APPLICATION GUIDE

Stairs, Handrails & Balustrades

SCOPE

This application guide includes design issues, span tables and timber sizes for stairs, handrails and balustrades. A typical situation incorporating all three elements is shown in Figure 1.

BCA REQUIREMENTS

Design issues are driven by regulatory requirements in the Building Code of Australia. It governs geometric constraints required to make stairs and balustrades safe and easy to use①. For instance, hand rails and balustrades are needed where the building occupants access areas with more than a 1.0m change in level. Other issues centre on the height, width, rake and spacing of elements. Strength and durability are also important, particularly in exterior applications.

STAIRS

Stair design consists of two main elements - treads which are walked upon, and stringers which support the treads – as shown in Figure 2. Sizes are determined by calculating the stair rake and the individual number of treads that can fit in the space available. Formulae for calculating this are provided in the BCA①, and once results have been confirmed, hardwood sizes for the treads and stringers can be selected from Tables 1 and 2. The table data is based on load assumptions derived from AS1170.1② for: domestic and residential activities in self contained dwellings, walking track structures and areas where people may congregate (without obstacles for moving people). Specific parameters covering these situation include: 5.0kPa uniformly distributed load, 4.5kN concentrated load and 2.4kN line load.

Figure 2: Stair components

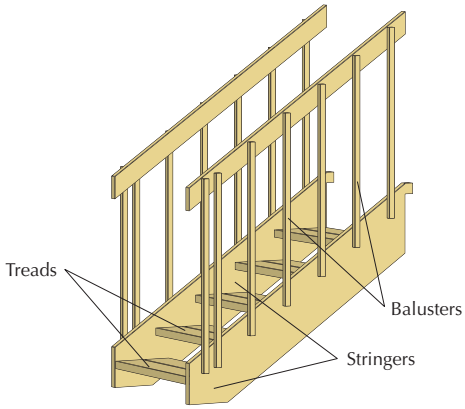
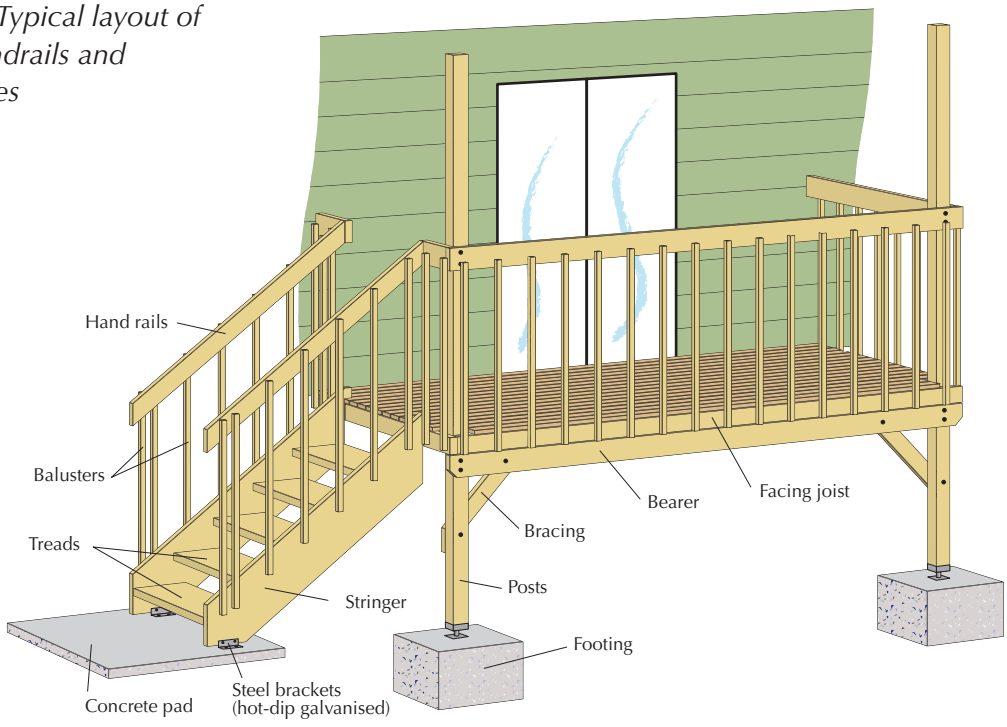


Figure 1: Typical layout of stairs, handrails and balustrades



① Refer BCA Volume 1, Clauses D2.8 to D2.18.
② AS1170.1 – Permanent imposed and other actions, Standards Australia.

Table 1: Tread sizes for seasoned and unseasoned hardwood

Tread Span (mm	Tread Thickness (mm)				
	Unseasoned Hardwood			Seasoned Hardwood	
	F11	F14	F17	F17	F27
800	38	38	38	35	35
900	50	38	38	35	35
1000	50	50	50	45	45
1100	50	50	50	45	45
1200	75	50	50	45	45
1300	75	75	50	70	45
1400	75	75	75	70	70
1500	75	75	75	70	70

Table 2: Stringer sizes for seasoned and unseasoned hardwood

Stringer Size Depth x Thickness (mm)	Stringer Span (mm) Tread Span (mm)						
	900	1000	1100	1200	1300	1400	1500
	SEASONED F17						
190 x 45	3100	3000	2800	2600	2500	2400	2300
220 x 45	3400	3300	3300	3100	3000	2800	2700
240 x 45	3700	3600	3500	3400	3300	3100	2900
290 x 45	4200	4100	400	3900	3900	3800	3700
	SEASONED F27						
190 x 45	3300	3200	3100	3100	3000	2900	2900
220 x 45	3700	3600	3500	3400	3400	3300	3200
240 x 45	3900	3800	3700	3700	3600	3500	3500
290 x 45	4500	4400	4300	4200	4100	4100	4000
	UNSEASONED F11						
200 x 50	2800	2700	2600	2400	2300	2200	2200
200 x 75	3200	3100	3000	2900	2800	2700	2600
225 x 50	3100	3000	2900	2800	2600	2500	2400
225 x 75	3600	3500	3400	3300	3200	3100	3000
250 x 50	3500	3400	3300	3100	3000	2800	2700
250 x 75	3900	3780	3700	3600	3600	3500	3300
	UNSEASONED F14						
200 x 50	2900	2800	2700	2600	2500	2400	2300
200 x 75	3300	3200	3100	3000	3000	2900	2800
225 x 50	3300	3200	3100	3000	2900	2700	2600
225 x 75	3700	3600	3500	3400	3300	3300	3200
250 x 50	3600	3500	3400	3300	3200	3100	2900
250 x 75	4100	4000	3900	3800	3700	3600	3600
	UNSEASONED F17						
200 x 50	3100	3000	2900	2800	2700	2700	2600
200 x 75	3500	3400	3300	3200	3100	3100	3000
225 x 50	3500	3400	3300	3200	3100	3000	2900
225 x 75	3900	3800	3700	3600	3500	3400	3400
250 x 50	3800	3700	3600	3500	3400	3400	3300
250 x 75	4200	4100	4000	3900	3800	3800	3700

HANDRAILS & BALUSTRADES

Handrail and balustrade design is governed by the definition of key load bearing components and related spanning issues – as shown in Figure 3. Spans and sizes have been calculated for domestic and residential buildings and are also suitable for office or work areas not susceptible to overcrowding or used as storage. (Note: Situations involving crowd restraint or vehicular traffic are not included – Refer BCA).

Load assumptions again draw on information from AS1170.1[2] and for:

Handrails include:

- Uniformly distributed horizontal or vertical load – 0.75kN/m
- Concentrated load in any direction – 0.6kN.

Balustrades include:

- Uniformly distributed horizontal load – 1.0kPa
- Concentrated load in any direction – 0.5kPa

Handrail spans and sizes in Table 3 can be used in exterior or interior applications. The table is for F22 stress graded timber where:

- Bending Strength of f'b = 65 MPa,
- Modulus of elasticity E = 16000 MPa,
- Joint Group = JD2.

Hardwood timbers that meet this criterion are Blackbutt, Ironbark, River Red Gum, Spotted Gum, Tallowwood, Turpentine and White Mahogany (Note: If free of strength reducing characteristics).

Figure 3: Handrail span

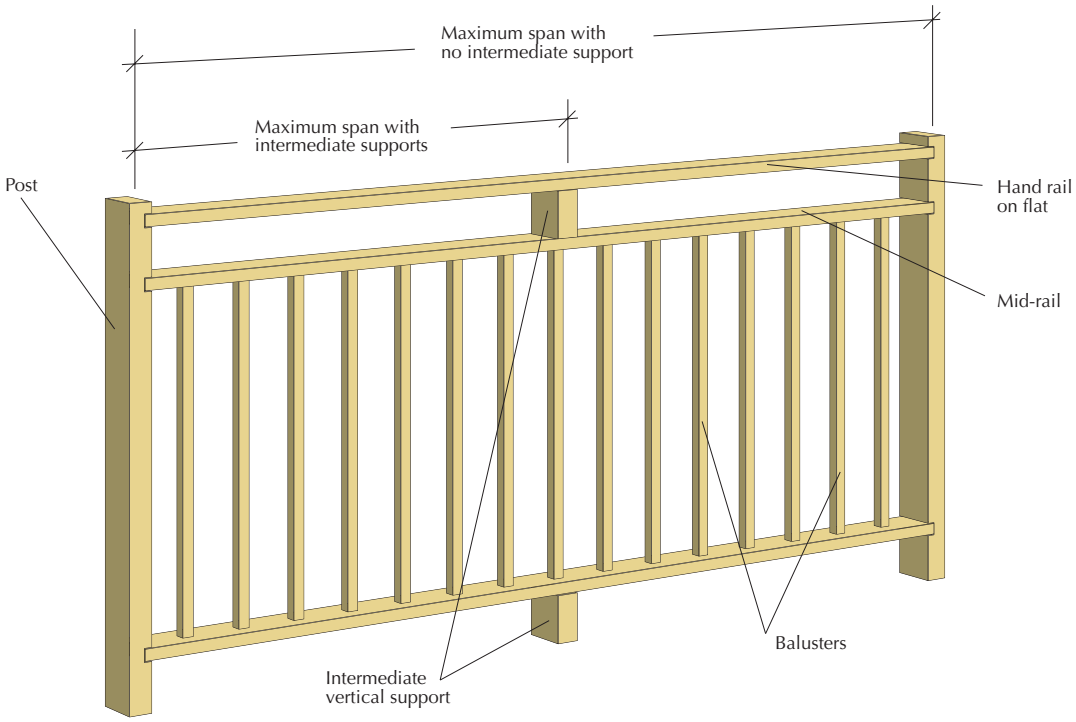


Table 3: Handrail sizes and maximum spans

Sizes/Description	No Intermediate Vertical Supports	Assisted by Intermediate Vertical Supports
65x65 (profiled) includes 63 x 66	3200	3200
42x65 (profiled)	2300	2900
42x85 (profiled)	2600	3500
35x70	2300	2900
35x90	2600	3500
35x120	2900	3600
45x70	2900	3100
45x90	3300	3600
45x120	3200	3600
63 x 79	3300	3600
70x70	3400	3400
70x90	3600	3600

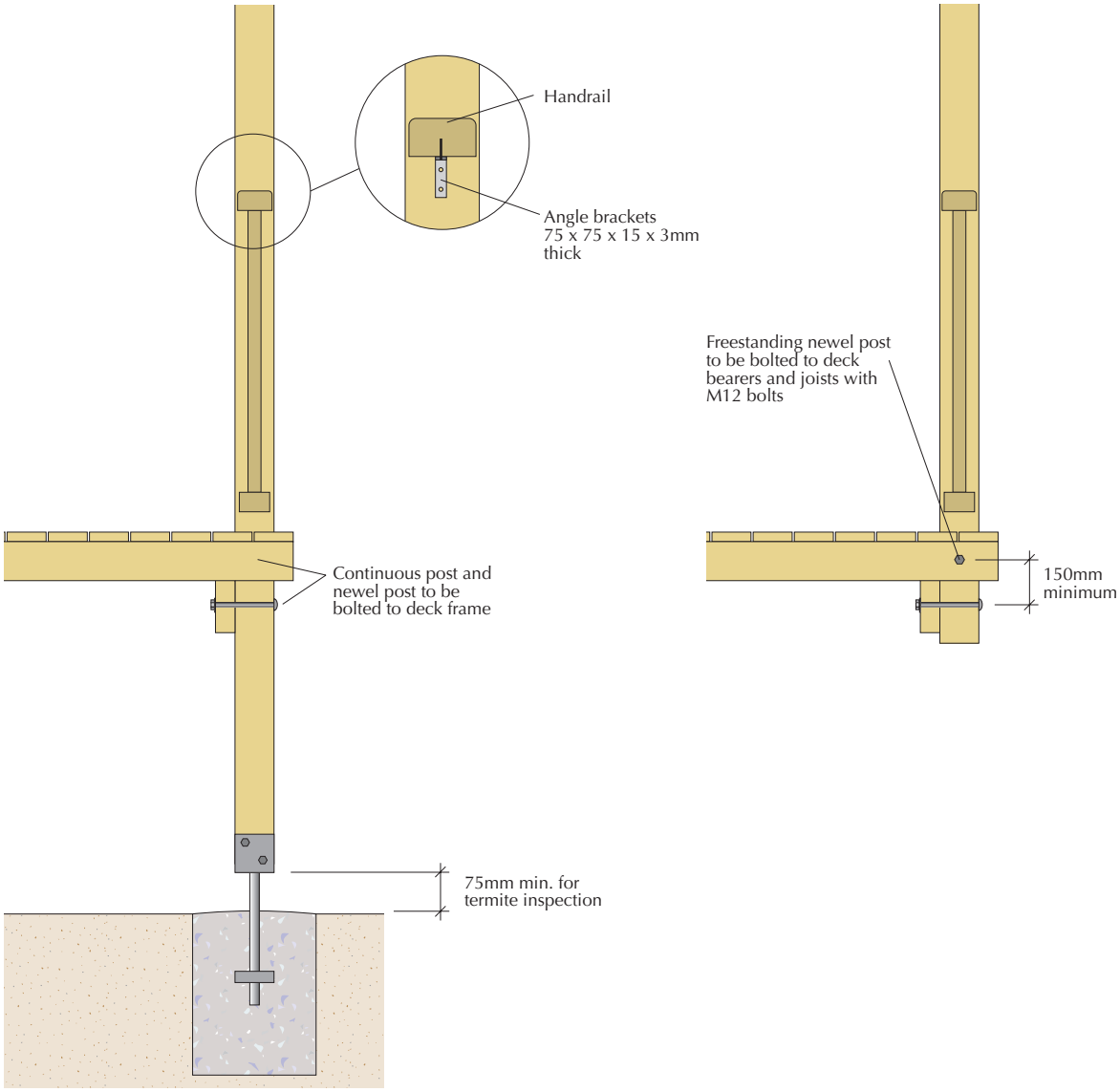
Notes:

1. No negative tolerances are permitted on the breadth or depth dimensions.
2. For determining which size to use for profiled handrails (e.g. bread loaf, ladies waist and colonial profiles), use overall dimensions given above.
3. All handrails are to be installed on the flat – i.e. with the larger dimension on the horizontal.
4. Handrail spans are based on the handrail being a secondary member with max 20mm deflection.

BALUSTRADE POSTS

Balustrade posts should be a minimum of 80 x 80mm in cross section, a maximum of 2.7m in height and at a maximum of spacing of 3.6m. Posts should be bolted to the deck or floor substructure with two M12 bolts with a minimum of 150mm gap between bolts – as shown in Figure 4. For posts that are to support roof and/or floor loads refer to AS1684[3] for sizing.

Figure 4: Post support to deck substructure



[3] AS 1684 Residential Timber Framed Construction, Standards Australia

HANDRAIL CONNECTIONS

Connections are essential in the transference of loads from handrails to posts. Table 4 provides design loads for these connections using the following steps:

1. Determine if the handrail involves a single or continuous span,
2. Quantify the length of the span,
3. Read the design load from the far right column in the table.

Table 4: Design loads for connections joining handrails to posts

Span Type	Handrail Span (mm)	Horizontal/Vertical Load kN
Single span handrails	1800	0.7KN per handrail end
	2100	0.8 KN per handrail end
	2400	0.9 KN per handrail end
	2700	1.05 KN per handrail end
	3000	1.15 KN per handrail end
	3300	1.25 KN per handrail end
	3600	1.35 KN per handrail end
Continuous span handrails	1800	1.4 KN per handrail end
	2100	1.6 KN per handrail end
	2400	1.8 KN per handrail end
	2700	2.1 KN per handrail end
	3000	2.3 KN per handrail end
	3300	2.5 KN per handrail end
	3600	2.7 KN per handrail end

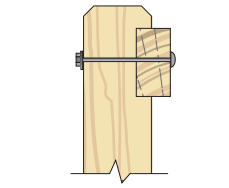
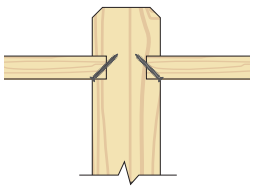
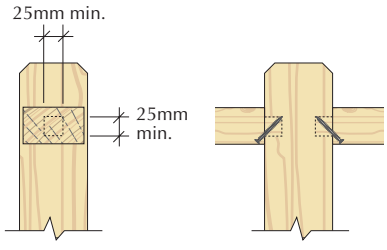
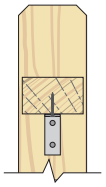
Note: Calculations are based on a uniformly distributed load of 0.75kN/m multiplied by the length of the handrail and halved to give loads going to each end of the handrail. Handrails shorter than those above should be checked to see if concentrated loads (i.e. 0.6kN) are higher, and if so, then this load should be used instead of uniformly distributed loads.

photo courtesy of: Outdoor Structures Australia

To find a connector that will meet the load requirements derived from Table 4, go to Table 5 and use the following steps:

1. Choose a preferred connector type,
2. Select a joint group to suit the timber species being used. If this is unknown choose the weakest group (i.e. JD3) or for accurate information refer to the Technical & Detailing Guide for Hardwoods and Cypress (referenced at end of this document).
3. Select the preferred number of connectors to be used in the joint – not all connections are applicable to all combinations of post and handrail sizes.
4. Read the load capacity for the connector(s) from the table.
5. Choose the connection if equal to or higher than the load determined in Table 4.

Table 5: Load capacities for handrail connections

Type of Connection	Load Capacities of Connection			
Connection A  Flush, Full or Half Checked and Bolted	Joint Group	Number of bolts	M10 (kN)	M12 (kN)
	JD1	1	3.7	6.2
		2	7.4	12.4
	JD2	1	3.2	5.3
		2	6.4	10.6
	JD3	1	2.4	4.0
		2	4.8	8.0
Connection B  Checked to post and Screw Fixed	Joint Group	Number of screws	Type 17	
			Nº 10	Nº 14
	JD1	1	4.3	5.6
		2	8.7	11.2
	JD2	1	3.3	4.3
		2	6.6	8.6
	JD3	1	2.6	3.3
		2	5.1	6.7
Connection C  Stop-housed and Nail or Screw Fixed	Joint Group	Screws		
		2 x Nº 10		2 x Nº 14
	JD1	4.8		7.5
	JD2	3.6		5.6
	JD3	2.8		4.4
	Joint Group	Nails		
		2 x 3.15 dia		2 x 3.75 dia
	JD1	1.9		2.7
	JD2	1.5		2.0
	JD3	1.1		1.6
Connection D  Brackets Screw Fixed	Joint Group	2 Screws per leg of Bracket		
		2 x Nº 10		2 x Nº 14
	JD1	4.8		7.5
	JD2	3.6		5.6
	JD3	2.8		4.4

Notes:

1. Bolts and screws are to be steel or stainless steel only.
2. Hardwood timber is assumed seasoned only.
3. Not all connections are applicable to all handrail and post sizes.

DURABILITY

For the external durability of stairs, handrails and balusters, timbers should have a natural durability Class of 1 or 2, or preservative treatment of H3 or higher.

Connectors should be hot-dip galvanised, or for coastal environments subjected to airborne salt deposits, stainless steel or fasteners with equivalent corrosion resistance should be used. For further information on durability refer to the Technical & Detailing Guide for Hardwoods and Cypress (referenced at the end of this guide).

Timber grading is required for all structural components used in stairs, handrails and balusters. They must be in accordance with AS2082④ and AS2858⑤. If laminated timber is being used it must comply with AS1328⑥. Finger jointed timber must comply with AS1491⑦. Other standards useful in describing appearance features include AS2796⑧ and AS1810⑨.

④ AS 2082 – 2000: Timber - Hardwood - Visually stress-graded for structural purposes, Standards Australia, Homebush,
⑤ AS 2858-2001: Softwood – Visually stress-graded for structural purposes, Standards Australia, Homebush,
⑥ AS 1328: Glued laminated structural timber, Standards Australia, Homebush,
⑦ AS 1491: Finger jointed structural timber, Standards Australia, Homebush,Check Currency
⑧ AS 2796: Timber - Hardwood – Sawn and milled products, Standards Australia, Homebush,
⑨ AS 1810 -1995: Timber - Seasoned cypress pine - Milled products, Standards Australia, Homebush,

RELATED DOCUMENTS

(From this Series of Timber Development Association Publications)

- Fire Requirements for Non-Domestic Fit-Out (including information on BCA requirements for fire and other issues).
- Technical & Detailing Guide – Australian Hardwood and Cypress (including information on moisture management, durability, appearance and structural issues).
- Non-domestic Decks, Board Walks and Light Vehicular Traffic Structures – Australian Hardwood and Cypress (including spans tables and details on key components).
- Domestic Decks – Australian Hardwood and Cypress (including spans tables and details on key components).

ACKNOWLEDGMENTS

- Timber Manual, National Association of Forest Industries Ltd., Canberra.
- Timber Handrails and Balustrades, Australian Timber Importers Federation.
- Residential Timber Decks, Timber Research and Development Advisory Council, Brisbane.
- Engineering data prepared by Project X Solutions Pty Ltd, consulting engineers, Rouse Hill, NSW.

photo courtesy of: the Timber Promotion Council

Australian Hardwood Network

For additional assistance please contact the Timber Advisory Service

1800 044 529

or visit the following websites:

www.timber.net.au

www.australianhardwood.net

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