17900	4480	1990	1120	717	498	366	280	179	124	91.4	70.0	44.8
5.0 RHS	10.3	∞	16100	4040	1790	1010	646	448	329	252	161	112	82.4	63.1	40.4
4.0 RHS	8.49	∞	13900	3480	1550	870	557	387	284	218	139	96.7	71.0	54.4	34.8
3.5 RHS	7.53	∞	12600	3160	1400	790	506	351	258	197	126	87.8	64.5	49.4	31.6
3.0 RHS	6.60	∞	11400	2850	1270	712	456	316	232	178	114	79.1	58.1	44.5	28.5
2.5 RHS	5.56	∞	9810	2450	1090	613	392	272	200	153	98.1	68.1	50.0	38.3	24.5
2.0 RHS	4.50	∞	8110	2030	901	507	324	225	165	127	81.1	56.3	41.4	31.7	20.3
1.6 RHS	3.64	∞	6660	1660	740	416	266	185	136	104	66.6	46.2	34.0	26.0	16.6
75 x 50 x 6.0 RHS	9.67	∞	13300	3330	1480	832	532	370	272	208	133	92.4	67.9	52.0	33.3
5.0 RHS	8.35	∞	12100	3030	1350	758	485	337	248	189	121	84.2	61.9	47.4	30.3
4.0 RHS	6.92	∞	10600	2640	1170	661	423	294	216	165	106	73.4	53.9	41.3	26.4
3.0 RHS	5.42	∞	8770	2190	974	548	351	244	179	137	87.7	60.9	44.7	34.3	21.9
2.5 RHS	4.58	∞	7580	1900	842	474	303	211	155	118	75.8	52.6	38.7	29.6	19.0
2.0 RHS	3.72	∞	6290	1570	699	393	252	175	128	98.3	62.9	43.7	32.1	24.6	15.7
1.6 RHS	3.01	∞	5180	1290	575	324	207	144	106	80.9	51.8	36.0	26.4	20.2	12.9
75 x 25 x 2.5 RHS	3.60	∞	1540	384	171	96.1	61.5	42.7	31.4	24.0	15.4	10.7	7.84	6.00	3.84
2.0 RHS	2.93	∞	1310	326	145	81.6	52.2	36.3	26.7	20.4	13.1	9.07	6.66	5.10	3.26
1.6 RHS	2.38	∞	1100	274	122	68.5	43.8	30.4	22.4	17.1	11.0	7.61	5.59	4.28	2.74
65 x 35 x 4.0 RHS	5.35	∞	3890	972	432	243	155	108	79.3	60.7	38.9	27.0	19.8	15.2	9.72
3.0 RHS	4.25	∞	3340	835	371	209	134	92.7	68.1	52.2	33.4	23.2	17.0	13.0	8.35
2.5 RHS	3.60	∞	2920	731	325	183	117	81.2	59.7	45.7	29.2	20.3	14.9	11.4	7.31
2.0 RHS	2.93	∞	2460	614	273	154	98.3	68.2	50.1	38.4	24.6	17.1	12.5	9.60	6.14
50 x 25 x 3.0 RHS	3.07	∞	1160	290	129	72.4	46.3	32.2	23.6	18.1	11.6	8.04	5.91	4.52	2.90
2.5 RHS	2.62	∞	1040	259	115	64.7	41.4	28.8	21.1	16.2	10.4	7.19	5.28	4.04	2.59
2.0 RHS	2.15	∞	887	222	98.6	55.5	35.5	24.6	18.1	13.9	8.87	6.16	4.53	3.47	2.22
1.6 RHS	1.75	∞	749	187	83.2	46.8	30.0	20.8	15.3	11.7	7.49	5.20	3.82	2.93	1.87
50 x 20 x 3.0 RHS	2.83	∞	670	168	74.5	41.9	26.8	18.6	13.7	10.5	6.70	4.66	3.42	2.62	1.68
2.5 RHS	2.42	∞	607	152	67.5	37.9	24.3	16.9	12.4	9.49	6.07	4.22	3.10	2.37	1.52
2.0 RHS	1.99	∞	527	132	58.5	32.9	21.1	14.6	10.8	8.23	5.27	3.66	2.69	2.06	1.32
1.6 RHS	1.63	∞	449	112	49.9	28.1	18.0	12.5	9.17	7.02	4.49	3.12	2.29	1.75	1.12

Note: 1. $N_{om} = \pi^2 EI / L_e^2$ (Clause 4.6.2 of AS 4100)



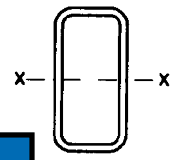
ELASTIC BUCKLING LOADS

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Non-Standard Thickness

TABLE *D*7.3.2-2(A)

buckling about x-axis



Designation d b t (mm mm mm)	Mass per m (kg/m)	Elastic Buckling Loads N_{om} (kN) — Effective Length (L_e) in metres: 0.0	0.25	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	5.0
125 x 75 x 2.8 RHS	8.39	∞	72200	18000	8020	4510	2890	2000	1470	1130	722	501	368	282	180
2.3 RHS	6.95	∞	60500	15100	6720	3780	2420	1680	1230	945	605	420	309	236	151
100 x 50 x 2.8 RHS	6.19	∞	31700	7930	3530	1980	1270	881	648	496	317	220	162	124	79.3
2.3 RHS	5.14	∞	26800	6700	2980	1670	1070	744	547	419	268	186	137	105	67.0
75 x 50 x 2.8 RHS	5.09	∞	15600	3900	1730	974	623	433	318	244	156	108	79.5	60.9	39.0
2.3 RHS	4.24	∞	13200	3310	1470	827	529	368	270	207	132	91.9	67.5	51.7	33.1
65 x 35 x 2.8 RHS	3.99	∞	8430	2110	937	527	337	234	172	132	84.3	58.5	43.0	32.9	21.1
2.3 RHS	3.34	∞	7230	1810	803	452	289	201	147	113	72.3	50.2	36.9	28.2	18.1
50 x 25 x 2.8 RHS	2.89	∞	3370	844	375	211	135	93.7	68.9	52.7	33.7	23.4	17.2	13.2	8.44
2.3 RHS	2.44	∞	2940	735	327	184	118	81.7	60.0	46.0	29.4	20.4	15.0	11.5	7.35
50 x 20 x 2.8 RHS	2.67	∞	2880	720	320	180	115	80.0	58.8	45.0	28.8	20.0	14.7	11.3	7.20
2.3 RHS	2.25	∞	2530	632	281	158	101	70.2	51.6	39.5	25.3	17.6	12.9	9.87	6.32

Note: 1. $N_{om} = \pi^2 EI / L_e^2$ (Clause 4.6.2 of AS 4100)

TABLE *D*7.3.2-2(B)

buckling about y-axis

Designation d b t (mm mm mm)	Mass per m (kg/m)	Elastic Buckling Loads N_{om} (kN) — Effective Length (L_e) in metres: 0.0	0.25	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	5.0
125 x 75 x 2.8 RHS	8.39	∞	32900	8220	3650	2060	1320	913	671	514	329	228	168	128	82.2
2.3 RHS	6.95	∞	27600	6910	3070	1730	1110	768	564	432	276	192	141	108	69.1
100 x 50 x 2.8 RHS	6.19	∞	10800	2690	1200	673	431	299	220	168	108	74.8	55.0	42.1	26.9
2.3 RHS	5.14	∞	9140	2290	1020	571	366	254	187	143	91.4	63.5	46.7	35.7	22.9
75 x 50 x 2.8 RHS	5.09	∞	8310	2080	923	519	332	231	169	130	83.1	57.7	42.4	32.4	20.8
2.3 RHS	4.24	∞	7080	1770	786	442	283	197	144	111	70.8	49.1	36.1	27.6	17.7
65 x 35 x 2.8 RHS	3.99	∞	3180	795	353	199	127	88.3	64.9	49.7	31.8	22.1	16.2	12.4	7.95
2.3 RHS	3.34	∞	2740	686	305	171	110	76.2	56.0	42.9	27.4	19.1	14.0	10.7	6.86
50 x 25 x 2.8 RHS	2.89	∞	1110	278	124	69.5	44.5	30.9	22.7	17.4	11.1	7.72	5.67	4.34	2.78
2.3 RHS	2.44	∞	979	245	109	61.2	39.2	27.2	20.0	15.3	9.79	6.80	5.00	3.83	2.45
50 x 20 x 2.8 RHS	2.67	∞	647	162	71.9	40.4	25.9	18.0	13.2	10.1	6.47	4.49	3.30	2.53	1.62
2.3 RHS	2.25	∞	577	144	64.1	36.1	23.1	16.0	11.8	9.02	5.77	4.01	2.94	2.25	1.44

Note: 1. $N_{om} = \pi^2 EI / L_e^2$ (Clause 4.6.2 of AS 4100)

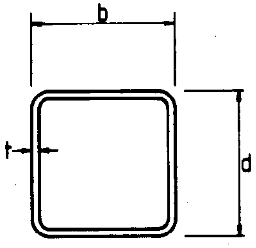
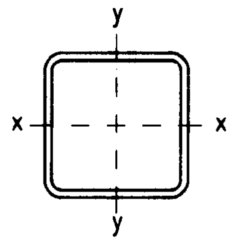


TABLE *D*7.3.2-3(1)

ELASTIC BUCKLING LOADS

DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0
Standard Thickness
buckling about x- and y-axis



Designation d b t	Mass per m	Elastic Buckling Loads N_{om} (MN) Effective Length (L_e) in metres													
mm mm mm	kg/m	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
100 x 100 x 6.0 SHS	16.7	∞	5.99	2.66	1.50	0.959	0.666	0.489	0.375	0.240	0.167	0.122	0.0937	0.0599	0.0416
5.0 SHS	14.2	∞	5.24	2.33	1.31	0.839	0.583	0.428	0.328	0.210	0.146	0.107	0.0819	0.0524	0.0364
4.0 SHS	11.6	∞	4.40	1.96	1.10	0.704	0.489	0.359	0.275	0.176	0.122	0.0898	0.0687	0.0440	0.0306
3.0 SHS	8.96	∞	3.49	1.55	0.874	0.559	0.388	0.285	0.218	0.140	0.0971	0.0713	0.0546	0.0349	0.0243
2.5 SHS	7.53	∞	2.97	1.32	0.743	0.476	0.330	0.243	0.186	0.119	0.0826	0.0607	0.0465	0.0297	0.0206
2.0 SHS	6.07	∞	2.43	1.08	0.607	0.388	0.270	0.198	0.152	0.0971	0.0674	0.0496	0.0379	0.0243	0.0169
90 x 90 x 3.0 SHS	8.01	∞	2.51	1.12	0.628	0.402	0.279	0.205	0.157	0.100	0.0698	0.0513	0.0393	0.0251	0.0174
2.5 SHS	6.74	∞	2.14	0.952	0.536	0.343	0.238	0.175	0.134	0.0857	0.0595	0.0437	0.0335	0.0214	0.0149
2.0 SHS	5.45	∞	1.75	0.780	0.439	0.281	0.195	0.143	0.110	0.0702	0.0487	0.0358	0.0274	0.0175	0.0122
1.6 SHS	4.39	∞	1.43	0.635	0.357	0.229	0.159	0.117	0.839	0.0572	0.0397	0.0292	0.0223	0.0143	0.00992
89 x 89 x 6.0 SHS	14.6	∞	4.06	1.80	1.01	0.649	0.451	0.331	0.254	0.162	0.113	0.0828	0.0634	0.0406	0.0282
5.0 SHS	12.5	∞	3.58	1.59	0.894	0.572	0.379	0.292	0.223	0.143	0.0993	0.0730	0.0559	0.0358	0.0248
3.5 SHS	9.06	∞	2.71	1.21	0.678	0.434	0.301	0.221	0.170	0.109	0.0754	0.0554	0.0424	0.0271	0.0188
75 x 75 x 6.0 SHS	12.0	∞	2.29	1.02	0.571	0.366	0.254	0.187	0.143	0.0914	0.0635	0.0466	0.0357	0.0229	0.0159
5.0 SHS	10.3	∞	2.04	0.906	0.510	0.326	0.227	0.166	0.127	0.0815	0.0566	0.0416	0.0319	0.0204	0.0142
4.0 SHS	8.49	∞	1.74	0.774	0.435	0.279	0.194	0.142	0.109	0.0697	0.0484	0.0355	0.0272	0.0174	0.0121
3.5 SHS	7.53	∞	1.57	0.699	0.393	0.252	0.175	0.128	0.0984	0.0629	0.0437	0.0321	0.0246	0.0157	0.0109
3.0 SHS	6.60	∞	1.41	0.628	0.353	0.226	0.157	0.115	0.0884	0.0565	0.0393	0.0289	0.0221	0.0141	0.00982
2.5 SHS	5.56	∞	1.21	0.539	0.303	0.194	0.135	0.0989	0.0757	0.0485	0.0337	0.0247	0.0189	0.0121	0.00841
2.0 SHS	4.50	∞	0.997	0.443	0.249	0.159	0.111	0.0814	0.0623	0.0399	0.0277	0.0203	0.0156	0.00997	0.00692

Note: 1. $N_{om} = \pi^2 EI / L_e^2$ (Clause 4.6.2 of AS 4100)

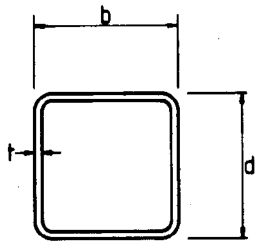


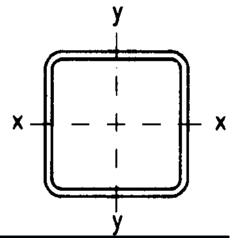
TABLE *D*7.3.2-3(2)

ELASTIC BUCKLING LOADS

DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

buckling about x- and y-axis



Designation d b t (mm mm mm)	Mass per m (kg/m)	Elastic Buckling Loads N_{om} (kN) — Effective Length (L_e) in metres: 0.0	0.25	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	5.0
75 x 75 x 6.0 SHS	12.0	∞	36600	9140	4060	2290	1460	1020	746	571	366	254	187	143	91.4
5.0 SHS	10.3	∞	32600	8150	3620	2040	1300	906	666	510	326	227	166	127	81.5
4.0 SHS	8.49	∞	27900	6970	3100	1740	1110	774	569	435	279	194	142	109	69.7
3.5 SHS	7.53	∞	25200	6290	2800	1570	1010	699	514	393	252	175	128	98.4	62.9
3.0 SHS	6.60	∞	22600	5650	2510	1410	905	628	462	353	226	157	115	88.4	56.5
2.5 SHS	5.56	∞	19400	4850	2150	1210	775	539	396	303	194	135	98.9	75.7	48.5
2.0 SHS	4.50	∞	15900	3990	1770	997	638	443	325	249	159	111	81.4	62.3	39.9
65 x 65 x 6.0 SHS	10.1	∞	22300	5580	2480	1390	892	620	455	349	223	155	114	87.1	55.8
5.0 SHS	8.75	∞	20200	5040	2240	1260	806	560	411	315	202	140	103	78.7	50.4
4.0 SHS	7.23	∞	17400	4360	1940	1090	697	484	356	272	174	121	88.9	68.1	43.6
3.0 SHS	5.66	∞	14300	3590	1590	896	574	398	293	224	143	99.6	73.2	56.0	35.9
2.5 SHS	4.78	∞	12400	3090	1370	772	494	343	252	193	124	85.8	63.0	48.2	30.9
2.0 SHS	3.88	∞	10200	2550	1130	638	408	283	208	159	102	70.9	52.1	39.9	25.5
1.6 SHS	3.13	∞	8370	2090	931	523	335	233	171	131	83.7	58.2	42.7	32.7	20.9
50 x 50 x 5.0 SHS	6.39	∞	8110	2030	902	507	325	225	166	127	81.1	56.3	41.4	31.7	20.3
4.0 SHS	5.35	∞	7220	1810	803	451	289	201	147	113	72.2	50.2	36.9	28.2	18.1
3.0 SHS	4.25	∞	6150	1540	683	384	246	171	125	96.1	61.5	42.7	31.4	24.0	15.4
2.5 SHS	3.60	∞	5350	1340	595	334	214	149	109	83.6	53.5	37.2	27.3	20.9	13.4
2.0 SHS	2.93	∞	4470	1120	496	279	179	124	91.2	69.8	44.7	31.0	22.8	17.5	11.2
1.6 SHS	2.38	∞	3700	924	411	231	148	103	75.4	57.8	37.0	25.7	18.9	14.4	9.24
40 x 40 x 4.0 SHS	4.09	∞	3320	831	369	208	133	92.3	67.8	51.9	33.2	23.1	17.0	13.0	8.31
3.0 SHS	3.30	∞	2940	736	327	184	118	81.8	60.1	46.0	29.4	20.4	15.0	11.5	7.36
2.5 SHS	2.82	∞	2590	649	288	162	104	72.1	53.0	40.5	25.9	18.0	13.2	10.1	6.49
2.0 SHS	2.31	∞	2190	548	244	137	87.7	60.9	44.7	34.2	21.9	15.2	11.2	8.56	5.48
1.6 SHS	1.88	∞	1830	458	203	114	73.2	50.8	37.3	28.6	18.3	12.7	9.34	7.15	4.58
35 x 35 x 3.0 SHS	2.83	∞	1880	470	209	117	75.1	52.2	38.3	29.4	18.8	13.0	9.58	7.34	4.70
2.5 SHS	2.42	∞	1670	418	186	104	66.8	46.4	34.1	26.1	16.3	11.6	8.52	6.53	4.18
2.0 SHS	1.99	∞	1420	356	158	89.0	56.9	39.5	29.1	22.2	14.2	9.89	7.26	5.56	3.56
1.6 SHS	1.63	∞	1200	299	133	74.8	47.9	33.2	24.4	18.7	12.0	8.31	6.10	4.67	2.99
30 x 30 x 2.0 SHS	1.68	∞	860	215	95.5	53.7	34.4	23.9	17.5	13.4	8.60	5.97	4.39	3.36	2.15
1.6 SHS	1.38	∞	729	182	81.0	45.6	29.2	20.3	14.9	11.4	7.29	5.06	3.72	2.85	1.82
25 x 25 x 2.5 SHS	1.64	∞	534	133	59.3	33.4	21.3	14.8	10.9	8.34	5.34	3.71	2.72	2.08	1.33
2.0 SHS	1.36	∞	469	117	52.1	29.3	18.7	13.0	9.56	7.32	4.69	3.25	2.39	1.83	1.17
1.6 SHS	1.12	∞	403	101	44.7	25.2	16.1	11.2	8.22	6.29	4.03	2.80	2.05	1.57	1.01
20 x 20 x 1.6 SHS	0.873	∞	192	48.0	21.3	12.0	7.68	5.33	3.92	3.00	1.92	1.33	0.979	0.750	0.480

Note: 1. $N_{om} = \pi^2 EI / L_e^2$ (Clause 4.6.2 of AS 4100)

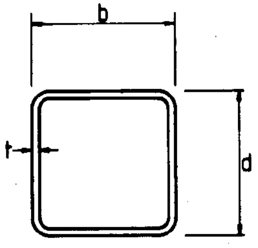


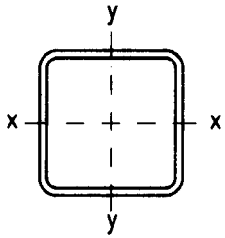
TABLE *D*7.3.2-4

ELASTIC BUCKLING LOADS

DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0

Non-Standard Thickness

buckling about x- and y-axis



Designation d b t	Mass per m	Elastic Buckling Loads N_{om} (kN) — Effective Length (L_e) in metres													
mm mm mm	kg/m	0.0	0.25	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	5.0
100 x 100 x 2.8 SHS	8.39	∞	52600	13200	5850	3290	2100	1460	1070	822	526	365	268	206	132
2.3 SHS	6.95	∞	44100	11000	4900	2760	1770	1230	901	690	441	306	225	172	110
75 x 75 x 2.8 SHS	6.19	∞	21400	5340	2370	1330	854	593	436	334	214	148	109	83.4	53.4
2.3 SHS	5.14	∞	18000	4510	2000	1130	721	501	368	282	180	125	92.0	70.5	45.1
65 x 65 x 2.3 SHS	4.42	∞	11500	2880	1280	719	460	320	235	180	115	79.9	58.7	45.0	28.8
50 x 50 x 2.8 SHS	3.99	∞	5840	1460	649	365	234	162	119	91.2	58.4	40.6	29.8	22.8	14.6
2.3 SHS	3.34	∞	5010	1250	557	313	200	139	102	78.3	50.1	34.8	25.6	19.6	12.5
40 x 40 x 2.8 SHS	3.11	∞	2810	703	312	176	112	78.1	57.4	43.9	28.1	19.5	14.3	11.0	7.03
2.3 SHS	2.62	∞	2440	610	271	152	97.6	67.8	49.8	38.1	24.4	16.9	12.4	9.53	6.10
35 x 35 x 2.8 SHS	2.67	∞	1800	450	200	112	72.0	50.0	36.7	28.1	18.0	12.5	9.18	7.03	4.50
2.3 SHS	2.25	∞	1580	394	175	98.5	63.1	43.8	32.2	24.6	15.8	10.9	8.04	6.16	3.94

Note: 1. $N_{om} = \pi^2 EI / L_e^2$ (Clause 4.6.2 of AS 4100)

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PART 8 MAXIMUM DESIGN LOADS FOR BEAMS

8

PAGE

TABLES

NOTE: SEE PAGE vii FOR THE SPECIFIC MATERIAL STANDARD REFERRED TO BY THE SECTION TYPE AND STEEL GRADE IN THESE TABLES.

PART 8 MAXIMUM DESIGN LOADS FOR BEAMS

*D*8.1 SCOPE

PART 8 gives values of maximum design loads distributed uniformly along the length of the beam with full lateral restraint for different beam support conditions.

Tables *D*8.1 for single span, simply supported beams
Tables *D*8.2 for continuous, two span, simply supported beams
Tables *D*8.3 for single span, fixed end beams
Tables *D*8.4 for cantilever beams

Each group of tables is separated into two series**:**

- the (A) series (e.g. Table *D*8.1-1 (A)) for the strength limit state
- the (B) series (e.g. Table *D*8.1-1 (B)) for the serviceability limit state

For each group of tables, the (A) series tables are immediately followed by the (B) series tables. The design load *(W* = total design load)* is assumed to be uniformly distributed and applied through the shear centre in the direction of the principal y-axis.

NOTE - BEAM SELF WEIGHT: For all tables, 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^*_L or W^*_S.

*D*8.2 METHOD

The maximum design load is the *lesser* of the strength limit state design load given in the (A) series tables determined in accordance with Section *D*8.2.1, and the serviceability limit state design load given in the (B) series tables determined and adjusted if necessary in accordance with Section *D*8.2.2.

*D*8.2.1 Strength Limit State Design

The value of the maximum design load (W^*_L) given in the tables is the lesser of the maximum design load (W^*_{L1}) associated with the design section moment capacity (ϕM_{sx}) and the maximum design load (W^*_{L2}) associated with the design shear capacity (ϕV_{vx}).

$$W^*_L = \text{Min.}\,[W^*_{L1}\,;\,W^*_{L2}]$$

The method is illustrated in Section *D*8.2.1.1 for the case of a simply supported beam.

Note: the interaction of shear and bending has not been included in the tables. If $V^* < 0.6\,\phi V_v$ or if $M^* < 0.75\,\phi M_s$ then no interaction check is necessary. Otherwise reference should be made to Section *D*8.4.

D8.2.1.1 W^*_{L1} - Based on Design Moment Capacity (simply supported beam)

For a beam with full lateral restraint, the design section moment capacity (ϕM_{sx}) is used, which for bending about the x-axis is given by:

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

where ϕ = 0.9 (Table 3.4 of AS 4100)
Z_{ex} = effective section modulus (see Section *D*1.2.3.2)
f_y = yield stress used in design

For a simply supported beam subject to uniformly distributed loading, the maximum bending moment (M_{max}) is given by:

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

where W = total uniformly distributed load
L = length of the beam

Therefore, substituting the design moment capacity (ϕM_{sx}) for beams with full lateral restraint for the maximum bending moment (M_{max}) and rearranging the equation gives:

Maximum Design Load (W^*_{L1}) based on the design moment capacity of the beam bending about the x-axis

$$W^*_{L1} = \frac{8\phi M_{sx}}{L}$$

The equations for the other support conditions are given in Table D8.2.

D8.2.1.2 W^*_{L2} - Based on Design Shear Capacity (simply supported beam)

The design shear capacity (ϕV_{vx}) is given in Section *D*4.2 of the Tables.

For a simply supported beam subject to uniformly distributed loading, the maximum shear force (V_{max}) is given by:

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

where W = total uniformly distributed load

Therefore, substituting the design shear capacity (ϕV_{vx}) for the maximum shear force (V_{max}) and rearranging the equation gives:

Maximum Design Load (W^*_{L2}) based on the design bending capacity of the beam bending about the x-axis

$$W^*_{L2} = 2\phi V_{vx}$$

The equations for the other support conditions are given in Table D8.2.

D8.2.2 Serviceability Limit State Design

The value of serviceability load (W^*_S) given in the tables is the maximum design load which will achieve a calculated total elastic deflection of $L/250$ (where L is the span of the beam).

For deflection limits other than span/250, the value of W^*_{S2} for the alternative deflection limit may be calculated from the tabulated value W^*_{S1} using the formula**:**

$$W^*_{S2} = \frac{250W^*_{S1}}{D}$$

where D = the denominator value in the deflection limit incorporating the span term (e.g. D = 500 for the $L/500$ deflection limit)

For sections with a high shape factor (ratio of plastic moment to the yield moment of a beam) it may be possible for the maximum stresses in a member to reach the yield stress at serviceability loads without exceeding the strength limit state. This will invalidate the deflection calculations based on the assumption of elastic behaviour. However it has been found that for the hollow sections contained in these tables, using the load factors in AS 1170 and AS 4100, the strength limit state will always be exceeded before first yield occurs. Therefore values of the load at which first yield occurs have not been included in the tables.

The method is illustrated below for the case of a simply supported beam.

W^*_{S1} - based on a Deflection Limit of $L/250$ (simply supported beam)

For a simply supported beam subject to a uniformly distributed load, the maximum deflection (Δ_{max}) is given by**:**

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

where W = total uniformly distributed load

L = length of span

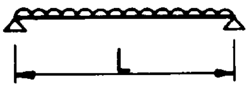
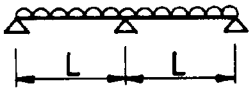
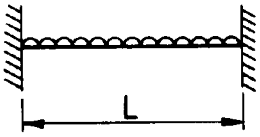
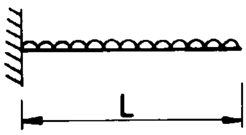
E = 200×10^3 MPa

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

Therefore, substituting Δ_{max} = L/250 and rearranging the equation gives the serviceability limit state maximum design load (W^*_S)**:**

$$W^*_S = \frac{384EI_x}{1250L^2}$$

Table *D*8.2: Summary of Equations for Maximum Design Loads

Span Type	Moment W_{L1}^*	Shear W_{L2}^*	Deflection W_{S1}^*
Single Span, Simply Supported 	$\frac{8\phi M_s}{L}$	$2\phi V_v$	$\frac{384}{5L^2}\frac{EI}{250}$
Continuous Two Span, Simply Supported 	$\frac{8\phi M_s}{L}$	$\frac{8\phi V_v}{5}$	$\frac{185}{L^2}\frac{EI}{250}$
Single Span, Fixed End 	$\frac{12\phi M_s}{L}$	$2\phi V_v$	$\frac{384}{L^2}\frac{EI}{250}$
Cantilever 	$\frac{2\phi M_s}{L}$	ϕV_v	$\frac{8}{L^2}\frac{EI}{250}$

*D*8.3 BEAMS WITH FULL LATERAL RESTRAINT

Full lateral restraint may be achieved for a member by:

a) continuous lateral restraint, or

b) full or partial restraint provided at sufficient locations along the beam.

The distance between these locations is termed the segment length and the maximum values of segment length to ensure full lateral restraint are tabulated for each section in the (A) series tables under the column "FLR". These values of maximum segment length are determined in accordance with the method outlined in section *D*4.1.3 of these tables. **FLR values are not given for SHS as they are not susceptible to lateral buckling.**

*D*8.4 ADDITIONAL DESIGN CHECKS

a) Interaction of Shear and Bending

Where large shear forces are coincident with large bending moments the interaction of shear and bending may govern the design. An interaction check needs to be done if the design shear is greater than 60% of the design shear capacity ($V^* > 0.6\ \phi V_v$) or if $M^* > 0.75\ \phi M_s$. However for the case of simply supported beams with uniformly distributed loads interaction of shear and bending will not be critical.

b) Compressive Bearing Action

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 *D*4.3. Tables *D*4.3-1 to *D*4.3-4 may be used to assist with any such assessment.

D8.5 OTHER LOAD CONDITIONS

The values given in Tables D8.1-1 to D8.1-4 are for single span, simply supported beams subject to uniformly distributed loads. However, the information presented in these tables may be used for other loading situations for beams with full lateral restraint and α_m = 1.0, using the equivalent uniform design loads given in Table D8.5 and in conjunction with the following procedure:

1) Calculate equivalent uniformly distributed maximum design load for moment (W^*_{EM}) using Table D8.5.

2) Based on W^*_{EM} select a section with an adequate maximum design load (W^*_{L1}) associated with the design shear capacity from Tables D8.1-1(A) to D8.1-4(A).

3) Calculate equivalent uniformly distributed maximum design load for shear (W^*_{EV}) using Table D8.5.

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 D4.2.3. A check is not necessary if the design shear is less than 60% of the design shear capacity ($V^* < 0.6\,\phi V_v$) or if $M^* < 0.75\,\phi M_s$.

6) Calculate equivalent uniformly distributed serviceability load (W^*_{ES}) using Table D8.5.

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}.

D8.6 EXAMPLES

1. A simply supported beam of 4 metres is subjected to uniformly distributed loads of:

G (Dead Load) = 4 kN (total load)

Q (Live Load) = 7 kN (total load)

The beam has continuous lateral support. The total deflection of the beam under serviceability loads must not exceed $L/250$.

Solution:

(a) Calculation of maximum design loads:

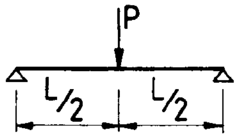
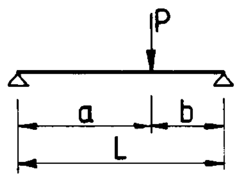
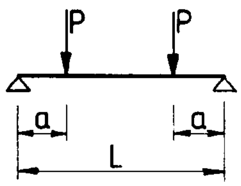
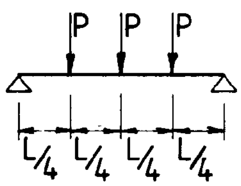
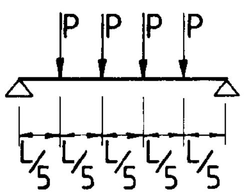
Strength limit state $W^*_L = 1.25G + 1.5Q$

$= 15.5$ kN

Serviceability limit state $W^*_S = G + 0.7Q$ (short term live load)

$= 8.90$ kN

Table *D*8.5: Table of Equivalent Uniformly Distributed Loads

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

(b) Use of the Tables:

Strength Limit State - Select a section with the least mass from the Tables such that the maximum design loads W^*_{L1} and W^*_{L2} are greater than or equal to W_L. It can be seen from Table *D*8.1-1(2)(A) that for a 100 x 50 x 2.5 DuraGal RHS Grade C450L0, the **maximum** design loads are:

W^*_{L1} = 18.4 kN
W^*_{L2} = 220 kN
∴ W^*_{L} = 18.4 kN (> 15.5 kN)

Therefore, a 100 x 50 x 2.5 DuraGal RHS has adequate strength.

Serviceability Limit State - From Table *D*8.1-1(1)(B) it can be seen that for a 150 x 50 x 2.5 DuraGal RHS Grade C450L0, the serviceability load is:

W^*_{S} = 9.76 kN (> 8.90 kN)

The most efficient and practical hollow sections for this application are RHS and SHS. The alternative sections which satisfy the above strength and serviceability limit states are listed below:

150 x 50 x 2.5 DuraGal RHS Grade C450L0	mass per metre = 7.53 kg/m
125 x 75 x 3.0 DuraGal RHS Grade C450L0	mass per metre = 8.96 kg/m
100 x 100 x 5.0 DuraGal SHS Grade C450L0	mass per metre = 14.2kg/m

Therefore, based on mass, select 150 x 50 x 2.5 DuraGal RHS Grade C450L0.

2. A beam which is simply supported has a span of 6.0 metres with full lateral restraint. The beam is subjected to nominal central dead and short term live loads of 1.0 kN and 2.5 kN respectively. Design a suitable DuraGal RHS in Grade C450L0 steel with no limit on deflection.

Solution:

(i) Calculate equivalent uniformly distributed maximum design load for moment (W^*_{EM})

From Table *D*8.5 (W^*_{EM}) associated with the central dead and live loads is:

W^*_{EM} = 2*P*
= 2 (1.25 x 1.0 + 1.5 x 2.5)
= 10 kN

(ii) Based on W^*_{EM} select the least mass section with an adequate maximum design load (W^*_{L1}) based on design moment capacity.

From Table *D*8.1-1(1)(A), a 100 x 50 x 2.5 DuraGal RHS Grade C450L0 has adequate maximum design load (W^*_{L1} = 12.2 kN).

(iii) Calculate equivalent uniformly distributed maximum design load for shear (W^*_{EV}).

From Table *D*8.5 the equivalent uniform moment load is:

W^*_{EV} = *P*
= 1.25 x 1.0 + 1.5 x 2.5
= 5.0 kN

(iv) Check that the section selected in Step 2 has an adequate maximum design load W^*_{L2} based on shear capacity.

From Table *D*8.1-1(1)(A), a 100 x 50 x 2.5 DuraGal RHS has adequate maximum design load (W^*_{L2} = 220 kN).

(v) Check if a shear and bending interaction check in accordance with Section *D*4.2.3 is necessary.

From Table *D*8.1-1(1)(A), W^*_{L2} = 220 kN for a 100 x 50 x 2.5 DuraGal RHS.

$$
\begin{aligned}
W^*_{L2} &= 2\,\phi V_v \\
\phi V_v &= \frac{220}{2} \\
&= 110 \text{ kN} \\
0.6\,\phi V_v &= 0.6 \times 110 \\
&= 66 \text{ kN} \\
&> 5.0 \text{ kN } (V^* = W^*_{EV})
\end{aligned}
$$

Therefore no shear and bending interaction check in accordance with Section *D*4.2.3 is necessary.

(vi) Calculate equivalent uniformly distributed serviceability load (W^*_{ES}).

From Table *D*8.5 W^*_{ES} for the central dead and live loads is**:**

$$
\begin{aligned}
W^*_{ES} &= \frac{8P}{5} \\
&= \frac{8}{5}(1.0 + 0.7 \times 2.5) \\
&= 4.4 \text{ kN}
\end{aligned}
$$

(vii) From Table *D*8.1-1(1)(B), a 150 x 50 x 3.0 DuraGal RHS is the least mass section with adequate maximum serviceability design load (W^*_{S1} = 5.10 kN) to resist W^*_{ES}.

∴ Adopt a 150 x 50 x 3.0 DuraGal Grade C450L0 section.

Note: In this example the self weight of the beam is not taken into consideration. The calculation should be repeated to include self weight if significant.

References:

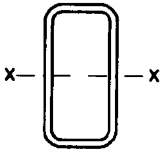
[1] Bradford, M.A., Bridge, R.Q., Trahair, N.S., "Worked Examples for Steel Members", *Australian Institute of Steel Construction*, 1990.

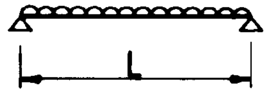
[2] "Steel Structures - Commentary (Supplement to AS 4100-1990)", *Standards Australia*, 1990.

TABLE *D*8.1-1(1)(A)

STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS

SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT
DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0
Standard Thickness
bending about x-axis





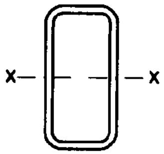
W^*_{L1} = Maximum Design Load based on Design Moment Capacity
W^*_{L2} = Maximum Design Load based on Design Shear Capacity
Maximum Design Load W^*_L is LESSER of W^*_{L1} and W^*_{L2}

Designation d b t	Mass per m	W^*_{L1} (kN) Span of Beam (*L*) in metres														W^*_{L2}	FLR
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
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	6.35
5.0 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	6.48
4.0 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	6.60
3.0 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	6.66
2.5 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	6.72
2.0 RHS	6.07	103	51.3	34.2	25.6	20.5	17.1	14.6	12.8	11.4	10.3	9.32	8.54	7.89	7.32	264	7.58
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	13.2
5.0 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	13.3
4.0 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	13.4
3.0 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	13.6
2.5 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	15.4
2.0 RHS	6.07	80.4	40.2	26.8	20.1	16.1	13.4	11.5	10.0	8.93	8.04	7.31	6.70	6.18	5.74	226	17.6
100 x 50 x 6.0 RHS	12.0																
5.0 RHS	10.3	129	64.4	42.9	32.2	25.8	21.5	18.4	16.1	14.3	12.9	11.7	10.7	9.91	9.20	417	8.03
4.0 RHS	8.49	108	54.1	36.1	27.1	21.6	18.0	15.5	13.5	12.0	10.8	9.84	9.02	8.33	7.73	341	8.14
3.5 RHS	7.53	97.0	48.5	32.3	24.2	19.4	16.2	13.9	12.1	10.8	9.70	8.82	8.08	7.46	6.93	301	8.19
3.0 RHS	6.60	86.4	43.2	28.8	21.6	17.3	14.4	12.3	10.8	9.60	8.64	7.85	7.20	6.64	6.17	261	8.16
2.5 RHS	5.56	73.5	38.7	24.5	18.4	14.7	12.2	10.5	9.18	8.16	7.35	6.68	6.12	5.65	5.25	220	8.22
2.0 RHS	4.50	59.0	29.5	19.7	14.7	11.8	9.83	8.43	7.37	6.55	5.90	5.36	4.92	4.54	4.21	178	8.41
1.6 RHS	3.64	40.4	20.2	13.5	10.1	8.08	6.73	5.77	5.05	4.49	4.04	3.67	3.37	3.11	2.89	143	10.0

Notes:
1. FLR = $0.436\ (\pi^2 E\, I_y\, G\, J / M^2_{sx})^{0.5}$ (See Section *D*4.1.3 of these tables for explanation)
   FLR = Segment length for full lateral restraint ($\phi M_{bx} = \phi M_{sx}$)
2. ϕ = 0.9
3. α_m = 1.0
4. α_s = 1.0
5. W^*_{L1} = $8\,\phi\, M_s / L$
6. W^*_{L2} = $2\,\phi\, V_v$

TABLE *D*8.1-1(1)(B)

SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS

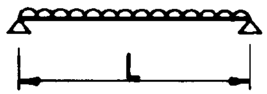


SIMPLY SUPPORTED BEAMS

***DuraGal* RECTANGULAR HOLLOW SECTIONS: GRADE C450L0**

Standard Thickness

bending about x-axis



W^*_{S1} = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250

Designation d b t	Mass per m	W^*_{S1} (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
150 x 50 x 6.0 RHS	16.7	311	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	273	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	230	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	183	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	156	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	128	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
125 x 75 x 6.0 RHS	16.7	256	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	224	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	188	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	149	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	127	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	104	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
100 x 50 x 6.0 RHS	12.0	105	26.3	11.7	6.56	4.20	2.92	2.14	1.64	1.30	1.05	0.868	0.729	0.622	0.536
5.0 RHS	10.3	93.9	23.5	10.4	5.87	3.75	2.61	1.92	1.47	1.16	0.939	0.776	0.652	0.555	0.479
4.0 RHS	8.49	80.3	20.1	8.92	5.02	3.21	2.23	1.64	1.25	0.991	0.803	0.664	0.558	0.475	0.410
3.5 RHS	7.53	72.6	18.1	8.06	4.54	2.90	2.02	1.48	1.13	0.896	0.726	0.600	0.504	0.429	0.370
3.0 RHS	6.60	65.4	16.4	7.27	4.09	2.62	1.82	1.33	1.02	0.807	0.654	0.541	0.454	0.387	0.334
2.5 RHS	5.56	56.0	14.0	6.23	3.50	2.24	1.56	1.14	0.876	0.692	0.560	0.463	0.389	0.332	0.286
2.0 RHS	4.50	46.1	11.5	5.12	2.88	1.84	1.28	0.940	0.720	0.569	0.461	0.381	0.320	0.273	0.235
1.6 RHS	3.64	37.7	9.41	4.18	2.35	1.51	1.05	0.769	0.588	0.465	0.377	0.311	0.262	0.223	0.192

Note: 1. Serviceabilty Load $W^*_{S1} = 384EI / [5(250L^2)]$

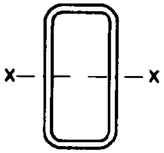


TABLE *D*8.1-1(2)(A)

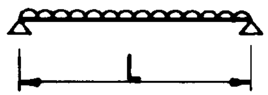
STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS

SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

bending about x-axis



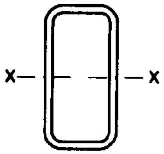
W^*_{L1} = Maximum Design Load based on Design Moment Capacity
W^*_{L2} = Maximum Design Load based on Design Shear Capacity
Maximum Design Load W^*_L is LESSER of W^*_{L1} and W^*_{L2}

Designation d b t	Mass per m	W^*_{L1} (kN) Span of Beam (*L*) in metres														W^*_{L2}	FLR
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	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	7.92
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	8.03
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	8.14
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	8.19
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	8.16
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	8.22
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	8.41
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	10.0
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	8.93
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	9.05
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	9.15
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	9.14
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	9.19
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	9.38
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	11.0
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	3.20
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	3.27
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	3.32
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	5.76
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	5.80
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	5.85
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	5.91
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	3.90
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	3.96
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	4.02
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	4.07
50 x 20 x 3.0 RHS	2.83	33.4	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	2.71
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	2.77
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	2.84
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	2.89

Notes:
1. FLR = $0.436\ (\pi^2 E\, I_y\, G\, J / M^2_{sx})^{0.5}$ (See Section *D*4.1.3 of these tables for explanation)
   FLR = Segment length for full lateral restraint ($\phi M_{bx} = \phi M_{sx}$)
2. ϕ = 0.9
3. α_m = 1.0
4. α_s = 1.0
5. W^*_{L1} = $8\ \phi\ M_s/L$
6. W^*_{L2} = $2\ \phi\ V_v$

TABLE *D*8.1-1(2)(B)

SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS

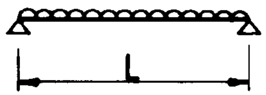


SIMPLY SUPPORTED BEAMS

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

bending about x-axis



W^*_{S1} = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250

Designation d b t	Mass per m	W^*_{S1} (kN) Span of Beam (*L*) in metres													
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0
100 x 50 x 6.0 RHS	12.0	420	187	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	375	167	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	321	143	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	290	129	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	262	116	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	224	99.6	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	184	81.9	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	151	66.9	37.7	24.1	16.7	12.3	9.41	6.03	4.18	3.07	2.35	1.86	1.51	1.05
75 x 50 x 6.0 RHS	9.67	197	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	178	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	155	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	128	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	110	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	91.3	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	75.0	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	70.1	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	58.6	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	48.5	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	80.7	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	69.1	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	60.1	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	50.1	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

Note: 1. Serviceabilty Load $W^*_{S1} = 384EI / [5(250L^2)]$

TABLE *D*8.1-2(A)

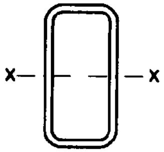
STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS

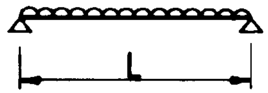
SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT

***DuraGal* RECTANGULAR HOLLOW SECTIONS: GRADE C450L0**

Non-Standard Thickness

bending about x-axis





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}

Designation d b t	Mass per m	W^*_{L1} (kN) Span of Beam (*L*) in metres														W^*_{L2}	FLR
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	kN	m
125 x 75 x 2.8 RHS	8.39	271	181	136	108	90.4	77.4	67.8	54.2	45.2	38.7	33.9	30.1	27.1	22.6	313	14.2
2.3 RHS	6.95	196	131	98.0	78.4	65.3	56.0	49.0	39.2	32.7	28.0	24.5	21.8	19.6	16.3	259	16.4
100 x 50 x 2.8 RHS	6.19	163	108	81.3	65.0	54.2	46.4	40.6	32.5	27.1	23.2	20.3	18.1	16.3	13.5	245	8.18
2.3 RHS	5.14	136	90.8	68.1	54.5	45.4	38.9	34.1	27.3	22.7	19.5	17.0	15.1	13.6	11.4	203	8.24
75 x 50 x 2.8 RHS	5.09	104	69.6	52.2	41.7	34.8	29.8	26.1	20.9	17.4	14.9	13.0	11.6	10.4	8.70	183	9.16
2.3 RHS	4.24	87.8	58.6	43.9	35.1	29.3	25.1	22.0	17.6	14.6	12.5	11.0	9.76	8.78	7.32	152	9.21
65 x 35 x 2.8 RHS	3.99	67.3	44.9	33.7	26.9	22.4	19.2	16.8	13.5	11.2	9.62	8.42	7.48	6.73	5.61	155	5.82
2.3 RHS	3.34	57.1	38.0	28.5	22.8	19.0	16.3	14.3	11.4	9.51	8.15	7.13	6.34	5.71	4.76	129	5.88
50 x 25 x 2.8 RHS	2.89	36.1	24.1	18.0	14.4	12.0	10.3	9.02	7.22	6.02	5.16	4.51	4.01	3.61	3.01	115	3.93
2.3 RHS	2.44	31.0	20.6	15.5	12.4	10.3	8.85	7.74	6.19	5.16	4.42	3.87	3.44	3.10	2.58	96.7	3.99
50 x 20 x 2.8 RHS	2.67	31.8	21.2	15.9	12.7	10.6	9.09	7.95	6.36	5.30	4.54	3.98	3.53	3.18	2.65	114	2.74
2.3 RHS	2.25	27.4	18.3	13.7	11.0	9.14	7.83	6.85	5.48	4.57	3.92	3.43	3.05	2.74	2.28	95.4	2.80

Notes:
1. FLR = $0.436\ (\pi^2 E I_y G J / M^2_{sx})^{0.5}$ (See Section *D*4.1.3 of these tables for explanation)
   FLR = Segment length for full lateral restraint ($\phi M_{bx} = \phi M_{sx}$)
2. ϕ = 0.9
3. α_m = 1.0
4. α_s = 1.0
5. W^*_{L1} = $8\ \phi\ M_s/L$
6. W^*_{L2} = $2\ \phi\ V_v$

DCTDHS/06
MARCH 2002

TABLE *D*8.1-2(B)

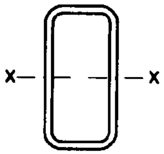
SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS

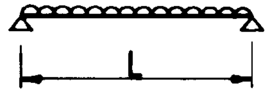
SIMPLY SUPPORTED BEAMS

***DuraGal* RECTANGULAR HOLLOW SECTIONS: GRADE C450L0**

Non-Standard Thickness

bending about x-axis





W^*_{S1} = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250

Designation d b t	Mass per m	W^*_{S1} (kN) Span of Beam (L) in metres													
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0
125 x 75 x 2.8 RHS	8.39	562	250	140	89.9	62.4	45.8	35.1	22.5	15.6	11.5	8.77	6.93	5.62	3.90
2.3 RHS	6.95	471	209	118	75.3	52.3	38.4	29.4	18.8	13.1	9.61	7.35	5.81	4.71	3.27
100 x 50 x 2.8 RHS	6.19	247	110	61.7	39.5	27.4	20.2	15.4	9.88	6.86	5.04	3.86	3.05	2.47	1.71
2.3 RHS	5.14	208	92.7	52.1	33.4	23.2	17.0	13.0	8.34	5.79	4.25	3.26	2.57	2.08	1.45
75 x 50 x 2.8 RHS	5.09	121	53.9	30.3	19.4	13.5	9.90	7.58	4.85	3.37	2.48	1.89	1.50	1.21	0.842
2.3 RHS	4.24	103	45.8	25.7	16.5	11.4	8.41	6.44	4.12	2.86	2.10	1.61	1.27	1.03	0.715
65 x 35 x 2.8 RHS	3.99	65.6	29.2	16.4	10.5	7.29	5.35	4.10	2.62	1.82	1.34	1.02	0.810	0.656	0.455
2.3 RHS	3.34	56.2	25.0	14.1	9.00	6.25	4.59	3.51	2.25	1.56	1.15	0.878	0.694	0.562	0.390
50 x 25 x 2.8 RHS	2.89	26.3	11.7	6.56	4.20	2.92	2.14	1.64	1.05	0.729	0.536	0.410	0.324	0.263	0.182
2.3 RHS	2.44	22.9	10.2	5.72	3.66	2.54	1.87	1.43	0.915	0.636	0.467	0.358	0.283	0.229	0.159
50 x 20 x 2.8 RHS	2.67	22.4	9.96	5.60	3.59	2.49	1.83	1.40	0.897	0.623	0.458	0.350	0.277	0.224	0.156
2.3 RHS	2.25	19.7	8.74	4.92	3.15	2.19	1.61	1.23	0.787	0.546	0.401	0.307	0.243	0.197	0.137

Note: 1. Serviceabilty Load $W^*_{S1} = 384EI / [5(250L^2)]$

TABLE *D*8.1-3(1)(A)

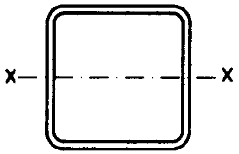
STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS

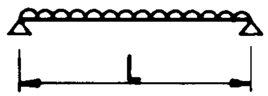
SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT

DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

bending about x-axis





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}

Designation d b t	Mass per m	W^*_{L1} (kN) Span of Beam (L) in metres														W^*_{L2}
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
100 x 100 x 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	120	60.1	40.1	30.1	24.1	20.0	17.2	15.0	13.4	12.0	10.9	10.0	9.25	8.59	271
2.5 SHS	7.53	91.0	45.5	30.3	22.7	18.2	15.2	13.0	11.4	10.1	9.10	8.27	7.58	7.00	6.50	228
2.0 SHS	6.07	65.1	32.5	21.7	16.3	13.0	10.8	9.30	8.13	7.23	6.51	5.92	5.42	5.01	4.65	184
90 x 90 x 3.0 SHS	8.01	95.4	47.7	31.8	23.8	19.1	15.9	13.6	11.9	10.6	9.54	8.67	7.95	7.34	6.81	242
2.5 SHS	6.74	77.9	38.9	26.0	19.5	15.6	13.0	11.1	9.74	8.65	7.79	7.08	6.49	5.99	5.56	204
2.0 SHS	5.45	55.5	27.8	18.5	13.9	11.1	9.25	7.93	6.94	6.17	5.55	5.05	4.63	4.27	3.96	165
1.6 SHS	4.39	39.9	19.9	13.3	9.97	7.98	6.65	5.70	4.98	4.43	3.99	3.63	3.32	3.07	2.85	133
89 x 89 x 6.0 SHS	9.06	116	57.8	38.5	28.9	23.1	19.3	16.5	14.5	12.8	11.6	10.5	9.64	8.89	8.26	275
5.0 SHS	12.5	159	79.5	53.0	39.8	31.8	26.5	22.7	19.9	17.7	15.9	14.5	13.3	12.2	11.4	379
3.5 SHS	14.6	183	91.6	61.1	45.8	36.6	30.5	26.2	22.9	20.4	18.3	16.7	15.3	14.1	13.1	443
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	42.3	21.2	14.1	10.6	8.47	7.06	6.05	5.29	4.70	4.23	3.85	3.53	3.26	3.02	136

Notes:
1. $\phi = 0.9$
2. $\alpha_m = 1.0$
3. $\alpha_s = 1.0$
4. $W^*_{L1} = 8 \phi M_s/L$
5. $W^*_{L2} = 2 \phi V_v$

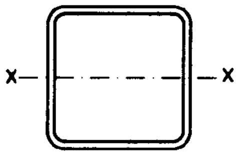


TABLE *D*8.1-3(1)(B)

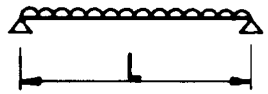
SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS

SIMPLY SUPPORTED BEAMS

DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

bending about x-axis



W^*_{S1} = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250

Designation d b t (mm mm mm)	Mass per m (kg/m)	W^*_{S1} (kN) Span of Beam (*L*) in metres 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
100 x 100 x 6.0 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
5.0 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
4.0 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
3.0 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
2.5 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
2.0 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 3.0 SHS	8.01	78.2	19.6	8.69	4.89	3.13	2.17	1.60	1.22	0.965	0.782	0.646	0.543	0.463	0.399
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
2.0 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
1.6 SHS	4.39	44.5	11.1	4.94	2.78	1.78	1.24	0.908	0.695	0.549	0.445	0.368	0.309	0.263	0.227
89 x 89 x 6.0 SHS	9.06	84.4	21.1	9.38	5.28	3.38	2.35	1.72	1.32	1.04	0.844	0.698	0.586	0.500	0.431
5.0 SHS	12.5	111	27.8	12.4	6.95	4.45	3.09	2.27	1.74	1.37	1.11	0.920	0.773	0.658	0.568
3.5 SHS	14.6	126	31.6	14.0	7.89	5.05	3.51	2.58	1.97	1.56	1.26	1.04	0.877	0.747	0.644
75 x 75 x 6.0 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
5.0 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
4.0 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
3.5 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
3.0 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
2.5 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
2.0 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

Note: 1. Serviceabilty Load $W^*_{S1} = 384EI / [5(250L^2)]$

TABLE D8.1-3(2)(A)

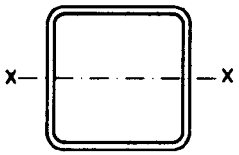
STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS

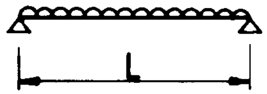
SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT

DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

bending about x-axis





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}

Designation d b t	Mass per m	W^*_{L1} (kN) Span of Beam (L) in metres														W^*_{L2}
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	kN
75 x 75 x 6.0 SHS	12.0	249	166	124	99.6	83.0	71.1	62.2	49.8	41.5	35.6	31.1	27.7	24.9	20.7	363
5.0 SHS	10.3	218	145	109	87.2	72.7	62.3	54.5	43.6	36.3	31.1	27.3	24.2	21.8	18.2	312
4.0 SHS	8.49	183	122	91.5	73.2	61.0	52.3	45.8	36.6	30.5	26.1	22.9	20.3	18.3	15.3	257
3.5 SHS	7.53	164	109	82.0	65.6	54.7	46.8	41.0	32.8	27.3	23.4	20.5	18.2	16.4	13.7	228
3.0 SHS	6.60	144	95.9	71.9	57.5	47.9	41.1	36.0	28.8	24.0	20.5	18.0	16.0	14.4	12.0	199
2.5 SHS	5.56	110	73.6	55.2	44.2	36.8	31.5	27.6	22.1	18.4	15.8	13.8	12.3	11.0	9.20	168
2.0 SHS	4.50	78.6	52.4	39.3	31.4	26.2	22.5	19.7	15.7	13.1	11.2	9.83	8.74	7.86	6.55	136
65 x 65 x 6.0 SHS	10.1	178	119	89.1	71.3	59.4	50.9	44.6	35.7	29.7	25.5	22.3	19.8	17.8	14.9	305
5.0 SHS	8.75	158	105	78.8	63.1	52.5	45.0	39.4	31.5	26.3	22.5	19.7	17.5	15.8	13.1	264
4.0 SHS	7.23	133	89.0	66.7	53.4	44.5	38.1	33.4	26.7	22.2	19.1	16.7	14.8	13.3	11.1	219
3.0 SHS	5.66	107	71.6	53.7	43.0	35.8	30.7	26.8	21.5	17.9	15.3	13.4	11.9	10.7	8.95	170
2.5 SHS	4.78	88.6	59.1	44.3	35.5	29.5	25.3	22.2	17.7	14.8	12.7	11.1	9.85	8.86	7.39	144
2.0 SHS	3.88	63.5	42.4	31.8	25.4	21.2	18.2	15.9	12.7	10.6	9.08	7.94	7.06	6.35	5.29	117
1.6 SHS	3.13	45.4	30.3	22.7	18.2	15.1	13.0	11.4	9.08	7.57	6.49	5.68	5.05	4.54	3.78	94.9
50 x 50 x 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
1.6 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
40 x 40 x 4.0 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
3.0 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
2.5 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 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 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 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. ϕ = 0.9 2. α_m = 1.0 3. α_s = 1.0 4. W^*_{L1} = $8 \phi M_s / L$ 5. W^*_{L2} = $2 \phi V_v$

DCTDHS/06
MARCH 2002

TABLE *D*8.1-3(2)(B)

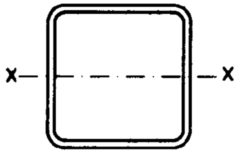
SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS

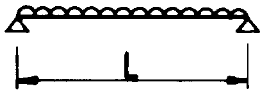
SIMPLY SUPPORTED BEAMS

DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

bending about x-axis





W^*_{S1} = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250

Designation d b t	Mass per m	W^*_{S1} (kN) Span of Beam (*L*) in metres													
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0
75 x 75 x 6.0 SHS	12.0	285	126	71.1	45.5	31.6	23.2	17.8	11.4	7.90	5.81	4.45	3.51	2.85	1.98
5.0 SHS	10.3	254	113	63.5	40.6	28.2	20.7	15.9	10.2	7.05	5.18	3.97	3.13	2.54	1.76
4.0 SHS	8.49	217	96.4	54.2	34.7	24.1	17.7	13.6	8.67	6.02	4.43	3.39	2.68	2.17	1.51
3.5 SHS	7.53	196	87.1	49.0	31.3	21.8	16.0	12.2	7.84	5.44	4.00	3.06	2.42	1.96	1.36
3.0 SHS	6.60	176	78.2	44.0	28.2	19.6	14.4	11.0	7.04	4.89	3.59	2.75	2.17	1.76	1.22
2.5 SHS	5.56	151	67.0	37.7	24.1	16.8	12.3	9.43	6.03	4.19	3.08	2.36	1.86	1.51	1.05
2.0 SHS	4.50	124	55.1	31.0	19.9	13.8	10.1	7.76	4.96	3.45	2.53	1.94	1.53	1.24	0.862
65 x 65 x 6.0 SHS	10.1	174	77.1	43.4	27.8	19.3	14.2	10.8	6.94	4.82	3.54	2.71	2.14	1.74	1.21
5.0 SHS	8.75	157	69.7	39.2	25.1	17.4	12.8	9.80	6.27	4.36	3.20	2.45	1.94	1.57	1.09
4.0 SHS	7.23	136	60.3	33.9	21.7	15.1	11.1	8.48	5.42	3.77	2.77	2.12	1.67	1.36	0.942
3.0 SHS	5.66	112	49.6	27.9	17.9	12.4	9.11	6.98	4.46	3.10	2.28	1.74	1.38	1.12	0.775
2.5 SHS	4.78	96.1	42.7	24.0	15.4	10.7	7.85	6.01	3.84	2.67	1.96	1.50	1.19	0.961	0.667
2.0 SHS	3.88	79.4	35.3	19.9	12.7	8.82	6.48	4.96	3.18	2.21	1.62	1.24	0.980	0.794	0.551
1.6 SHS	3.13	65.2	29.0	16.3	10.4	7.24	5.32	4.07	2.61	1.81	1.33	1.02	0.805	0.652	0.453
50 x 50 x 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
1.6 SHS	2.38	28.8	12.8	7.19	4.60	3.20	2.35	1.80	1.15	0.799	0.587	0.449	0.355	0.288	0.200
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 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 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 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	0.0184	0.0149	0.0104

Note: 1. Serviceabilty Load $W^*_{S1} = 384EI / [5(250L^2)]$

TABLE *D*8.1-4(A)

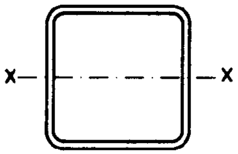
STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS

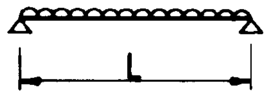
SIMPLY SUPPORTED BEAMS WITH FULL LATERAL RESTRAINT

***DuraGal* SQUARE HOLLOW SECTIONS: GRADE C450L0**

Non-Standard Thickness

bending about x-axis





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}

Designation d b t	Mass per m	W^*_{L1} (kN) Span of Beam (*L*) in metres														W^*_{L2}
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	kN
100 x 100 x 2.8 SHS	8.39	201	134	100	80.2	66.9	57.3	50.1	40.1	33.4	28.7	25.1	22.3	20.1	16.7	254
2.3 SHS	6.95	150	99.7	74.8	59.8	49.8	42.7	37.4	29.9	24.9	21.4	18.7	16.6	15.0	12.5	211
75 x 75 x 2.8 SHS	6.19	131	87.0	65.3	52.2	43.5	37.3	32.6	26.1	21.8	18.6	16.3	14.5	13.1	10.9	187
2.3 SHS	5.14	97.1	64.7	48.6	38.8	32.4	27.7	24.3	19.4	16.2	13.9	12.1	10.8	9.71	8.09	155
65 x 65 x 2.3 SHS	4.42	78.6	52.4	39.3	31.4	26.2	22.5	19.6	15.7	13.1	11.2	9.82	8.73	7.86	6.55	133
50 x 50 x 2.8 SHS	3.99	57.5	38.3	28.8	23.0	19.2	16.4	14.4	11.5	9.58	8.21	7.19	6.39	5.75	4.79	119
2.3 SHS	3.34	48.7	32.5	24.4	19.5	16.2	13.9	12.2	9.75	8.12	6.96	6.09	5.42	4.87	4.06	100
40 x 40 x 2.8 SHS	3.11	35.2	23.5	17.6	14.1	11.7	10.1	8.80	7.04	5.86	5.03	4.40	3.91	3.52	2.93	92.5
2.3 SHS	2.62	30.1	20.1	15.0	12.0	10.0	8.60	7.52	6.02	5.01	4.30	3.76	3.34	3.01	2.51	78.2
35 x 35 x 2.8 SHS	2.67	26.1	17.4	13.0	10.4	8.69	7.45	6.52	5.21	4.34	3.72	3.26	2.90	2.61	2.17	79.0
2.3 SHS	2.25	22.4	15.0	11.2	8.98	7.48	6.41	5.61	4.49	3.74	3.21	2.80	2.49	2.24	1.87	67.1

Notes:
1. ϕ = 0.9
2. α_m = 1.0
3. α_s = 1.0
4. W^*_{L1} = $8 \phi M_s/L$
5. W^*_{L2} = $2 \phi V_v$

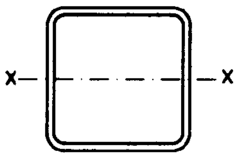


TABLE *D*8.1-4(B)

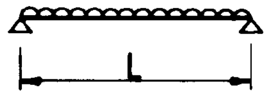
SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS

SIMPLY SUPPORTED BEAMS

***DuraGal* SQUARE HOLLOW SECTIONS: GRADE C450L0**

Non-Standard Thickness

bending about x-axis



W^*_{S1} = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250

Designation d b t	Mass per m	W^*_{S1} (kN) Span of Beam (L) in metres													
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0
100 x 100 x 2.8 SHS	8.39	409	182	102	65.5	45.5	33.4	25.6	16.4	11.4	8.36	6.40	5.06	4.09	2.84
2.3 SHS	6.95	343	153	85.8	54.9	38.2	28.0	21.5	13.7	9.54	7.01	5.37	4.24	3.43	2.38
75 x 75 x 2.8 SHS	6.19	166	73.8	41.5	26.6	18.5	13.6	10.4	6.65	4.61	3.39	2.60	2.05	1.66	1.15
2.3 SHS	5.14	140	62.4	35.1	22.5	15.6	11.5	8.77	5.61	3.90	2.86	2.19	1.73	1.40	0.975
65 x 65 x 2.3 SHS	4.42	89.6	39.8	22.4	14.3	9.95	7.31	5.60	3.58	2.49	1.83	1.40	1.11	0.896	0.622
50 x 50 x 2.8 SHS	3.99	45.4	20.2	11.4	7.27	5.05	3.71	2.84	1.82	1.26	0.927	0.710	0.561	0.454	0.316
2.3 SHS	3.34	39.0	17.3	9.74	6.24	4.33	3.18	2.44	1.56	1.08	0.795	0.609	0.481	0.390	0.271
40 x 40 x 2.8 SHS	3.11	21.9	9.72	5.47	3.50	2.43	1.79	1.37	0.875	0.608	0.446	0.342	0.270	0.219	0.152
2.3 SHS	2.62	19.0	8.44	4.75	3.04	2.11	1.55	1.19	0.759	0.527	0.387	0.297	0.234	0.190	0.132
35 x 35 x 2.8 SHS	2.67	14.0	6.22	3.50	2.24	1.56	1.14	0.875	0.560	0.389	0.286	0.219	0.173	0.140	0.0973
2.3 SHS	2.25	12.3	5.45	3.07	1.96	1.36	1.00	0.767	0.491	0.341	0.250	0.192	0.151	0.123	0.0852

Note: 1. Serviceabilty Load $W^*_{S1} = 384EI / [5(250L^2)]$

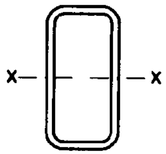


TABLE *D*8.2-1(1)(A)

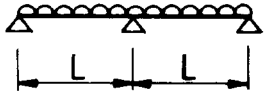
STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS

CONTINUOUS BEAMS WITH FULL LATERAL RESTRAINT

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

bending about x-axis



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}

Designation d b t	Mass per m	W^*_{L1} (kN) Span of Beam (*L*) in metres														W^*_{L2}	FLR
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
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	599	26.4
5.0 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	506	26.9
4.0 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	411	27.4
3.0 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	312	27.6
2.5 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	262	27.9
2.0 RHS	6.07	103	51.3	34.2	25.6	20.5	17.1	14.6	12.8	11.4	10.3	9.32	8.54	7.89	7.32	211	31.4
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	507	54.7
5.0 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	430	55.1
4.0 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	350	55.5
3.0 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	267	56.2
2.5 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	224	64.0
2.0 RHS	6.07	80.4	40.2	26.8	20.1	16.1	13.4	11.5	10.0	8.93	8.04	7.31	6.70	6.18	5.74	181	73.0
100 x 50 x 6.0 RHS	12.0	147	73.5	49.0	36.7	29.4	24.5	21.0	18.4	16.3	14.7	13.4	12.2	11.3	10.5	391	32.8
5.0 RHS	10.3	129	64.4	42.9	32.2	25.8	21.5	18.4	16.1	14.3	12.9	11.7	10.7	9.91	9.20	333	33.3
4.0 RHS	8.49	108	54.1	36.1	27.1	21.6	18.0	15.5	13.5	12.0	10.8	9.84	9.02	8.33	7.73	273	33.8
3.5 RHS	7.53	97.0	48.5	32.3	24.2	19.4	16.2	13.9	12.1	10.8	9.70	8.82	8.08	7.46	6.93	241	34.0
3.0 RHS	6.60	86.4	43.2	28.8	21.6	17.3	14.4	12.3	10.8	9.60	8.64	7.85	7.20	6.64	6.17	209	33.9
2.5 RHS	5.56	73.5	36.7	24.5	18.4	14.7	12.2	10.5	9.18	8.16	7.35	6.68	6.12	5.65	5.25	176	34.1
2.0 RHS	4.50	59.0	29.5	19.7	14.7	11.8	9.83	8.43	7.37	6.55	5.90	5.36	4.92	4.54	4.21	142	34.9
1.6 RHS	3.64	40.4	20.2	13.5	10.1	8.08	6.73	5.77	5.05	4.49	4.04	3.67	3.37	3.11	2.89	115	41.6

Notes:
1. FLR = 1.809 $(\pi^2 E I_y G J / M^2_{sx})^{0.5}$ (See Section *D*4.1.3 of these tables for explanation)
   FLR = Segment length for full lateral restraint ($\phi M_{bx} = \phi M_{sx}$)
2. ϕ = 0.9
3. α_m = 1.0
4. α_s = 1.0
5. W^*_{L1} = $8 \phi M_s / L$
6. W^*_{L2} = $1.6 \phi V_v$

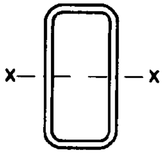


TABLE *D*8.2-1(1)(B)

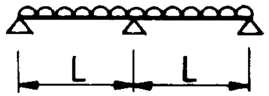
SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS

CONTINUOUS BEAMS

***DuraGal* RECTANGULAR HOLLOW SECTIONS: GRADE C450L0**

Standard Thickness

bending about x-axis



W^*_{S1} = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250

Designation d b t	Mass per m	W^*_{S1} (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
150 x 50 x 6.0 RHS	16.7	749	187	83.2	46.8	30.0	20.8	15.3	11.7	9.24	7.49	6.19	5.20	4.43	3.82
5.0 RHS	14.2	657	164	73.0	41.1	26.3	18.3	13.4	10.3	8.11	6.57	5.43	4.56	3.89	3.35
4.0 RHS	11.6	553	138	61.4	34.6	22.1	15.4	11.3	8.64	6.83	5.53	4.57	3.84	3.27	2.82
3.0 RHS	8.96	442	110	49.1	27.6	17.7	12.3	9.02	6.90	5.45	4.42	3.65	3.07	2.61	2.25
2.5 RHS	7.53	376	94.0	41.8	23.5	15.0	10.4	7.67	5.88	4.64	3.76	3.11	2.61	2.23	1.92
2.0 RHS	6.07	307	76.8	34.1	19.2	12.3	8.53	6.27	4.80	3.79	3.07	2.54	2.13	1.82	1.57
125 x 75 x 6.0 RHS	16.7	616	154	68.4	38.5	24.6	17.1	12.6	9.62	7.60	6.16	5.09	4.28	3.64	3.14
5.0 RHS	14.2	539	135	59.9	33.7	21.6	15.0	11.0	8.42	6.65	5.39	4.45	3.74	3.19	2.75
4.0 RHS	11.6	452	113	50.2	28.2	18.1	12.6	9.22	7.06	5.58	4.52	3.74	3.14	2.67	2.31
3.0 RHS	8.96	359	89.9	39.9	22.5	14.4	9.98	7.33	5.62	4.44	3.59	2.97	2.50	2.13	1.83
2.5 RHS	7.53	306	76.4	34.0	19.1	12.2	8.49	6.24	4.78	3.77	3.06	2.53	2.12	1.81	1.56
2.0 RHS	6.07	249	62.4	27.7	15.6	9.98	6.93	5.09	3.90	3.08	2.49	2.06	1.73	1.48	1.27
100 x 50 x 6.0 RHS	12.0	253	63.3	28.1	15.8	10.1	7.03	5.16	3.95	3.12	2.53	2.09	1.76	1.50	1.29
5.0 RHS	10.3	226	56.5	25.1	14.1	9.04	6.28	4.61	3.53	2.79	2.26	1.87	1.57	1.34	1.15
4.0 RHS	8.49	193	48.4	21.5	12.1	7.74	5.37	3.95	3.02	2.39	1.93	1.60	1.34	1.14	0.987
3.5 RHS	7.53	175	43.7	19.4	10.9	6.99	4.86	3.57	2.73	2.16	1.75	1.44	1.21	1.03	0.892
3.0 RHS	6.60	158	39.4	17.5	9.85	6.30	4.38	3.22	2.46	1.95	1.58	1.30	1.09	0.932	0.804
2.5 RHS	5.56	135	33.7	15.0	8.44	5.40	3.75	2.75	2.11	1.67	1.35	1.12	0.937	0.799	0.689
2.0 RHS	4.50	111	27.7	12.3	6.94	4.44	3.08	2.26	1.73	1.37	1.11	0.917	0.771	0.657	0.566
1.6 RHS	3.64	90.7	22.7	10.1	5.67	3.63	2.52	1.85	1.42	1.12	0.907	0.750	0.630	0.537	0.463

Note: 1. Serviceabilty Load $W^*_{S1} = 185EI/(250L^2)$

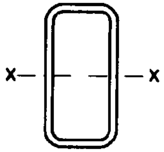
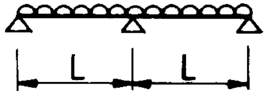


TABLE *D*8.2-1(2)(A)

STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS

CONTINUOUS BEAMS WITH FULL LATERAL RESTRAINT
DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0
Standard Thickness
bending about x-axis



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}

Designation d b t	Mass per m	W^*_{L1} (kN) Span of Beam (*L*) in metres														W^*_{L2}	FLR
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	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	391	32.8
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	333	33.3
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	273	33.8
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	241	34.0
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	209	33.9
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	176	34.1
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	142	34.9
1.6 RHS	3.64	80.8	53.6	40.4	32.3	26.9	23.1	20.2	16.2	13.5	11.5	10.1	8.96	8.08	6.73	115	41.6
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	284	37.1
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	245	37.5
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	202	38.0
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	156	37.9
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	132	38.1
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	107	38.9
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	86.4	45.4
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	127	13.3
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	103	13.5
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	83.1	13.8
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	170	23.9
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	132	24.1
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	112	24.3
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	90.7	24.5
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	97.8	16.2
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	83.3	16.4
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	68.1	16.7
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	55.5	16.9
50 x 20 x 3.0 RHS	2.83	33.4	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	96.5	11.2
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	82.2	11.5
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	67.3	11.8
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	54.7	12.0

Notes:
1. FLR = $1.809\ (\pi^2 E\, I_y\, G\, J / M^2_{sx})^{0.5}$ (See Section *D*4.1.3 of these tables for explanation)
   FLR = Segment length for full lateral restraint ($\phi M_{bx} = \phi M_{sx}$)
2. ϕ = 0.9
3. α_m = 1.0
4. α_s = 1.0
5. W^*_{L1} = $8\ \phi\ M_s / L$
6. W^*_{L2} = $1.6\ \phi\ V_v$

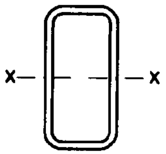


TABLE *D*8.2-1(2)(B)

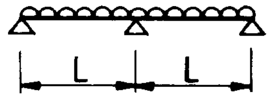
SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS

CONTINUOUS BEAMS

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

bending about x-axis



W^*_{S1} = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250

Designation d b t (mm mm mm)	Mass per m (kg/m)	W^*_{S1} (kN) Span of Beam (L) in metres: 0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0
100 x 50 x 6.0 RHS	12.0	1010	450	253	162	112	82.6	63.3	40.5	28.1	20.7	15.8	12.5	10.1	7.03
5.0 RHS	10.3	904	402	226	145	100	73.8	56.5	36.2	25.1	18.5	14.1	11.2	9.04	6.28
4.0 RHS	8.49	774	344	193	124	86.0	63.2	48.4	30.9	21.5	15.8	12.1	9.55	7.74	5.37
3.5 RHS	7.53	699	311	175	112	77.7	57.1	43.7	28.0	19.4	14.3	10.9	8.63	6.99	4.86
3.0 RHS	6.60	630	280	158	101	70.0	51.4	39.4	25.2	17.5	12.9	9.85	7.78	6.30	4.38
2.5 RHS	5.56	540	240	135	86.4	60.0	44.1	33.7	21.6	15.0	11.0	8.44	6.67	5.40	3.75
2.0 RHS	4.50	444	197	111	71.0	49.3	36.2	27.7	17.8	12.3	9.06	6.94	5.48	4.44	3.08
1.6 RHS	3.64	363	161	90.7	58.1	40.3	29.6	22.7	14.5	10.1	7.41	5.67	4.48	3.63	2.52
75 x 50 x 6.0 RHS	9.67	474	210	118	75.8	52.6	38.7	29.6	18.9	13.2	9.66	7.40	5.85	4.74	3.29
5.0 RHS	8.35	430	191	107	68.8	47.8	35.1	26.9	17.2	11.9	8.77	6.72	5.31	4.30	2.98
4.0 RHS	6.92	373	166	93.3	59.7	41.4	30.4	23.3	14.9	10.4	7.61	5.83	4.61	3.73	2.59
3.0 RHS	5.42	309	137	77.2	49.4	34.3	25.2	19.3	12.4	8.58	6.30	4.83	3.81	3.09	2.14
2.5 RHS	4.58	266	118	66.5	42.6	29.6	21.7	16.6	10.6	7.39	5.43	4.16	3.29	2.66	1.85
2.0 RHS	3.72	220	97.8	55.0	35.2	24.4	18.0	13.8	8.80	6.11	4.49	3.44	2.72	2.20	1.53
1.6 RHS	3.01	181	80.3	45.2	28.9	20.1	14.7	11.3	7.23	5.02	3.69	2.82	2.23	1.81	1.25
75 x 25 x 2.5 RHS	3.60	169	75.0	42.2	27.0	18.8	13.8	10.6	6.75	4.69	3.45	2.64	2.08	1.69	1.17
2.0 RHS	2.93	141	62.7	35.3	22.6	15.7	11.5	8.82	5.64	3.92	2.88	2.20	1.74	1.41	0.980
1.6 RHS	2.38	117	51.9	29.2	18.7	13.0	9.54	7.30	4.67	3.25	2.38	1.83	1.44	1.17	0.811
65 x 35 x 4.0 RHS	5.35	194	86.4	48.6	31.1	21.6	15.9	12.1	7.77	5.40	3.97	3.04	2.40	1.94	1.35
3.0 RHS	4.25	166	73.9	41.6	26.6	18.5	13.6	10.4	6.65	4.62	3.40	2.60	2.05	1.66	1.16
2.5 RHS	3.60	145	64.3	36.2	23.2	16.1	11.8	9.05	5.79	4.02	2.95	2.26	1.79	1.45	1.01
2.0 RHS	2.93	121	53.7	30.2	19.3	13.4	9.86	7.55	4.83	3.35	2.46	1.89	1.49	1.21	0.839
50 x 25 x 3.0 RHS	3.07	66.1	29.4	16.5	10.6	7.35	5.40	4.13	2.65	1.84	1.35	1.03	0.817	0.661	0.459
2.5 RHS	2.62	58.5	26.0	14.6	9.36	6.50	4.78	3.66	2.34	1.63	1.19	0.915	0.723	0.585	0.406
2.0 RHS	2.15	49.6	22.1	12.4	7.94	5.51	4.05	3.10	1.99	1.38	1.01	0.775	0.613	0.496	0.345
1.6 RHS	1.75	41.5	18.5	10.4	6.65	4.62	3.39	2.60	1.66	1.15	0.848	0.649	0.513	0.415	0.289
50 x 20 x 3.0 RHS	2.83	56.3	25.0	14.1	9.01	6.26	4.60	3.52	2.25	1.56	1.15	0.880	0.695	0.563	0.391
2.5 RHS	2.42	50.2	22.3	12.5	8.03	5.57	4.10	3.14	2.01	1.39	1.02	0.784	0.619	0.502	0.348
2.0 RHS	1.99	42.8	19.0	10.7	6.85	4.76	3.49	2.68	1.71	1.19	0.874	0.669	0.528	0.428	0.297
1.6 RHS	1.63	36.0	16.0	9.00	5.76	4.00	2.94	2.25	1.44	1.00	0.735	0.562	0.444	0.360	0.250

Note: 1. Serviceabilty Load W^*_{S1} =185EI / (250L^2)

TABLE *D*8.2-2(A)

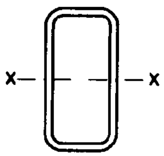
STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS

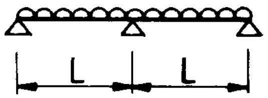
CONTINUOUS BEAMS WITH FULL LATERAL RESTRAINT

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Non-Standard Thickness

bending about x-axis





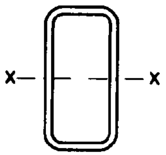
W^*_{L1} = Maximum Design Load based on Design Moment Capacity
W^*_{L2} = Maximum Design Load based on Design Shear Capacity
Maximum Design Load W^*_L is LESSER of W^*_{L1} and W^*_{L2}

Designation d b t	Mass per m	W^*_{L1} (kN) Span of Beam (*L*) in metres														W^*_{L2}	FLR
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	kN	m
125 x 75 x 2.8 RHS	8.39	271	181	136	108	90.4	77.4	67.8	54.2	45.2	38.7	33.9	30.1	27.1	22.6	250	58.8
2.3 RHS	6.95	196	131	98.0	78.4	65.3	56.0	49.0	39.2	32.7	28.0	24.5	21.8	19.6	16.3	207	68.1
100 x 50 x 2.8 RHS	6.19	163	108	81.3	65.0	54.2	46.4	40.6	32.5	27.1	23.2	20.3	18.1	16.3	13.5	196	34.0
2.3 RHS	5.14	136	90.8	68.1	54.5	45.4	38.9	34.1	27.3	22.7	19.5	17.0	15.1	13.6	11.4	162	34.2
75 x 50 x 2.8 RHS	5.09	104	69.6	52.2	41.7	34.8	29.8	26.1	20.9	17.4	14.9	13.0	11.6	10.4	8.70	146	38.0
2.3 RHS	4.24	87.8	58.6	43.9	35.1	29.3	25.1	22.0	17.6	14.6	12.5	11.0	9.76	8.78	7.32	122	38.2
65 x 35 x 2.8 RHS	3.99	67.3	44.9	33.7	26.9	22.4	19.2	16.8	13.5	11.2	9.62	8.42	7.48	6.73	5.61	124	24.1
2.3 RHS	3.34	57.1	38.0	28.5	22.8	19.0	16.3	14.3	11.4	9.51	8.15	7.13	6.34	5.71	4.76	103	24.4
50 x 25 x 2.8 RHS	2.89	36.1	24.1	18.0	14.4	12.0	10.3	9.02	7.22	6.02	5.16	4.51	4.01	3.61	3.01	92.1	16.3
2.3 RHS	2.44	31.0	20.6	15.5	12.4	10.3	8.85	7.74	6.19	5.16	4.42	3.87	3.44	3.10	2.58	77.3	16.5
50 x 20 x 2.8 RHS	2.67	31.8	21.2	15.9	12.7	10.6	9.09	7.95	6.36	5.30	4.54	3.98	3.53	3.18	2.65	90.9	11.3
2.3 RHS	2.25	27.4	18.3	13.7	11.0	9.14	7.83	6.85	5.48	4.57	3.92	3.43	3.05	2.74	2.28	76.3	11.6

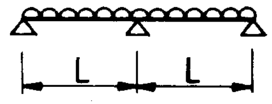
Notes:
1. FLR = 1.809 $(\pi^2 E I_y G J / M^2_{sx})^{0.5}$ (See Section *D*4.1.3 of these tables for explanation)
   FLR = Segment length for full lateral restraint ($\phi M_{bx} = \phi M_{sx}$)
2. ϕ = 0.9
3. α_m = 1.0
4. α_s = 1.0
5. W^*_{L1} = $8 \phi M_s / L$
6. W^*_{L2} = $1.6 \phi V_v$

TABLE *D*8.2-2(B)

SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS



CONTINUOUS BEAMS
DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0
Non-Standard Thickness
bending about x-axis



W^*_{S1} = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250

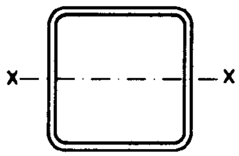
Designation d b t	Mass per m	W^*_{S1} (kN) Span of Beam (L) in metres													
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0
125 x 75 x 2.8 RHS	8.39	1350	601	338	216	150	110	84.5	54.1	37.6	27.6	21.1	16.7	13.5	9.39
2.3 RHS	6.95	1130	504	283	181	126	92.6	70.9	45.4	31.5	23.1	17.7	14.0	11.3	7.87
100 x 50 x 2.8 RHS	6.19	595	264	149	95.2	66.1	48.6	37.2	23.8	16.5	12.1	9.29	7.34	5.95	4.13
2.3 RHS	5.14	502	223	126	80.4	55.8	41.0	31.4	20.1	14.0	10.2	7.85	6.20	5.02	3.49
75 x 50 x 2.8 RHS	5.09	292	130	73.0	46.7	32.5	23.8	18.3	11.7	8.12	5.96	4.56	3.61	2.92	2.03
2.3 RHS	4.24	248	110	62.0	39.7	27.6	20.3	15.5	9.92	6.89	5.06	3.88	3.06	2.48	1.72
65 x 35 x 2.8 RHS	3.99	158	70.2	39.5	25.3	17.6	12.9	9.87	6.32	4.39	3.22	2.47	1.95	1.58	1.10
2.3 RHS	3.34	135	60.2	33.9	21.7	15.0	11.1	8.46	5.42	3.76	2.76	2.12	1.67	1.35	0.940
50 x 25 x 2.8 RHS	2.89	63.2	28.1	15.8	10.1	7.03	5.16	3.95	2.53	1.76	1.29	0.988	0.781	0.632	0.439
2.3 RHS	2.44	55.1	24.5	13.8	8.82	6.13	4.50	3.45	2.21	1.53	1.13	0.861	0.681	0.551	0.383
50 x 20 x 2.8 RHS	2.67	54.0	24.0	13.5	8.64	6.00	4.41	3.38	2.16	1.50	1.10	0.844	0.667	0.540	0.375
2.3 RHS	2.25	47.4	21.1	11.8	7.58	5.26	3.87	2.96	1.90	1.32	0.967	0.740	0.585	0.474	0.329

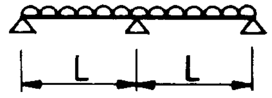
Note: 1. Serviceabilty Load $W^*_{S1} = 185EI / (250L^2)$

TABLE *D*8.2-3(1)(A)

STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS

CONTINUOUS BEAMS WITH FULL LATERAL RESTRAINT
DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0
Standard Thickness
bending about x-axis





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}

Designation d b t	Mass per m	W^*_{L1} (kN) Span of Beam (*L*) in metres														W^*_{L2}
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
100 x 100 x 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	406
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	346
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	283
3.0 SHS	8.96	120	60.1	40.1	30.1	24.1	20.0	17.2	15.0	13.4	12.0	10.9	10.0	9.25	8.59	217
2.5 SHS	7.53	91.0	45.5	30.3	22.7	18.2	15.2	13.0	11.4	10.1	9.10	8.27	7.58	7.00	6.50	182
2.0 SHS	6.07	65.1	32.5	21.7	16.3	13.0	10.8	9.30	8.13	7.23	6.51	5.92	5.42	5.01	4.65	147
90 x 90 x 3.0 SHS	8.01	95.4	47.7	31.8	23.8	19.1	15.9	13.6	11.9	10.6	9.54	8.67	7.95	7.34	6.81	194
2.5 SHS	6.74	77.9	38.9	26.0	19.5	15.6	13.0	11.1	9.74	8.65	7.79	7.08	6.49	5.99	5.56	163
2.0 SHS	5.45	55.5	27.8	18.5	13.9	11.1	9.25	7.93	6.94	6.17	5.55	5.05	4.63	4.27	3.96	132
1.6 SHS	4.39	39.9	19.9	13.3	9.97	7.98	6.65	5.70	4.98	4.43	3.99	3.63	3.32	3.07	2.85	107
89 x 89 x 6.0 SHS	9.06	116	57.8	38.5	28.9	23.1	19.3	16.5	14.5	12.8	11.6	10.5	9.64	8.89	8.26	220
5.0 SHS	12.5	159	79.5	53.0	39.8	31.8	26.5	22.7	19.9	17.7	15.9	14.5	13.3	12.2	11.4	303
3.5 SHS	14.6	183	91.6	61.1	`45.8	36.6	30.5	26.2	22.9	20.4	18.3	16.7	15.3	14.1	13.1	354
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	290
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	250
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	206
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	183
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	159
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	134
2.0 SHS	4.50	42.3	21.2	14.1	10.6	8.47	7.06	6.05	5.29	4.70	4.23	3.85	3.53	3.26	3.02	109

Notes:
1. ϕ = 0.9
2. α_m = 1.0
3. α_s = 1.0
4. W^*_{L1} = $8 \phi M_s / L$
5. W^*_{L2} = $1.6 \phi V_v$

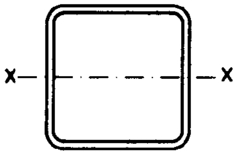


TABLE *D*8.2-3(1)(B)

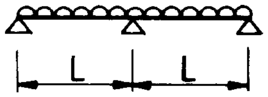
SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS

CONTINUOUS BEAMS

***DuraGal* SQUARE HOLLOW SECTIONS: GRADE C450L0**

Standard Thickness

bending about x-axis



W^*_{S1} = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250

Designation d b t (mm mm mm)	Mass per m (kg/m)	W^*_{S1} (kN) Span of Beam (L) in metres 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
100 x 100 x 6.0 SHS	16.7	449	112	49.9	28.1	18.0	12.5	9.17	7.02	5.55	4.49	3.71	3.12	2.66	2.29
5.0 SHS	14.2	393	98.3	43.7	24.6	15.7	10.9	8.02	6.14	4.85	3.93	3.25	2.73	2.33	2.01
4.0 SHS	11.6	330	82.5	36.7	20.6	13.2	9.16	6.73	5.15	4.07	3.30	2.73	2.29	1.95	1.68
3.0 SHS	8.96	262	65.5	29.1	16.4	10.5	7.28	5.35	4.09	3.23	2.62	2.17	1.82	1.55	1.34
2.5 SHS	7.53	223	55.7	24.8	13.9	8.92	6.19	4.55	3.48	2.75	2.23	1.84	1.55	1.32	1.14
2.0 SHS	6.07	182	45.5	20.2	11.4	7.28	5.06	3.72	2.84	2.25	1.82	1.50	1.26	1.08	0.929
90 x 90 x 3.0 SHS	8.01	188	47.1	20.9	11.8	7.54	5.23	3.84	2.94	2.33	1.88	1.56	1.31	1.11	0.961
2.5 SHS	6.74	161	40.2	17.9	10.0	6.43	4.46	3.28	2.51	1.98	1.61	1.33	1.12	0.951	0.820
2.0 SHS	5.45	132	32.9	14.6	8.22	5.26	3.65	2.68	2.05	1.62	1.32	1.09	0.913	0.778	0.671
1.6 SHS	4.39	107	26.8	11.9	6.70	4.29	2.98	2.19	1.67	1.32	1.07	0.885	0.744	0.634	0.547
89 x 89 x 6.0 SHS	9.06	203	50.8	22.6	12.7	8.14	5.65	4.15	3.18	2.51	2.03	1.68	1.41	1.20	1.04
5.0 SHS	12.5	268	67.0	29.8	16.8	10.7	7.45	5.47	4.19	3.31	2.68	2.22	1.86	1.59	1.37
3.5 SHS	14.6	304	76.1	33.8	19.0	12.2	8.45	6.21	4.75	3.76	3.04	2.51	2.11	1.80	1.55
75 x 75 x 6.0 SHS	12.0	171	42.8	19.0	10.7	6.85	4.76	3.50	2.68	2.12	1.71	1.42	1.19	1.01	0.874
5.0 SHS	10.3	153	38.2	17.0	9.55	6.11	4.25	3.12	2.39	1.89	1.53	1.26	1.06	0.904	0.780
4.0 SHS	8.49	131	32.6	14.5	8.16	5.22	3.63	2.67	2.04	1.61	1.31	1.08	0.907	0.773	0.666
3.5 SHS	7.53	118	29.5	13.1	7.37	4.72	3.28	2.41	1.84	1.46	1.18	0.975	0.819	0.698	0.602
3.0 SHS	6.60	106	26.5	11.8	6.62	4.24	2.94	2.16	1.66	1.31	1.06	0.876	0.736	0.627	0.541
2.5 SHS	5.56	90.8	22.7	10.1	5.68	3.63	2.52	1.85	1.42	1.12	0.908	0.751	0.631	0.538	0.463
2.0 SHS	4.50	74.7	18.7	8.30	4.67	2.99	2.08	1.52	1.17	0.923	0.747	0.618	0.519	0.442	0.381

Note: 1. Serviceabilty Load $W^*_{S1} = 185EI / (250L^2)$

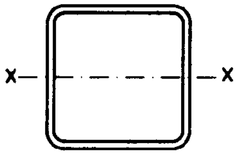
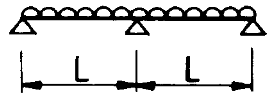


TABLE *D*8.2-3(2)(A)

STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS

CONTINUOUS BEAMS WITH FULL LATERAL RESTRAINT
DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0
Standard Thickness
bending about x-axis



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}

Designation d b t	Mass per m	W^*_{L1} (kN) Span of Beam (*L*) in metres														W^*_{L2}
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	kN
75 x 75 x 6.0 SHS	12.0	249	166	124	99.6	83.0	71.1	62.2	49.8	41.5	35.6	31.1	27.7	24.9	20.7	290
5.0 SHS	10.3	218	145	109	87.2	72.7	62.3	54.5	43.6	36.3	31.1	27.3	24.2	21.8	18.2	250
4.0 SHS	8.49	183	122	91.5	73.2	61.0	52.3	45.8	36.6	30.5	26.1	22.9	20.3	18.3	15.3	206
3.5 SHS	7.53	164	109	82.0	65.6	54.7	46.8	41.0	32.8	27.3	23.4	20.5	18.2	16.4	13.7	183
3.0 SHS	6.60	144	95.9	71.9	57.5	47.9	41.1	36.0	28.8	24.0	20.5	18.0	16.0	14.4	12.0	159
2.5 SHS	5.56	110	73.6	55.2	44.2	36.8	31.5	27.6	22.1	18.4	15.8	13.8	12.3	11.0	9.20	134
2.0 SHS	4.50	78.6	52.4	39.3	31.4	26.2	22.5	19.7	15.7	13.1	11.2	9.83	8.74	7.86	6.55	109
65 x 65 x 6.0 SHS	10.1	178	119	89.1	71.3	59.4	50.9	44.6	35.7	29.7	25.5	22.3	19.8	17.8	14.9	244
5.0 SHS	8.75	158	105	78.8	63.1	52.5	45.0	39.4	31.5	26.3	22.5	19.7	17.5	15.8	13.1	211
4.0 SHS	7.23	133	89.0	66.7	53.4	44.5	38.1	33.4	26.7	22.2	19.1	16.7	14.8	13.3	11.1	175
3.0 SHS	5.66	107	71.6	53.7	43.0	35.8	30.7	26.8	21.5	17.9	15.3	13.4	11.9	10.7	8.95	136
2.5 SHS	4.78	88.6	59.1	44.3	35.5	29.5	25.3	22.2	17.7	14.8	12.7	11.1	9.85	8.86	7.39	115
2.0 SHS	3.88	63.5	42.4	31.8	25.4	21.2	18.2	15.9	12.7	10.6	9.08	7.94	7.06	6.35	5.29	93.7
1.6 SHS	3.13	45.4	30.3	22.7	18.2	15.1	13.0	11.4	9.08	7.57	6.49	5.68	5.05	4.54	3.78	75.9
50 x 50 x 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	154
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	129
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	101
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	86.4
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	70.7
1.6 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	57.5
40 x 40 x 4.0 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	98.3
3.0 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	78.3
2.5 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	67.2
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	55.3
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	45.2
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	66.8
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	57.6
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	47.6
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	39.1
30 x 30 x 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	39.9
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	32.9
25 x 25 x 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	38.4
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	32.3
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	26.8
20 x 20 x 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	20.6

Notes: 1. ϕ = 0.9 2. α_m = 1.0 3. α_s = 1.0 4. W^*_{L1} = $8 \phi M_s/L$ 5. W^*_{L2} = $1.6 \phi V_v$

TABLE *D*8.2-3(2)(B)

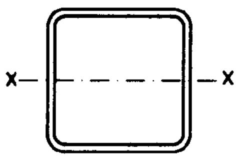
SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS

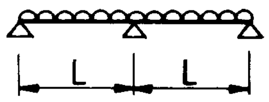
CONTINUOUS BEAMS

DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

bending about x-axis





W^*_{S1} = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250

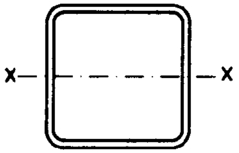
Designation d b t	Mass per m	W^*_{S1} (kN) Span of Beam (*L*) in metres													
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0
75 x 75 x 6.0 SHS	12.0	685	305	171	110	76.2	56.0	42.8	27.4	19.0	14.0	10.7	8.46	6.85	4.76
5.0 SHS	10.3	611	272	153	97.8	67.9	49.9	38.2	24.5	17.0	12.5	9.55	7.55	6.11	4.25
4.0 SHS	8.49	522	232	131	83.6	58.0	42.6	32.6	20.9	14.5	10.7	8.16	6.45	5.22	3.63
3.5 SHS	7.53	472	210	118	75.5	52.4	38.5	29.5	18.9	13.1	9.63	7.37	5.83	4.72	3.28
3.0 SHS	6.60	424	188	106	67.8	47.1	34.6	26.5	17.0	11.8	8.65	6.62	5.23	4.24	2.94
2.5 SHS	5.56	363	162	90.8	58.1	40.4	29.7	22.7	14.5	10.1	7.42	5.68	4.49	3.63	2.52
2.0 SHS	4.50	299	133	74.7	47.8	33.2	24.4	18.7	12.0	8.30	6.10	4.67	3.69	2.99	2.08
65 x 65 x 6.0 SHS	10.1	418	186	105	66.9	46.5	34.1	26.1	16.7	11.6	8.53	6.53	5.16	4.18	2.90
5.0 SHS	8.75	378	168	94.5	60.4	42.0	30.8	23.6	15.1	10.5	7.71	5.90	4.66	3.78	2.62
4.0 SHS	7.23	327	145	81.7	52.3	36.3	26.7	20.4	13.1	9.07	6.67	5.10	4.03	3.27	2.27
3.0 SHS	5.66	269	119	67.2	43.0	29.9	21.9	16.8	10.8	7.47	5.49	4.20	3.32	2.69	1.87
2.5 SHS	4.78	232	103	57.9	37.0	25.7	18.9	14.5	9.26	6.43	4.72	3.62	2.86	2.32	1.61
2.0 SHS	3.88	191	85.0	47.8	30.6	21.3	15.6	12.0	7.65	5.31	3.90	2.99	2.36	1.91	1.33
1.6 SHS	3.13	157	69.8	39.2	25.1	17.4	12.8	9.81	6.28	4.36	3.20	2.45	1.94	1.57	1.09
50 x 50 x 5.0 SHS	6.39	152	67.6	38.0	24.3	16.9	12.4	9.51	6.08	4.22	3.10	2.38	1.88	1.52	1.06
4.0 SHS	5.35	135	60.2	33.8	21.7	15.0	11.1	8.46	5.42	3.76	2.76	2.12	1.67	1.35	0.940
3.0 SHS	4.25	115	51.2	28.8	18.4	12.8	9.41	7.20	4.61	3.20	2.35	1.80	1.42	1.15	0.800
2.5 SHS	3.60	100	44.6	25.1	16.0	11.1	8.19	6.27	4.01	2.79	2.05	1.57	1.24	1.00	0.697
2.0 SHS	2.93	83.8	37.2	20.9	13.4	9.31	6.84	5.23	3.35	2.33	1.71	1.31	1.03	0.838	0.582
1.6 SHS	2.38	69.3	30.8	17.3	11.1	7.70	5.66	4.33	2.77	1.92	1.41	1.08	0.855	0.693	0.481
40 x 40 x 4.0 SHS	4.09	62.3	27.7	15.6	9.97	6.92	5.09	3.89	2.49	1.73	1.27	0.973	0.769	0.623	0.433
3.0 SHS	3.30	55.2	24.5	13.8	8.83	6.13	4.51	3.45	2.21	1.53	1.13	0.862	0.681	0.552	0.383
2.5 SHS	2.82	48.6	21.6	12.2	7.78	5.40	3.97	3.04	1.95	1.35	0.993	0.760	0.600	0.486	0.338
2.0 SHS	2.31	41.1	18.3	10.3	6.57	4.57	3.35	2.57	1.64	1.14	0.838	0.642	0.507	0.411	0.285
1.6 SHS	1.88	34.3	15.2	8.58	5.49	3.81	2.80	2.14	1.37	0.953	0.700	0.536	0.424	0.343	0.238
35 x 35 x 3.0 SHS	2.83	35.2	15.7	8.80	5.63	3.91	2.87	2.20	1.41	0.978	0.719	0.550	0.435	0.352	0.245
2.5 SHS	2.42	31.3	13.9	7.83	5.01	3.48	2.56	1.96	1.25	0.870	0.639	0.489	0.387	0.313	0.217
2.0 SHS	1.99	26.7	11.9	6.67	4.27	2.96	2.18	1.67	1.07	0.741	0.545	0.417	0.329	0.267	0.185
1.6 SHS	1.63	22.4	9.97	5.61	3.59	2.49	1.83	1.40	0.897	0.623	0.458	0.350	0.277	0.224	0.156
30 x 30 x 2.0 SHS	1.68	16.1	7.16	4.03	2.58	1.79	1.32	1.01	0.645	0.448	0.329	0.252	0.199	0.161	0.112
1.6 SHS	1.38	13.7	6.07	3.42	2.19	1.52	1.12	0.854	0.547	0.380	0.279	0.214	0.169	0.137	0.0949
25 x 25 x 2.5 SHS	1.64	10.0	4.45	2.50	1.60	1.11	0.817	0.625	0.400	0.278	0.204	0.156	0.124	0.100	0.0695
2.0 SHS	1.36	8.78	3.90	2.20	1.41	0.976	0.717	0.549	0.351	0.244	0.179	0.137	0.108	0.0878	0.0610
1.6 SHS	1.12	7.55	3.36	1.89	1.21	0.839	0.616	0.472	0.302	0.210	0.154	0.118	0.0932	0.0755	0.0524
20 x 20 x 1.6 SHS	0.873	3.60	1.60	0.899	0.576	0.400	0.294	0.225	0.144	0.0999	0.0734	0.0562	0.0444	0.0360	0.0250

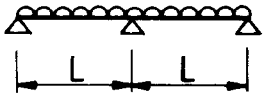
Note: 1. Serviceabilty Load $W^*_{S1} = 185EI / (250L^2)$

TABLE *D*8.2-4(A)

STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS

CONTINUOUS BEAMS WITH FULL LATERAL RESTRAINT
DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0
Non-Standard Thickness
bending about x-axis





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}

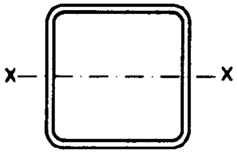
Designation d b t	Mass per m	W^*_{L1} (kN) Span of Beam (*L*) in metres														W^*_{L2}
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	kN
100 x 100 x 2.8 SHS	8.39	201	134	100	80.2	66.9	57.3	50.1	40.1	33.4	28.7	25.1	22.3	20.1	16.7	203
2.3 SHS	6.95	150	99.7	74.8	59.8	49.8	42.7	37.4	29.9	24.9	21.4	18.7	16.6	15.0	12.5	169
75 x 75 x 2.8 SHS	6.19	131	87.0	65.3	52.2	43.5	37.3	32.6	26.1	21.8	18.6	16.3	14.5	13.1	10.9	149
2.3 SHS	5.14	97.1	64.7	48.6	38.8	32.4	27.7	24.3	19.4	16.2	13.9	12.1	10.8	9.71	8.09	124
65 x 65 x 2.3 SHS	4.42	78.6	52.4	39.3	31.4	26.2	22.5	19.6	15.7	13.1	11.2	9.82	8.73	7.86	6.55	107
50 x 50 x 2.8 SHS	3.99	57.5	38.3	28.8	23.0	19.2	16.4	14.4	11.5	9.58	8.21	7.19	6.39	5.75	4.79	95.5
2.3 SHS	3.34	48.7	32.5	24.4	19.5	16.2	13.9	12.2	9.75	8.12	6.96	6.09	5.42	4.87	4.06	80.2
40 x 40 x 2.8 SHS	3.11	35.2	23.5	17.6	14.1	11.7	10.1	8.80	7.04	5.86	5.03	4.40	3.91	3.52	2.93	74.0
2.3 SHS	2.62	30.1	20.1	15.0	12.0	10.0	8.60	7.52	6.02	5.01	4.30	3.76	3.34	3.01	2.51	62.5
35 x 35 x 2.8 SHS	2.67	26.1	17.4	13.0	10.4	8.69	7.45	6.52	5.21	4.34	3.72	3.26	2.90	2.61	2.17	63.2
2.3 SHS	2.25	22.4	15.0	11.2	8.98	7.48	6.41	5.61	4.49	3.74	3.21	2.80	2.49	2.24	1.87	53.7

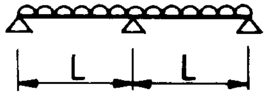
Notes:
1. $\phi = 0.9$
2. $\alpha_m = 1.0$
3. $\alpha_s = 1.0$
4. $W^*_{L1} = 8 \phi M_s / L$
5. $W^*_{L2} = 1.6 \phi V_v$

TABLE *D*8.2-4(B)

SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS

CONTINUOUS BEAMS
***DuraGal* SQUARE HOLLOW SECTIONS: GRADE C450L0**
Non-Standard Thickness
bending about x-axis





W^*_{S1} = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250

Designation d b t	Mass per m	W^*_{S1} (kN) Span of Beams (L) in metres													
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0
100 x 100 x 2.8 SHS	8.39	986	438	247	158	110	80.5	61.7	39.5	27.4	20.1	15.4	12.2	9.86	6.85
2.3 SHS	6.95	827	368	207	132	91.9	67.5	51.7	33.1	23.0	16.9	12.9	10.2	8.27	5.74
75 x 75 x 2.8 SHS	6.19	400	178	100	64.0	44.5	32.7	25.0	16.0	11.1	8.17	6.25	4.94	4.00	2.78
2.3 SHS	5.14	338	150	84.5	54.1	37.6	27.6	21.1	13.5	9.39	6.90	5.28	4.17	3.38	2.35
65 x 65 x 2.3 SHS	4.42	216	95.9	53.9	34.5	24.0	17.6	13.5	8.63	5.99	4.40	3.37	2.66	2.16	1.50
50 x 50 x 2.8 SHS	3.99	109	48.6	27.4	17.5	12.2	8.94	6.84	4.38	3.04	2.23	1.71	1.35	1.09	0.760
2.3 SHS	3.34	93.9	41.7	23.5	15.0	10.4	7.66	5.87	3.76	2.61	1.92	1.47	1.16	0.939	0.652
40 x 40 x 2.8 SHS	3.11	52.7	23.4	13.2	8.43	5.85	4.30	3.29	2.11	1.46	1.08	0.823	0.650	0.527	0.366
2.3 SHS	2.62	45.7	20.3	11.4	7.32	5.08	3.73	2.86	1.83	1.27	0.933	0.715	0.565	0.457	0.318
35 x 35 x 2.8 SHS	2.67	33.7	15.0	8.43	5.40	3.75	2.75	2.11	1.35	0.937	0.689	0.527	0.417	0.337	0.234
2.3 SHS	2.25	29.6	13.1	7.39	4.73	3.28	2.41	1.85	1.18	0.821	0.603	0.462	0.365	0.296	0.205

Note: 1. Serviceabilty Load $W^*_{S1} = 185EI / (250L^2)$

TABLE *D*8.3-1(1)(A)

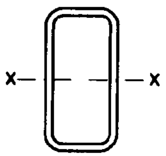
STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS

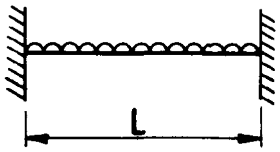
FIXED END BEAMS WITH FULL LATERAL RESTRAINT

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

bending about x-axis





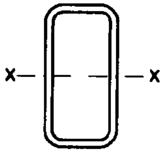
W^*_{L1} = Maximum Design Load based on Design Moment Capacity
W^*_{L2} = Maximum Design Load based on Design Shear Capacity
Maximum Design Load W^*_L is LESSER of W^*_{L1} and W^*_{L2}

Designation d b t	Mass per m	W^*_{L1} (kN) Span of Beam (*L*) in metres														W^*_{L2}	FLR
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
150 x 50 x 6.0 RHS	16.7	443	221	148	111	88.6	73.8	63.3	55.4	49.2	44.3	40.3	36.9	34.1	31.6	749	28.7
5.0 RHS	14.2	383	192	128	95.8	76.7	63.9	54.8	47.9	42.6	38.3	34.8	31.9	29.5	27.4	633	29.3
4.0 RHS	11.6	318	159	106	79.5	63.6	53.0	45.4	39.8	35.3	31.8	28.9	26.5	24.5	22.7	514	29.8
3.0 RHS	8.96	250	125	83.3	62.5	50.0	41.7	35.7	31.2	27.8	25.0	22.7	20.8	19.2	17.9	391	30.1
2.5 RHS	7.53	212	106	70.5	52.9	42.3	35.3	30.2	26.4	23.5	21.2	19.2	17.6	16.3	15.1	328	30.4
2.0 RHS	6.07	154	76.9	51.3	38.4	30.8	25.6	22.0	19.2	17.1	15.4	14.0	12.8	11.8	11.0	264	34.2
125 x 75 x 6.0 RHS	16.7	409	205	136	102	81.9	68.2	58.5	51.2	45.5	40.9	37.2	34.1	31.5	29.2	634	59.6
5.0 RHS	14.2	354	177	118	88.4	70.7	58.9	50.5	44.2	39.3	35.4	32.1	29.5	27.2	25.3	538	60.0
4.0 RHS	11.6	293	146	97.6	73.2	58.6	48.8	41.8	36.6	32.5	29.3	26.6	24.4	22.5	20.9	438	60.4
3.0 RHS	8.96	226	113	75.4	56.5	45.2	37.7	32.3	28.3	25.1	22.6	20.6	18.8	17.4	16.2	334	61.2
2.5 RHS	7.53	169	84.4	56.3	42.2	33.8	28.1	24.1	21.1	18.8	16.9	15.3	14.1	13.0	12.1	281	69.7
2.0 RHS	6.07	121	60.3	40.2	30.1	24.1	20.1	17.2	15.1	13.4	12.1	11.0	10.0	9.28	8.61	226	79.5
100 x 50 x 6.0 RHS	12.0	220	110	73.5	55.1	44.1	36.7	31.5	27.5	24.5	22.0	20.0	18.4	17.0	15.7	489	35.8
5.0 RHS	10.3	193	96.6	64.4	48.3	38.6	32.2	27.6	24.2	21.5	19.3	17.6	16.1	14.9	13.8	417	36.3
4.0 RHS	8.49	162	81.2	54.1	40.6	32.5	27.1	23.2	20.3	18.0	16.2	14.8	13.5	12.5	11.6	341	36.8
3.5 RHS	7.53	145	72.7	48.5	36.4	29.1	24.2	20.8	18.2	16.2	14.5	13.2	12.1	11.2	10.4	301	37.0
3.0 RHS	6.60	130	64.8	43.2	32.4	25.9	21.6	18.5	16.2	14.4	13.0	11.8	10.8	9.97	9.25	261	36.9
2.5 RHS	5.56	110	55.1	36.7	27.5	22.0	18.4	15.7	13.8	12.2	11.0	10.0	9.18	8.48	7.87	220	37.1
2.0 RHS	4.50	88.5	44.2	29.5	22.1	17.7	14.7	12.6	11.1	9.83	8.85	8.04	7.37	6.81	6.32	178	38.0
1.6 RHS	3.64	60.6	30.3	20.2	15.2	12.1	10.1	8.66	7.58	6.73	6.06	5.51	5.05	4.66	4.33	143	45.3

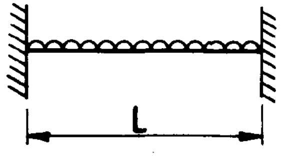
Notes:
1. FLR = $1.970\ (\pi^2 E I_y G J / M^2_{SX})^{0.5}$ (See Section *D*4.1.3 of these tables for explanation)
   FLR = Segment length for full lateral restraint ($\phi M_{bx} = \phi M_{sx}$)
2. ϕ = 0.9
3. α_m = 1.0
4. α_s = 1.0
5. W^*_{L1} = $12\ \phi\ M_s / L$
6. W^*_{L2} = $2\ \phi\ V_v$

TABLE *D*8.3-1(1)(B)

SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS



FIXED END BEAMS
DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0
Standard Thickness
bending about x-axis



W^*_{S1} = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250

Designation d b t (mm mm mm)	Mass per m (kg/m)	W^*_{S1} (kN) Span of Beam (L) in metres 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
150 x 50 x 6.0 RHS	16.7	1550	389	173	97.1	62.2	43.2	31.7	24.3	19.2	15.5	12.8	10.8	9.20	7.93
5.0 RHS	14.2	1360	341	152	85.3	54.6	37.9	27.8	21.3	16.8	13.6	11.3	9.47	8.07	6.96
4.0 RHS	11.6	1150	287	128	71.7	45.9	31.9	23.4	17.9	14.2	11.5	9.49	7.97	6.79	5.86
3.0 RHS	8.96	917	229	102	57.3	36.7	25.5	18.7	14.3	11.3	9.17	7.58	6.37	5.43	4.68
2.5 RHS	7.53	781	195	86.7	48.8	31.2	21.7	15.9	12.2	9.64	7.81	6.45	5.42	4.62	3.98
2.0 RHS	6.07	638	159	70.8	39.8	25.5	17.7	13.0	9.96	7.87	6.38	5.27	4.43	3.77	3.25
125 x 75 x 6.0 RHS	16.7	1280	320	142	79.9	51.1	35.5	26.1	20.0	15.8	12.8	10.6	8.88	7.56	6.52
5.0 RHS	14.2	1120	280	124	69.9	44.7	31.1	22.8	17.5	13.8	11.2	9.24	7.77	6.62	5.71
4.0 RHS	11.6	938	235	104	58.6	37.5	26.1	19.1	14.7	11.6	9.38	7.75	6.51	5.55	4.79
3.0 RHS	8.96	746	187	82.9	46.6	29.8	20.7	15.2	11.7	9.21	7.46	6.17	5.18	4.41	3.81
2.5 RHS	7.53	634	159	70.5	39.7	25.4	17.6	12.9	9.91	7.83	6.34	5.24	4.41	3.75	3.24
2.0 RHS	6.07	518	129	57.5	32.4	20.7	14.4	10.6	8.09	6.39	5.18	4.28	3.60	3.06	2.64
100 x 50 x 6.0 RHS	12.0	525	131	58.4	32.8	21.0	14.6	10.7	8.21	6.48	5.25	4.34	3.65	3.11	2.68
5.0 RHS	10.3	469	117	52.1	29.3	18.8	13.0	9.58	7.33	5.79	4.69	3.88	3.26	2.78	2.39
4.0 RHS	8.49	401	100	44.6	25.1	16.1	11.2	8.19	6.27	4.96	4.01	3.32	2.79	2.38	2.05
3.5 RHS	7.53	363	90.7	40.3	22.7	14.5	10.1	7.40	5.67	4.48	3.63	3.00	2.52	2.15	1.85
3.0 RHS	6.60	327	81.8	36.3	20.4	13.1	9.08	6.67	5.11	4.04	3.27	2.70	2.27	1.94	1.67
2.5 RHS	5.56	280	70.0	31.1	17.5	11.2	7.78	5.72	4.38	3.46	2.80	2.32	1.95	1.66	1.43
2.0 RHS	4.50	230	57.6	25.6	14.4	9.21	6.40	4.70	3.60	2.84	2.30	1.90	1.60	1.36	1.18
1.6 RHS	3.64	188	47.1	20.9	11.8	7.53	5.23	3.84	2.94	2.32	1.88	1.56	1.31	1.11	0.961

Note: 1. Serviceabilty Load $W^*_{S1} = 384EI/(250L^2)$

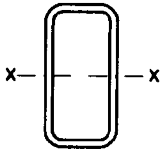


TABLE *D*8.3-1(2)(A)

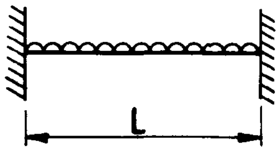
STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS

FIXED END BEAMS WITH FULL LATERAL RESTRAINT

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

bending about x-axis



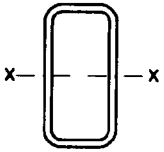
W^*_{L1} = Maximum Design Load based on Design Moment Capacity
W^*_{L2} = Maximum Design Load based on Design Shear Capacity
Maximum Design Load W^*_L is LESSER of W^*_{L1} and W^*_{L2}

Designation d b t	Mass per m	W^*_{L1} (kN) Span of Beam (*L*) in metres														W^*_{L2}	FLR
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	kN	m
100 x 50 x 6.0 RHS	12.0	441	294	220	176	147	126	110	88.1	73.5	63.0	55.1	49.0	44.1	36.7	489	35.8
5.0 RHS	10.3	386	258	193	155	129	110	96.6	77.3	64.4	55.2	48.3	42.9	38.6	32.2	417	36.3
4.0 RHS	8.49	325	216	162	130	108	92.8	81.2	64.9	54.1	46.4	40.6	36.1	32.5	27.1	341	36.8
3.5 RHS	7.53	291	194	145	116	97.0	83.1	72.7	58.2	48.5	41.6	36.4	32.3	29.1	24.2	301	37.0
3.0 RHS	6.60	259	173	130	104	86.4	74.0	64.8	51.8	43.2	37.0	32.4	28.8	25.9	21.6	261	36.9
2.5 RHS	5.56	220	147	110	88.1	73.5	63.0	55.1	44.1	36.7	31.5	27.5	24.5	22.0	18.4	220	37.1
2.0 RHS	4.50	177	118	88.5	70.8	59.0	50.6	44.2	35.4	29.5	25.3	22.1	19.7	17.7	14.7	178	38.0
1.6 RHS	3.64	121	80.8	60.6	48.5	40.4	34.6	30.3	24.2	20.2	17.3	15.2	13.5	12.1	10.1	143	45.3
75 x 50 x 6.0 RHS	9.67	273	182	136	109	90.9	77.9	68.2	54.6	45.5	39.0	34.1	30.3	27.3	22.7	356	40.4
5.0 RHS	8.35	242	161	121	96.8	80.7	69.1	60.5	48.4	40.3	34.6	30.2	26.9	24.2	20.2	306	40.9
4.0 RHS	6.92	206	137	103	82.2	68.5	58.7	51.4	41.1	34.3	29.4	25.7	22.8	20.6	17.1	252	41.3
3.0 RHS	5.42	166	111	83.0	66.4	55.4	47.4	41.5	33.2	27.7	23.7	20.8	18.5	16.6	13.8	195	41.3
2.5 RHS	4.58	142	94.6	70.9	56.7	47.3	40.5	35.5	28.4	23.6	20.3	17.7	15.8	14.2	11.8	165	41.5
2.0 RHS	3.72	115	76.4	57.3	45.8	38.2	32.7	28.6	22.9	19.1	16.4	14.3	12.7	11.5	9.54	134	42.4
1.6 RHS	3.01	80.3	53.5	40.1	32.1	26.8	22.9	20.1	16.1	13.4	11.5	10.0	8.92	8.03	6.69	108	49.5
75 x 25 x 2.5 RHS	3.60	97.8	65.2	48.9	39.1	32.6	27.9	24.4	19.6	16.3	14.0	12.2	10.9	9.78	8.15	158	14.5
2.0 RHS	2.93	80.8	53.8	40.4	32.3	26.9	23.1	20.2	16.2	13.5	11.5	10.1	8.97	8.08	6.73	128	14.8
1.6 RHS	2.38	66.2	44.2	33.1	26.5	22.1	18.9	16.6	13.2	11.0	9.46	8.28	7.36	6.62	5.52	104	15.0
65 x 35 x 4.0 RHS	5.35	129	86.0	64.5	51.6	43.0	36.9	32.3	25.8	21.5	18.4	16.1	14.3	12.9	10.8	212	26.0
3.0 RHS	4.25	107	71.2	53.4	42.7	35.6	30.5	26.7	21.4	17.8	15.3	13.4	11.9	10.7	8.90	165	26.2
2.5 RHS	3.60	91.9	61.3	45.9	36.8	30.6	26.3	23.0	18.4	15.3	13.1	11.5	10.2	9.19	7.66	139	26.4
2.0 RHS	2.93	75.8	50.5	37.9	30.3	25.3	21.7	19.0	15.2	12.6	10.8	9.48	8.42	7.58	6.32	113	26.7
50 x 25 x 3.0 RHS	3.07	57.0	38.0	28.5	22.8	19.0	16.3	14.2	11.4	9.50	8.14	7.12	6.33	5.70	4.75	122	17.6
2.5 RHS	2.62	49.6	33.1	24.8	19.8	16.5	14.2	12.4	9.92	8.27	7.09	6.20	5.51	4.96	4.14	104	17.9
2.0 RHS	2.15	41.4	27.6	20.7	16.6	13.8	11.8	10.4	8.29	6.91	5.92	5.18	4.60	4.14	3.45	85.2	18.2
1.6 RHS	1.75	34.3	22.8	17.1	13.7	11.4	9.79	8.57	6.85	5.71	4.90	4.28	3.81	3.43	2.86	69.3	18.4
50 x 20 x 3.0 RHS	2.83	50.1	33.4	25.1	20.1	16.7	14.3	12.5	10.0	8.36	7.16	6.27	5.57	5.01	4.18	121	12.2
2.5 RHS	2.42	43.9	29.2	21.9	17.5	14.6	12.5	11.0	8.77	7.31	6.26	5.48	4.87	4.39	3.65	103	12.5
2.0 RHS	1.99	36.8	24.5	18.4	14.7	12.3	10.5	9.19	7.35	6.13	5.25	4.60	4.08	3.68	3.06	84.1	12.8
1.6 RHS	1.63	30.5	20.3	15.3	12.2	10.2	8.72	7.63	6.10	5.08	4.36	3.81	3.39	3.05	2.54	68.4	13.0

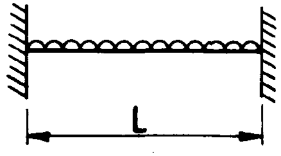
Notes:
1. FLR = $1.970\ (\pi^2 E I_y G J / M^2_{sx})^{0.5}$ (See Section *D*4.1.3 of these tables for explanation)
   FLR = Segment length for full lateral restraint ($\phi M_{bx} = \phi M_{sx}$)
2. ϕ = 0.9
3. α_m = 1.0
4. α_s = 1.0
5. W^*_{L1} = $12\ \phi\ M_s / L$
6. W^*_{L2} = $2\ \phi\ V_v$

TABLE *D*8.3-1(2)(B)

SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS



FIXED END BEAMS
DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0
Standard Thickness
bending about x-axis



W^*_{S1} = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250

Designation d b t	Mass per m	W^*_{S1} (kN) Span of Beam (*L*) in metres													
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0
100 x 50 x 6.0 RHS	12.0	2100	934	525	336	233	171	131	84.0	58.4	42.9	32.8	25.9	21.0	14.6
5.0 RHS	10.3	1880	834	469	300	209	153	117	75.1	52.1	38.3	29.3	23.2	18.8	13.0
4.0 RHS	8.49	1610	714	401	257	178	131	100	64.2	44.6	32.8	25.1	19.8	16.1	11.2
3.5 RHS	7.53	1450	645	363	232	161	118	90.7	58.1	40.3	29.6	22.7	17.9	14.5	10.1
3.0 RHS	6.60	1310	581	327	209	145	107	81.8	52.3	36.3	26.7	20.4	16.1	13.1	9.08
2.5 RHS	5.56	1120	498	280	179	125	91.5	70.0	44.8	31.1	22.9	17.5	13.8	11.2	7.78
2.0 RHS	4.50	921	409	230	147	102	75.2	57.6	36.9	25.6	18.8	14.4	11.4	9.21	6.40
1.6 RHS	3.64	753	335	188	121	83.7	61.5	47.1	30.1	20.9	15.4	11.8	9.3	7.53	5.23
75 x 50 x 6.0 RHS	9.67	983	437	246	157	109	80.2	61.4	39.3	27.3	20.1	15.4	12.1	9.83	6.83
5.0 RHS	8.35	892	397	223	143	99.1	72.8	55.8	35.7	24.8	18.2	13.9	11.0	8.92	6.20
4.0 RHS	6.92	774	344	194	124	86.0	63.2	48.4	31.0	21.5	15.8	12.1	9.56	7.74	5.38
3.0 RHS	5.42	641	285	160	103	71.2	52.3	40.1	25.6	17.8	13.1	10.0	7.91	6.41	4.45
2.5 RHS	4.58	552	245	138	88.4	61.4	45.1	34.5	22.1	15.3	11.3	8.63	6.82	5.52	3.84
2.0 RHS	3.72	457	203	114	73.1	50.7	37.3	28.5	18.3	12.7	9.32	7.14	5.64	4.57	3.17
1.6 RHS	3.01	375	167	93.7	60.0	41.7	30.6	23.4	15.0	10.4	7.65	5.86	4.63	3.75	2.60
75 x 25 x 2.5 RHS	3.60	350	156	87.6	56.1	38.9	28.6	21.9	14.0	9.73	7.15	5.48	4.33	3.50	2.43
2.0 RHS	2.93	293	130	73.2	46.9	32.5	23.9	18.3	11.7	8.14	5.98	4.58	3.62	2.93	2.03
1.6 RHS	2.38	243	108	60.6	38.8	26.9	19.8	15.2	9.70	6.74	4.95	3.79	2.99	2.43	1.68
65 x 35 x 4.0 RHS	5.35	403	179	101	64.5	44.8	32.9	25.2	16.1	11.2	8.23	6.30	4.98	4.03	2.80
3.0 RHS	4.25	345	153	86.3	55.3	38.4	28.2	21.6	13.8	9.59	7.05	5.40	4.26	3.45	2.40
2.5 RHS	3.60	300	134	75.1	48.1	33.4	24.5	18.8	12.0	8.35	6.13	4.69	3.71	3.00	2.09
2.0 RHS	2.93	251	111	62.7	40.1	27.9	20.5	15.7	10.0	6.96	5.12	3.92	3.09	2.51	1.74
50 x 25 x 3.0 RHS	3.07	137	61.0	34.3	22.0	15.3	11.2	8.58	5.49	3.81	2.80	2.15	1.69	1.37	0.953
2.5 RHS	2.62	121	54.0	30.4	19.4	13.5	9.92	7.59	4.86	3.37	2.48	1.90	1.50	1.21	0.844
2.0 RHS	2.15	103	45.8	25.8	16.5	11.4	8.41	6.44	4.12	2.86	2.10	1.61	1.27	1.03	0.715
1.6 RHS	1.75	86.2	38.3	21.6	13.8	9.58	7.04	5.39	3.45	2.40	1.76	1.35	1.06	0.862	0.599
50 x 20 x 3.0 RHS	2.83	117	52.0	29.2	18.7	13.0	9.54	7.31	4.68	3.25	2.39	1.83	1.44	1.17	0.812
2.5 RHS	2.42	104	46.3	26.0	16.7	11.6	8.50	6.51	4.17	2.89	2.13	1.63	1.29	1.04	0.723
2.0 RHS	1.99	88.9	39.5	22.2	14.2	9.87	7.25	5.55	3.55	2.47	1.81	1.39	1.10	0.889	0.617
1.6 RHS	1.63	74.7	33.2	18.7	12.0	8.30	6.10	4.67	2.99	2.08	1.52	1.17	0.922	0.747	0.519

Note: 1. Serviceabilty Load $W^*_{S1} = 384EI / (250L^2)$

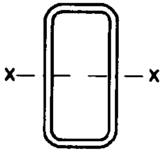
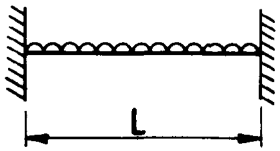


TABLE *D*8.3-2(A)

STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS

FIXED END BEAMS WITH FULL LATERAL RESTRAINT
DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0
Non-Standard Thickness
bending about x-axis



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}

Designation d b t	Mass per m	W^*_{L1} (kN) Span of Beam (*L*) in metres														W^*_{L2}	FLR
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	kN	m
125 x 75 x 2.8 RHS	8.39	407	271	203	163	136	116	102	81.3	67.8	58.1	50.8	45.2	40.7	33.9	313	64.1
2.3 RHS	6.95	294	196	147	118	98.0	84.0	73.5	58.8	49.0	42.0	36.8	32.7	29.4	24.5	259	74.1
100 x 50 x 2.8 RHS	6.19	244	163	122	97.5	81.3	69.7	61.0	48.8	40.6	34.8	30.5	27.1	24.4	20.3	245	37.0
2.3 RHS	5.14	204	136	102	81.8	68.1	58.4	51.1	40.9	34.1	29.2	25.5	22.7	20.4	17.0	203	37.2
75 x 50 x 2.8 RHS	5.09	157	104	78.3	62.6	52.2	44.7	39.1	31.3	26.1	22.4	19.6	17.4	15.7	13.0	183	41.4
2.3 RHS	4.24	132	87.8	65.9	52.7	43.9	37.6	32.9	26.4	22.0	18.8	16.5	14.6	13.2	11.0	152	41.6
65 x 35 x 2.8 RHS	3.99	101	67.3	50.5	40.4	33.7	28.9	25.2	20.2	16.8	14.4	12.6	11.2	10.1	8.42	155	26.3
2.3 RHS	3.34	85.6	57.1	42.8	34.2	28.5	24.5	21.4	17.1	14.3	12.2	10.7	9.51	8.56	7.13	129	26.5
50 x 25 x 2.8 RHS	2.89	54.1	36.1	27.1	21.7	18.0	15.5	13.5	10.8	9.02	7.73	6.77	6.02	5.41	4.51	115	17.8
2.3 RHS	2.44	46.4	31.0	23.2	18.6	15.5	13.3	11.6	9.29	7.74	6.64	5.81	5.16	4.64	3.87	96.7	18.0
50 x 20 x 2.8 RHS	2.67	47.7	31.8	23.9	19.1	15.9	13.6	11.9	9.54	7.95	6.82	5.96	5.30	4.77	3.98	114	12.4
2.3 RHS	2.25	41.1	27.4	20.6	16.4	13.7	11.7	10.3	8.22	6.85	5.87	5.14	4.57	4.11	3.43	95.4	12.6

Notes:
1. FLR = $1.970\ (\pi^2 E I_y G J / M^2_{SX})^{0.5}$ (See Section *D*4.1.3 of these tables for explanation)
   FLR = Segment length for full lateral restraint ($\phi M_{bx} = \phi M_{sx}$)
2. ϕ = 0.9
3. α_m = 1.0
4. α_s = 1.0
5. W^*_{L1} = $12\ \phi\ M_s/L$
6. W^*_{L2} = $2\ \phi\ V_v$

onesteel market mills

TABLE *D*8.3-2(B)

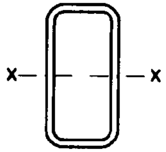
SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS

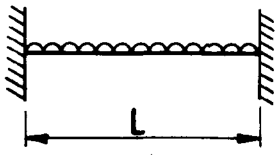
FIXED END BEAMS

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Non-Standard Thickness

bending about x-axis





W^*_{S1} = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250

Designation d b t (mm mm mm)	Mass per m (kg/m)	W^*_{S1} (kN) Span of Beam (L) in metres: 0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0
125 x 75 x 2.8 RHS	8.39	2810	1250	702	449	312	229	175	112	78.0	57.3	43.9	34.7	28.1	19.5
2.3 RHS	6.95	2350	1050	588	377	261	192	147	94.1	65.4	48.0	36.8	29.1	23.5	16.3
100 x 50 x 2.8 RHS	6.19	1230	549	309	198	137	101	77.2	49.4	34.3	25.2	19.3	15.2	12.3	8.57
2.3 RHS	5.14	1040	463	261	167	116	85.1	65.2	41.7	29.0	21.3	16.3	12.9	10.4	7.24
75 x 50 x 2.8 RHS	5.09	606	270	152	97.0	67.4	49.5	37.9	24.3	16.8	12.4	9.47	7.49	6.06	4.21
2.3 RHS	4.24	515	229	129	82.4	57.2	42.0	32.2	20.6	14.3	10.5	8.05	6.36	5.15	3.58
65 x 35 x 2.8 RHS	3.99	328	146	82.0	52.5	36.4	26.8	20.5	13.1	9.11	6.69	5.12	4.05	3.28	2.28
2.3 RHS	3.34	281	125	70.3	45.0	31.2	22.9	17.6	11.2	7.81	5.74	4.39	3.47	2.81	1.95
50 x 25 x 2.8 RHS	2.89	131	58.3	32.8	21.0	14.6	10.7	8.20	5.25	3.65	2.68	2.05	1.62	1.31	0.912
2.3 RHS	2.44	114	50.9	28.6	18.3	12.7	9.34	7.15	4.58	3.18	2.34	1.79	1.41	1.14	0.795
50 x 20 x 2.8 RHS	2.67	112	49.8	28.0	17.9	12.5	9.15	7.01	4.48	3.11	2.29	1.75	1.38	1.12	0.778
2.3 RHS	2.25	98.3	43.7	24.6	15.7	10.9	8.03	6.15	3.93	2.73	2.01	1.54	1.21	0.983	0.683

Note: 1. Serviceabilty Load $W^*_{S1} = 384EI / (250L^2)$

TABLE *D*8.3-3(1)(A)

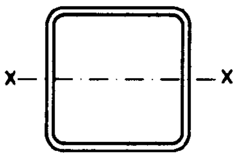
STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS

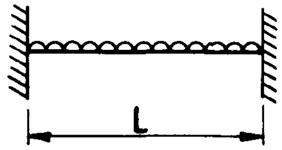
FIXED END BEAMS WITH FULL LATERAL RESTRAINT

DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

bending about x-axis





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}

Designation d b t	Mass per m	W^*_{L1} (kN) Span of Beam (L) in metres														W^*_{L2}
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
100 x 100 x 6.0 SHS	16.7	357	179	119	89.4	71.5	59.6	51.1	44.7	39.7	35.7	32.5	29.8	27.5	25.5	507
5.0 SHS	14.2	309	154	103	77.2	61.7	51.4	44.1	38.6	34.3	30.9	28.1	25.7	23.7	22.0	432
4.0 SHS	11.6	252	126	84.1	63.1	50.5	42.1	36.0	31.5	28.0	25.2	22.9	21.0	19.4	18.0	353
3.0 SHS	8.96	180	90.2	60.1	45.1	36.1	30.1	25.8	22.6	20.0	18.0	16.4	15.0	13.9	12.9	271
2.5 SHS	7.53	136	68.2	45.5	34.1	27.3	22.7	19.5	17.1	15.2	13.6	12.4	11.4	10.5	9.75	228
2.0 SHS	6.07	97.6	48.8	32.5	24.4	19.5	16.3	13.9	12.2	10.8	9.76	8.87	8.13	7.51	6.97	184
90 x 90 x 3.0 SHS	8.01	143	71.5	47.7	35.8	28.6	23.8	20.4	17.9	15.9	14.3	13.0	11.9	11.0	10.2	242
2.5 SHS	6.74	117	58.4	38.9	29.2	23.4	19.5	16.7	14.6	13.0	11.7	10.6	9.74	8.99	8.34	204
2.0 SHS	5.45	83.3	41.6	27.8	20.8	16.7	13.9	11.9	10.4	9.25	8.33	7.57	6.94	6.40	5.95	165
1.6 SHS	4.39	59.8	29.9	19.9	15.0	12.0	9.97	8.55	7.48	6.65	5.98	5.44	4.98	4.60	4.27	133
89 x 89 x 6.0 SHS	9.06	173	86.7	57.8	43.4	34.7	28.9	24.8	21.7	19.3	17.3	15.8	14.5	13.3	12.4	275
5.0 SHS	12.5	239	119	79.5	59.6	47.7	39.8	34.1	29.8	26.5	23.9	21.7	19.9	18.4	17.0	379
3.5 SHS	14.6	275	137	91.6	68.7	55.0	45.8	39.3	34.4	30.5	27.5	25.0	22.9	21.1	19.6	443
75 x 75 x 6.0 SHS	12.0	187	93.3	62.2	46.7	37.3	31.1	26.7	23.3	20.7	18.7	17.0	15.6	14.4	13.3	363
5.0 SHS	10.3	164	81.8	54.5	40.9	32.7	27.3	23.4	20.4	18.2	16.4	14.9	13.6	12.6	11.7	312
4.0 SHS	8.49	137	68.6	45.8	34.3	27.5	22.9	19.6	17.2	15.3	13.7	12.5	11.4	10.6	9.80	257
3.5 SHS	7.53	123	61.5	41.0	30.7	24.6	20.5	17.6	15.4	13.7	12.3	11.2	10.2	9.46	8.78	228
3.0 SHS	6.60	108	53.9	36.0	27.0	21.6	18.0	15.4	13.5	12.0	10.8	9.81	8.99	8.30	7.70	199
2.5 SHS	5.56	82.8	41.4	27.6	20.7	16.6	13.8	11.8	10.4	9.20	8.28	7.53	6.90	6.37	5.91	168
2.0 SHS	4.50	63.5	31.8	21.2	15.9	12.7	10.6	9.07	7.94	7.06	6.35	5.77	5.29	4.89	4.54	136

Notes:
1. ϕ = 0.9
2. α_m = 1.0
3. α_s = 1.0
4. W^*_{L1} = $12 \phi M_s/L$
5. W^*_{L2} = $2.0 \phi V_v$

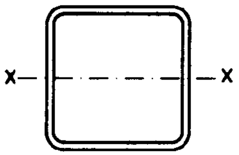
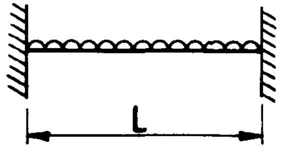


TABLE *D*8.3-3(1)(B)

SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS

FIXED END BEAMS
***DuraGal* SQUARE HOLLOW SECTIONS: GRADE C450L0**
Standard Thickness
bending about x-axis



W^*_{S1} = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250

Designation d b t	Mass per m	W^*_{S1} (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
100 x 100 x 6.0 SHS	16.7	933	233	104	58.3	37.3	25.9	19.0	14.6	11.5	9.33	7.71	6.48	5.52	4.76
5.0 SHS	14.2	816	204	90.7	51.0	32.6	22.7	16.7	12.8	10.1	8.16	6.75	5.67	4.83	4.16
4.0 SHS	11.6	685	171	76.1	42.8	27.4	19.0	14.0	10.7	8.45	6.85	5.66	4.76	4.05	3.49
3.0 SHS	8.96	544	136	60.4	34.0	21.8	15.1	11.1	8.50	6.71	5.44	4.49	3.78	3.22	2.77
2.5 SHS	7.53	463	116	51.4	28.9	18.5	12.9	9.44	7.23	5.71	4.63	3.82	3.21	2.74	2.36
2.0 SHS	6.07	378	94.5	42.0	23.6	15.1	10.5	7.71	5.90	4.67	3.78	3.12	2.62	2.24	1.93
90 x 90 x 3.0 SHS	8.01	391	97.8	43.4	24.4	15.6	10.9	7.98	6.11	4.83	3.91	3.23	2.72	2.31	1.99
2.5 SHS	6.74	333	83.4	37.1	20.8	13.3	9.26	6.81	5.21	4.12	3.33	2.76	2.32	1.97	1.70
2.0 SHS	5.45	273	68.2	30.3	17.1	10.9	7.58	5.57	4.27	3.37	2.73	2.26	1.90	1.62	1.39
1.6 SHS	4.39	222	55.6	24.7	13.9	8.90	6.18	4.54	3.47	2.75	2.22	1.84	1.54	1.32	1.13
89 x 89 x 6.0 SHS	9.06	422	106	46.9	26.4	16.9	11.7	8.62	6.60	5.21	4.22	3.49	2.93	2.50	2.15
5.0 SHS	12.5	556	139	61.8	34.8	22.3	15.5	11.4	8.69	6.87	5.56	4.60	3.86	3.29	2.84
3.5 SHS	14.6	631	158	70.2	39.5	25.3	17.5	12.9	9.87	7.80	6.31	5.22	4.39	3.74	3.22
75 x 75 x 6.0 SHS	12.0	356	88.9	39.5	22.2	14.2	9.88	7.26	5.56	4.39	3.56	2.94	2.47	2.10	1.81
5.0 SHS	10.3	317	79.3	35.3	19.8	12.7	8.81	6.48	4.96	3.92	3.17	2.62	2.20	1.88	1.62
4.0 SHS	8.49	271	67.8	30.1	16.9	10.8	7.53	5.53	4.24	3.35	2.71	2.24	1.88	1.60	1.38
3.5 SHS	7.53	245	61.2	27.2	15.3	9.80	6.80	5.00	3.83	3.02	2.45	2.02	1.70	1.45	1.25
3.0 SHS	6.60	220	55.0	24.4	13.8	8.80	6.11	4.49	3.44	2.72	2.20	1.82	1.53	1.30	1.12
2.5 SHS	5.56	189	47.1	21.0	11.8	7.54	5.24	3.85	2.95	2.33	1.89	1.56	1.31	1.12	0.962
2.0 SHS	4.50	155	38.8	17.2	9.69	6.20	4.31	3.17	2.42	1.91	1.55	1.28	1.08	0.918	0.791

Note: 1. Serviceabilty Load $W^*_{S1} = 384EI / (250L^2)$

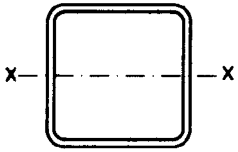


TABLE *D*8.3-3(2)(A)

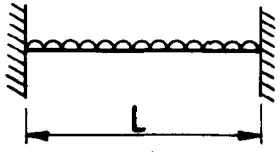
STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS

FIXED END BEAMS WITH FULL LATERAL RESTRAINT

***DuraGal* SQUARE HOLLOW SECTIONS: GRADE C450L0**

Standard Thickness

bending about x-axis



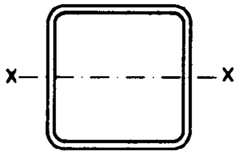
W^*_{L1} = Maximum Design Load based on Design Moment Capacity
W^*_{L2} = Maximum Design Load based on Design Shear Capacity
Maximum Design Load W^*_L is LESSER of W^*_{L1} and W^*_{L2}

Designation d b t	Mass per m	W^*_{L1} (kN) Span of Beam (*L*) in metres														W^*_{L2}
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	kN
75 x 75 x 6.0 SHS	12.0	373	249	187	149	124	107	93.3	74.7	62.2	53.3	46.7	41.5	37.3	31.1	363
5.0 SHS	10.3	327	218	164	131	109	93.4	81.8	65.4	54.5	46.7	40.9	36.3	32.7	27.3	312
4.0 SHS	8.49	275	183	137	110	91.5	78.4	68.6	54.9	45.8	39.2	34.3	30.5	27.5	22.9	257
3.5 SHS	7.53	246	164	123	98.4	82.0	70.3	61.5	49.2	41.0	35.1	30.7	27.3	24.6	20.5	228
3.0 SHS	6.60	216	144	108	86.3	71.9	61.6	53.9	43.1	36.0	30.8	27.0	24.0	21.6	18.0	199
2.5 SHS	5.56	166	110	82.8	66.2	55.2	47.3	41.4	33.1	27.6	23.7	20.7	18.4	16.6	13.8	168
2.0 SHS	4.50	118	78.6	59.0	47.2	39.3	33.7	29.5	23.6	19.7	16.8	14.7	13.1	11.8	9.83	136
65 x 65 x 6.0 SHS	10.1	267	178	134	107	89.1	76.4	66.8	53.5	44.6	38.2	33.4	29.7	26.7	22.3	305
5.0 SHS	8.75	236	158	118	94.6	78.8	67.6	59.1	47.3	39.4	33.8	29.6	26.3	23.6	19.7	264
4.0 SHS	7.23	200	133	100	80.1	66.7	57.2	50.1	40.0	33.4	28.6	25.0	22.2	20.0	16.7	219
3.0 SHS	5.66	161	107	80.5	64.4	53.7	46.0	40.3	32.2	26.8	23.0	20.1	17.9	16.1	13.4	170
2.5 SHS	4.78	133	88.6	66.5	53.2	44.3	38.0	33.2	26.6	22.2	19.0	16.6	14.8	13.3	11.1	144
2.0 SHS	3.88	95.3	63.5	47.6	38.1	31.8	27.2	23.8	19.1	15.9	13.6	11.9	10.6	9.53	7.94	117
1.6 SHS	3.13	68.1	45.4	34.1	27.2	22.7	19.5	17.0	13.6	11.4	9.73	8.51	7.57	6.81	5.68	94.9
50 x 50 x 5.0 SHS	6.39	128	85.3	63.9	51.2	42.6	36.5	32.0	25.6	21.3	18.3	16.0	14.2	12.8	10.7	192
4.0 SHS	5.35	111	73.8	55.3	44.3	36.9	31.6	27.7	22.1	18.4	15.8	13.8	12.3	11.1	9.22	161
3.0 SHS	4.25	91.2	60.8	45.6	36.5	30.4	26.1	22.8	18.2	15.2	13.0	11.4	10.1	9.12	7.60	127
2.5 SHS	3.60	78.5	52.3	39.2	31.4	26.2	22.4	19.6	15.7	13.1	11.2	9.81	8.72	7.85	6.54	108
2.0 SHS	2.93	63.9	42.6	32.0	25.6	21.3	18.3	16.0	12.8	10.7	9.13	7.99	7.10	6.39	5.33	88.3
1.6 SHS	2.38	46.1	30.7	23.0	18.4	15.4	13.2	11.5	9.22	7.68	6.58	5.76	5.12	4.61	3.84	71.9
40 x 40 x 4.0 SHS	4.09	65.5	43.6	32.7	26.2	21.8	18.7	16.4	13.1	10.9	9.35	8.18	7.27	6.55	5.46	123
3.0 SHS	3.30	55.6	37.1	27.8	22.3	18.5	15.9	13.9	11.1	9.27	7.95	6.95	6.18	5.56	4.64	97.9
2.5 SHS	2.82	48.3	32.2	24.1	19.3	16.1	13.8	12.1	9.66	8.05	6.90	6.03	5.36	4.83	4.02	84.0
2.0 SHS	2.31	40.2	26.8	20.1	16.1	13.4	11.5	10.0	8.04	6.70	5.74	5.02	4.46	4.02	3.35	69.1
1.6 SHS	1.88	32.7	21.8	16.4	13.1	10.9	9.35	8.18	6.55	5.45	4.68	4.09	3.64	3.27	2.73	56.5
35 x 35 x 3.0 SHS	2.83	41.1	27.4	20.6	16.4	13.7	11.7	10.3	8.22	6.85	5.87	5.14	4.57	4.11	3.43	83.5
2.5 SHS	2.42	35.9	23.9	18.0	14.4	12.0	10.3	8.98	7.18	5.99	5.13	4.49	3.99	3.59	2.99	72.0
2.0 SHS	1.99	30.1	20.1	15.0	12.0	10.0	8.59	7.52	6.02	5.01	4.30	3.76	3.34	3.01	2.51	59.5
1.6 SHS	1.63	24.9	16.6	12.5	9.98	8.31	7.13	6.24	4.99	4.16	3.56	3.12	2.77	2.49	2.08	48.8
30 x 30 x 2.0 SHS	1.68	21.4	14.3	10.7	8.57	7.15	6.12	5.36	4.29	3.57	3.06	2.68	2.38	2.14	1.79	49.9
1.6 SHS	1.38	17.9	11.9	8.95	7.16	5.96	5.11	4.47	3.58	2.98	2.56	2.24	1.99	1.79	1.49	41.2
25 x 25 x 2.5 SHS	1.64	16.6	11.1	8.32	6.66	5.55	4.76	4.16	3.33	2.77	2.38	2.08	1.85	1.66	1.39	48.0
2.0 SHS	1.36	14.3	9.50	7.13	5.70	4.75	4.07	3.56	2.85	2.38	2.04	1.78	1.58	1.43	1.19	40.3
1.6 SHS	1.12	12.0	8.01	6.01	4.80	4.00	3.43	3.00	2.40	2.00	1.72	1.50	1.33	1.20	1.00	33.5
20 x 20 x 1.6 SHS	0.873	7.30	4.86	3.65	2.92	2.43	2.08	1.82	1.46	1.22	1.04	0.912	0.811	0.730	0.608	25.8

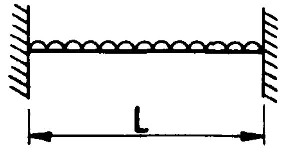
Notes: 1. ϕ = 0.9 2. α_m = 1.0 3. α_s = 1.0 4. W^*_{L1} = $12 \phi M_s / L$ 5. W^*_{L2} = $2 \phi V_v$

TABLE *D*8.3-3(2)(B)

SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS



FIXED END BEAMS
DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0
Standard Thickness
bending about x-axis



W^*_{S1} = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250

Designation d b t	Mass per m	W^*_{S1} (kN) Span of Beam (L) in metres													
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0
75 x 75 x 6.0 SHS	12.0	1420	632	356	228	158	116	88.9	56.9	39.5	29.0	22.2	17.6	14.2	9.88
5.0 SHS	10.3	1270	564	317	203	141	104	79.3	50.8	35.3	25.9	19.8	15.7	12.7	8.81
4.0 SHS	8.49	1080	482	271	173	120	88.5	67.8	43.4	30.1	22.1	16.9	13.4	10.8	7.53
3.5 SHS	7.53	980	435	245	157	109	80.0	61.2	39.2	27.2	20.0	15.3	12.1	9.80	6.80
3.0 SHS	6.60	880	391	220	141	97.8	71.8	55.0	35.2	24.4	18.0	13.8	10.9	8.80	6.11
2.5 SHS	5.56	754	335	189	121	83.8	61.6	47.1	30.2	21.0	15.4	11.8	9.31	7.54	5.24
2.0 SHS	4.50	620	276	155	99.3	68.9	50.6	38.8	24.8	17.2	12.7	9.69	7.66	6.20	4.31
65 x 65 x 6.0 SHS	10.1	868	386	217	139	96.4	70.8	54.2	34.7	24.1	17.7	13.6	10.7	8.68	6.03
5.0 SHS	8.75	784	349	196	125	87.1	64.0	49.0	31.4	21.8	16.0	12.3	9.68	7.84	5.45
4.0 SHS	7.23	678	301	170	108	75.3	55.3	42.4	27.1	18.8	13.8	10.6	8.37	6.78	4.71
3.0 SHS	5.66	558	248	140	89.3	62.0	45.6	34.9	22.3	15.5	11.4	8.72	6.89	5.58	3.88
2.5 SHS	4.78	481	214	120	76.9	53.4	39.2	30.0	19.2	13.3	9.81	7.51	5.93	4.81	3.34
2.0 SHS	3.88	397	176	99.3	63.5	44.1	32.4	24.8	15.9	11.0	8.10	6.20	4.90	3.97	2.76
1.6 SHS	3.13	326	145	81.5	52.1	36.2	26.6	20.4	13.0	9.05	6.65	5.09	4.02	3.26	2.26
50 x 50 x 5.0 SHS	6.39	316	140	78.9	50.5	35.1	25.8	19.7	12.6	8.77	6.44	4.93	3.90	3.16	2.19
4.0 SHS	5.35	281	125	70.3	45.0	31.2	22.9	17.6	11.2	7.81	5.74	4.39	3.47	2.81	1.95
3.0 SHS	4.25	239	106	59.8	38.3	26.6	19.5	15.0	9.57	6.64	4.88	3.74	2.95	2.39	1.66
2.5 SHS	3.60	208	92.5	52.1	33.3	23.1	17.0	13.0	8.33	5.78	4.25	3.25	2.57	2.08	1.45
2.0 SHS	2.93	174	77.3	43.5	27.8	19.3	14.2	10.9	6.95	4.83	3.55	2.72	2.15	1.74	1.21
1.6 SHS	2.38	144	63.9	36.0	23.0	16.0	11.7	8.99	5.75	4.00	2.94	2.25	1.78	1.44	0.999
40 x 40 x 4.0 SHS	4.09	129	57.5	32.3	20.7	14.4	10.6	8.08	5.17	3.59	2.64	2.02	1.60	1.29	0.898
3.0 SHS	3.30	115	50.9	28.6	18.3	12.7	9.35	7.16	4.58	3.18	2.34	1.79	1.41	1.15	0.796
2.5 SHS	2.82	101	44.9	25.2	16.2	11.2	8.24	6.31	4.04	2.80	2.06	1.58	1.25	1.01	0.701
2.0 SHS	2.31	85.3	37.9	21.3	13.6	9.48	6.96	5.33	3.41	2.37	1.74	1.33	1.05	0.853	0.592
1.6 SHS	1.88	71.2	31.6	17.8	11.4	7.91	5.81	4.45	2.85	1.98	1.45	1.11	0.879	0.712	0.494
35 x 35 x 3.0 SHS	2.83	73.1	32.5	18.3	11.7	8.12	5.97	4.57	2.92	2.03	1.49	1.14	0.902	0.731	0.508
2.5 SHS	2.42	65.0	28.9	16.2	10.4	7.22	5.31	4.06	2.60	1.81	1.33	1.02	0.802	0.650	0.451
2.0 SHS	1.99	55.4	24.6	13.8	8.86	6.15	4.52	3.46	2.22	1.54	1.13	0.865	0.684	0.554	0.385
1.6 SHS	1.63	46.6	20.7	11.6	7.45	5.17	3.80	2.91	1.86	1.29	0.950	0.727	0.575	0.466	0.323
30 x 30 x 2.0 SHS	1.68	33.4	14.9	8.36	5.35	3.72	2.73	2.09	1.34	0.929	0.683	0.523	0.413	0.334	0.232
1.6 SHS	1.38	28.4	12.6	7.09	4.54	3.15	2.32	1.77	1.13	0.788	0.579	0.443	0.350	0.284	0.197
25 x 25 x 2.5 SHS	1.64	20.8	9.23	5.19	3.32	2.31	1.70	1.30	0.831	0.577	0.424	0.324	0.256	0.208	0.144
2.0 SHS	1.36	18.2	8.10	4.56	2.92	2.03	1.49	1.14	0.729	0.506	0.372	0.285	0.225	0.182	0.127
1.6 SHS	1.12	15.7	6.96	3.92	2.51	1.74	1.28	0.979	0.627	0.435	0.320	0.245	0.193	0.157	0.109
20 x 20 x 1.6 SHS	0.873	7.47	3.32	1.87	1.19	0.830	0.610	0.467	0.299	0.207	0.152	0.117	0.0922	0.0747	0.0519

Note: 1. Serviceabilty Load $W^*_{S1} = 384EI / (250L^2)$

TABLE *D*8.3-4(A)

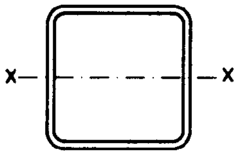
STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS

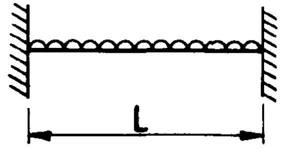
FIXED END BEAMS WITH FULL LATERAL RESTRAINT

***DuraGal* SQUARE HOLLOW SECTIONS: GRADE C450L0**

Non-Standard Thickness

bending about x-axis





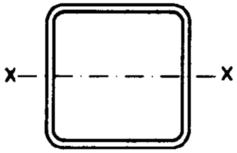
W^*_{L1} = Maximum Design Load based on Design Moment Capacity
W^*_{L2} = Maximum Design Load based on Design Shear Capacity
Maximum Design Load W^*_L is LESSER of W^*_{L1} and W^*_{L2}

Designation d b t	Mass per m	W^*_{L1} (kN) Span of Beam (*L*) in metres														W^*_{L2}
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	kN
100 x 100 x 2.8 SHS	8.39	301	201	150	120	100	86.0	75.2	60.2	50.1	43.0	37.6	33.4	30.1	25.1	254
2.3 SHS	6.95	224	150	112	89.7	74.8	64.1	56.1	44.9	37.4	32.0	28.0	24.9	22.4	18.7	211
75 x 75 x 2.8 SHS	6.19	196	131	97.9	78.3	65.3	55.9	48.9	39.2	32.6	28.0	24.5	21.8	19.6	16.3	187
2.3 SHS	5.14	146	97.1	72.8	58.3	48.6	41.6	36.4	29.1	24.3	20.8	18.2	16.2	14.6	12.1	155
65 x 65 x 2.3 SHS	4.42	118	78.6	58.9	47.2	39.3	33.7	29.5	23.6	19.6	16.8	14.7	13.1	11.8	9.82	133
50 x 50 x 2.8 SHS	3.99	86.3	57.5	43.1	34.5	28.8	24.6	21.6	17.3	14.4	12.3	10.8	9.58	8.63	7.19	119
2.3 SHS	3.34	73.1	48.7	36.6	29.2	24.4	20.9	18.3	14.6	12.2	10.4	9.14	8.12	7.31	6.09	100
40 x 40 x 2.8 SHS	3.11	52.8	35.2	26.4	21.1	17.6	15.1	13.2	10.6	8.80	7.54	6.60	5.86	5.28	4.40	92.5
2.3 SHS	2.62	45.1	30.1	22.6	18.1	15.0	12.9	11.3	9.03	7.52	6.45	5.64	5.01	4.51	3.76	78.2
35 x 35 x 2.8 SHS	2.67	39.1	26.1	19.6	15.6	13.0	11.2	9.78	7.82	6.52	5.59	4.89	4.34	3.91	3.26	79.0
2.3 SHS	2.25	33.7	22.4	16.8	13.5	11.2	9.62	8.41	6.73	5.61	4.81	4.21	3.74	3.37	2.80	67.1

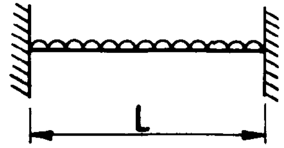
Notes:
1. ϕ = 0.9
2. α_m = 1.0
3. α_s = 1.0
4. W^*_{L1} = $12 \phi M_s / L$
5. W^*_{L2} = $2 \phi V_v$

TABLE *D*8.3-4(B)

SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS



FIXED END BEAMS
DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0
Non-Standard Thickness
bending about x-axis



W^*_{S1} = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250

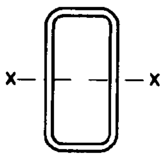
Designation d b t	Mass per m	W^*_{S1} (kN) Span of Beam (*L*) in metres												
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0
100 x 100 x 2.8 SHS	8.39	2050	910	512	328	227	167	128	81.9	56.9	41.8	32.0	25.3	20.5	14.2
2.3 SHS	6.95	1720	763	429	275	191	140	107	68.7	47.7	35.0	26.8	21.2	17.2	11.9
75 x 75 x 2.8 SHS	6.19	831	369	208	133	92.3	67.8	51.9	33.2	23.1	17.0	13.0	10.3	8.31	5.77
2.3 SHS	5.14	702	312	175	112	78.0	57.3	43.9	28.1	19.5	14.3	11.0	8.66	7.02	4.87
65 x 65 x 2.3 SHS	4.42	448	199	112	71.7	49.8	36.6	28.0	17.9	12.4	9.14	7.00	5.53	4.48	3.11
50 x 50 x 2.8 SHS	3.99	227	101	56.8	36.4	25.2	18.5	14.2	9.09	6.31	4.64	3.55	2.80	2.27	1.58
2.3 SHS	3.34	195	86.6	48.7	31.2	21.7	15.9	12.2	7.79	5.41	3.98	3.04	2.41	1.95	1.35
40 x 40 x 2.8 SHS	3.11	109	48.6	27.3	17.5	12.2	8.93	6.83	4.37	3.04	2.23	1.71	1.35	1.09	0.759
2.3 SHS	2.62	94.9	42.2	23.7	15.2	10.5	7.75	5.93	3.80	2.64	1.94	1.48	1.17	0.949	0.659
35 x 35 x 2.8 SHS	2.67	70.0	31.1	17.5	11.2	7.78	5.72	4.38	2.80	1.95	1.43	1.09	0.865	0.700	0.486
2.3 SHS	2.25	61.3	27.3	15.3	9.81	6.82	5.01	3.83	2.45	1.70	1.25	0.958	0.757	0.613	0.426

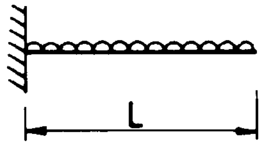
Note: 1. Serviceabilty Load $W^*_{S1} = 384EI / (250L^2)$

TABLE *D*8.4-1(1)(A)

STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS

CANTILEVER BEAMS WITH FULL LATERAL RESTRAINT
DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0
Standard Thickness
bending about x-axis





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}

Designation d b t	Mass per m	W^*_{L1} (kN) Span of Beam (*L*) in metres														W^*_{L2}	FLR
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
150 x 50 x 6.0 RHS	16.7	73.8	36.9	24.6	18.5	14.8	12.3	10.5	9.23	8.20	7.38	6.71	6.15	5.68	5.27	374	26.4
5.0 RHS	14.2	63.9	31.9	21.3	16.0	12.8	10.6	9.13	7.98	7.10	6.39	5.81	5.32	4.91	4.56	316	26.9
4.0 RHS	11.6	53.0	26.5	17.7	13.3	10.6	8.83	7.57	6.63	5.89	5.30	4.82	4.42	4.08	3.79	257	27.4
3.0 RHS	8.96	41.7	20.8	13.9	10.4	8.33	6.94	5.95	5.21	4.63	4.17	3.79	3.47	3.20	2.98	195	27.6
2.5 RHS	7.53	35.3	17.6	11.8	8.81	7.05	5.83	5.04	4.41	3.92	3.53	3.20	2.94	2.71	2.52	164	27.9
2.0 RHS	6.07	25.6	12.8	8.54	6.41	5.13	4.27	3.66	3.20	2.85	2.56	2.33	2.14	1.97	1.83	132	31.4
125 x 75 x 6.0 RHS	16.7	68.2	34.1	22.7	17.1	13.6	11.4	9.75	8.53	7.58	6.82	6.20	5.68	5.25	4.87	317	54.7
5.0 RHS	14.2	58.9	29.5	19.6	14.7	11.8	9.82	8.42	7.37	6.55	5.89	5.36	4.91	4.53	4.21	269	55.1
4.0 RHS	11.6	48.8	24.4	16.3	12.2	9.76	8.14	6.97	6.10	5.42	4.88	4.44	4.07	3.76	3.49	219	55.5
3.0 RHS	8.96	37.7	18.8	12.6	9.42	7.54	6.28	5.38	4.71	4.19	3.77	3.43	3.14	2.90	2.69	167	56.2
2.5 RHS	7.53	28.1	14.1	9.38	7.03	5.63	4.69	4.02	3.52	3.13	2.81	2.56	2.34	2.16	2.01	140	64.0
2.0 RHS	6.07	20.1	10.0	6.70	5.02	4.02	3.35	2.87	2.51	2.23	2.01	1.83	1.67	1.55	1.44	113	73.0
100 x 50 x 6.0 RHS	12.0	36.7	18.4	12.2	9.18	7.35	6.12	5.25	4.59	4.08	3.67	3.34	3.06	2.83	2.62	244	32.8
5.0 RHS	10.3	32.2	16.1	10.7	8.05	6.44	5.37	4.60	4.03	3.58	3.22	2.93	2.68	2.48	2.30	208	33.3
4.0 RHS	8.49	27.1	13.5	9.02	6.77	5.41	4.51	3.87	3.38	3.01	2.71	2.46	2.26	2.08	1.93	170	33.8
3.5 RHS	7.53	24.2	12.1	8.08	6.06	4.85	4.04	3.46	3.03	2.69	2.42	2.20	2.02	1.87	1.73	151	34.0
3.0 RHS	6.60	21.6	10.8	7.20	5.40	4.32	3.60	3.08	2.70	2.40	2.16	1.96	1.80	1.66	1.54	131	33.9
2.5 RHS	5.56	18.4	9.18	6.12	4.59	3.67	3.06	2.62	2.30	2.04	1.84	1.67	1.53	1.41	1.31	110	34.1
2.0 RHS	4.50	14.7	7.37	4.92	3.69	2.95	2.46	2.11	1.84	1.64	1.47	1.34	1.23	1.13	1.05	88.9	34.9
1.6 RHS	3.64	10.1	5.05	3.37	2.53	2.02	1.68	1.44	1.26	1.12	1.01	0.918	0.842	0.777	0.721	71.7	41.6

Notes:
1. FLR = $1.809\ (\pi^2 E\, I_y\, G\, J / M^2_{sx})^{0.5}$ (See Section *D*4.1.3 of these tables for explanation)
   FLR = Segment length for full lateral restraint ($\phi M_{bx} = \phi M_{sx}$)
2. ϕ = 0.9
3. α_m = 1.0
4. α_s = 1.0
5. W^*_{L1} = $2\ \phi\ M_s/L$
6. W^*_{L2} = $\phi\ V_v$

TABLE *D*8.4-1(1)(B)

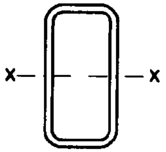
SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS

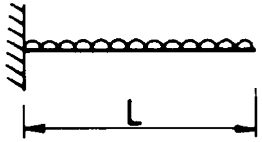
CANTILEVER BEAMS

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

bending about x-axis





W^*_{S1} = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250

Designation d b t (mm mm mm)			Mass per m (kg/m)	W^*_{S1} (kN) Span of Beam (L) in metres													
				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
150 x 50 x		6.0 RHS	16.7	32.4	8.10	3.60	2.02	1.30	0.899	0.661	0.506	0.400	0.324	0.268	0.225	0.192	0.165
		5.0 RHS	14.2	28.4	7.11	3.16	1.78	1.14	0.790	0.580	0.444	0.351	0.284	0.235	0.197	0.168	0.145
		4.0 RHS	11.6	23.9	5.98	2.66	1.49	0.956	0.664	0.488	0.374	0.295	0.239	0.198	0.166	0.141	0.122
		3.0 RHS	8.96	19.1	4.78	2.12	1.19	0.764	0.531	0.390	0.299	0.236	0.191	0.158	0.133	0.113	0.0975
		2.5 RHS	7.53	16.3	4.07	1.81	1.02	0.650	0.452	0.332	0.254	0.201	0.163	0.134	0.113	0.0962	0.0830
		2.0 RHS	6.07	13.3	3.32	1.48	0.830	0.531	0.369	0.271	0.208	0.164	0.133	0.110	0.0922	0.0786	0.0678
125 x 75 x		6.0 RHS	16.7	26.6	6.66	2.96	1.66	1.07	0.740	0.544	0.416	0.329	0.266	0.220	0.185	0.158	0.136
		5.0 RHS	14.2	23.3	5.83	2.59	1.46	0.932	0.647	0.476	0.364	0.288	0.233	0.193	0.162	0.138	0.119
		4.0 RHS	11.6	19.5	4.89	2.17	1.22	0.782	0.543	0.399	0.305	0.241	0.195	0.162	0.136	0.116	0.0997
		3.0 RHS	8.96	15.5	3.89	1.73	0.971	0.622	0.432	0.317	0.243	0.192	0.155	0.128	0.108	0.0920	0.0793
		2.5 RHS	7.53	13.2	3.30	1.47	0.826	0.529	0.367	0.270	0.207	0.163	0.132	0.109	0.0918	0.0782	0.0674
		2.0 RHS	6.07	10.8	2.70	1.20	0.674	0.431	0.300	0.220	0.169	0.133	0.108	0.0892	0.0749	0.0638	0.0550
100 x 50 x		6.0 RHS	12.0	10.9	2.74	1.22	0.684	0.438	0.304	0.223	0.171	0.135	0.109	0.0904	0.0760	0.0647	0.0558
		5.0 RHS	10.3	9.78	2.44	1.09	0.611	0.391	0.272	0.200	0.153	0.121	0.0978	0.0808	0.0679	0.0579	0.0499
		4.0 RHS	8.49	8.36	2.09	0.929	0.523	0.335	0.232	0.171	0.131	0.103	0.0836	0.0691	0.0581	0.0495	0.0427
		3.5 RHS	7.53	7.56	1.89	0.840	0.472	0.302	0.210	0.154	0.118	0.0933	0.0756	0.0625	0.0525	0.0447	0.0386
		3.0 RHS	6.60	6.81	1.70	0.757	0.426	0.273	0.189	0.139	0.106	0.0841	0.0681	0.0563	0.0473	0.0403	0.0348
		2.5 RHS	5.56	5.84	1.46	0.649	0.365	0.233	0.162	0.119	0.0912	0.0721	0.0584	0.0482	0.0405	0.0345	0.0298
		2.0 RHS	4.50	4.80	1.20	0.533	0.300	0.192	0.133	0.0979	0.0750	0.0592	0.0480	0.0397	0.0333	0.0284	0.0245
		1.6 RHS	3.64	3.92	0.981	0.436	0.245	0.157	0.109	0.0801	0.0613	0.0484	0.0392	0.0324	0.0272	0.0232	0.0200

Note: 1. Serviceabilty Load $W^*_{S1} = 8EI/(250L^2)$

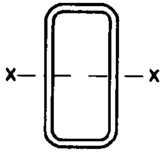


TABLE *D*8.4-1(2)(A)

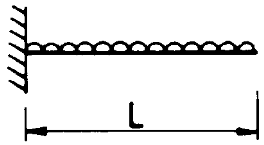
STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS

CANTILEVER BEAMS WITH FULL LATERAL RESTRAINT

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

bending about x-axis



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}

Designation d b t	Mass per m	W^*_{L1} (kN) Span of Beam (*L*) in metres														W^*_{L2}	FLR
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	kN	m
100 x 50 x 6.0 RHS	12.0	73.5	49.0	36.7	29.4	24.5	21.0	18.4	14.7	12.2	10.5	9.18	8.16	7.35	6.12	244	32.8
5.0 RHS	10.3	64.4	42.9	32.2	25.8	21.5	18.4	16.1	12.9	10.7	9.20	8.05	7.16	6.44	5.37	208	33.3
4.0 RHS	8.49	54.1	36.1	27.1	21.6	18.0	15.5	13.5	10.8	9.02	7.73	6.77	6.01	5.41	4.51	170	33.8
3.5 RHS	7.53	48.5	32.3	24.2	19.4	16.2	13.9	12.1	9.70	8.08	6.93	6.06	5.39	4.85	4.04	151	34.0
3.0 RHS	6.60	43.2	28.8	21.6	17.3	14.4	12.3	10.8	8.64	7.20	6.17	5.40	4.80	4.32	3.60	131	33.9
2.5 RHS	5.56	36.7	24.5	18.4	14.7	12.2	10.5	9.18	7.35	6.12	5.25	4.59	4.08	3.67	3.06	110	34.1
2.0 RHS	4.50	29.5	19.7	14.7	11.8	9.83	8.43	7.37	5.90	4.92	4.21	3.69	3.28	2.95	2.46	88.9	34.9
1.6 RHS	3.64	20.2	13.5	10.1	8.08	6.73	5.77	5.05	4.04	3.37	2.89	2.53	2.24	2.02	1.68	71.7	41.6
75 x 50 x 6.0 RHS	9.67	45.5	30.3	22.7	18.2	15.2	13.0	11.4	9.09	7.58	6.49	5.68	5.05	4.55	3.79	178	37.1
5.0 RHS	8.35	40.3	26.9	20.2	16.1	13.4	11.5	10.1	8.07	6.72	5.76	5.04	4.48	4.03	3.36	153	37.5
4.0 RHS	6.92	34.3	22.8	17.1	13.7	11.4	9.79	8.56	6.85	5.71	4.89	4.28	3.81	3.43	2.85	126	38.0
3.0 RHS	5.42	27.7	18.5	13.8	11.1	9.23	7.91	6.92	5.54	4.61	3.95	3.46	3.08	2.77	2.31	97.4	37.9
2.5 RHS	4.58	23.6	15.8	11.8	9.46	7.88	6.75	5.91	4.73	3.94	3.38	2.95	2.63	2.36	1.97	82.3	38.1
2.0 RHS	3.72	19.1	12.7	9.54	7.64	6.36	5.45	4.77	3.82	3.18	2.73	2.39	2.12	1.91	1.59	66.8	38.9
1.6 RHS	3.01	13.4	8.92	6.69	5.35	4.46	3.82	3.34	2.68	2.23	1.91	1.67	1.49	1.34	1.11	54.0	45.4
75 x 25 x 2.5 RHS	3.60	16.3	10.9	8.15	6.52	5.43	4.66	4.07	3.26	2.72	2.33	2.04	1.81	1.63	1.36	79.1	13.3
2.0 RHS	2.93	13.5	8.97	6.73	5.38	4.49	3.85	3.36	2.69	2.24	1.92	1.68	1.50	1.35	1.12	64.2	13.5
1.6 RHS	2.38	11.0	7.36	5.52	4.42	3.68	3.15	2.76	2.21	1.84	1.58	1.38	1.23	1.10	0.920	51.9	13.8
65 x 35 x 4.0 RHS	5.35	21.5	14.3	10.8	8.60	7.17	6.15	5.38	4.30	3.59	3.07	2.69	2.39	2.15	1.79	106	23.9
3.0 RHS	4.25	17.8	11.9	8.90	7.12	5.94	5.09	4.45	3.56	2.97	2.54	2.23	1.98	1.78	1.48	82.3	24.1
2.5 RHS	3.60	15.3	10.2	7.66	6.13	5.10	4.38	3.83	3.06	2.55	2.19	1.91	1.70	1.53	1.28	69.7	24.3
2.0 RHS	2.93	12.6	8.42	6.32	5.05	4.21	3.61	3.16	2.53	2.11	1.81	1.58	1.40	1.26	1.05	56.7	24.5
50 x 25 x 3.0 RHS	3.07	9.50	6.33	4.75	3.80	3.17	2.71	2.37	1.90	1.58	1.36	1.19	1.06	0.950	0.791	61.1	16.2
2.5 RHS	2.62	8.27	5.51	4.14	3.31	2.76	2.36	2.07	1.65	1.38	1.18	1.03	0.919	0.827	0.689	52.1	16.4
2.0 RHS	2.15	6.91	4.60	3.45	2.76	2.30	1.97	1.73	1.38	1.15	0.986	0.863	0.767	0.691	0.575	42.6	16.7
1.6 RHS	1.75	5.71	3.81	2.86	2.28	1.90	1.63	1.43	1.14	0.952	0.816	0.714	0.635	0.571	0.476	34.7	16.9
50 x 20 x 3.0 RHS	2.83	8.36	5.57	4.18	3.34	2.79	2.39	2.09	1.67	1.39	1.19	1.04	0.928	0.836	0.696	60.3	11.2
2.5 RHS	2.42	7.31	4.87	3.65	2.92	2.44	2.09	1.83	1.46	1.22	1.04	0.914	0.812	0.731	0.609	51.4	11.5
2.0 RHS	1.99	6.13	4.08	3.06	2.45	2.04	1.75	1.53	1.23	1.02	0.875	0.766	0.681	0.613	0.511	42.0	11.8
1.6 RHS	1.63	5.08	3.39	2.54	2.03	1.69	1.45	1.27	1.02	0.847	0.726	0.635	0.565	0.508	0.424	34.2	12.0

Notes:
1. FLR = $1.809\ (\pi^2 E\ I_y\ G\ J\ /\ M^2_{sx})^{0.5}$ (See Section *D*4.1.3 of these tables for explanation)
   FLR = Segment length for full lateral restraint ($\phi M_{bx} = \phi M_{sx}$)
2. ϕ = 0.9
3. α_m = 1.0
4. α_s = 1.0
5. W^*_{L1} = $2\ \phi\ M_s/L$
6. W^*_{L2} = $\phi\ V_v$

TABLE *D*8.4-1(2)(B)

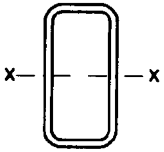
SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS

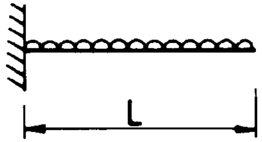
CANTILEVER BEAMS

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

bending about x-axis





W^*_{S1} = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250

Designation d b t (mm mm mm)	Mass per m (kg/m)	W^*_{S1} (kN) Span of Beam (*L*) in metres: 0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0
100x 50 x 6.0 RHS	12.0	43.8	19.5	10.9	7.00	4.86	3.57	2.74	1.75	1.22	0.893	0.684	0.540	0.438	0.304
5.0 RHS	10.3	39.1	17.4	9.78	6.26	4.35	3.19	2.44	1.56	1.09	0.798	0.611	0.483	0.391	0.272
4.0 RHS	8.49	33.5	14.9	8.36	5.35	3.72	2.73	2.09	1.34	0.929	0.683	0.523	0.413	0.335	0.232
3.5 RHS	7.53	30.2	13.4	7.56	4.84	3.36	2.47	1.89	1.21	0.840	0.617	0.472	0.373	0.302	0.210
3.0 RHS	6.60	27.3	12.1	6.81	4.36	3.03	2.22	1.70	1.09	0.757	0.556	0.426	0.336	0.273	0.189
2.5 RHS	5.56	23.3	10.4	5.84	3.74	2.59	1.91	1.46	0.934	0.649	0.476	0.365	0.288	0.233	0.162
2.0 RHS	4.50	19.2	8.53	4.80	3.07	2.13	1.57	1.20	0.768	0.533	0.392	0.300	0.237	0.192	0.133
1.6 RHS	3.64	15.7	6.97	3.92	2.51	1.74	1.28	0.981	0.628	0.436	0.320	0.245	0.194	0.157	0.109
75 x 50 x 6.0 RHS	9.67	20.5	9.10	5.12	3.28	2.28	1.67	1.28	0.819	0.569	0.418	0.320	0.253	0.205	0.142
5.0 RHS	8.35	18.6	8.26	4.65	2.97	2.07	1.52	1.16	0.743	0.516	0.379	0.290	0.229	0.186	0.129
4.0 RHS	6.92	16.1	7.17	4.03	2.58	1.79	1.32	1.01	0.645	0.448	0.329	0.252	0.199	0.161	0.112
3.0 RHS	5.42	13.4	5.94	3.34	2.14	1.48	1.09	0.835	0.534	0.371	0.273	0.209	0.165	0.134	0.0927
2.5 RHS	4.58	11.5	5.11	2.88	1.84	1.28	0.939	0.719	0.460	0.320	0.235	0.180	0.142	0.115	0.0799
2.0 RHS	3.72	9.51	4.23	2.38	1.52	1.06	0.777	0.595	0.381	0.264	0.194	0.149	0.117	0.0951	0.0661
1.6 RHS	3.01	7.81	3.47	1.95	1.25	0.868	0.638	0.488	0.312	0.217	0.159	0.122	0.0964	0.0781	0.0542
75 x 25 x 2.5 RHS	3.60	7.30	3.24	1.83	1.17	0.811	0.596	0.456	0.292	0.203	0.149	0.114	0.0901	0.0730	0.0507
2.0 RHS	2.93	6.10	2.71	1.53	0.976	0.678	0.498	0.381	0.244	0.170	0.125	0.0953	0.0753	0.0610	0.0424
1.6 RHS	2.38	5.05	2.25	1.26	0.808	0.561	0.412	0.316	0.202	0.140	0.103	0.0789	0.0624	0.0505	0.0351
65 x 35 x 4.0 RHS	5.35	8.40	3.73	2.10	1.34	0.934	0.686	0.525	0.336	0.233	0.171	0.131	0.104	0.0840	0.0583
3.0 RHS	4.25	7.19	3.20	1.80	1.15	0.799	0.587	0.450	0.288	0.200	0.147	0.112	0.0888	0.0719	0.0500
2.5 RHS	3.60	6.26	2.78	1.56	1.00	0.695	0.511	0.391	0.250	0.174	0.128	0.0978	0.0773	0.0626	0.0435
2.0 RHS	2.93	5.22	2.32	1.31	0.836	0.580	0.426	0.326	0.209	0.145	0.107	0.0816	0.0645	0.0522	0.0363
50 x 25 x 3.0 RHS	3.07	2.86	1.27	0.715	0.458	0.318	0.233	0.179	0.114	0.0794	0.0584	0.0447	0.0353	0.0286	0.0199
2.5 RHS	2.62	2.53	1.12	0.633	0.405	0.281	0.207	0.158	0.101	0.0703	0.0517	0.0395	0.0312	0.0253	0.0176
2.0 RHS	2.15	2.15	0.954	0.537	0.343	0.238	0.175	0.134	0.0858	0.0596	0.0438	0.0335	0.0265	0.0215	0.0149
1.6 RHS	1.75	1.80	0.799	0.449	0.287	0.200	0.147	0.112	0.0719	0.0499	0.0367	0.0281	0.0222	0.0180	0.0125
50 x 20 x 3.0 RHS	2.83	2.44	1.08	0.609	0.390	0.271	0.199	0.152	0.0974	0.0676	0.0497	0.0381	0.0301	0.0244	0.0169
2.5 RHS	2.42	2.17	0.964	0.542	0.347	0.241	0.177	0.136	0.0868	0.0603	0.0443	0.0339	0.0268	0.0217	0.0151
2.0 RHS	1.99	1.85	0.823	0.463	0.296	0.206	0.151	0.116	0.0740	0.0514	0.0378	0.0289	0.0229	0.0185	0.0129
1.6 RHS	1.63	1.56	0.692	0.389	0.249	0.173	0.127	0.0973	0.0623	0.0432	0.0318	0.0243	0.0192	0.0156	0.0108

Note: 1. Serviceabilty Load $W^*_{S1} = 8EI / (250L^2)$

TABLE *D*8.4-2(A)

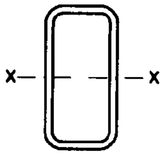
STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS

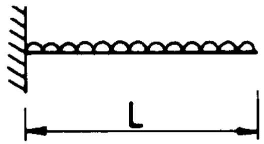
CANTILEVER BEAMS WITH FULL LATERAL RESTRAINT

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Non-Standard Thickness

bending about x-axis





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}

Designation d b t	Mass per m	W^*_{L1} (kN) Span of Beam (*L*) in metres														W^*_{L2}	FLR
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	kN	m
125 x 75 x 2.8 RHS	8.39	67.8	45.2	33.9	27.1	22.6	19.4	16.9	13.6	11.3	9.68	8.47	7.53	6.78	5.65	156	58.8
2.3 RHS	6.95	49.0	32.7	24.5	19.6	16.3	14.0	12.3	9.80	8.17	7.00	6.13	5.44	4.90	4.08	129	68.1
100 x 50 x 2.8 RHS	6.19	40.6	27.1	20.3	16.3	13.5	11.6	10.2	8.13	6.77	5.81	5.08	4.52	4.06	3.39	122	34.0
2.3 RHS	5.14	34.1	22.7	17.0	13.6	11.4	9.73	8.52	6.81	5.68	4.87	4.26	3.78	3.41	2.84	102	34.2
75 x 50 x 2.8 RHS	5.09	26.1	17.4	13.0	10.4	8.70	7.45	6.52	5.22	4.35	3.73	3.26	2.90	2.61	2.17	91.4	38.0
2.3 RHS	4.24	22.0	14.6	11.0	8.78	7.32	6.27	5.49	4.39	3.66	3.14	2.74	2.44	2.20	1.83	76.2	38.2
65 x 35 x 2.8 RHS	3.99	16.8	11.2	8.42	6.73	5.61	4.81	4.21	3.37	2.81	2.40	2.10	1.87	1.68	1.40	77.3	24.1
2.3 RHS	3.34	14.3	9.51	7.13	5.71	4.76	4.08	3.57	2.85	2.38	2.04	1.78	1.59	1.43	1.19	64.6	24.4
50 x 25 x 2.8 RHS	2.89	9.02	6.02	4.51	3.61	3.01	2.58	2.26	1.80	1.50	1.29	1.13	1.00	0.902	0.752	57.5	16.3
2.3 RHS	2.44	7.74	5.16	3.87	3.10	2.58	2.21	1.94	1.55	1.29	1.11	0.968	0.860	0.774	0.645	48.3	16.5
50 x 20 x 2.8 RHS	2.67	7.95	5.30	3.98	3.18	2.65	2.27	1.99	1.59	1.33	1.14	0.994	0.884	0.795	0.663	56.8	11.3
2.3 RHS	2.25	6.85	4.57	3.43	2.74	2.28	1.96	1.71	1.37	1.14	0.979	0.857	0.761	0.685	0.571	47.7	11.6

Notes:
1. FLR = $1.809\ (\pi^2 E I_y G J / M^2_{sx})^{0.5}$ (See Section *D*4.1.3 of these tables for explanation)
   FLR = Segment length for full lateral restraint ($\phi M_{bx} = \phi M_{sx}$)
2. ϕ = 0.9
3. α_m = 1.0
4. α_s = 1.0
5. W^*_{L1} = $2 \phi M_s / L$
6. W^*_{L2} = ϕV_v

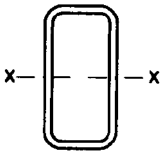


TABLE *D*8.4-2(B)

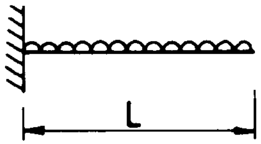
SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS

CANTILEVER BEAMS

DuraGal RECTANGULAR HOLLOW SECTIONS: GRADE C450L0

Non-Standard Thickness

bending about x-axis



W^*_{S1} = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250

Designation d b t	Mass per m	W^*_{S1} (kN) Span of Beam (L) in metres													
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0
125 x 75 x 2.8 RHS	8.39	58.5	26.0	14.6	9.36	6.50	4.78	3.66	2.34	1.62	1.19	0.914	0.722	0.585	0.406
2.3 RHS	6.95	49.0	21.8	12.3	7.84	5.45	4.00	3.06	1.96	1.36	1.00	0.766	0.605	0.490	0.340
100 x 50 x 2.8 RHS	6.19	25.7	11.4	6.43	4.12	2.86	2.10	1.61	1.03	0.714	0.525	0.402	0.318	0.257	0.179
2.3 RHS	5.14	21.7	9.65	5.43	3.47	2.41	1.77	1.36	0.869	0.603	0.443	0.339	0.268	0.217	0.151
75 x 50 x 2.8 RHS	5.09	12.6	5.61	3.16	2.02	1.40	1.03	0.790	0.505	0.351	0.258	0.197	0.156	0.126	0.0877
2.3 RHS	4.24	10.7	4.77	2.68	1.72	1.19	0.876	0.670	0.429	0.298	0.219	0.168	0.132	0.107	0.0745
65 x 35 x 2.8 RHS	3.99	6.83	3.04	1.71	1.09	0.759	0.558	0.427	0.273	0.190	0.139	0.107	0.0843	0.0683	0.0474
2.3 RHS	3.34	5.86	2.60	1.46	0.937	0.651	0.478	0.366	0.234	0.163	0.120	0.0915	0.0723	0.0586	0.0407
50 x 25 x 2.8 RHS	2.89	2.73	1.22	0.684	0.438	0.304	0.223	0.171	0.109	0.0760	0.0558	0.0427	0.0338	0.0273	0.0190
2.3 RHS	2.44	2.38	1.06	0.596	0.381	0.265	0.195	0.149	0.0954	0.0662	0.0487	0.0372	0.0294	0.0238	0.0166
50 x 20 x 2.8 RHS	2.67	2.34	1.04	0.584	0.374	0.259	0.191	0.146	0.0934	0.0649	0.0477	0.0365	0.0288	0.0234	0.0162
2.3 RHS	2.25	2.05	0.911	0.512	0.328	0.228	0.167	0.128	0.0819	0.0569	0.0418	0.0320	0.0253	0.0205	0.0142

Note: 1. Serviceabilty Load $W^*_{S1} = 8EI / (250L^2)$

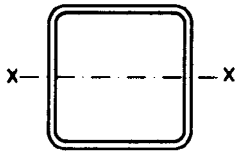
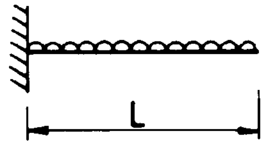


TABLE *D*8.4-3(1)(A)

STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS

CANTILEVER BEAMS WITH FULL LATERAL RESTRAINT
***DuraGal* SQUARE HOLLOW SECTIONS: GRADE C450L0**
Standard Thickness
bending about x-axis



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}

Designation d b t	Mass per m	W^*_{L1} (kN) Span of Beam (*L*) in metres														W^*_{L2}
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
100 x 100 x 6.0 SHS	16.7	59.6	29.8	19.9	14.9	11.9	9.93	8.51	7.45	6.62	5.96	5.42	4.96	4.58	4.25	253
5.0 SHS	14.2	51.4	25.7	17.1	12.9	10.3	8.57	7.35	6.43	5.72	5.14	4.68	4.29	3.96	3.67	216
4.0 SHS	11.6	42.1	21.0	14.0	10.5	8.41	7.01	6.01	5.26	4.67	4.21	3.82	3.50	3.23	3.00	177
3.0 SHS	8.96	30.1	15.0	10.0	7.52	6.01	5.01	4.30	3.76	3.34	3.01	2.73	2.51	2.31	2.15	135
2.5 SHS	7.53	22.7	11.4	7.58	5.69	4.55	3.79	3.25	2.84	2.53	2.27	2.07	1.90	1.75	1.62	114
2.0 SHS	6.07	16.3	8.13	5.42	4.07	3.25	2.71	2.32	2.03	1.81	1.63	1.48	1.36	1.25	1.16	92.2
90 x 90 x 3.0 SHS	8.01	23.8	11.9	7.95	5.96	4.77	3.97	3.41	2.98	2.65	2.38	2.17	1.99	1.83	1.70	121
2.5 SHS	6.74	19.5	9.74	6.49	4.87	3.89	3.25	2.78	2.43	2.16	1.95	1.77	1.62	1.50	1.39	102
2.0 SHS	5.45	13.9	6.94	4.63	3.47	2.78	2.31	1.98	1.73	1.54	1.39	1.26	1.16	1.07	0.991	82.6
1.6 SHS	4.39	9.97	4.98	3.32	2.49	1.99	1.66	1.42	1.25	1.11	0.997	0.906	0.831	0.767	0.712	66.7
89 x 89 x 6.0 SHS	9.06	28.9	14.5	9.64	7.23	5.78	4.82	4.13	3.61	3.21	2.89	2.63	2.41	2.22	2.06	138
5.0 SHS	12.5	39.8	19.9	13.3	9.94	7.95	6.63	5.68	4.97	4.42	3.98	3.62	3.31	3.06	2.84	189
3.5 SHS	14.6	45.8	22.9	15.3	11.5	9.16	7.63	6.54	5.73	5.09	4.58	4.16	3.82	3.52	3.27	221
75 x 75 x 6.0 SHS	12.0	31.1	15.6	10.4	7.78	6.22	5.19	4.44	3.89	3.46	3.11	2.83	2.59	2.39	2.22	181
5.0 SHS	10.3	27.3	13.6	9.08	6.81	5.45	4.54	3.89	3.41	3.03	2.73	2.48	2.27	2.10	1.95	156
4.0 SHS	8.49	22.9	11.4	7.63	5.72	4.58	3.81	3.27	2.86	2.54	2.29	2.08	1.91	1.76	1.63	129
3.5 SHS	7.53	20.5	10.2	6.83	5.12	4.10	3.42	2.93	2.56	2.28	2.05	1.86	1.71	1.58	1.46	114
3.0 SHS	6.60	18.0	8.99	5.99	4.49	3.60	3.00	2.57	2.25	2.00	1.80	1.63	1.50	1.38	1.28	99.4
2.5 SHS	5.56	13.8	6.90	4.60	3.45	2.76	2.30	1.97	1.73	1.53	1.38	1.25	1.15	1.06	0.986	84.0
2.0 SHS	4.50	10.6	5.29	3.53	2.65	2.12	1.76	1.51	1.32	1.18	1.06	0.962	0.882	0.814	0.756	68.2

Notes:
1. ϕ = 0.9
2. α_m = 1.0
3. α_s = 1.0
4. W^*_{L1} = $2 \phi M_s / L$
5. W^*_{L2} = ϕV_v

TABLE *D*8.4-3(1)(B)

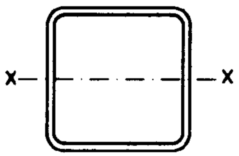
SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS

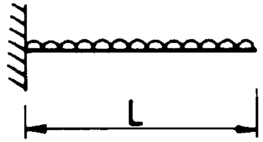
CANTILEVER BEAMS

***DuraGal* SQUARE HOLLOW SECTIONS: GRADE C450L0**

Standard Thickness

bending about x-axis





W^*_{S1} = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250

Designation d b t (mm mm mm)	Mass per m (kg/m)	W^*_{S1} (kN) Span of Beam (L) in metres 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
100 x 100 x 6.0 SHS	16.7	19.4	4.86	2.16	1.21	0.777	0.540	0.397	0.304	0.240	0.194	0.161	0.135	0.115	0.0992
5.0 SHS	14.2	17.0	4.25	1.89	1.06	0.680	0.472	0.347	0.266	0.210	0.170	0.141	0.118	0.101	0.0868
4.0 SHS	11.6	14.3	3.57	1.59	0.892	0.571	0.396	0.291	0.223	0.176	0.143	0.118	0.0991	0.0844	0.0728
3.0 SHS	8.96	11.3	2.83	1.26	0.708	0.453	0.315	0.231	0.177	0.140	0.113	0.0936	0.0787	0.0670	0.0578
2.5 SHS	7.53	9.64	2.41	1.07	0.603	0.386	0.268	0.197	0.151	0.119	0.0964	0.0797	0.0669	0.0570	0.0492
2.0 SHS	6.07	7.87	1.97	0.875	0.492	0.315	0.219	0.161	0.123	0.0972	0.0787	0.0651	0.0547	0.0466	0.0402
90 x 90 x 3.0 SHS	8.01	8.15	2.04	0.905	0.509	0.326	0.226	0.166	0.127	0.101	0.0815	0.0673	0.0566	0.0482	0.0416
2.5 SHS	6.74	6.95	1.74	0.772	0.434	0.278	0.193	0.142	0.109	0.0858	0.0695	0.0574	0.0482	0.0411	0.0354
2.0 SHS	5.45	5.69	1.42	0.632	0.355	0.227	0.158	0.116	0.0889	0.0702	0.0569	0.0470	0.0395	0.0337	0.0290
1.6 SHS	4.39	4.63	1.16	0.515	0.290	0.185	0.129	0.0946	0.0724	0.0572	0.0463	0.0383	0.0322	0.0274	0.0236
89 x 89 x 6.0 SHS	9.06	8.80	2.20	0.977	0.550	0.352	0.244	0.180	0.137	0.109	0.0880	0.0727	0.0611	0.0520	0.0449
5.0 SHS	12.5	11.6	2.90	1.29	0.724	0.464	0.322	0.237	0.181	0.143	0.116	0.0958	0.0805	0.0686	0.0591
3.5 SHS	14.6	13.2	3.29	1.46	0.822	0.526	0.365	0.268	0.206	0.162	0.132	0.109	0.0914	0.0778	0.0671
75 x 75 x 6.0 SHS	12.0	7.41	1.85	0.823	0.463	0.296	0.206	0.151	0.116	0.0915	0.0741	0.0612	0.0515	0.0438	0.0378
5.0 SHS	10.3	6.61	1.65	0.734	0.413	0.264	0.184	0.135	0.103	0.0816	0.0661	0.0546	0.0459	0.0391	0.0337
4.0 SHS	8.49	5.65	1.41	0.627	0.353	0.226	0.157	0.115	0.0882	0.0697	0.0565	0.0467	0.0392	0.0334	0.0288
3.5 SHS	7.53	5.10	1.28	0.567	0.319	0.204	0.142	0.104	0.0797	0.0630	0.0510	0.0422	0.0354	0.0302	0.0260
3.0 SHS	6.60	4.58	1.15	0.509	0.286	0.183	0.127	0.0935	0.0716	0.0566	0.0458	0.0379	0.0318	0.0271	0.0234
2.5 SHS	5.56	3.93	0.982	0.436	0.246	0.157	0.109	0.0802	0.0614	0.0485	0.0393	0.0325	0.0273	0.0232	0.0200
2.0 SHS	4.50	3.23	0.808	0.359	0.202	0.129	0.0898	0.0659	0.0505	0.0399	0.0323	0.0267	0.0224	0.0191	0.0165

Note: 1. Serviceabilty Load $W^*_{S1} = 8EI / (250L^2)$

TABLE *D*8.4-3(2)(A)

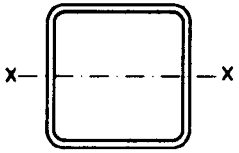
STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS

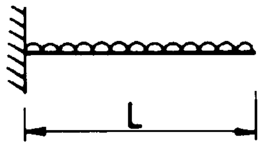
CANTILEVER BEAMS WITH FULL LATERAL RESTRAINT

DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

bending about x-axis





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}

Designation d b t	Mass per m	W^*_{L1} (kN) Span of Beam (*L*) in metres														W^*_{L2}
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	kN
75 x 75 x 6.0 SHS	12.0	62.2	41.5	31.1	24.9	20.7	17.8	15.6	12.4	10.4	8.89	7.78	6.91	6.22	5.19	181
5.0 SHS	10.3	54.5	36.3	27.3	21.8	18.2	15.6	13.6	10.9	9.08	7.79	6.81	6.06	5.45	4.54	156
4.0 SHS	8.49	45.8	30.5	22.9	18.3	15.3	13.1	11.4	9.15	7.63	6.54	5.72	5.08	4.58	3.81	129
3.5 SHS	7.53	41.0	27.3	20.5	16.4	13.7	11.7	10.2	8.20	6.83	5.86	5.12	4.55	4.10	3.42	114
3.0 SHS	6.60	36.0	24.0	18.0	14.4	12.0	10.3	8.99	7.19	5.99	5.14	4.49	4.00	3.60	3.00	99.4
2.5 SHS	5.56	27.6	18.4	13.8	11.0	9.20	7.89	6.90	5.52	4.60	3.94	3.45	3.07	2.76	2.30	84.0
2.0 SHS	4.50	19.7	13.1	9.83	7.86	6.55	5.62	4.91	3.93	3.28	2.81	2.46	2.18	1.97	1.64	68.2
65 x 65 x 6.0 SHS	10.1	44.6	29.7	22.3	17.8	14.9	12.7	11.1	8.91	7.43	6.37	5.57	4.95	4.46	3.71	153
5.0 SHS	8.75	39.4	26.3	19.7	15.8	13.1	11.3	9.85	7.88	6.57	5.63	4.93	4.38	3.94	3.28	132
4.0 SHS	7.23	33.4	22.2	16.7	13.3	11.1	9.53	8.34	6.67	5.56	4.77	4.17	3.71	3.34	2.78	109
3.0 SHS	5.66	26.8	17.9	13.4	10.7	8.95	7.67	6.71	5.37	4.47	3.84	3.36	2.98	2.68	2.24	85.0
2.5 SHS	4.78	22.2	14.8	11.1	8.86	7.39	6.33	5.54	4.43	3.69	3.17	2.77	2.46	2.22	1.85	72.0
2.0 SHS	3.88	15.9	10.6	7.94	6.35	5.29	4.54	3.97	3.18	2.65	2.27	1.99	1.76	1.59	1.32	58.6
1.6 SHS	3.13	11.4	7.57	5.68	4.54	3.78	3.24	2.84	2.27	1.89	1.62	1.42	1.26	1.14	0.946	47.5
50 x 50 x 5.0 SHS	6.39	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	96.0
4.0 SHS	5.35	18.4	12.3	9.22	7.38	6.15	5.27	4.61	3.69	3.07	2.63	2.30	2.05	1.84	1.54	80.6
3.0 SHS	4.25	15.2	10.1	7.60	6.08	5.07	4.35	3.80	3.04	2.53	2.17	1.90	1.69	1.52	1.27	63.4
2.5 SHS	3.60	13.1	8.72	6.54	5.23	4.36	3.74	3.27	2.62	2.18	1.87	1.63	1.45	1.31	1.09	54.0
2.0 SHS	2.93	10.7	7.10	5.33	4.26	3.55	3.04	2.66	2.13	1.78	1.52	1.33	1.18	1.07	0.888	44.2
1.6 SHS	2.38	7.68	5.12	3.84	3.07	2.56	2.19	1.92	1.54	1.28	1.10	0.960	0.853	0.768	0.640	35.9
40 x 40 x 4.0 SHS	4.09	10.9	7.27	5.46	4.36	3.64	3.12	2.73	2.18	1.82	1.56	1.36	1.21	1.09	0.909	61.4
3.0 SHS	3.30	9.27	6.18	4.64	3.71	3.09	2.65	2.32	1.85	1.55	1.32	1.16	1.03	0.927	0.773	49.0
2.5 SHS	2.82	8.05	5.36	4.02	3.22	2.68	2.30	2.01	1.61	1.34	1.15	1.01	0.894	0.805	0.671	42.0
2.0 SHS	2.31	6.70	4.46	3.35	2.68	2.23	1.91	1.67	1.34	1.12	0.957	0.837	0.744	0.670	0.558	34.6
1.6 SHS	1.88	5.45	3.64	2.73	2.18	1.82	1.56	1.36	1.09	0.909	0.779	0.682	0.606	0.545	0.455	28.3
35 x 35 x 3.0 SHS	2.83	6.85	4.57	3.43	2.74	2.28	1.96	1.71	1.37	1.14	0.979	0.856	0.761	0.685	0.571	41.8
2.5 SHS	2.42	5.99	3.99	2.99	2.39	2.00	1.71	1.50	1.20	0.998	0.855	0.748	0.665	0.599	0.499	36.0
2.0 SHS	1.99	5.01	3.34	2.51	2.01	1.67	1.43	1.25	1.00	0.836	0.716	0.627	0.557	0.501	0.418	29.8
1.6 SHS	1.63	4.16	2.77	2.08	1.66	1.39	1.19	1.04	0.831	0.693	0.594	0.520	0.462	0.416	0.346	24.4
30 x 30 x 2.0 SHS	1.68	3.57	2.38	1.79	1.43	1.19	1.02	0.893	0.715	0.595	0.510	0.447	0.397	0.357	0.298	25.0
1.6 SHS	1.38	2.98	1.99	1.49	1.19	0.994	0.852	0.746	0.596	0.497	0.426	0.373	0.331	0.298	0.249	20.6
25 x 25 x 2.5 SHS	1.64	2.77	1.85	1.39	1.11	0.925	0.793	0.694	0.555	0.462	0.396	0.347	0.308	0.277	0.231	24.0
2.0 SHS	1.36	2.38	1.58	1.19	0.950	0.792	0.679	0.594	0.475	0.396	0.339	0.297	0.264	0.238	0.198	20.2
1.6 SHS	1.12	2.00	1.33	1.00	0.801	0.667	0.572	0.500	0.400	0.334	0.286	0.250	0.222	0.200	0.167	16.7
20 x 20 x 1.6 SHS	0.873	1.22	0.811	0.608	0.486	0.405	0.347	0.304	0.243	0.203	0.174	0.152	0.135	0.122	0.101	12.9

Notes: 1. ϕ = 0.9 2. α_m = 1.0 3. α_s = 1.0 4. $W^*_{L1} = 2\,\phi\, M_s/L$ 5. $W^*_{L2} = \phi\, V_v$

DCTDHS/06 MARCH 2002

TABLE *D*8.4-3(2)(B)

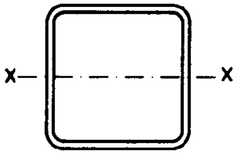
SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS

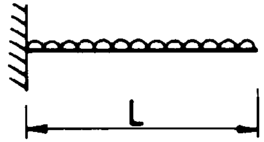
CANTILEVER BEAMS

DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0

Standard Thickness

bending about x-axis





W^*_{S1} = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250

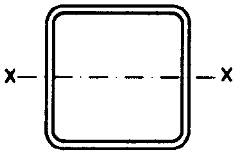
Designation d b t	Mass per m	W^*_{S1} (kN) Span of Beam (*L*) in metres													
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0
75 x 75 x 6.0 SHS	12.0	29.6	13.2	7.41	4.74	3.29	2.42	1.85	1.19	0.823	0.605	0.463	0.366	0.296	0.206
5.0 SHS	10.3	26.4	11.8	6.61	4.23	2.94	2.16	1.65	1.06	0.734	0.540	0.413	0.326	0.264	0.184
4.0 SHS	8.49	22.6	10.0	5.65	3.61	2.51	1.84	1.41	0.904	0.627	0.461	0.353	0.279	0.226	0.157
3.5 SHS	7.53	20.4	9.07	5.10	3.27	2.27	1.67	1.28	0.816	0.567	0.417	0.319	0.252	0.204	0.142
3.0 SHS	6.60	18.3	8.15	4.58	2.93	2.04	1.50	1.15	0.733	0.509	0.374	0.286	0.226	0.183	0.127
2.5 SHS	5.56	15.7	6.98	3.93	2.51	1.75	1.28	0.982	0.629	0.436	0.321	0.246	0.194	0.157	0.109
2.0 SHS	4.50	12.9	5.74	3.23	2.07	1.44	1.06	0.808	0.517	0.359	0.264	0.202	0.160	0.129	0.0898
65 x 65 x 6.0 SHS	10.1	18.1	8.04	4.52	2.89	2.01	1.48	1.13	0.723	0.502	0.369	0.283	0.223	0.181	0.126
5.0 SHS	8.75	16.3	7.26	4.08	2.61	1.82	1.33	1.02	0.654	0.454	0.333	0.255	0.202	0.163	0.113
4.0 SHS	7.23	14.1	6.28	3.53	2.26	1.57	1.15	0.883	0.565	0.392	0.288	0.221	0.174	0.141	0.0981
3.0 SHS	5.66	11.6	5.17	2.91	1.86	1.29	0.949	0.727	0.465	0.323	0.237	0.182	0.144	0.116	0.0807
2.5 SHS	4.78	10.0	4.45	2.50	1.60	1.11	0.817	0.626	0.400	0.278	0.204	0.156	0.124	0.100	0.0695
2.0 SHS	3.88	8.27	3.68	2.07	1.32	0.919	0.675	0.517	0.331	0.230	0.169	0.129	0.102	0.0827	0.0574
1.6 SHS	3.13	6.79	3.02	1.70	1.09	0.754	0.554	0.424	0.272	0.189	0.139	0.106	0.0838	0.0679	0.0471
50 x 50 x 5.0 SHS	6.39	6.58	2.92	1.64	1.05	0.731	0.537	0.411	0.263	0.183	0.134	0.103	0.0812	0.0658	0.0457
4.0 SHS	5.35	5.86	2.60	1.46	0.937	0.651	0.478	0.366	0.234	0.163	0.119	0.0915	0.0723	0.0586	0.0407
3.0 SHS	4.25	4.98	2.21	1.25	0.797	0.554	0.407	0.311	0.199	0.138	0.102	0.0779	0.0615	0.0498	0.0346
2.5 SHS	3.60	4.34	1.93	1.08	0.694	0.482	0.354	0.271	0.174	0.120	0.0885	0.0678	0.0536	0.0434	0.0301
2.0 SHS	2.93	3.62	1.61	0.905	0.579	0.402	0.296	0.226	0.145	0.101	0.0739	0.0566	0.0447	0.0362	0.0252
1.6 SHS	2.38	3.00	1.33	0.749	0.479	0.333	0.245	0.187	0.120	0.0832	0.0612	0.0468	0.0370	0.0300	0.0208
40 x 40 x 4.0 SHS	4.09	2.69	1.20	0.674	0.431	0.299	0.220	0.168	0.108	0.0748	0.0550	0.0421	0.0333	0.0269	0.0187
3.0 SHS	3.30	2.39	1.06	0.597	0.382	0.265	0.195	0.149	0.0955	0.0663	0.0487	0.0373	0.0295	0.0239	0.0166
2.5 SHS	2.82	2.10	0.935	0.526	0.336	0.234	0.172	0.131	0.0841	0.0584	0.0429	0.0329	0.0260	0.0210	0.0146
2.0 SHS	2.31	1.78	0.790	0.444	0.284	0.197	0.145	0.111	0.0711	0.0494	0.0363	0.0278	0.0219	0.0178	0.0123
1.6 SHS	1.88	1.48	0.659	0.371	0.237	0.165	0.121	0.0927	0.0593	0.0412	0.0303	0.0232	0.0183	0.0148	0.0103
35 x 35 x 3.0 SHS	2.83	1.52	0.677	0.381	0.244	0.169	0.124	0.0952	0.0609	0.0423	0.0311	0.0238	0.0188	0.0152	0.0106
2.5 SHS	2.42	1.35	0.602	0.339	0.217	0.150	0.111	0.0846	0.0542	0.0376	0.0276	0.0212	0.0167	0.0135	0.00940
2.0 SHS	1.99	1.15	0.513	0.288	0.185	0.128	0.0942	0.0721	0.0462	0.0321	0.0235	0.0180	0.0142	0.0115	0.00801
1.6 SHS	1.63	0.970	0.431	0.242	0.155	0.108	0.0792	0.0606	0.0388	0.0269	0.0198	0.0152	0.0120	0.00970	0.00674
30 x 30 x 2.0 SHS	1.68	0.697	0.310	0.174	0.111	0.0774	0.0569	0.0436	0.0279	0.0194	0.0142	0.0109	0.00860	0.00697	0.00484
1.6 SHS	1.38	0.591	0.263	0.148	0.0946	0.0657	0.0482	0.0369	0.0236	0.0164	0.0121	0.00924	0.00730	0.00591	0.00410
25 x 25 x 2.5 SHS	1.64	0.433	0.192	0.108	0.0692	0.0481	0.0353	0.0270	0.0173	0.0120	0.00883	0.00676	0.00534	0.00433	0.00300
2.0 SHS	1.36	0.380	0.169	0.0949	0.0608	0.0422	0.0310	0.0237	0.0152	0.0105	0.00775	0.00593	0.00469	0.00380	0.00264
1.6 SHS	1.12	0.326	0.145	0.0816	0.0522	0.0363	0.0266	0.0204	0.0131	0.00907	0.00666	0.00510	0.00403	0.00326	0.00227
20 x 20 x 1.6 SHS	0.873	0.156	0.0691	0.0389	0.0249	0.0173	0.0127	0.00972	0.00622	0.00432	0.00317	0.00243	0.00192	0.00156	0.00108

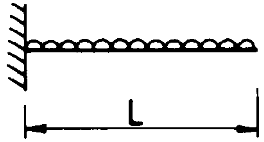
Note: 1. Serviceabilty Load $W^*_{S1} = 8EI / (250L^2)$

TABLE *D*8.4-4(A)

STRENGTH LIMIT STATE MAXIMUM DESIGN LOADS

CANTILEVER WITH FULL LATERAL RESTRAINT
DuraGal SQUARE HOLLOW SECTIONS: GRADE C450L0
Non-Standard Thickness
bending about x-axis





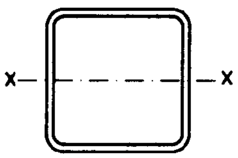
W^*_{L1} = Maximum Design Load based on Design Moment Capacity
W^*_{L2} = Maximum Design Load based on Design Shear Capacity
Maximum Design Load W^*_L is LESSER of W^*_{L1} and W^*_{L2}

Designation d b t	Mass per m	W^*_{L1} (kN) Span of Beams (*L*) in metres														W^*_{L2}
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	kN
100 x 100 x 2.8 SHS	8.39	50.1	33.4	25.1	20.1	16.7	14.3	12.5	10.0	8.36	7.16	6.27	5.57	5.01	4.18	127
2.3 SHS	6.95	37.4	24.9	18.7	15.0	12.5	10.7	9.34	7.48	6.23	5.34	4.67	4.15	3.74	3.11	105
75 x 75 x 2.8 SHS	6.19	32.6	21.8	16.3	13.1	10.9	9.32	8.16	6.53	5.44	4.66	4.08	3.63	3.26	2.72	93.3
2.3 SHS	5.14	24.3	16.2	12.1	9.71	8.09	6.94	6.07	4.86	4.05	3.47	3.03	2.70	2.43	2.02	77.7
65 x 65 x 2.3 SHS	4.42	19.6	13.1	9.82	7.86	6.55	5.61	4.91	3.93	3.27	2.81	2.46	2.18	1.96	1.64	66.7
50 x 50 x 2.8 SHS	3.99	14.4	9.58	7.19	5.75	4.79	4.11	3.59	2.88	2.40	2.05	1.80	1.60	1.44	1.20	59.7
2.3 SHS	3.34	12.2	8.12	6.09	4.87	4.06	3.48	3.05	2.44	2.03	1.74	1.52	1.35	1.22	1.02	50.1
40 x 40 x 2.8 SHS	3.11	8.80	5.86	4.40	3.52	2.93	2.51	2.20	1.76	1.47	1.26	1.10	0.977	0.880	0.733	46.2
2.3 SHS	2.62	7.52	5.01	3.76	3.01	2.51	2.15	1.88	1.50	1.25	1.07	0.940	0.836	0.752	0.627	39.1
35 x 35 x 2.8 SHS	2.67	6.52	4.34	3.26	2.61	2.17	1.86	1.63	1.30	1.09	0.931	0.815	0.724	0.652	0.543	39.5
2.3 SHS	2.25	5.61	3.74	2.80	2.24	1.87	1.60	1.40	1.12	0.935	0.801	0.701	0.623	0.561	0.467	33.6

Notes:
1. ϕ = 0.9
2. α_m = 1.0
3. α_s = 1.0
4. W^*_{L1} = $2 \phi M_s / L$
5. W^*_{L2} = ϕV_v

TABLE *D*8.4-4(B)

SERVICEABILITY LIMIT STATE MAXIMUM DESIGN LOADS

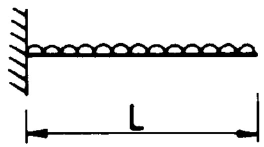


CANTILEVER BEAMS

***DuraGal* SQUARE HOLLOW SECTIONS: GRADE C450L0**

Non-Standard Thickness

bending about x-axis



W^*_{S1} = Maximum Serviceability Design Load based on Deflection Limit of SPAN / 250

Designation d b t	Mass per m	W^*_{S1} (kN) Span of Beam (L) in metres													
mm mm mm	kg/m	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0
100 x 100 x 2.8 SHS	8.39	42.7	19.0	10.7	6.82	4.74	3.48	2.67	1.71	1.18	0.871	0.666	0.527	0.427	0.296
2.3 SHS	6.95	35.8	15.9	8.94	5.72	3.97	2.92	2.24	1.43	0.994	0.730	0.559	0.442	0.358	0.248
75 x 75 x 2.8 SHS	6.19	17.3	7.69	4.33	2.77	1.92	1.41	1.08	0.692	0.481	0.353	0.270	0.214	0.173	0.120
2.3 SHS	5.14	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
65 x 65 x 2.3 SHS	4.42	9.33	4.15	2.33	1.49	1.04	0.762	0.583	0.373	0.259	0.190	0.146	0.115	0.0933	0.0648
50 x 50 x 2.8 SHS	3.99	4.73	2.10	1.18	0.757	0.526	0.386	0.296	0.189	0.131	0.0966	0.0740	0.0584	0.0473	0.0329
2.3 SHS	3.34	4.06	1.80	1.01	0.650	0.451	0.331	0.254	0.162	0.113	0.0829	0.0634	0.0501	0.0406	0.0282
40 x 40 x 2.8 SHS	3.11	2.28	1.01	0.570	0.365	0.253	0.186	0.142	0.0911	0.0633	0.0465	0.0356	0.0281	0.0228	0.0158
2.3 SHS	2.62	1.98	0.879	0.494	0.316	0.220	0.161	0.124	0.0791	0.0549	0.0404	0.0309	0.0244	0.0198	0.0137
35 x 35 x 2.8 SHS	2.67	1.46	0.648	0.365	0.233	0.162	0.119	0.0912	0.0584	0.0405	0.0298	0.0228	0.0180	0.0146	0.0101
2.3 SHS	2.25	1.28	0.568	0.319	0.204	0.142	0.104	0.0799	0.0511	0.0355	0.0261	0.0200	0.0158	0.0128	0.00887

Note: 1. Serviceabilty Load $W^*_{S1} = 8EI / (250L^2)$

onesteel market mills

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